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Marine Ascomycetes from Algae and Animal Hosts[1]

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Although the number of algicolous fungi is small, they are of particular interest because of their parasitic or symbiotic properties. Only 79 species of filamentous fungi – out of a total of 465 marine species – are associated with marine algae, and 18 with animals; many of them have not been illustrated in detail. The present paper provides illustrations and full descriptions of 8 marine ascomycetes, 6 of them from algae and 2 from animal hosts. The algicolous species belong to the genera *Didymella, Haloguignardia, Spathulospora* and *Turgidosculum*; those from animals are members of *Abyssomyces* and *Laboulbenia*. The illustrations are line drawings made with the aid of a camera lucida, and are almost all based on type material.

Introduction

Major compilations of the marine mycological literature (Johnson and Sparrow 1961, Kohlmeyer and Kohlmeyer 1964–1969, 1979, Kohlmeyer and Volkmann-Kohlmeyer 1991, Hyde and Pointing 2000) show that research during the past five decades has concentrated mostly on lignicolous, rarely on algicolous fungi. Among 465 described filamentous higher marine fungi, only 79 are associated with algae as parasites or symbionts, and 18 with animal hosts (Kohlmeyer and Kohlmeyer 1979, Kohlmeyer and Volkmann-Kohlmeyer 1991). Because precise illustrations are lacking, or published photographs do not show all essential features, we present the following detailed line drawings, prepared with the help of a camera lucida, for 8 marine ascomycetes from algae and animal hosts. Most of these illustrations are based on type material. The classification follows Eriksson *et al.* (2001).

Taxonomy

Abyssomyces hydrozoicus Kohlm., Ber. Dtsch. Bot. Ges. 83: 505–507, 1970; publ. 1971 (Sordariomycetes – genus of uncertain position; Figs 1, 2)

Ascomata 130–155 × 135–155 µm, subglobose to pyriform, superficial, solitary, ostiolate, papillate, coriaceous, light brown, setose (Figs 1, 2A, B). *Papillae* 95–120 × 40–55 µm, subconical to cylindrical, periphysate (Figs 1, 2C). *Peridium* 12–20 µm thick, three-layered; on the outside a crustose, brown, non-cellular layer; middle layer of truncate to ellipsoidal cells, hyaline, forming setae; inner layer of flattened cells, hyaline (Fig. 2D). *Setae* 8–60 µm long, 3.5–5 µm diam. at the base, 2–2.5 µm diam. at the tip, subuliform, non- or one-septate (Fig. 2D). *Asci* 60–90 × 6–9 µm, eight-spored, subcylindrical to fusiform, short stipitate, thin-walled, unitunicate, developing at the base of the ascomatal venter (Fig 1). *Ascospores* 18–20 × 3.5–4 µm, biseriate, subcylindrical, straight or somewhat curved, triseptate, not constricted, hyaline, at each apex a semiglobose, gelatinous cap, 0.5–1 µm diam., sometimes with a mucilaginous sheath (Fig. 2E).
Host: Hydrorhiza and hydrocaulon of hydrozoans, attached to stony corals.
Distribution: Atlantic Ocean near South Orkney Islands, between 631 and 641 m depth.
Material examined: Isotype, J. K. 2754, IMS.

Didymella magnei Feldm.-Maz., Rev. Gén. Bot. 65: 414–415, 1958 (Dothideomycetes – genus of uncertain position; Figs 3, 4)

Ascomata 70–120 × 80–130 µm, subglobose, immersed, ostiolate, epapillate, carbonaceous to coriaceous, black (Fig. 3). *Ostiole* circular, 1–2 µm diam. *Peridium* 19–28 µm thick around the ostiole, 6–13 µm at the hyaline side and base; ellipsoidal or elongate cells with large lumina, forming a *textura angularis* (Fig. 4A). *Paraphyses* filamentous, some ramose, deliquescing. *Asci* 25–38 × 7.5–10 µm, eight-spored, ellipsoidal, thin-walled, unitunicate, without apical apparatuses, developing along the sides and base of the venter (Figs 3, 4B). *Ascospores* (8–) 11.5–16.5 × (2–)3–4 µm, biseriate, elongate-ellipsoidal, one-septate, not constricted, hyaline, covered by a thin, gelatinous sheath (Fig. 4C).
Host: *Palmaria palmata* (L.) Kuntze.
Distribution: Atlantic Ocean (France).

[1] Submitted 27 August 2002; accepted 5 February 2003.

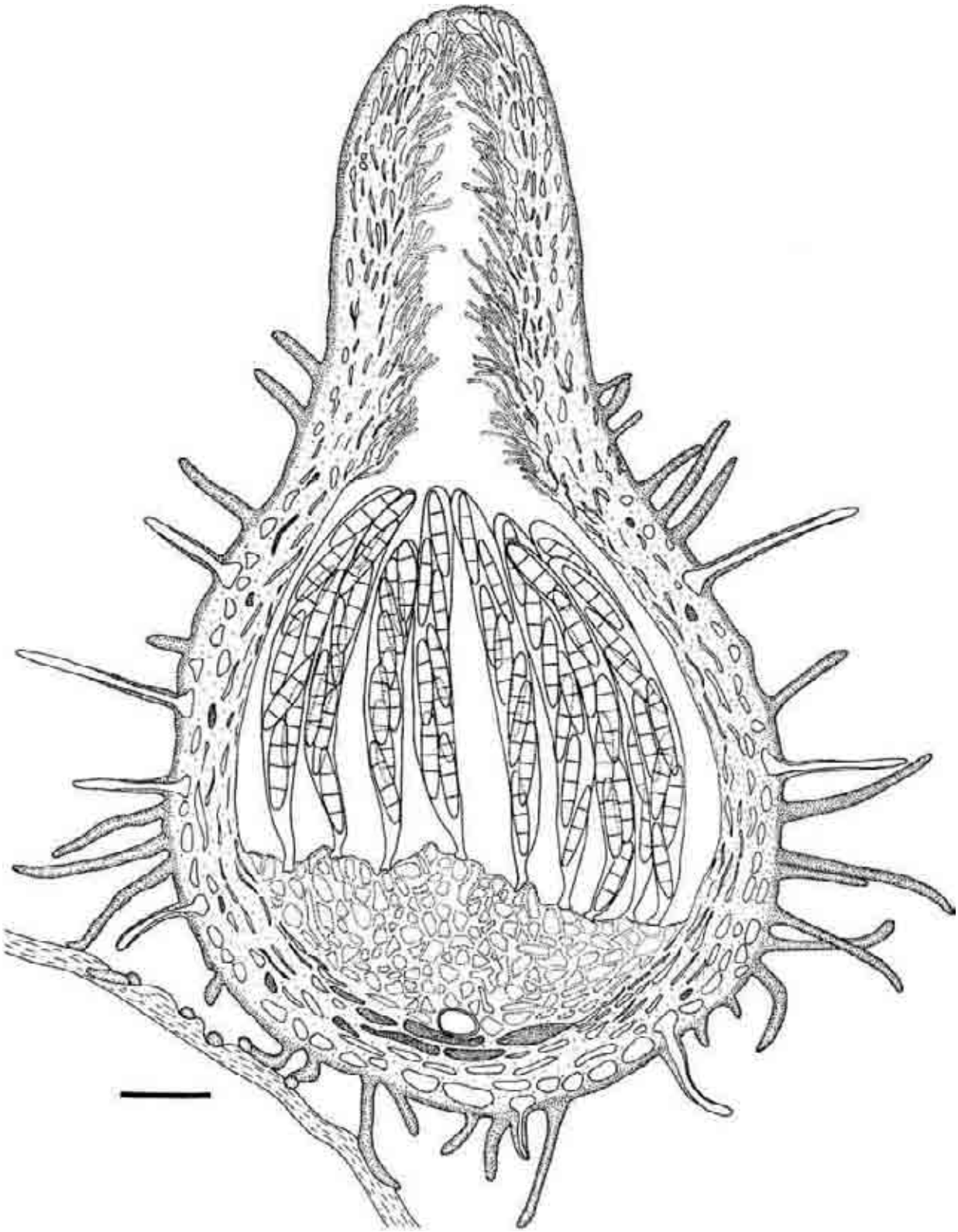


Fig. 1. *Abyssomyces hydrozoicus*. Longitudinal section through ascoma, attached to the wall of a hydrorhiza of a hydrozoan; peridium with brown setae; ostiole with periphyses; some cells in the wall and cells between ascogenous tissue and basal wall stain reddish-blue in hematoxylin; the large refractive cell at the base of the ascogenous tissue is possibly a remnant of the ascogon. Bar line = 20 μm. From isotype, J. K. 2754 (Herb. IMS).

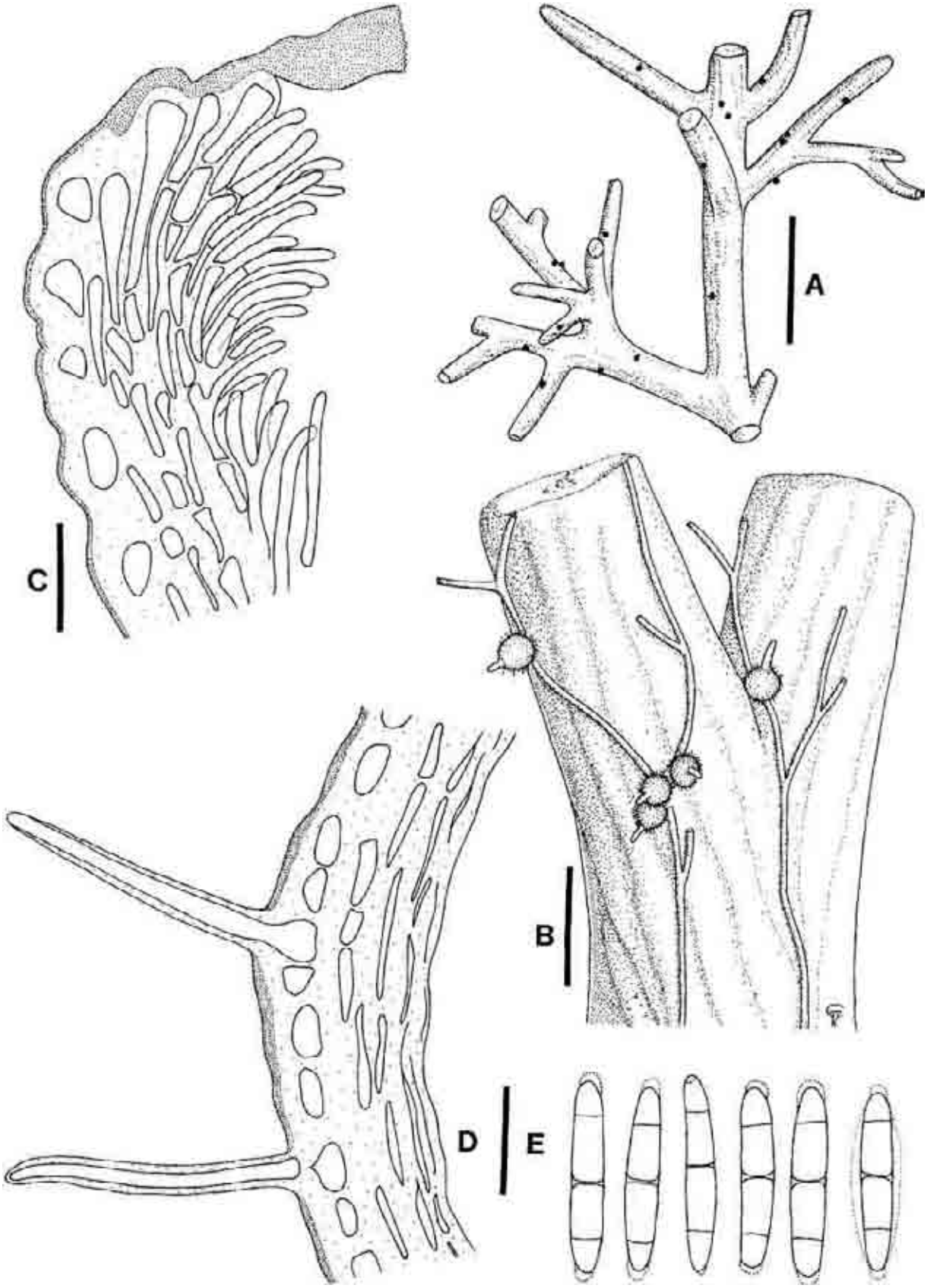


Fig. 2. *Abyssomyces hydrozoicus*. A. Whitish, calcareous skeleton of a stony coral (anthozoa) with ascomata appearing as dark spots. Bar line = 4 mm. B. Ascomata attached to the hydrorhiza of an epizoic hydrozoan on a stony coral. Bar line = 500 µm. C. Longitudinal section through peridium in the ostiole; brown, crustose outer layer to the left and above, periphyses to the right. Bar line = 10 µm. D. Section through peridium, showing setae seated in the outer cell layer. Bar line = 10 µm. E. Ascospores with gelatinous apical caps. Bar line = 10 µm. From isotype, J. K. 2754 (Herb. IMS).

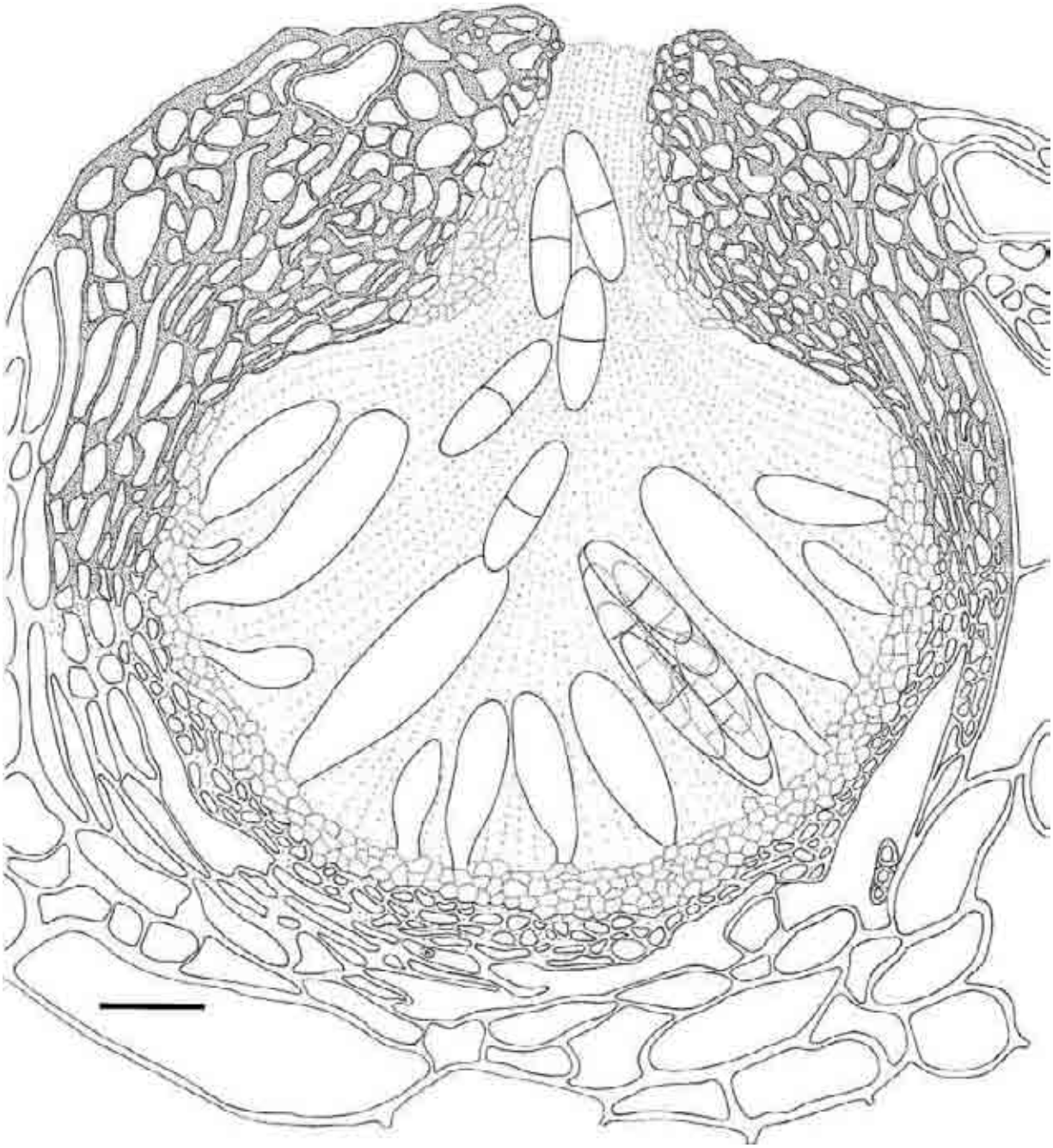


Fig. 3. *Didymella magnei*. Longitudinal section through ascoma, immersed in *Palmaria palmata*; peridium thickened around the ostiole; asci along the sides and base of the venter; large algal cells at the bottom. Bar line = 10 µm. Type slide of G. Feldmann.

Material examined: Holotype, microscope slides Herb. G. Feldmann.
Note: The taxonomic position of *D. magnei* is uncertain since its ascospores are different from all other *Didymella* species. Ascospores in this genus are distinctly inflated in the upper cell near the septum.

Haloguignardia irritans (Setch. *et* Estee) Cribb *et* J. W. Cribb, Univ. Queensland Pap., Dep. Bot. 3: 98, 1956 (Sordariomycetes, Phyllachorales, Phyllachoraceae; Figs 5–8)
≡ *Guignardia irritans* Setch *et* Estee, *in* Estee, Univ. Calif., Berkeley, Publ. Bot. 4: 311, 1913

Galls 3–20 mm diam., grapelike, with ascomata or spermogonia, forming fingerlike processes, 1–5 × 0.5–1.5 mm, on stems, blades and vesicles of the alga. *Ascomata* 385–860 × 320–900 µm, subglobose to el-

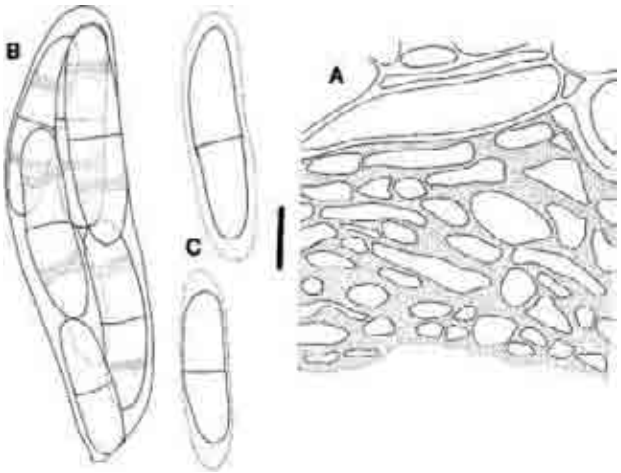


Fig. 4. *Didymella magnei*. A. Section through peridium, large host cells above. B. Ascus. C. Ascospores with gelatinous sheaths. Bar line = 5 µm. Type slide of G. Feldmann.

lipsoidal, singly in the apex of gall processes, ostiolate, papillate, coriaceous, hyaline (Fig. 5). *Papillae* 115–180 × 80–185 µm, cylindrical, periphysate; ostiole occluded by a gelatinous matrix; ostiolar canal projecting into the venter with a pseudoparenchymatous tube composed of thin-walled cells with large lumina (Figs 5, 7A). *Peridium* 15–32 µm thick, cells flattened, forming a *textura angularis* (Fig. 6A). *Paraphyses* absent; centers of immature ascomata filled with a pseudoparenchymatous tissue of hyaline, thin-walled deliquescing cells (Fig. 6B). *Asci* 130–160 × 26–32 µm, eight-spored, clavate to oblong-ventricose, thin-walled, unitunicate, early deliquescing, developing all along the inner wall, almost up to the ostiolar tube (Figs 5, 6B). *Ascospores* (30–) 35–50 × (10–) 12–15 µm (including appendages), oblong-ellipsoidal to fusiform, one-celled, tapering at the apices (Figs 6C–G). *Appendages* covering the ascospore apices, conelike, divided into five to seven annular chambers, mucus-filled; distal chamber biturbinate, releasing mucus from an apical porus (Figs 6 D–G). *Spermogonia* 420–740 × 350–615 µm, ellipsoidal, singly in apices of fingerlike processes, ostiolate, papillate, coriaceous, hyaline (Figs 7B, 8). *Papillae* 50–70 × 110–200 µm, cylindrical, periphysate; ostiole occluded by a gelatinous matrix (Fig. 7C). *Peridium* 10–18 µm thick. *Spermatiophores* 20–44 × 2 µm, simple or branched, septate, filiform, covering the interior walls and lobes of the spermogonial cavity (Figs 7D, E, 8). *Spermatia* 2.5–3.5 × 1.5–2 µm, ellipsoidal to subglobose, one-celled hyaline, at the base with a gelatinous appendage, often catenulate (Fig. 7F). Appendages are not part of the spermatiophore. They can be observed during spermatial ontogeny, when spermatia form chains and are separated by a gelatinous, unstained substance. Spermatia stain reddish in hematoxylin and deep purple in violamin.

Hosts: *Cystoseira osmundacea* (Turn.) C. Ag., *C. setchellii* Gardn., *Halidrys dioica* Gardn.

Distribution: Pacific Ocean (California, U.S.A.).

Material examined: *H. dioica*, San Pedro, CA, 27 Sept. 1911, leg. N. L. Gardner, UC 173497 (holotype); same data, Oct. 1912, UC 173496; *C. setchellii,* Coronado/Santiago, CA, 14 Aug. 1945, Herb. M. H. Hommersand 1034; *C. osmundacea*, Davenport, CA, 28 June 1968, leg. J. Kohlmeyer, J. K. 2640; *Cystoseira* sp., Refugio Beach and Carpinteria Beach, CA, 2 July 1968, leg. J. Kohlmeyer, J. K. 2607, 2639.

Haloguignardia oceanica (Ferd. *et* Winge) Kohlm., Marine Biology 8: 344, 1971 (Sordariomycetes, Phyllachorales, Phyllachoraceae; Figs 9–11)
≡ *Phyllachorella oceanica* Ferd. *et* Winge, Mycologia 12: 103, 1920

Galls 2–5.4 × 3.3–8.7 mm, grapelike, with ascomata or spermogonia, on stipes of the alga (Fig. 9). *Ascomata* 350–650 × 275–510 µm, subglobose to pyriform, immersed in the surface of the gall, ostiolate, papillate, coriaceous with dark brown clypei, hyaline at the bases, surrounded by a pseudostroma of fungal and host cells, gregarious (Figs 9B, 10). *Papillae* 125–280 × 100–200 µm; ostiolar canal lined with hyaline periphysoid cells (Fig. 10). *Peridium* 14–26 µm thick, cells flattened, forming a *textura angularis*, merging on the outside into the pseudostroma. *Paraphyses* absent; centers of immature ascomata filled with a pseudoparenchymatous tissue of hyaline, thin-walled deliquescing cells. *Asci* 50–80 × 22–32 µm, eight-spored, clavate, pedunculate, thin-walled, unitunicate, early deliquescing, developing all along the inner wall, almost up to the ostiolar canal (Figs 10, 11F,G). *Ascospores* 19.5–32 (–36) × 9–14 µm (excluding appendages), at first fusiform, then ellipsoidal, one-celled, thick-walled, hyaline, appendaged (Figs 11A–E). *Appendages* conical, at first covering each apex like a cap, with delicate striae or chambers, eventually deciduous (Figs 11A–E). *Spermogonia* 210–260 µm diam., subglobose, immersed, ostiolate, epapillate, coriaceous, hyaline to light brown, gregarious (Fig. 11H). *Ostioles* round, periphysate. *Peridium* 10–20 µm thick (Fig. 11I). *Spermatiophores* 25–47.5 × 2–4.5 µm, simple, septate, filiform, attenuate, covering the interior walls of the spermogonial cavity (Figs 11H, I). *Spermatia* 3–4 × 1.5–2 µm, ellipsoidal, one-celled, hyaline (Fig. 11I).

Hosts: *Sargassum fluitans* (Boergesen) Boergesen, *S. natans* (L.) Gaillon.

Distribution: Atlantic Ocean (Bahamas [washed up], U.S.A. [washed up in North Carolina], Sargasso Sea [free floating]).

Material examined: *Sargassum fluitans* and *S. natans*, March 1914, Sargasso Sea, leg. C. H. Ostenfeld, holotype (Herb. C); *Sargassum* cfr. *fluitans*, 29 June 1970,

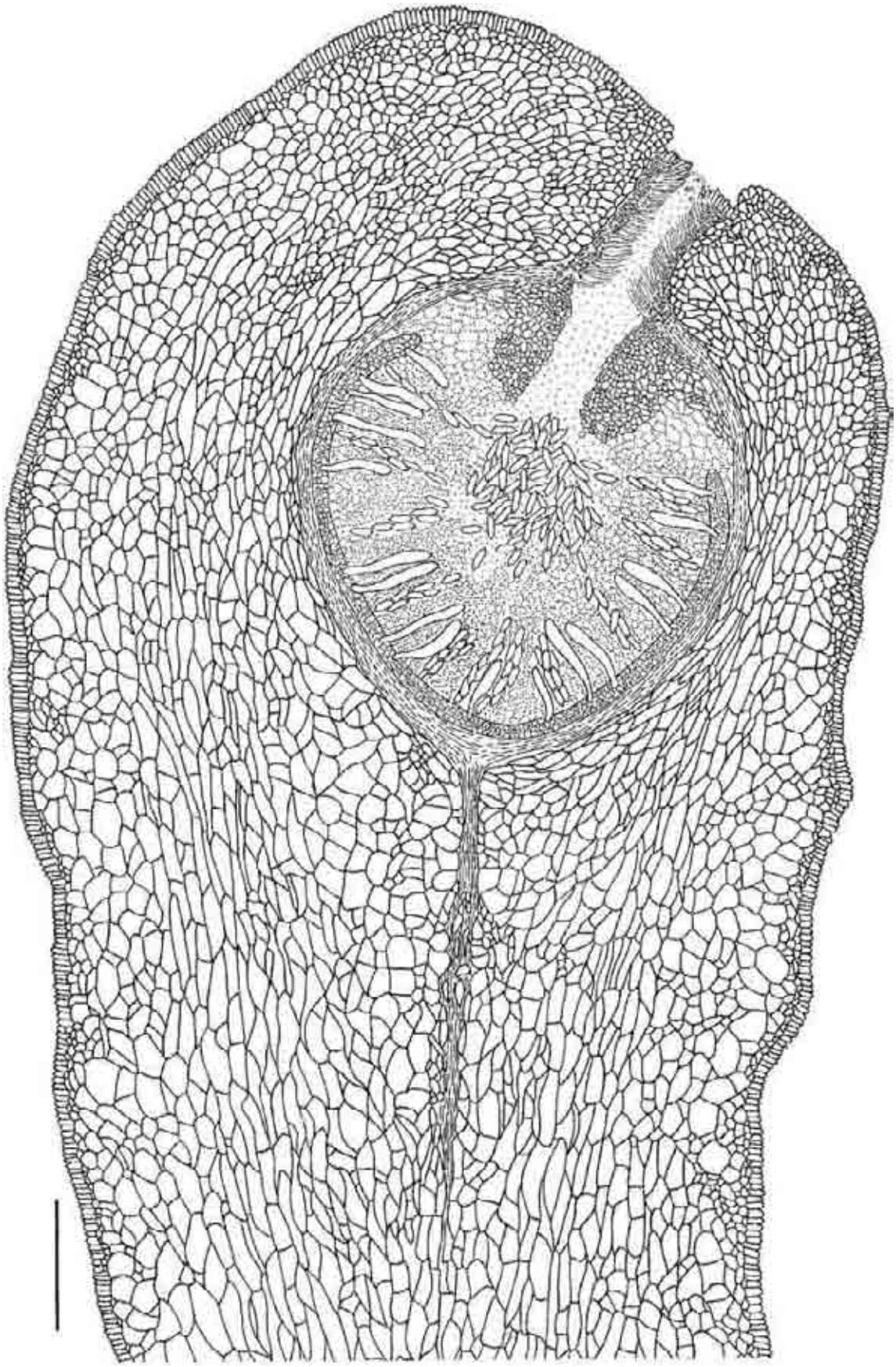


Fig. 5. *Haloguignardia irritans*. Longitudinal section through projection of a gall with ascoma embedded in algal tissue; asci develop on a layer of ascogenous tissue along the wall; ostiole with periphyses and tube of ostiolar canal extending into the ascomatal cavity. Bar line = 150 μm. From Herb. J. K. 2646 (Herb. IMS).

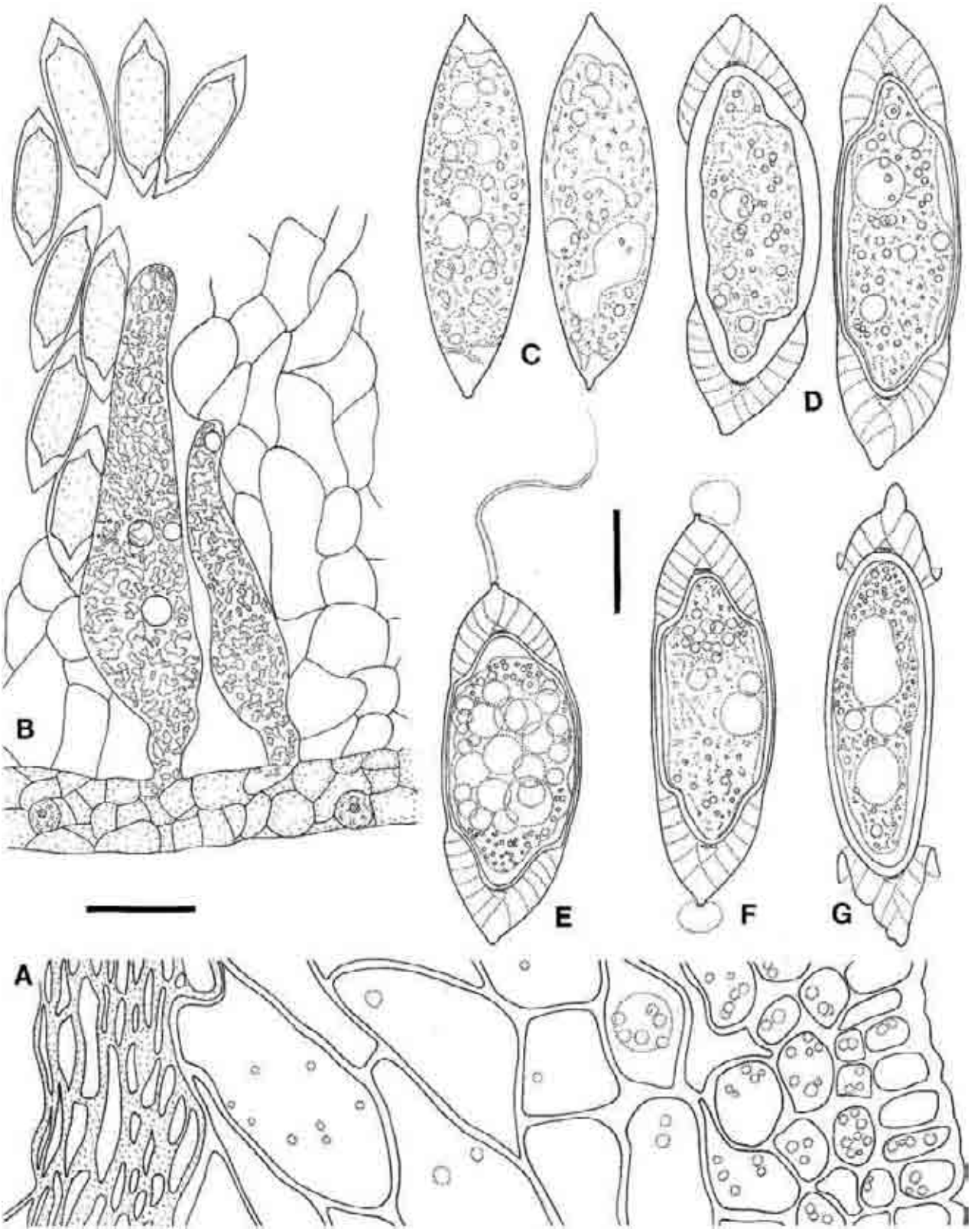
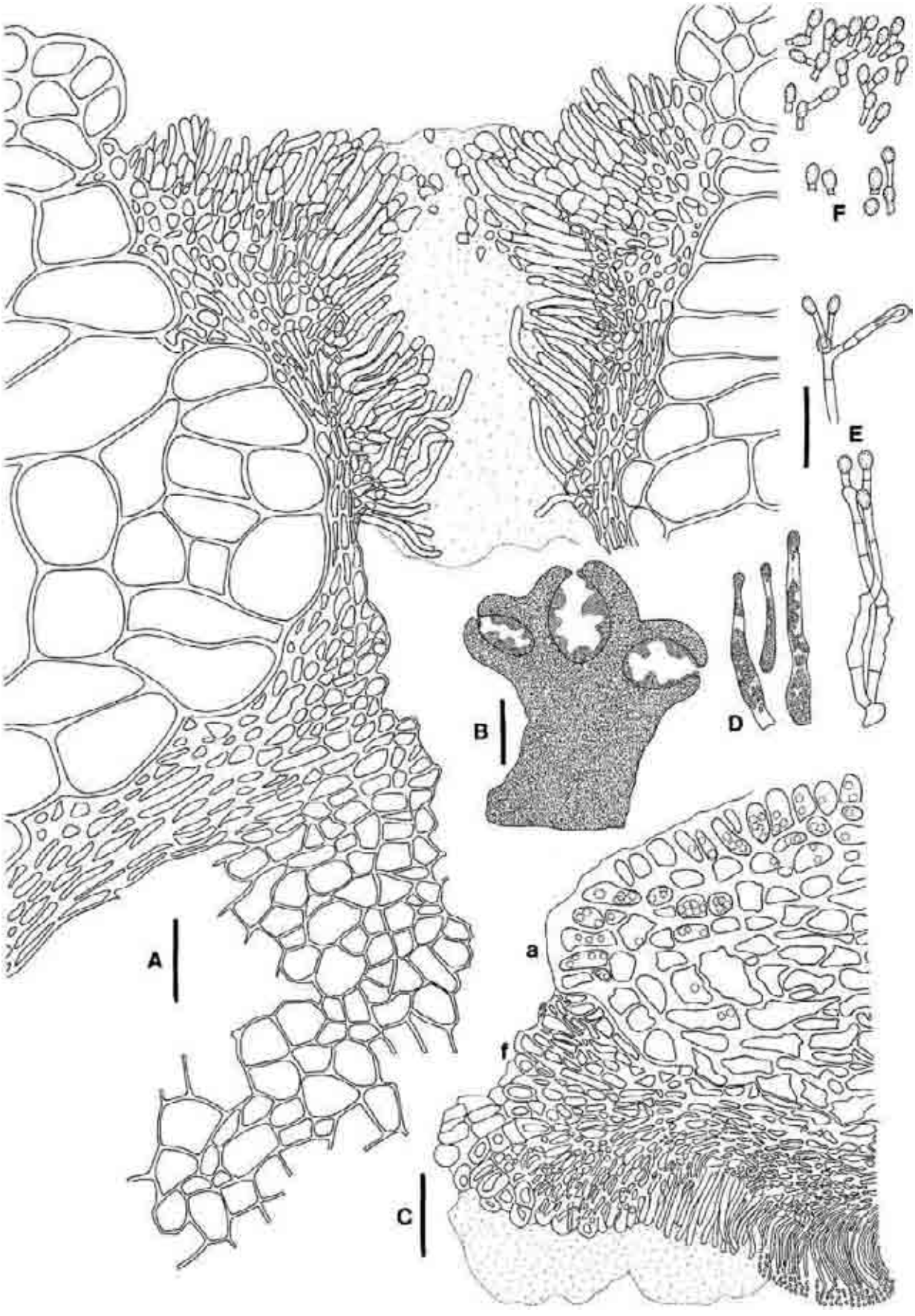


Fig. 6. *Haloguignardia irritans*. A and B. Sections through parts of ascomata; A. From the side, large algal cells to the right, peridium with compressed cells to the left; B. Two immature asci on the layer of ascogenous cells, mature ascospores released from a dissolved ascus (left), pseudoparenchymatous cells of centrum tissue (right). Bar line = 25 µm. C–G. Ascospores; C. Immature; D–G. Mature, with apical, chambered appendages; E and F. Mucus exuded from apical chambers, made visible in violamin; G. Ascospore damaged, appendages partly peeling off. Bar line = 10 µm. A from Herb. M. H. Hommersand 1034; B from Herb. J. K. 2607; C–G from J. K. 2639 (Herb. IMS).


A
B
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a
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Fig. 7. *Haloguignardia irritans*. A. Longitudinal section through ascomatal ostiole with periphyses and gelatinous material in the opening; pseudoparenchymatous cells of the ostiolar tube at the bottom; large algal cells surrounding the opening. Bar line = 25 μm. B. Longitudinal section through projection of a gall with three spermogonia. Bar line = 500 μm. C. Longitudinal section through part of ostiole of spermogonium; algal cells = a; fungal wall (f) with gelatinous material at the opening; periphyses merging into spermatiophores at the bottom, right. Bar line = 25 μm. D and E. Spermatiophores. F. Spermatia with gelatinous appendages, some forming chains. D–F. Bar line = 10 μm. D. Stained in violamin. A from Herb. M. H. Hommersand 1034, the others from J. K. 2640 (Herb. IMS).

Fig. 8. *Haloguignardia irritans*. Longitudinal section through projection of a gall with spermogonium embedded in algal tissue; spermatiophores developing along the wall and on lobes extending into the cavity. Bar line = 150 μm. From J. K. 2640 (Herb. IMS).

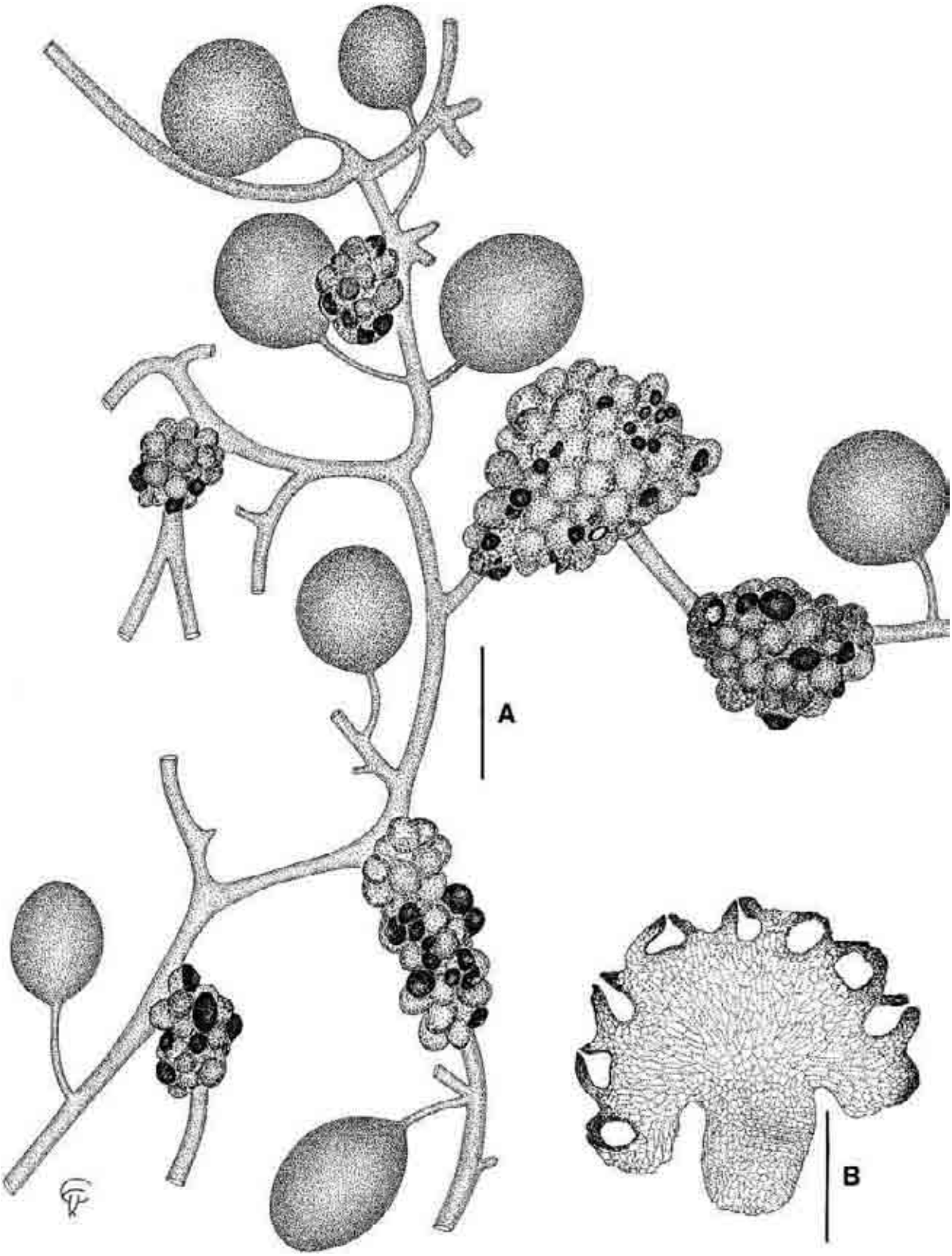

Fig. 9. *Haloguignardia oceanica.* A. Galls on *Sargassum* sp.; the black discoloration is caused by the hyperparasitic anamorph *Gloeosporidina cecidii*. Bar line = 4 mm. B. Section through a gall, showing arrangement of ascomata. Bar line = 1 mm. From holotype (Herb. C).

Sargasso Sea, leg. J. K. Dooley, J. K. 2724 (Herb. IMS); *S. natans*, 18 June 1972, Bogue Banks, Carteret County, North Carolina, leg. J. and E. Kohlmeyer, J. K. 3022 (Herb. IMS).

Note: Galls produced by the alga in reaction to infection by *H. oceanica* are often attacked by the hyperparasite *Gloeosporidium cecidii* (Kohlm.) Sutton, causing black discolorations (Fig. 9A; Kohlmeyer 1972).

Laboulbenia marina F. Picard, C. R. Séances Soc. Biol. Ses. Fil. 65: 484–485, 1908 (Laboulbeniomycetes, Laboulbeniales, Laboulbeniaceae; Fig. 12)

Thallus 150–230 µm long (including ascoma), surface with indistinct wavy lines (Figs 12A,B). *Receptacles* 105–112 × 48–53 µm, composed of an elongate basal cell (I) forming a blackish foot, attached to the host, and of a longer subbasal cell (II) that subtends

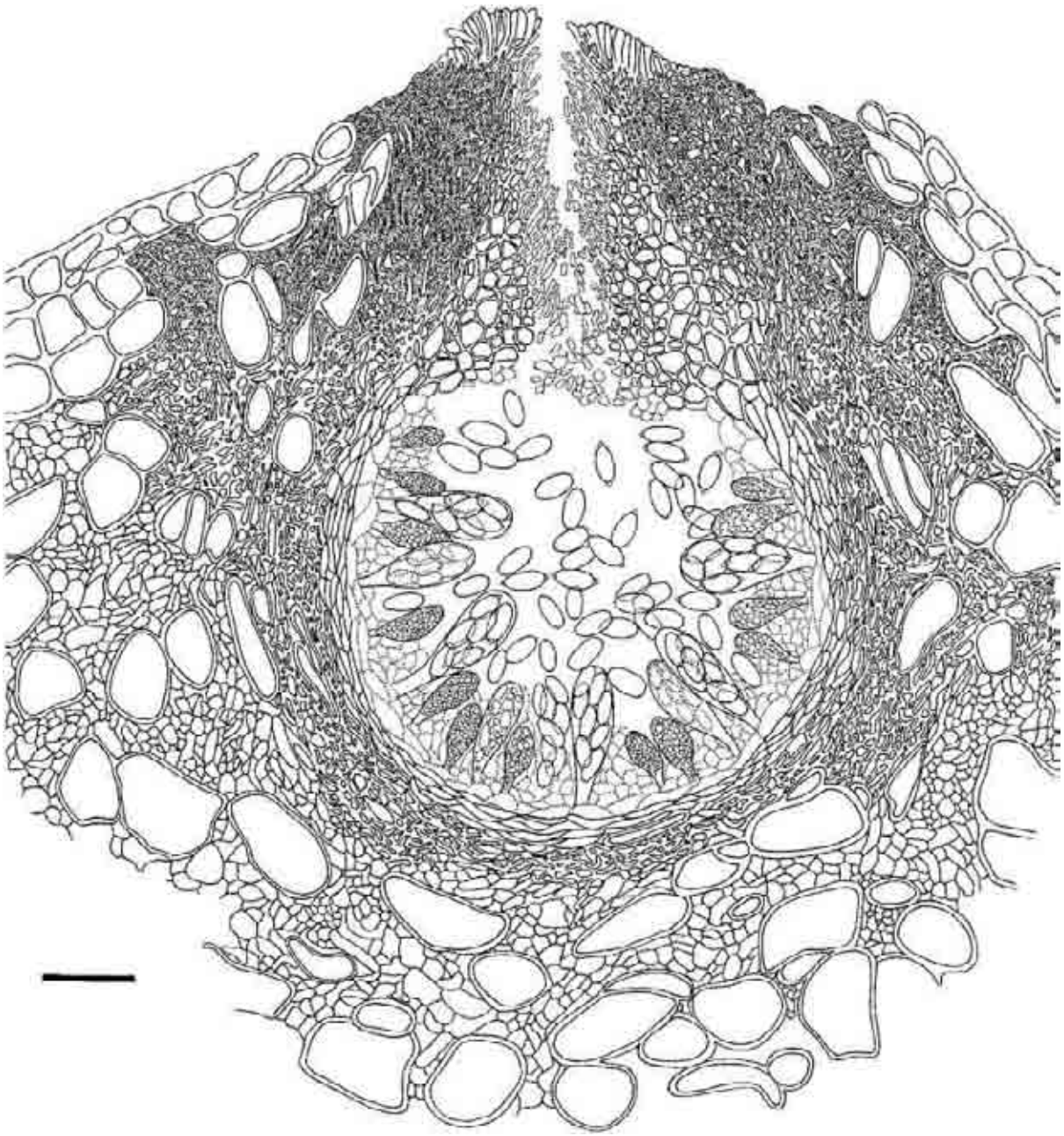

Fig. 10. *Haloguignardia oceanica*. Longitudinal section through ascoma surrounded by large algal cells, forming a pseudostroma; asci along the entire wall; ostiolar canal with periphysoid cells. Bar line = 50 µm. From holotype (Herb. C).

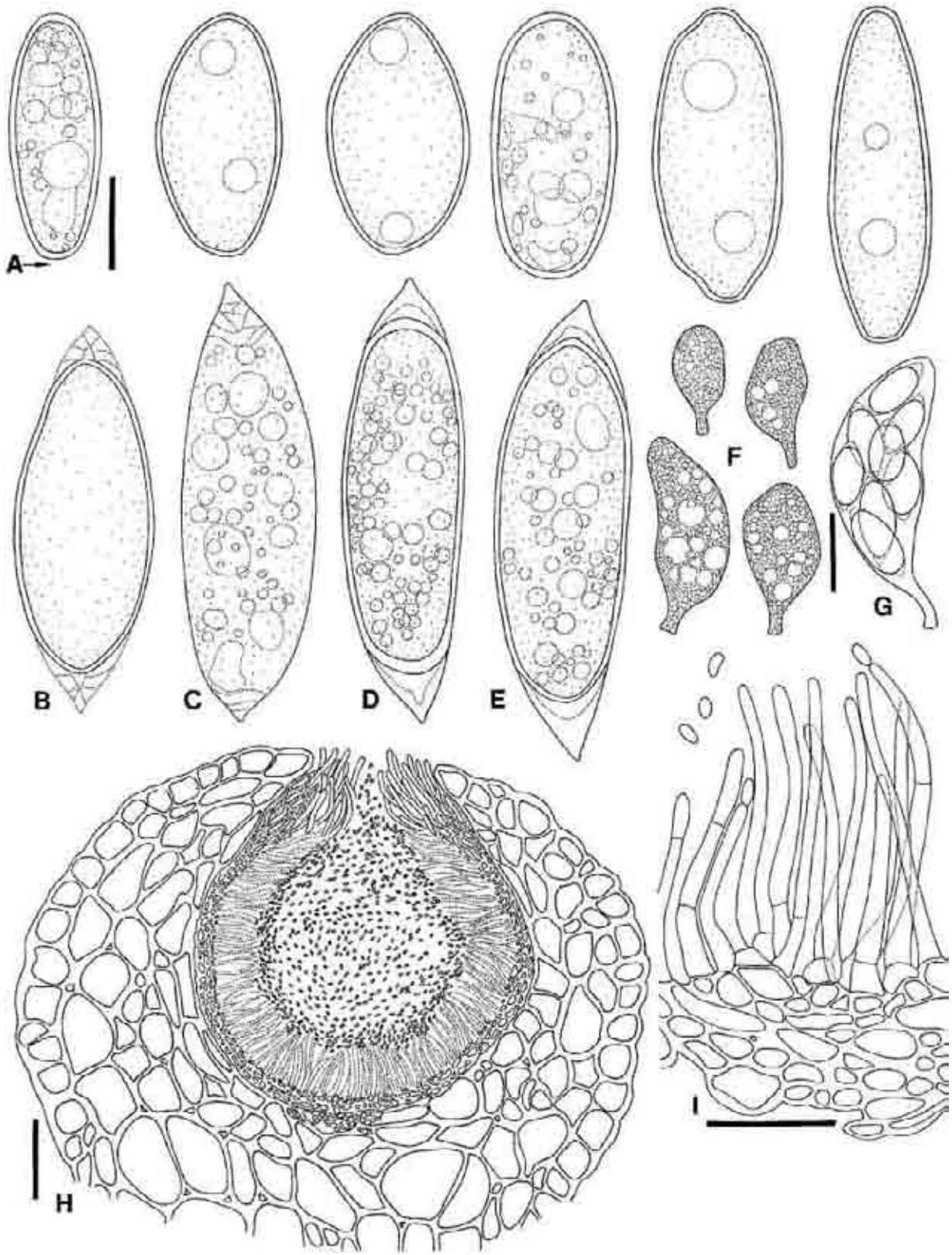

Fig. 11. *Haloguignardia oceanica*. A–E. Ascospores (C–E = giant spores). Bar line = 10 µm. A. Appendages dissolved; B, D, E. With apical caps, B showing chambers; C. Immature, with apical striations. F and G. Asci, in F immature. Bar line = 20 µm. H. Longitudinal section through spermogonium embedded in algal tissue; note the clear separation between spermogonium and surrounding host cells in contrast to ascoma (Fig. 10). Bar line = 50 µm. I. Section though peridium with spermatiophores. Bar line = 20 µm. From holotype (Herb. C).

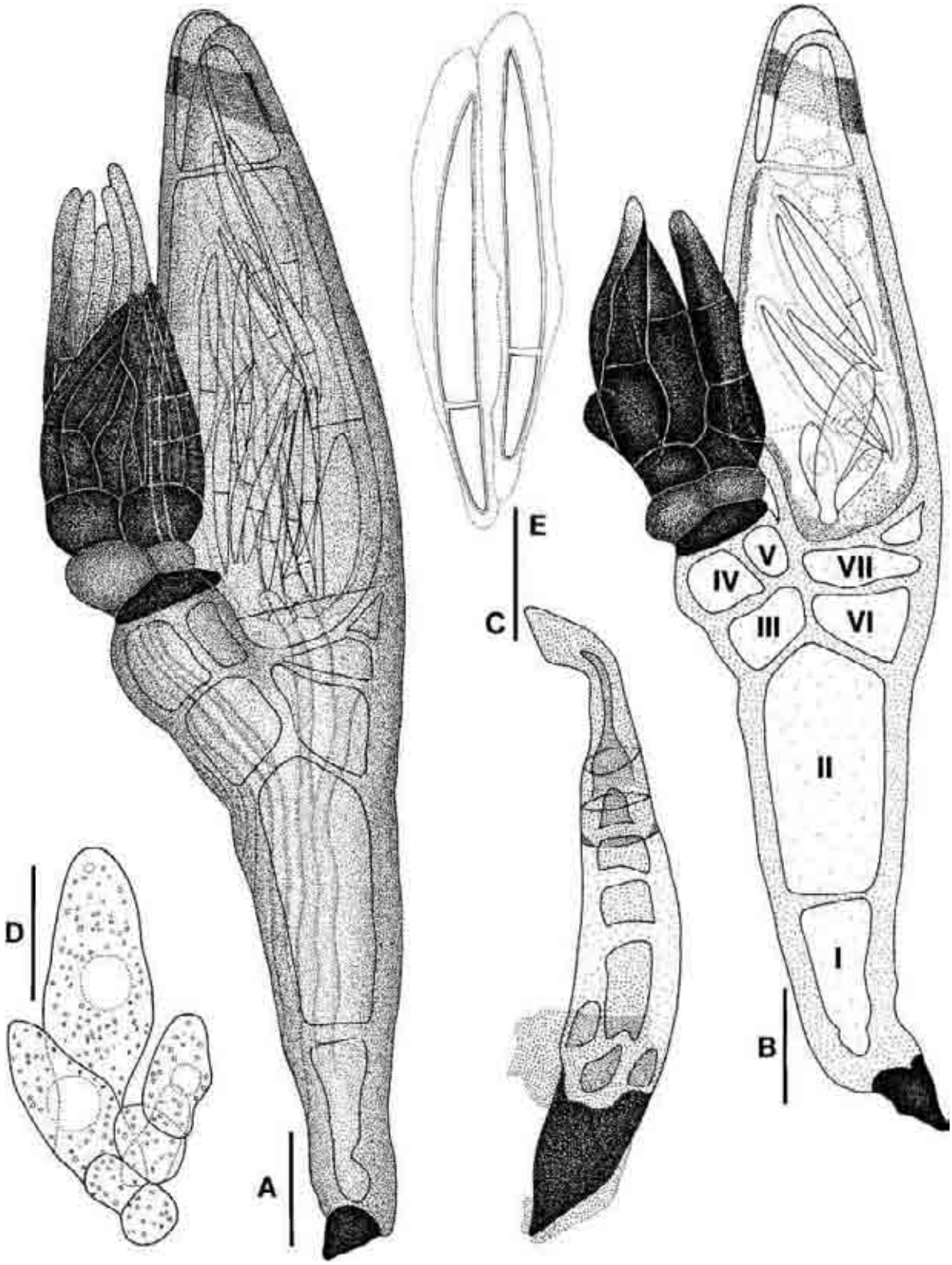

Fig. 12. *Laboulbenia marina*. A and B. Thallus, A in surface view, showing wavy ornamentation, appendages to the left; B in optical section, showing receptacles (Roman numbers explained in text), ascoma with asci and spores, and appendages on left side. Bar lines = 20 μm. C. Aborted thallus. D. Young asci. E. Pair of ascospores, covered by a mucilaginous sheath. Bar lines for C–E = 10 μm. From Herb. R. K. Benjamin, slide no 2537.

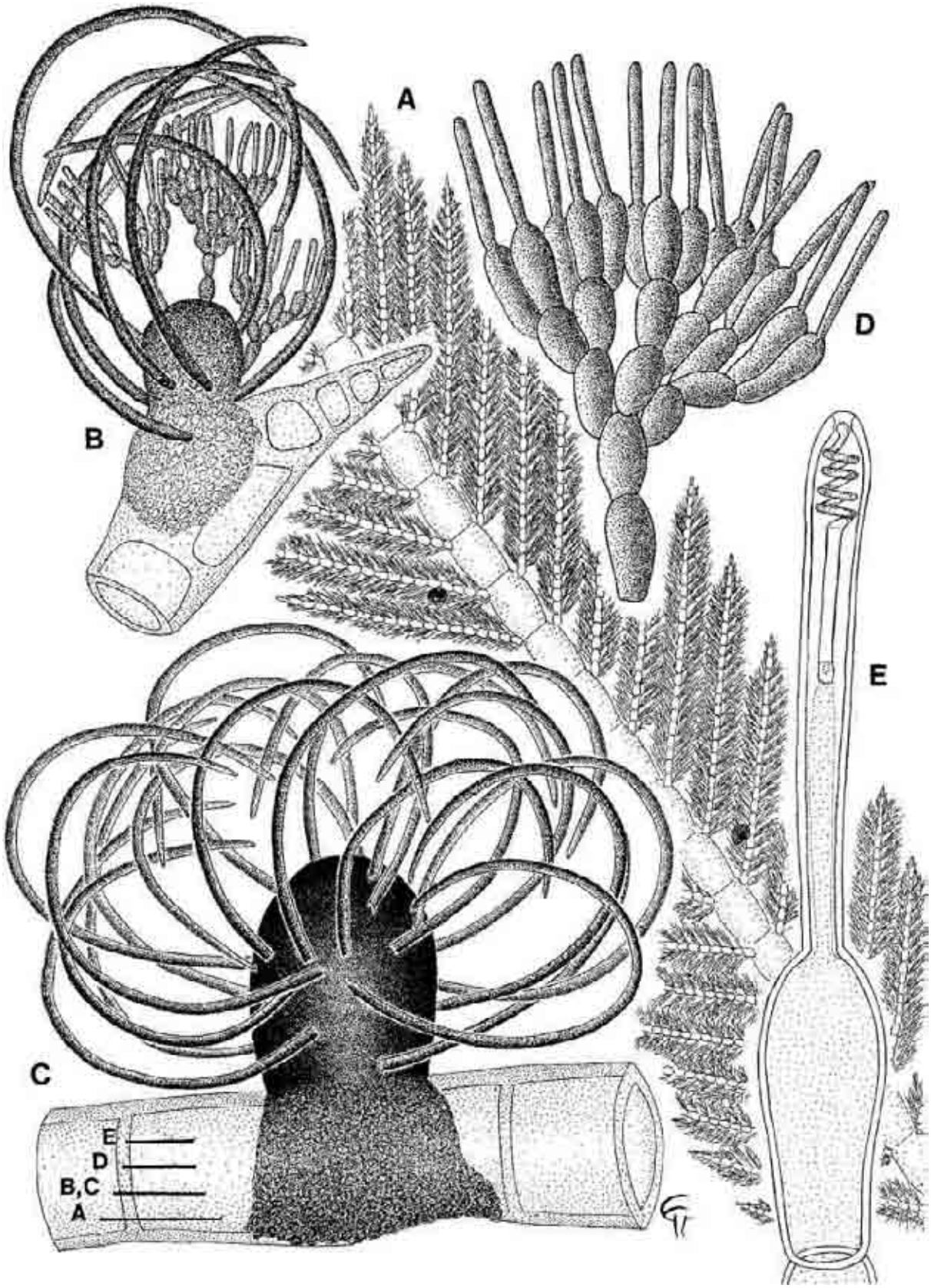

Fig. 13. *Spathulospora adelpha* from *Ballia callitricha.* A. Habit of alga. Bar line = 2 mm. B. Fungal thallus and immature ascoma covered with sterile hairs and antheridia on tip of *Ballia*. Bar line = 150 μm. C. Mature ascoma seated on a crustose thallus, sterile hairs cover the surface. Bar line = 150 μm. D. Candelabrumlike antheridial hair, bearing lageniform antheridia. Bar line = 25 μm. E. Antheridium, in the tip of the neck a cylindrical spermatium with a coiled apical appendage. Bar line = 5 μm. From paratype J. K. 2981 (Herb. IMS).

two short cells (III and VI), placed side by side; cell III subtends two smaller cells (IV and V) that support the appendages; cell VI subtends cells VII and VIII bearing the ascoma (Figs 12A,B). *Ascomata* 76–118 × 38–44 µm, elongate-ellipsoidal, wide at the base, attenuate and conical at the apex, sessile, ostiolate, hyaline to light brown, at maturity with a darker zone around the ostiole, solitary (Figs 12A,B). *Appendages* originating from cells IV and V that are topped by a black cell bearing two unequal lighter cells; each of these give rise to up to four appendages; the latter 30–38 µm long, 8–10 µm diam. at the base, 4 µm at the apex, dark at the base, light colored at the tip, three- or four-celled, constricted at the septa. *Antheridia* not seen. *Asci* four-spored, ellipsoidal to clavate, thin-walled, unitunicate, early deliquescing, developing at the base of the ascomatal venter (Figs 12B,D). *Ascospores* 26–35 × 4 µm, elongate-fusoid, pointed at the apex, rounded at the base, somewhat curved, one-septate in the lower third, hyaline, covered by a mucilaginous sheath, released from the ascoma and attaching to a host in pairs (Fig. 12E).

Host: *Aepus robini* (Laboulbène), a beetle of the *Laminaria* zone.

Distribution: Atlantic Ocean (France).

Material examined: *A. robini*, Omonville-la-Rouge, Manche, France, 3 Aug. 1968, leg. J. Balazuc, slide No. 2537 of R. K Benjamin.

Spathulospora adelpha Kohlm., Mycologia 65: 615, 1973 (Spathulosporomycetes, Spathulosporales, Spathulosporaceae; Fig. 13)

Germinating ascospore producing appressorium, perforating the algal wall and proliferating along the inner wall of one cell, forming a hypostroma of assimilative cells. *Thallus* crustose, covering one cell of the host, bearing sterile and fertile hairs, and trichogynes (Figs 13B,C). *Ascomata* 290–500 × 150–310 µm, ovoidal, superficial, ostiolate, epapillate, periphysate, coriaceous, fuscous, subiculate, hairy, solitary or geminate (Fig. 13C). *Peridium* 35–80 µm thick, composed of 5–10 layers of cells, polygonal and brown on the outside, flattened and hyaline on the inside, forming a *textura angularis* in longitudinal section. *Sterile hairs* 500–650 × 8–15 µm, enclosing ascoma and antheridia, curved, cylindrical, tapering, fuscous, septate, thick-walled, immersed in peridium (Figs 13B, C). *Antheridial hairs* candelabrum-like; stalks 70–80 × 12–16 µm, cylindrical, two- to three-septate, ramose at the tip, bearing 15–22 phialidelike antheridia (Fig. 13D). *Antheridia* 55–72 µm long, lageniform; venters 19–30 × 10–13 µm, cylindrical; necks 24–45 × 4–8 µm, obconical to cylindrical, producing spermatia (Figs 13D, E). *Spermatia* 14–15 × 1 µm, cylindrical; with an apical, filiform, coiled appendage (Fig. 13E). *Trichogynes* filamentous, cylindrical, septate. *Hamathecium* absent. *Asci* eight-spored, clavate, thin-walled, unitunicate, early deliquescing. *Ascospores* 70–104 × 16–23 µm, fusiform, somewhat curved, one-celled, hyaline; each end with a conical, mucus-filled appendage.

Host: *Ballia callitricha* (C. Agardh) Kützing (Fig. 13A).

Distribution: Pacific Ocean (Australia [Southeast Australia]).

Material examined: Holotype, isotype, Herb. NY, IMS. Numerous additional collections are listed by Kohlmeyer (1973) and Kohlmeyer and Kohlmeyer (1975).

Spathulospora phycophila A. R. Caval. *et* T. W. Johnson, Mycologia 57: 927–928, 1965 (Spathulosporomycetes, Spathulosporales, Spathulosporaceae; Figs 14–16)

Germinating ascospores perforating the algal wall and proliferating along the inner wall of one cell, forming a hypostroma of assimilative cells (Fig. 14D); frequently the fungus induces in the alga a wild growth of hairs near the ascomata. *Thallus* crustose, covering one cell of the host, bearing sterile and fertile hairs, and trichogynes. *Ascomata* (110–) 157–320 µm diam., subglobose, superficial, ostiolate, epapillate, coriaceous, fuscous, subiculate, hairy, solitary (Figs 14A, 15). *Peridium* 12–40 µm thick, composed of 6–8 layers of cells, forming a *textura angularis* in longitudinal section (Figs 14B,C, 15). *Sterile hairs* 120–280 × 10–18.5 µm enclosing ascoma and antheridia, strongly curved, cylindrical, tapering, fuscous, 2–9(–13) septate, thick-walled, immersed in peridium (Figs 14A,C, 15). *Antheridial hairs* 150–160 × 10–12 µm, two- to four-septate, thick-walled, branching dichotomously at the tip, bearing less than 10 phialidelike antheridia (Figs 16C, D). *Antheridia* 20–22 µm long, lageniform; venters 9.5–14 × 5.5–9 µm, ellipsoidal; necks 4–9.5 × 2.2–3.3 µm, obconical to cylindrical, producing spermatia (Figs 16C,D). *Spermatia* 8.5 × 0.5 µm, filiform, non-septate. *Trichogynes* 27 × 8.5–9 µm, filamentous, cylindrical. *Hamathecium* absent. *Asci* 80–125 × 30–40 µm, eight-spored, cylindrical to clavate, thin-walled, unitunicate, early deliquescing (Fig. 15). *Ascospores* 80–110 × 10–13 µm, fusiform, straight or curved, spathulate at both tips, one-celled, hyaline, with a thin gelatinous sheath that merges into a thick, appendage-like cover around each tip (Figs 16A,B).

Hosts: *Ballia callitricha* and *B. scoparia* (J. D. Hooker *et* Harvey) Harvey.

Distribution: Pacific Ocean (Australia [Victoria, South Australia]), New Zealand [North Island].

Material examined: Holotype, Herb. BPI. Additional collections are listed by Kohlmeyer and Kohlmeyer (1975).

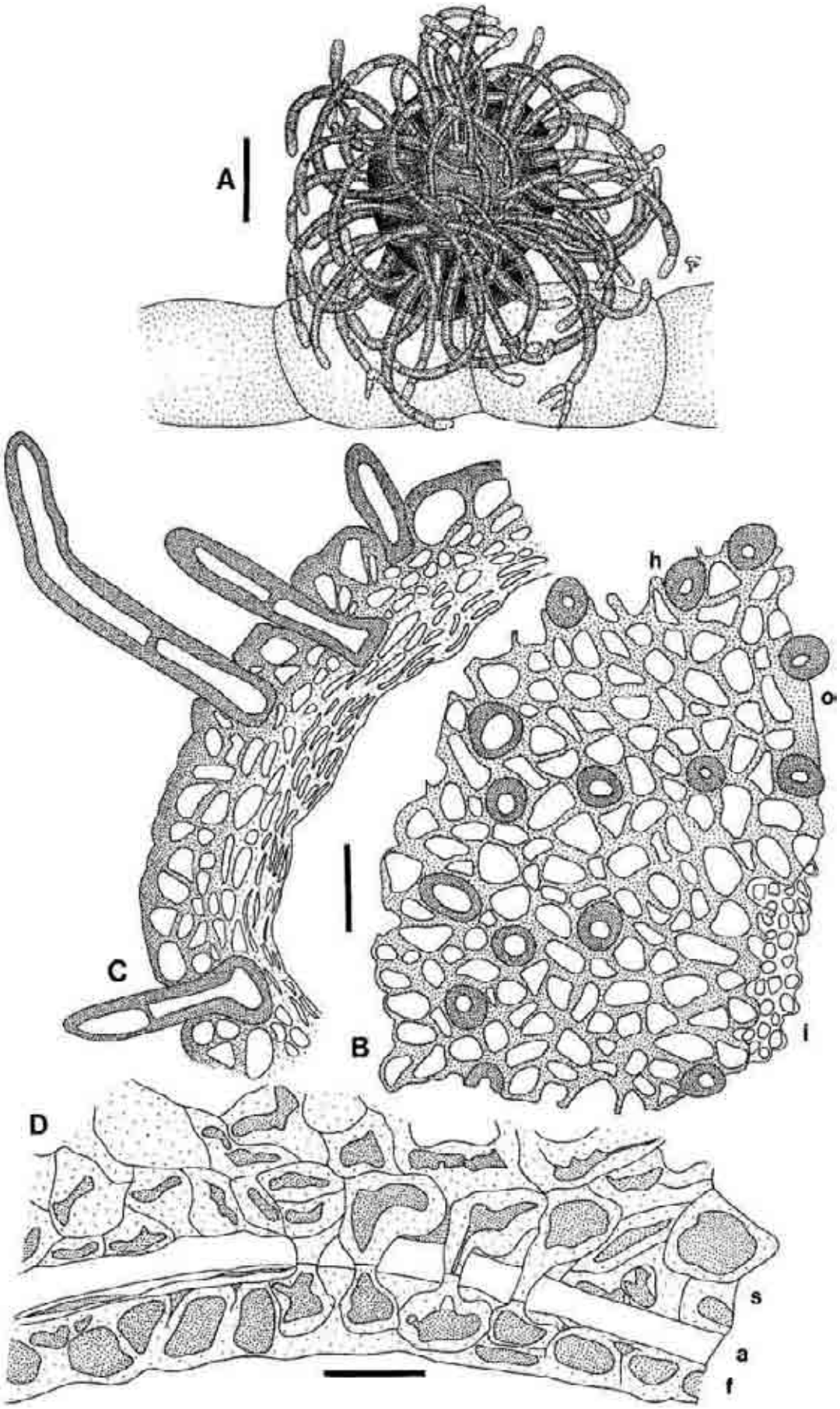
A
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Fig. 14. *Spathulospora phycophila*. A. Ascoma with sterile and antheridial hairs on *Ballia callitricha.* Bar line = 75 µm. B. Tangential section through peridium with dark hairs in cross section (h), cells of outer layer (o), inner layer (i). Bar line = 20 µm. C. Cross section through peridium with hair bases, outer and inner layers of cells. Bar line = 20 µm. D. Cross section through subiculum (s), algal wall (a) perforated by fungal cells, and intracellular crust (hypostroma) of assimilative fungal cells (f). Bar line = 10 µm. From holotype (Herb. BPI).

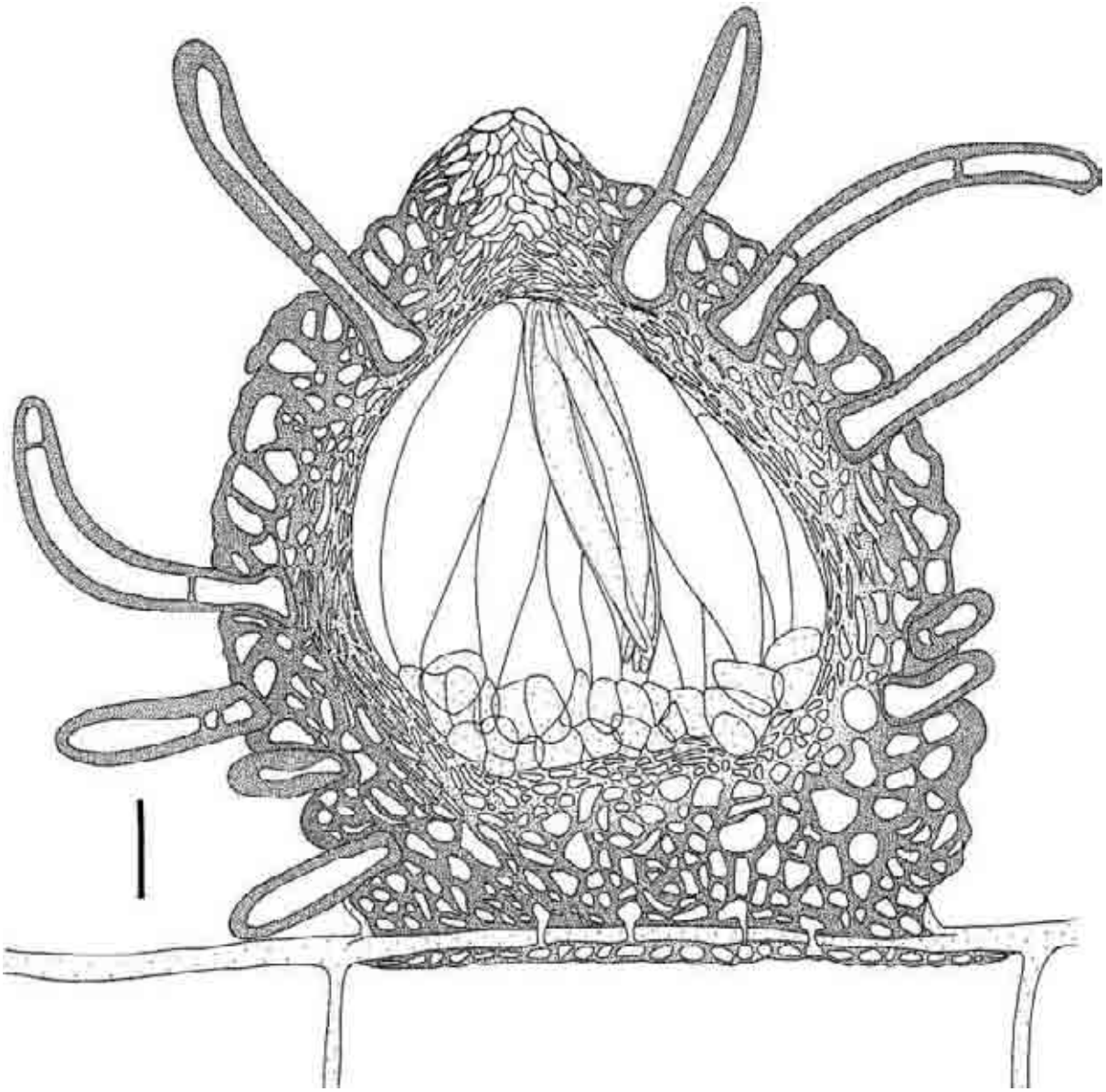

Fig. 15. *Spathulospora phycophila.* Longitudinal section through ascoma, attached with a subiculum to the algal filament; tips of curved hairs cut off; asci develop on an ascogenous tissue of large, thin-walled, yellowish cells; ostiole still closed; thin intracellular crust (hypostroma) inside the host cell. Bar line = 20 µm. From holotype (Herb. BPI).

Turgidosculum ulvae (M. Reed) Kohlm. *et* E. Kohlm., Bot. Jahrb. Syst. 92: 429, 1972 (Mastodiaceae – family of uncertain position; Figs 17–19)
≡ *Guignardia ulvae* M. Reed, Univ. Calif., Berkeley, Publ. Bot. 1: 160, 1902.

Mycelium forming a dense network of *textura intricata* between the upper and lower layer of algal cells (Figs 18, 19K). *Ascomata* 330–560 × 330–600 µm, subglobose, immersed or erumpent, ostiolate, epapillate, coriaceous, dark brown above and at base, hyaline at the sides, solitary or gregarious, sometimes geminate (Fig. 18). *Ostiolar canal* periphysate; closed by a gelatinous, turgescent swelling cushion (Fig. 18). *Asci* 43–57 × 9–15.5 µm, eight-spored, clavate, pedunculate, thick-walled, unitunicate, deliquescing, developing all along the inner wall, up to the ostiolar canal (Figs 18, 19A–E). *Ascospores* (8.5–) 10–13 (–14) × 3.5–7 µm, broadly ellipsoidal to ovoid, one-

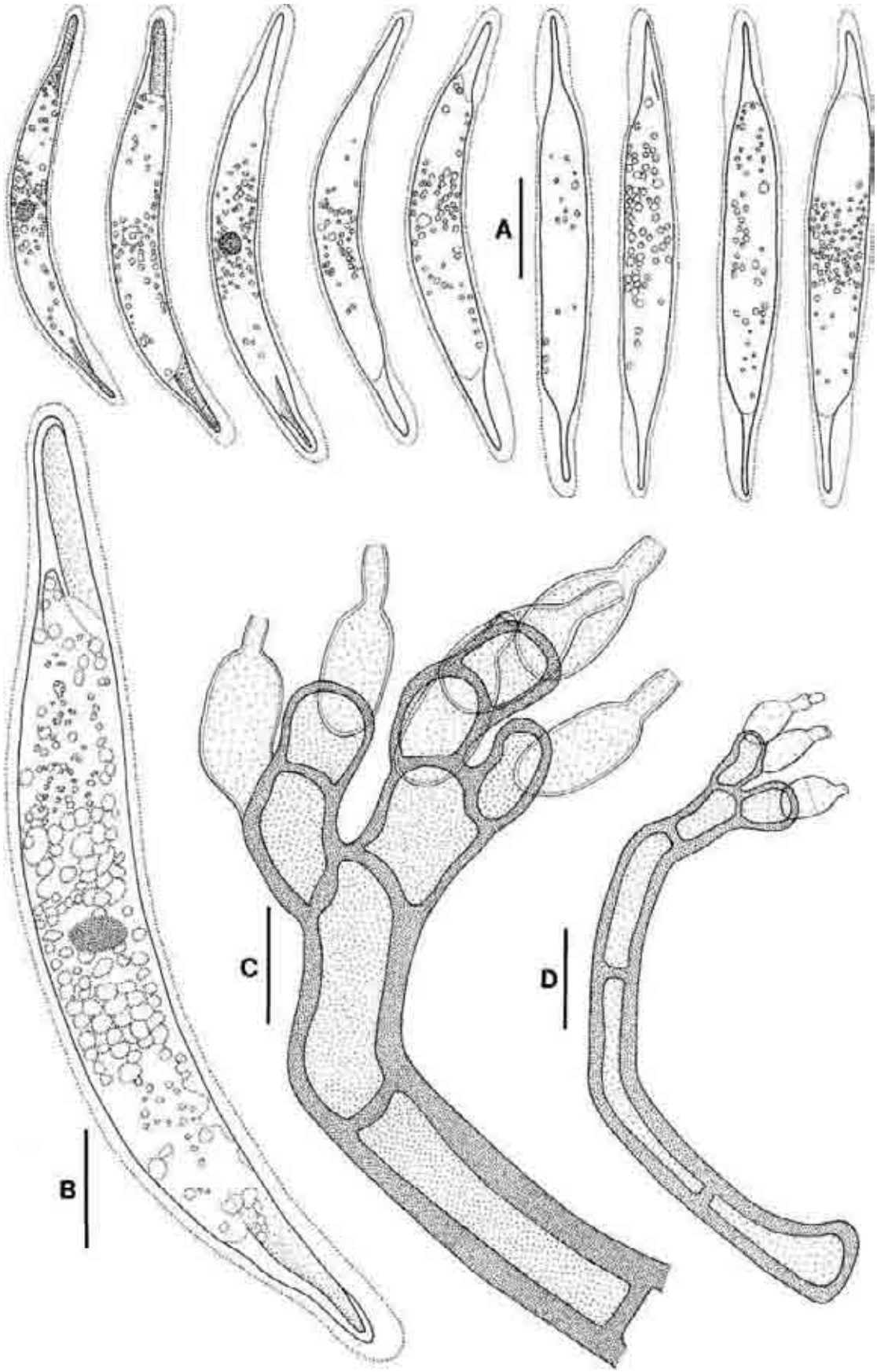

Fig. 16. *Spathulospora phycophila*. A and B. Ascospores with spathulate or spoon-shaped tips, surrounded by gelatinous sheaths; some spores showing the central nucleus (stained in hematoxylin). Bar lines = 10 μm (B), 20 μm (A). C and D. Antheridial hairs, branching at the apices, bearing antheridia. Bar lines = 10 μm (C), 20 μm (D). From holotype (Herb. BPI).

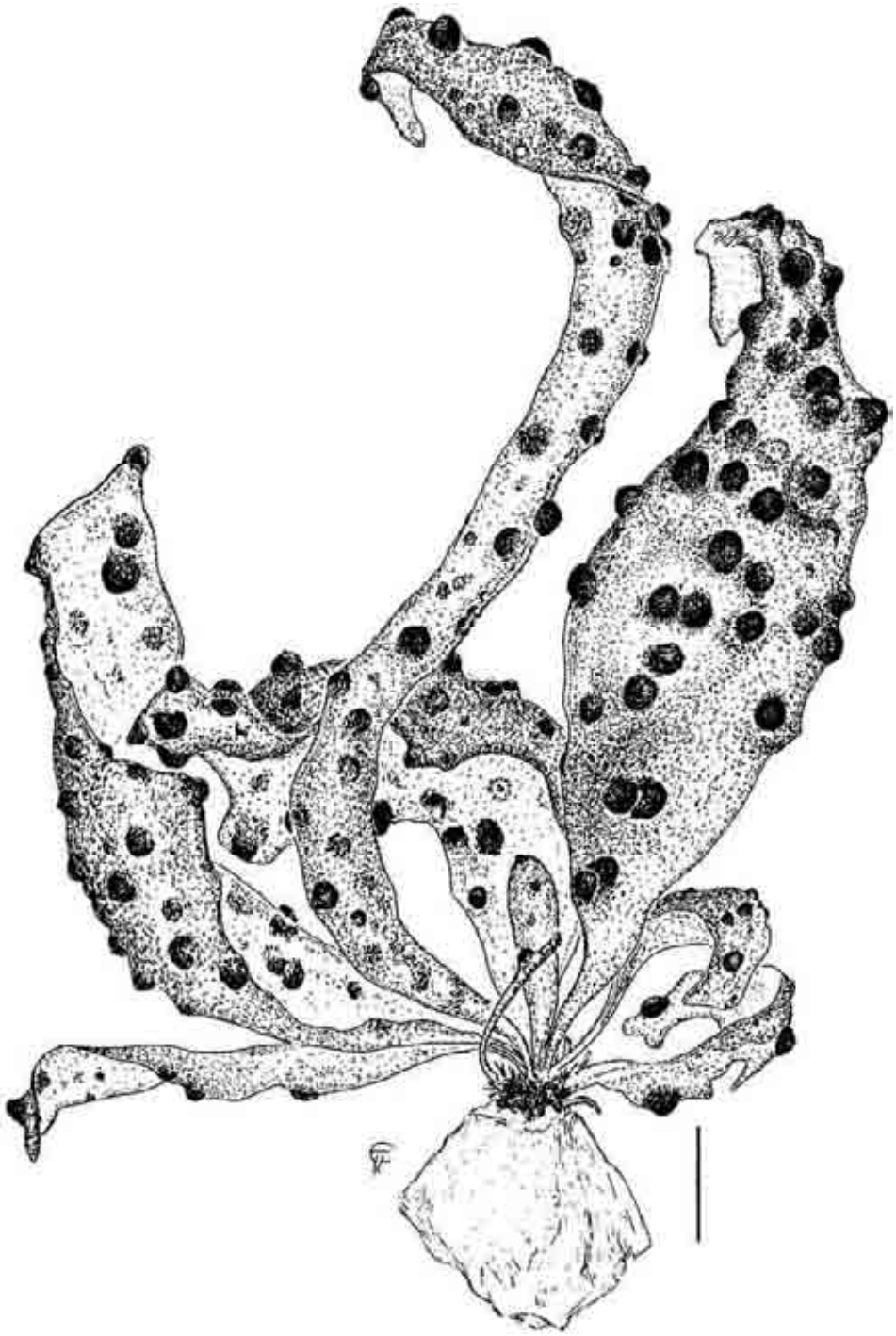

Fig. 17. Habit of *Blidingia minima* var. *vexata* with dark ascomata and spermogonia of *Turgidosculum ulvae*. Bar line = 2 mm. From Herb. Setzer No. 3750.

celled, hyaline, at maturity accumulating in the ascomatal venter (Figs 18, 19F–H). *Spermogonia* 100–200 × 210–350 µm, lentiform, immersed, irregularly chambered, ostiolate, epapillate, coriaceous, brown above and at base, hyaline at the sides (Fig. 19K). *Spermatiophores* 8–14 × 1.7–2.4 µm, conical, lining the walls and lobes of the spermogonial locule (Figs 19I,K). *Spermatia* 8–11 × 0.6–1 µm, filiform, 1-celled, hyaline (Fig. 19J).

Host: *Blidingia minima* var. *vexata* (Setchell *et* Gardner) J. M. Norris (Fig. 17).

Distribution: Pacific Ocean (Canada [British Columbia], U.S.A. [California, Oregon, Washington]).

Material examined: Lectotype (Kohlmeyer and Kohlmeyer 1972), San Francisco, California 1898, leg. W. A. Setchell (Herb. FH); Fort Cronkite, Marin County, California, 11 Oct. 1969, leg. R. Setzer (Herb. Setzer No. 3750 and IMS).

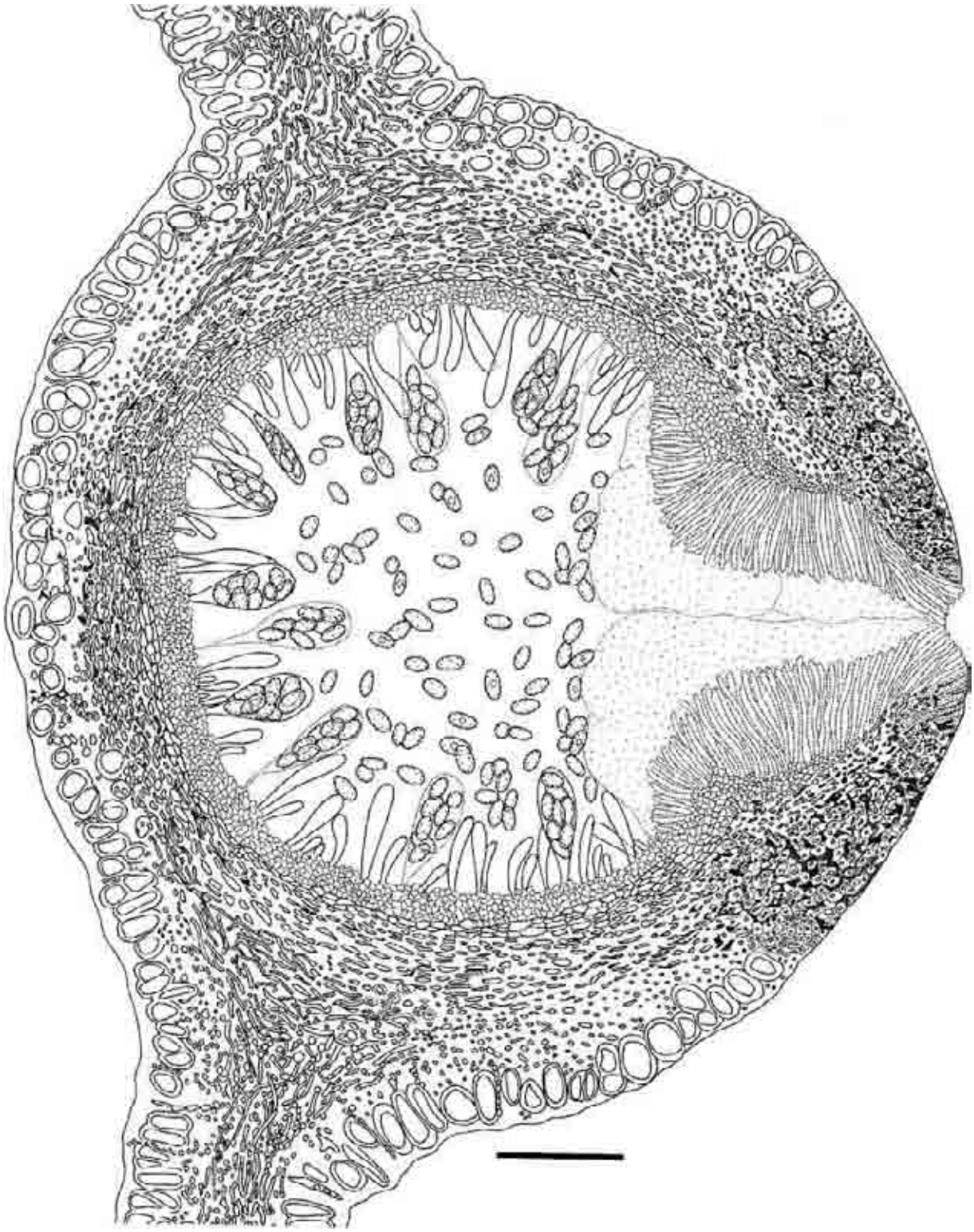

Fig. 18. *Turgidosculum ulvae.* Longitudinal section through ascoma with periphyses, turgid ostiolar swelling cushion, and asci developing along the inner wall; hyphal layer between the upper and lower algal layer (on both sides of the ascoma). Bar line = 50 µm. From Herb. Setzer No. 3750.

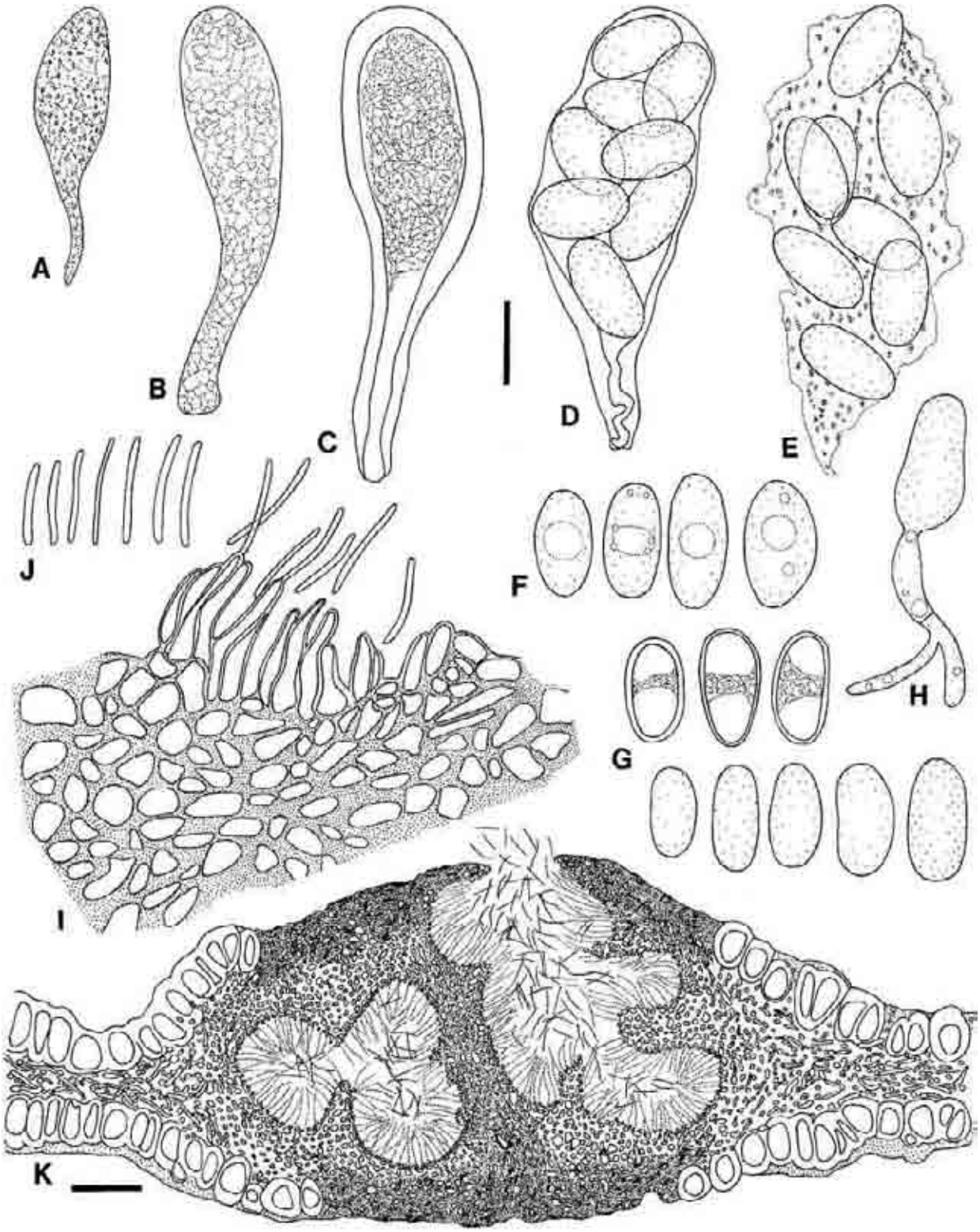

Fig. 19. *Turgidosculum ulvae*. A–E. Asci in different stages of development. A–C. Immature. D. Mature, beginning dissolution. E. Ascospore release by dissolution of the ascus wall. F–H. Ascospores, the central row in optical section. H. Germination. I. Section through spermogonial peridium with spermatiophores and spermatia. J. Spermatia. K. Longitudinal section through spermogonium with irregular chambers; spermatiophores lining the walls of the locules; algal thallus on both sides of the spermogonium pushed apart by the central hyphal layer. Bar line for A–J = 10 μm, for K = 25 μm. C, D and G from type material (Herb. FH), the others from Herb. Setzer No. 3750.

Note: The association between *B. minima* var. *vexata* and *T. ulvae* is a mycophycobiosis *sensu* Kohlmeyer and Kohlmeyer (1979).

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