with spore production in the simplest known sporophytes.

The widespread photosynthetic activity occurring in the sporophytes of the Hepaticae and the Musci is interpreted as evidence in support of the homologous or transformation theory which emphasizes the fundamental similarity of the two alternating generations.

Barnard College,
Columbia University,
New York City

LITERATURE CITED

Bold, H. C. 1938. The nutrition of the sporophyte in the Hepaticae. Amer. Jour. Bot. 25: 551–557.

Bower, F. O. 1908. The origin of a land flora. London.

———. 1935. Primitive land plants. London.

Campbell, D. H. 1930. The structure and development of mosses and ferns. New York.

Goebel, K. 1930. Organographie dere Pflanzen. III. Aufl., Zweiter Teil. Jena.

Juller, E. 1937. Der Generations-und Phasenwechsel bei *Stigeoclonium subspinosum*. Arch. Protistenk. 89: 55–93.

Smith, G. M. 1938. Cryptogamic Botany. Vol. II. Bryophytes and Pteridophytes. New York.

Stone, W. E. 1932. The origin, development, and increase of chloroplasts in the potato. Jour. Agric. Res. 45: 421–435.

Studhalter, R. A. 1938. Independence of sporophyte in Riella and Sphaerocarpus. Ann. Bryolog. 11: 153–154.

NEW AND UNUSUAL SPECIES OF THE GEOGLOSSACEAE [1]

E. B. Mains

In 1908 Durand monographed the *Geoglossaceae* of North America, recognizing 42 species, 6 of *Mitrula*, 5 of *Microglossum*, 4 of *Corynetes*, 3 of *Gloeoglossum*, 7 of *Geoglossum*, 5 of *Trichoglossum*, 2 of *Spathularia*, 3 of *Leotia*, 2 of *Vibrissea*, 2 of *Apostemidium*, and 3 of *Cudonia*. Later he (1921) reported 3 additional species, 1 of *Geoglossum* and 2 of *Trichoglossum*. Three other species have been added to the family for North America through the description of a new species each of *Trichoglossum* by Sinden and Fitzpatrick (1930), of *Apostemidium* by Kanouse (1936) and of *Mitrula* by Mains (1935). In this paper three new species are described, 1 of *Trichoglossum* and 2 of *Cudonia*, and one species of *Mitrula* is placed in synonymy, bringing the species for North America to 47. Information is also included concerning several rare species.

Cudonia **monticola** sp. nov.—Ascophoribus solitariis, gregariis vel caespitosis, pileatis, 3–10 cm. altis; pileis variis, convexis, inaequabiliter hemisphericis, subspathulatis, 10–30 mm. latis, pallide incarnato-cinnamoneis vel incarnato-alutaceis, rugosis; 5–7 mm. latis, sursum attenuatis, avellaneis; asci clavatis 90–100 × 8–10 μ, infra attenuatis; ascosporis acicularibus, 20–24 (28) × 2 μ hyalinis; paraphysibus filiformibus, hyalinis apicibus curvatis (fig. 1).

Specimen typicum: Lake Crescent, Washington, VI. 6, 1939, A. H. Smith (14060).

Ascophores single, gregarious or caespitose, pileate, fleshy-leathery, 3–10 cm. high; pilei variable in shape, convex, irregularly hemispherical, laterally compressed or subspathulate, rugose; stipes 5–7 mm. thick below, somewhat attenuated upward, avellaneus or wood-brown; asci clavate, 90–100 × 8–10 μ, attenuated below, the spores in the upper half or third; ascospores acicular, 20–24 (28) × 2 μ, hyaline; paraphyses filiform, hyaline, curved at the apices.

On spruce needles and coniferous débris, Lake Crescent, Washington, June 3, 1939, A. H. Smith (14009) and June 6, 1939 (14060, type); Cape Flattery, Washington, May 27, 1939, A. H. Smith (13785).

The colors given above were from notes of A. H. Smith from the fresh plants. In the dried specimens the pilei and stipes are hazel or darker. The measurements are from the dried specimens and the fresh plants were considerably larger, making the species one of the largest in the genus.

In its relationship, *Cudonia monticola* is near *C. constrictospora* S. Ito & Imai, reported from Japan. The latter, however, has spores constricted at the middle.

Cudonia **grisea** sp. nov.—Ascophoribus gregariis, pileatis, 1.5–5 cm. altis; pileis convexis, 5–15 mm. latis, griseis, levibus; stipitibus 3–8 mm. latis, sursum attenuatis, levibus, fuscis; ascis clavatis, 70–90 × 6–8 μ, infra attenuatis; ascosporis hyalinis, acicularibus, 18–22 × 1.5–2 μ; paraphysibus filiformibus, hyalinis, apicibus curvatis (fig. 2).

Specimen typicum: Hoh River, Washington, V. 18, 1939, A. H. Smith (13521).

Ascophores gregarious, pileate, stipitate, fleshy, 1.5–5 cm. high; pilei convex, thick, 5–15 mm. broad, drab or dark gray, smooth; stipes 3–8 mm. thick below, attenuated upward, smooth, fuscus; asci 8-spored, clavate, 70–90 × 6–8 μ, attenuated below; ascospores acicular, 18–22 × 1.5–2 μ, hyaline; paraphyses filiform, hyaline, curved at the apices.

On rotten coniferous wood, Hoh River, Washington, May 18, 1939, A. H. Smith (13521, type); Olympic Hot Springs, Washington, June 5, 1939,

[1] Received for publication February 21, 1940.
Paper from the Department of Botany and the Herbarium of the University of Michigan.

A. H. Smith (14100). Sol Duc Park Trail, Olympic Mts., Washington, June 20, 1939, A. H. Smith (14482).

The description of the ascophores was drawn from notes made by A. H. Smith from the fresh specimens. In the dried specimens the ascophores are brownish-black. The pilei are wrinkled with the margins somewhat incurved and the stipes are longitudinally striate. The smooth gray pilei when fresh and the small spores distinguish the species.

Cudonia orientalis Lloyd and C. convoluta Lloyd.—In 1916 Lloyd described two species, *C. orientalis* and *C. convoluta*, from a Japanese collection (209) received from A. Yasuda. Later he received another collection (380) which Professor Yasuda considered a better collection of the same. Lloyd (1916b) somewhat doubtfully identified this as *C. convoluta*. In 1923 he received another Japanese collection from J. E. A. Lewis which he (1923) also identified as *C. convoluta*. Through the kindness of J. A. Stevenson, I have had the privilege of examining these specimens, which are now in the Lloyd Herbarium of the Mycological Collections of the United States Bureau of Plant Industry.

The type of *Cudonia orientalis* (Lloyd Herb. no. 32321) is accompanied by the following data: Sendai, Japan, October 22, 1900, A. Yasuda, 209; fruit-body brown; head 1–2 cm. wide; ascus $120 \times 10\ \mu$; ascospore $80 \times 3\ \mu$. There is a colored drawing (fig. 3) initialed A. Y. showing two ascophores 30 and 42 mm. high with convex hemispherical pilei, 12–16 mm. broad, and stipes 2–4 mm. broad at the bases and tapering somewhat upward. The upper surfaces of the pilei are illustrated as smooth with no indication of folds or ridges. There is a notation "ascop. needle-shaped." The collection (fig. 4) probably contained 7 or 8 ascophores which are now mostly broken. They apparently were 15–18 mm. long and are now brownish black, very hard, the tissues horny. The pilei are somewhat wrinkled and folded, 5–8 mm. wide. The stipes are longitudinally furrowed, 2 mm. below and tapering up to 1 mm. The asci are clavate, much attenuated below, 100–150 μ long and 10 μ wide above. No free ascospores were found and those in the asci were not clearly differentiated. Lloyd states that the spores "appear to be about 50 μ long." The paraphyses are hyaline, filiform and somewhat curved at the apices. The size of the spores, an important diagnostic character, is very doubtful.

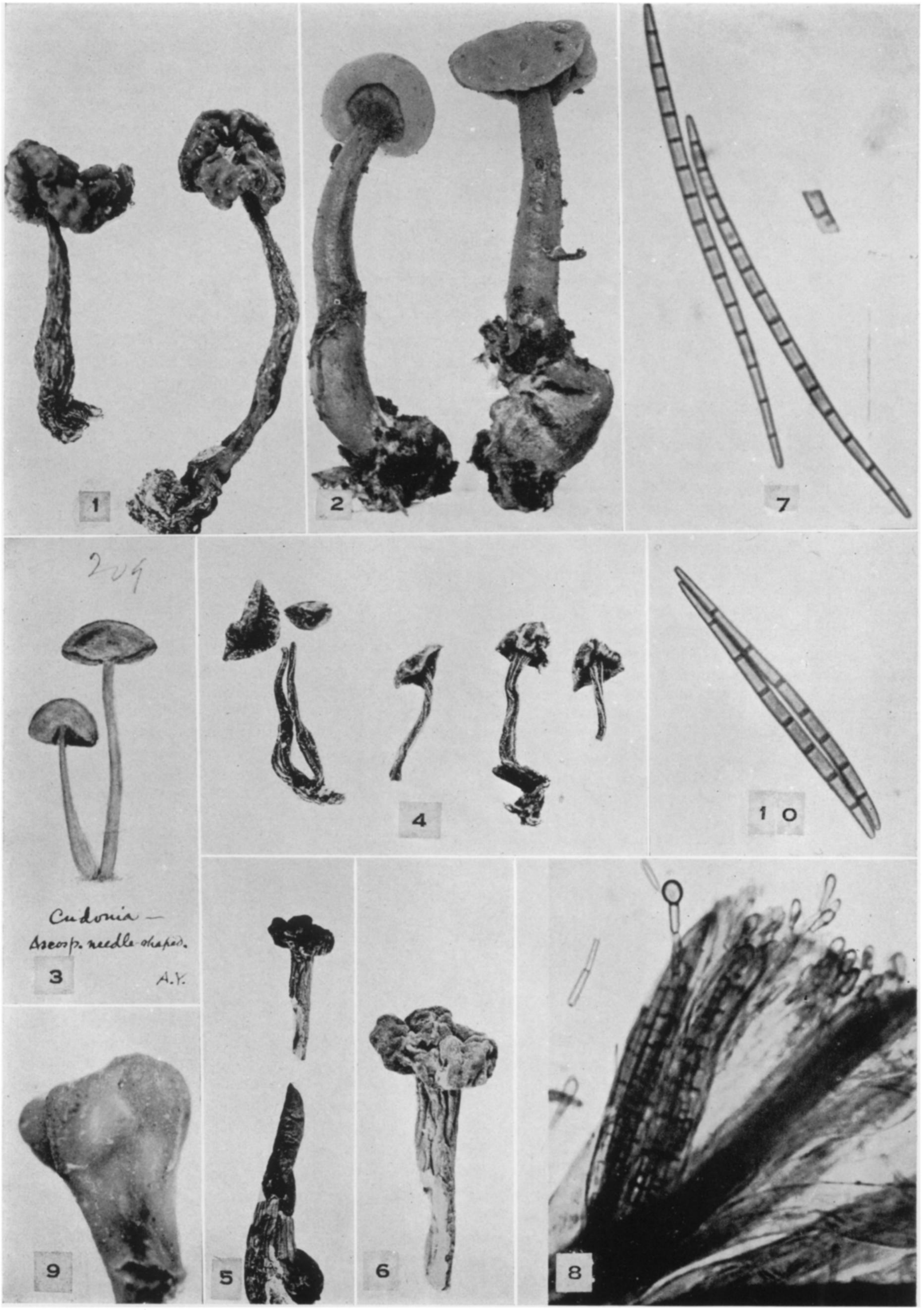
The type of *Cudonia convoluta* (Lloyd Herb. no. 32322) was apparently separated from Yasuda's collection 209. It has 7 ascophores which have been well illustrated by Lloyd (1916, fig. 803–805). They are dark reddish-brown, 15–20 mm. long. The stipes are striate, 1.5–2 mm. thick at the bases, tapering slightly upward. Lloyd describes the ascophores as capitate and places considerable emphasis on the character, stating that the species is intermediate between *Cudonia* and *Mitrula*, resembling *Mitrula* in this respect. The ascophores are pileate, not capitate. The pilei have recurved until their edges meet the stipes thus giving a capitate appearance. They are 3–4 mm. wide and much wrinkled. The tissue is now hard and horny. The asci are clavate, much attenuated below, 90–120 μ long and 10 μ wide above. No free ascospores were seen in the material examined and those in the asci were poorly differentiated. Lloyd states that the spores are 25–30 μ long, clavate-filiform. The paraphyses are hyaline, filiform, somewhat curved at the apices.

The types of *Cudonia orientalis* and *C. convoluta* differ only slightly in color and in the extent to which the pilei are reflexed and wrinkled. I have not been able to substantiate the difference which Lloyd gives for the spores. He apparently was not certain concerning the spores of *C. orientalis*. It seems doubtful if the species are distinct.

Yasuda's collection 380 (Lloyd Herb. no. 15801) identified as *Cudonia convoluta* (fig. 5 and 6) differs markedly from the two previous collections. The ascophores are now broken but they apparently were large, probably up to 80 mm. long. The stipes are cinnamon-brown, enlarged at the base up to 13 mm. and tapering upward to a width of 3 mm. The pilei are chestnut-brown, 7–12 mm. across, with the margins reflexed and the hymenia convex and much convoluted. The subhymenial layer is soft and spongy. The asci are clavate, much attenuated below, 80–120 $\times 9\ \mu$. Free ascospores were not seen and those in the asci were poorly differentiated. The paraphyses are hyaline, filiform and somewhat curved at the apices. This may be *C. monticola* or, as pointed out by Imai (1936), *C. constrictospora*. Without well-differentiated ascospores it is not possible to definitely place this collection.

Lewis' collection (Lloyd Herb. no. 32323) was identified as *Cudonia convoluta* and illustrated by Lloyd (1923). The collection contained several ascophores. All except one are now broken. They probably measured up to 35 mm. long. There are 2 or 3 stipes that are pale buff and pilei that are ochraceous. The stipes and the undersides of the pilei are white flocculose. There are a few radial ribs on the undersides of the pilei. The unbroken ascophore is dark brown and horny. The latter has the appearance of having been overheated in drying. The asci are clavate, $120–150 \times 10\ \mu$, and the ascospores are acicular, $50–66 \times 2\ \mu$. The paraphyses are filiform, hyaline and curved or circinate at apices. Curiously enough Lloyd makes no mention of the dark brown specimen which might be interpreted as *C. convoluta*. He states that the collection "when dry, is pale yellow, not brown, with no red" and "on its color, could be called a new species." At the time of Lloyd's statement it was a new species, because it apparently is *Cudonia helvelloides*, as Imai (1936) has suggested.

I am strongly inclined to the opinion that Yasuda's original specimen (209) was overheated in drying, thus accounting for the horny condition noted above. In the light of the Lewis specimen it may be *C. helvelloides*. As far as the evidence furnished by the specimens and descriptions is concerned it might


1
2
7
209
Cudonia —
Ascosp. needle-shaped.
A.Y.
3
4
10
9
5
6
8

equally well be *C. circinans*. I have found overheated specimens in collections of *C. circinans* which resemble the Yasuda specimens. It seems doubtful whether the identities of *C. orientalis* and *C. convoluta* can be determined with any degree of certainty.

GEOGLOSSUM PYGMAEUM Gerard.—Ascophores 3, 15–20 mm. high, brownish black, the ascogenous portions about one-third of the total length, cylindric or clavate, 1–2 mm. wide; stipes very slender, about 0.5 mm.; asci clavate, $180–220 \times 18–20\ \mu$; ascospores 8, parallel or slightly overlapping, brown, cylindric-clavate, narrowing toward each end, $120–180 \times 6\ \mu$, 15-septate when mature (fig. 7); paraphyses slightly longer than the asci, pale, cylindric and remotely septate below, terminating above in one to three pyriform or ellipsoid brown cells, constricted above at the septa (fig. 8).

Keener House, Tennessee, August 3, 1938, A. H. Smith (9698).

Durand (1908) cites only the type collection consisting of two small ascophores in the Herbarium of the New York State Museum. The species has probably been overlooked by collectors on account of the small size of the ascophores. In Smith's collection a few of the asci show an abnormal development of the ascospores. Only three to six spores matured and one or more of these are larger than the others. Immature spores also occur with less than 15 septa.

MITRULA GRACILIS Karst.—Ascophores 10–20 mm. in length, capitate; heads obovoid or subgloboid (fig. 9), $3–5 \times 3–4$ mm., pale ochraceous (reddish-brown when dried), smooth, rugose or lacunose-wrinkled, sharply delimited from the stipes; stipes creamy white (reddish-brown to straw-yellow at base when dried), slender, about 1 mm., smooth; asci clavate, $65–90 \times 6–9\ \mu$, 8-spored, pores blue with iodine; ascospores biseriate, cylindric-fusoid, $10–14 \times 2\ \mu$; paraphyses filiform, sometimes slightly thickened at the apices.

Growing on living moss in swampy ground, Leal, Colorado (8600 ft.), August 11, 1917, C. H. Kauffman; on mossy stump, Tolland, Colorado (9500 ft.), September 14, 1920, C. H. Kauffman.

These collections were reported by Kauffman (1921) as *M. muscicola*. The description above has been prepared from his field notes on the fresh material and from the specimens in the Herbarium of the University of Michigan.

There has been considerable doubt expressed concerning the separation of *M. gracilis* and *M. muscicola*. Durand (1908) states that *M. gracilis* differs principally in the smaller size and more even hymenium. The ascophores of *M. gracilis* have been described (Durand, 1908; Henning, 1885) as 10–20 mm. long, the stipes slender, 0.5–0.7 mm. thick, brownish yellow or incarnate, the heads 1–2 mm. in diameter, orange-brown, smooth or somewhat convolute. The ascophores of *M. muscicola* are given (Durand, 1908, 1921; Karsten, 1883; Seaver, 1911) as 8–15 mm. long, the stipes 0.5–1.0 mm. thick, whitish to yellow, the heads 2–4 mm. yellowish, pale cinnamon-brown or ferrugineous, smooth, rugulose below, irregularly furrowed, or cerebriform. Apparently the descriptions of *M. gracilis* were taken from dried specimens and those of *M. muscicola* from fresh plants. This doubtless explains part of the differences in color and size. It is to be noted that both smooth and uneven hymenia are recorded in a number of collections of *M. muscicola*. There seems no valid reason for retaining these as separate species. The species is alpine and boreal and has been collected in North America, in Greenland, Labrador, Newfoundland, Alberta and Colorado.

TRICHOGLOSSUM **octopartitum** sp. nov.—Ascophoribus clavatis, 1.5–4.0 cm. altis, sursum 2–4 mm. latis, atris, hirsutis; stipibus gracilibus, 1.0–1.5 mm. latis; ascis clavatis, $175–200 \times 18–20\ \mu$; ascosporis 8, fusoideo-clavatis, fuligineis, $100–140 \times 6\ \mu$, 7-septatis (fig. 10); setis brunneis, acuminatis, $240\ \mu$ altis; paraphysibus sursum leniter incrassatis, curvatis vel circinatis, paucis septis.

Specimen typicum: San Agustin, El Cayo, British Honduras, VIII. 7, 1936, E. B. Mains (4097).

Ascophores clavate, 1.5–4 cm. high, slender, 2–4 mm. wide above, black, hirsute; stipes slender, 1–15 mm. wide; asci clavate, $175–200 \times 18–20\ \mu$. Ascospores fusoid-clavate, attenuated toward both ends from above the middle, $100–140 \times 6\ \mu$, usually 7-septate; setae brown, acuminate, up to $240\ \mu$, projecting considerably above the hymenium; paraphyses slightly exceeding the asci, somewhat enlarged at the apices, curved or circinating, sparsely septate.

On ground, San Agustin, El Cayo, British Honduras, August 7, 1936, E. B. Mains (4097, type); Cades Cove, Smoky Mountains National Park, Tennessee, August 31, 1938, L. R. Hesler and A. H. Smith (10742).

This species is closely related to *Trichoglossum hirsutum* (Pers.) Boud. The latter has 15-septate ascospores. The other species of *Trichoglossum* with 7-septate ascospores have spores which are shorter and clavate or cylindric instead of being attenuated toward both ends from slightly above the middle as in *T. hirsutum* and *T. octopartitum*.

HERBARIUM,
UNIVERSITY OF MICHIGAN,
ANN ARBOR, MICHIGAN

Fig. 1–10.—Fig. 1. Two ascophores of *Cudonia monticola,* photographed from dried specimens, ×2.—Fig. 2. Two ascophores of *Cudonia grisea,* photographed from fresh specimens by A. H. Smith, ×2.—Fig. 3. Photograph of the drawing accompanying the type of *Cudonia orientalis,* ×1.—Fig. 4. Ascophores of the type specimen of *Cudonia orientalis,* ×2.—Fig. 5. Ascophore of specimen identified as *Cudonia convoluta* (Yasuda 380), ×1.—Fig. 6. Pileus of the same enlarged ×2.—Fig. 7. Ascospores of *Geoglossum pygmaeum,* ×500.—Fig. 8. Asci and paraphyses of *Geoglossum pygmaeum,* ×400.—Fig. 9. Head of an ascophore of *Mitrula gracilis* (×10) collected by C. H. Kauffman, Tolland, Colorado, September 14, 1920.—Fig. 10. Ascospores from the type specimen of *Trichoglossum octopartitum,* ×500.

LITERATURE CITED

DURAND, E. J. 1908. The *Geoglossaceae* of North America. Ann. Mycol. 6: 387–477. 22 pl.

———. 1921. New or noteworthy *Geoglossaceae*. Mycologia 13: 184–187.

HENNING, E. 1885. Bidrag till svampfloran i Norges sydligare fjelltrakter. no. 5: 49–74.

IMAI, S. 1936. Studies in the *Geoglossaceae* of Japan. III. The genus *Cudonia*. Bot. Mag. Tokyo 50: 671–676.

KANOUSE, BESSIE B. 1936. Notes on new or unusual Michigan *Discomycetes* III. Papers Michigan Acad. Sci. Arts and Letters 21: 97–104. 1 pl.

KARSTEN, P. A. 1883. Fragmenta mycologia. Hedwigia 22: 17–18.

KAUFFMAN, C. H. 1921. The mycological flora of the higher Rockies of Colorado. Papers Michigan Acad. Sci. Arts and Letters 1: 101–150. 5 pl.

LLOYD, C. G. 1916. The *Geoglossaceae*. Mycological Writings. 24 pp.

———. 1916b. Mycological Writings. Letter 63. Note 504. p. 15.

———. 1923. Mycological Writings 7: 1230 (fig. 2568).

MAINS, E. B. 1935. Michigan fungi I. Papers Michigan Acad. Sci. Arts and Letters 20: 81–93. 5 pl.

SEAVER, F. J. 1911. Studies in Colorado fungi I. *Discomycetes*. Mycologia 3: 57–66.

SINDEN, J. W., AND H. M. FITZPATRICK. 1930. A new *Trichoglossum*. Mycologia 22: 55–61. 1 pl.

MACROSPOROGENESIS AND EMBRYOLOGY OF PORTULACA OLERACEA[1]

D. C. Cooper

ROCÉN (1927) BRIEFLY noted representative stages in macrosporogenesis, embryo sac formation and embryology of *Portulaca oleracea* L. and found that the course of development in this species was similar to that found in seven other members of the Portulacaceae. The mature embryo sac had earlier been described by d'Hubert (1896) who mentions the inclusion of starch grains.

Buds of various ages, open and withered flowers, and a series of stages in the development of the fruits were collected from plants growing along the roadsides near the campus of the University of Wisconsin and fixed in a number of standard fixing solutions. The best series of stages was obtained from material fixed in Karpechenko's modification of Nawaschin's solution. The material was embedded in paraffin, and sections 10 to 12 μ in thickness were cut, mounted serially and stained in either Delafield's or Erhlich's haematoxylin. The stages showing fertilization were obtained from withered flowers which were collected about noon on a bright day. The ovary walls were cut away in order to obtain rapid penetration of the fixing agent. This particular material was cut at 15 μ.

DEVELOPMENT OF THE OVULE.—The ovary of *Portulaca oleracea* L. consists of two carpels with a small placenta on the axillary wall of each. The ovules appear as rounded protuberances from the surface of the placenta. The archesporial cell, a subepidermal cell, is differentiated and shortly thereafter the inner integument appears, beginning as an outgrowth of the epidermis on one side of the ovule and within 3 or 4 cells of its apex (Pl. I, fig. 1). Adjacent epidermal cells at the same level become meristematic until ultimately a complete ring of cells grows outward and forward. This ring of cells grows beyond the apex of the nucellus for some distance and its inner surface forms the micropyle of the mature ovule. At maturity the inner integument is two layers of cells in thickness at its base and ranges from 3 to 5 layers of cells in thickness in the region of the micropyle.

The outer integument likewise arises as a meristematic outgrowth of the epidermis of the ovule. Its place of origin is immediately basal to that of the inner integument. The outer integument grows forward slowly and never reaches the point where its apex takes any part in the formation of the micropyle (fig. 12). It remains two layers of cells in thickness throughout its development.

The entire ovule grows more rapidly on one side and thus bends back upon itself so that at maturity its micropyle is adjacent to the apex of the funiculus. The mature ovule assumes a campylotropous-anatropous position. The bend of the embryo sac is in the region of the antipodals rather than in its midregion as is characteristic of campylotropous ovules. The nucellus, especially in the apical region, develops rapidly at later stages in the maturation of the ovule and there are several layers of cells between the embryo sac and the micropyle at the time of fertilization (fig. 15). The funiculus elongates greatly during this course of development, and at maturity its length from base of ovule to placenta approximates that of the ovule. At the same time the placenta shrinks in size and only a vestige of it remains when the ovule is mature.

The archesporial cell (fig. 1) divides to form a primary parietal cell and a primary sporogeneous cell (fig. 2). The latter cell elongates until it is fully twice as long as wide and the nucleus maintains a central location (fig. 3). The chalazal end of the cell is somewhat rounded and is much narrower than the micropylar end. While the nucleus is passing through the heterotypic prophases which are similar to those described for microsporogenesis (Cooper, 1935a) the cytoplasm remains finely vacuolate with the exception of one or two large vacuoles between

[1] Received for publication February 28, 1940.

Paper from the Department of Genetics (no. 261), Agricultural Experiment Station, University of Wisconsin. Published with the approval of the Director of the Station.