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TWO NEW SPECIES OF CONIDIOBOLUS FOUND IN PLANT DETRITUS[1]

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ABSTRACT

DRECHSLER, CHARLES. (Plant Industry Sta., Beltsville, Md.) Two new species of Conidiobolus found in plant detritus. Amer. Jour. Bot. 47(5): 368–377. Illus. 1960.—By canopying Petri plates of maize-meal agar with small quantities of friable or mealy plant detritus 2 new species of *Conidiobolus*, both of moderate dimensions, were isolated. They are described as *C.* **incongruus** and *C.* **multivagus.** The former, obtained from leaf mold collected in Colorado, produces zygospores which with respect to their internal organization differ markedly from those of congeneric species but resemble rather closely the globuliferous zygospores of *Basidiobolus haptosporus* and *B. meristosporus. Conidiobolus multivagus*, obtained from decayed twigs of *Casuarina equisetifolia* gathered in western Florida, forms a mycelium that soon becomes conspicuously disconnected. The disconnected condition here results partly from the production of many detached slender filaments, which, by constantly withdrawing protoplasmic materials from the posterior end while elongating at the tip, migrate through the slated substratum apparently without any intake of nutrients. The detached conidia of *C. incongruus* are provided with a more prominent basal papilla than those of *C. multivagus*, though both species show equally sharp demarcation between the globose main contour of the conidium and the dome-shaped contour of the papillia.

THE 2 readily culturable entomophthoraceous fungi herein described as new members of the genus *Conidiobolus* Brefeld (1884) came to light in Petri plates of maize-meal agar canopied with small quantities of friable or mealy detritus taken up from the ground in wooded areas. Dried material of the 2 species has been deposited in the National Fungus Collection, Beltsville, Maryland; and living cultures of them have been transmitted to the American Type Culture Collection, Washington, D. C. As living cultures in the future, no less than in the past, may eventually be lost despite diligent care directed toward their maintenance, it is unfortunate that in dried agar specimens the fungi here concerned do not reveal well either their outward form or their internal organization. To compensate in part for the shortcomings of the desiccated specimens, and at the same time to set forth the more usual variations with respect to size and shape, reproductive bodies from living cultures of normal development are figured in numbers permitting some little scope for random selection.

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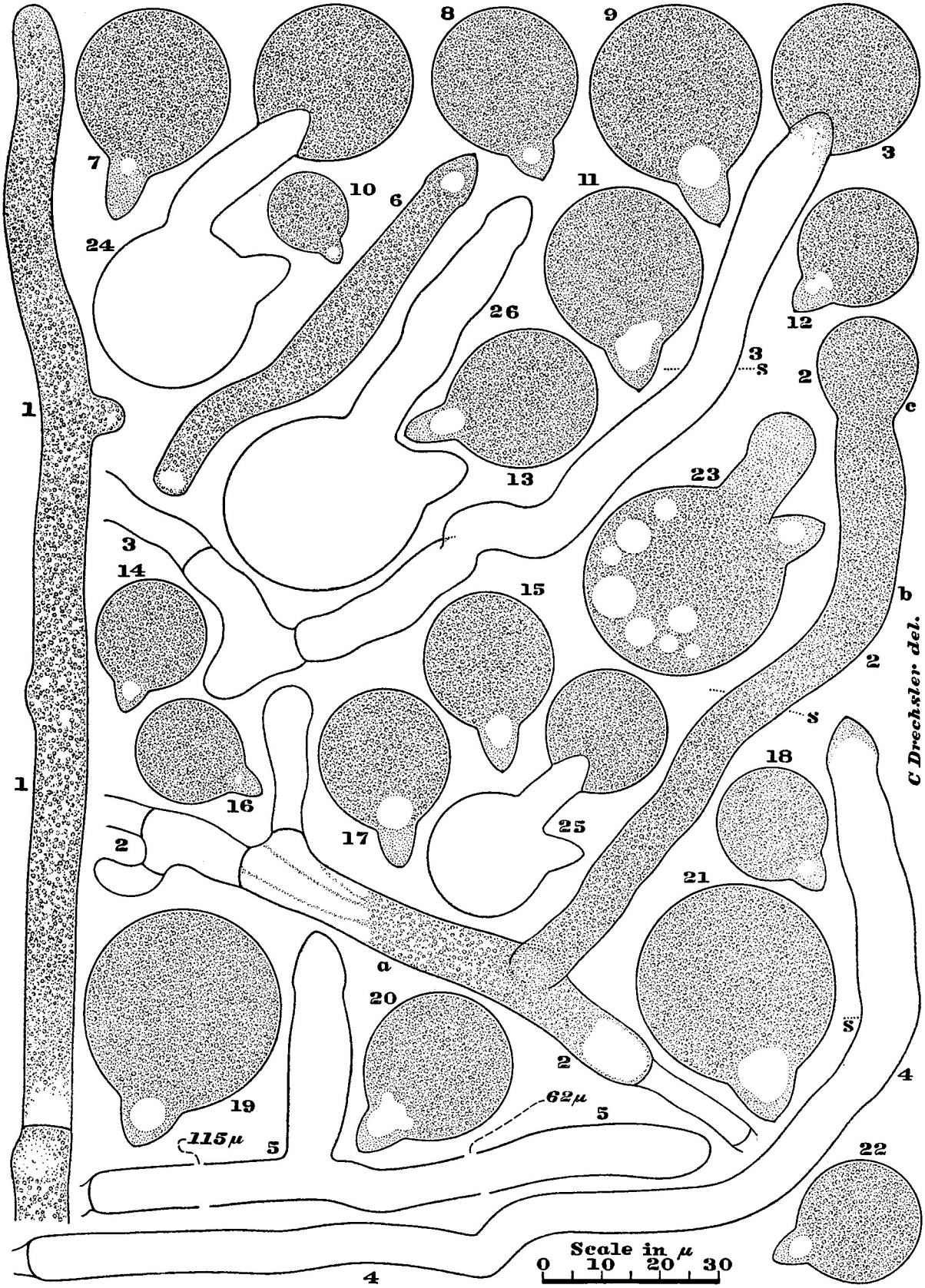
Fig. 1–26. *Conidiobolus incongruus* as found in maize-meal-agar plate culture; drawn at a uniform magnification with the aid of a camera lucida; ×1000.—Fig. 1. Terminal portion of a hypha at margin of an actively growing mycelium —Fig. 2. Submerged hypha of which a segment, a, has put forth a conidiophore, b, bearing a young conidium, c; s. surface of substratum.—Fig. 3. Conidiophore bearing a delimited conidium; s, surface of substratum.—Fig. 4. Terminal portion of a conidiophore from which a conidium has sprung off; s, surface of substratum.—Fig. 5. Empty segment of procumbent hypha bearing a short conidiophore from which a conidium has sprung off; for lack of space 2 portions of hypha 115μ and 62μ long, respectively, are omitted.—Fig. 6. Detached living cell that originated as distal part of a denuded conidiophore.—Fig. 7–22. Detached conidia showing usual variation in size and shape.—Fig. 23. Conidium in early stage of germination.—Fig. 24, 25. Two empty conidial envelopes each bearing an empty broad conidiophore surmounted by a secondary conidium ready to spring off.—Fig. 26. Empty conidial envelope with empty conidiophore from which a conidium has sprung off.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CONIDIOBOLUS **incongruus** sp. nov.[3]—Mycelium when developing on somewhat dry and only moderately rich substrata usually not readily visible to the naked eye, but under more humid conditions putting forth aerial hyphae and thereby forming a downy mantle; assimilative hyphae colorless, filamentous, branched, near the center of a mycelium consisting partly of distended segments 10–16 μ wide, in their courses toward the margin giving off branches 2–6 μ wide, at the margin of an actively growing mycelium commonly terminating in a cell 175–400 μ long and 6–9 μ wide, from which penultimate cells mostly 50–150 μ long are delimited one after another; conidiophores colorless, simple, usually extending 30–130 μ into the air toward the main source of light, mostly 5–12 μ wide, in many instances distended subapically, then being widest about 10 μ below the attachment of the conidium; conidia springing off forcibly, globose or elongate-ellipsoidal, measuring usually 13–37 μ in width and 18–42 μ in total length inclusive of the sharply demarcated basal papilla, which is mostly 3–9 μ long and 4–12 μ wide; zygospores commonly arising through union of 2 contiguous segments of the same hypha, globose or elongate-ellipsoidal, mostly 18–45 μ long and 15–40 μ wide, yellowish at maturity, then surrounded by a wall usually 1–2 μ thick, in a resting state containing a single somewhat lustrous globose central body usually 4–5 μ in diameter and many indistinct globules 1.5–3 μ in diameter.

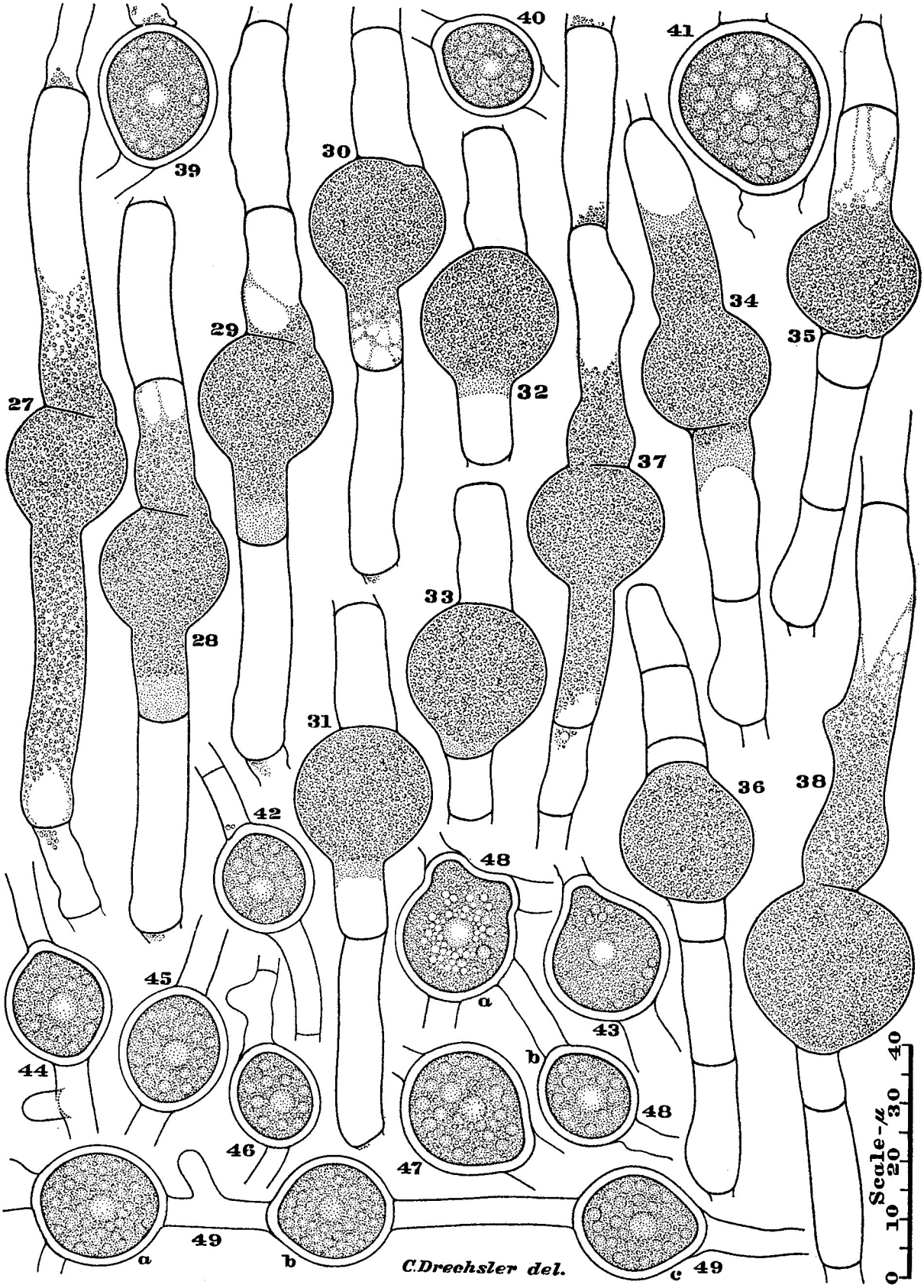
[3] Mycelium in materiis macris et aliquid siccis oculo nudo vix visibile, sed in materiis humidioribus hyphas saepe in aerem emittens, denique velamen lanuginosum ostentans; hyphae assumentes incoloratae, filiformes, ramosae, in medio mycelio saepius partim ex cellulis inflatis 10–16μ crassis constantes, in cursis diversis hic illic ramos 2–6μ latos emittentes, in margine mycelii in cellulam plerumque 175–400μ longam et 6–9μ latam abeuntes quae cellulas paenultimas 50–150μ longas deinceps abscidit; hyphae fertiles incoloratae, simplices, in aerem vulgo 30–130μ ad lucem protendentes, plerumque 5–12μ latae, interdum circa 10μ subter apicem leviter inflatae; conidia absilientia, globosa vel elongato-ellipsoidea, in toto plerumque 18–42μ longa, 13–37μ lata, basi papilla saepius 3–9μ longa et 4–12μ lata praedita; zygosporae vulgo e copulatione duarum contiguarum cellularum ejusdem hyphae oriundae, globosae vel elongato-ellipsoideae, plerumque 18–45 μ longae, 15–40 μ latae, in maturitate flavidae, muro 1–2μ crasso circumdatae, saepius uno claro globoso centrali corpore 4–5μ diametro et multis hebetioribus globulis plerumque 1.5–3μ crassis instructae.

Habitat in foliis arborum putrescentibus prope Durango, Colorado, et Fort Collins, Colorado. Typus: National Fungus Collection 71631; American Type Culture Collection 13645.

Conidiobolus incongruus was obtained from friable duff kindly gathered by Ross W. Davidson on July 3, 1958, in woods near Durango, Colorado, at an elevation of approximately 2000 m. as well as from more thoroughly decomposed leaf mold he collected a few days later in woods near Fort Collins, Colorado. The fungus would seem to have been present rather abundantly in both localities, for it developed here and there in all maize-meal-agar plates canopied with material from either source. The young mycelia escaped notice on ordinary inspection but were readily discovered when the substratum was examined by reflected light, though the luster by which their presence could be detected under such illumination was less pronounced than that presented by mycelia of various congeneric species. More extensive tracts of mycelium in older Petri plate cultures were likewise found relatively inconspicuous to the naked eye, as asexual reproductive apparatus was here commonly extended into the air only in moderate quantity. However, in sloped tubes of maize-meal agar the fungus, as a rule, is easily seen, for, owing presumably to the more humid conditions prevailing in the smaller containers, the lower portion of the surface usually becomes lightly covered with cottony mycelium, and in some instances the cottony weft spreads upward over nearly the whole slant.

Many of the hyphal segments produced, one after another, in penultimate position behind each elongating terminal segment (fig. 1) at the margin of a growing mycelium soon withdraw their contents from one or both ends, and then are found connected with their neighbors only by portions of empty tubular membrane. Some submerged segments (fig. 2a) give rise to a conidiophore (fig. 2b) which makes its way to the surface (fig. 2–4:s), grows ascendingly into the air, and then yields up its contents in forming a globose conidium (fig. 2c, 3). When the full-grown conidium has been delimited proximally by a convex partition it abruptly everts its basal membrane in springing off forcibly, thus leaving the conidiophore in a denuded state (fig. 4). A similar sequence of events leads also to denudation of conidiophores that have been extended directly into the air from procumbent hyphal segments (fig. 5). Now and then the distal portion of a denuded conidiophore retains a con-

Fig. 27–49. *Conidiobolus incongruus* as found in maize-meal-agar plate culture; drawn at a uniform magnification with the aid of a camera lucida; ×1000.—Fig. 27–33. Seven stages in the conjunction of 2 adjacent hyphal segments, drawn after successive intervals of approximately 15 minutes; the last stage represents a young zygospore.—Fig. 34–36. Three successive stages in the conjugation of 2 other adjacent hyphal segments, showing condition at intervals of approximately 20 min.; the last stage, again, represents a young zygospore.—Fig. 37. Intermediate stage in conjugation of another pair of adjacent hyphal segments.—Fig. 38. Sexual reproductive unit in which the movement of contents from the filamentous portion of the receptive segment was completed earlier than the movement of protoplasm from the contributing segment.—Fig. 39–47. Individual zygospores in resting state.—Fig. 48. Portion of mycelium with 2 zygospores, a and b, in resting condition.—Fig. 49. Portion of mycelium with three zygospores, a–c, in resting condition.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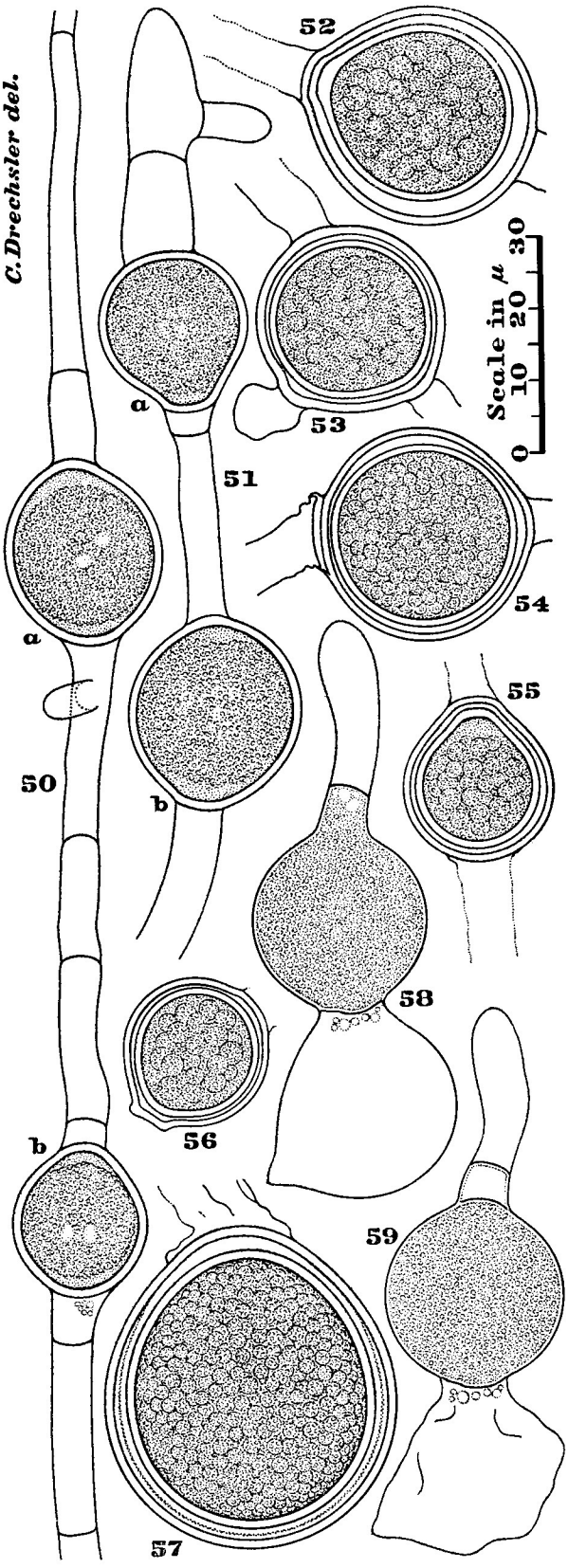
siderable quantity of protoplasm and is walled off proximally as a separate cell (fig. 6). The subapical distention observable in some conidiophores (fig. 2b, 3, 5) makes for resemblance to the somewhat less robust *C. polytocus* Drechsler (1955c).

Conidiobolus incongruus further resembles *C. polytocus* in that its detached conidia (fig. 7–22) show rather sharp demarcation between the globose main part enveloped by the peripheral membrane and the dome-shaped or paraboloid papilla surrounded by the everted basal membrane. In general the basal papilla of *C. incongruus* is more prominent than that of *C. polytocus*, its greater dimensions inviting comparison with the sharply demarcated and boldly protuberant papillae of *C. brefeldianus* Couch (1939) and *Delacroixia coronata* (Cost.) Sacc. & Sydow emend.Gallaud (1905). On moist, unoccupied substratum detached conidia of *C. incongruus* commonly germinate by extending a germ hypha that grows into a mycelium, though here in some instances, and more commonly on substratum already occupied by the fungus, they put forth a stout outgrowth (fig. 23) on which is produced a secondary conidium (fig. 24, 25) that eventually springs off, leaving behind the empty membrane of its parent (fig. 26). Through recurrent repetitional development, conidia of generally small dimensions come into being (fig. 10). Formation of microconidia through the multiplicative reproduction noted in *D. coronata*, in *C. brefeldianus*, and most abundantly in *C. polytocus*, has so far not been observed in *C. incongruus*. Nor has the fungus been seen producing elongated conidia of the type formed in 7 congeneric species—among them most copiously in *C. heterosporus* Drechsler (1953b)—on slender conidiophores sent up from detached conidia.

Sexual reproduction proceeds plenteously in maize-meal-agar cultures of *Conidiobolus incongruus*, being initiated as a rule within 2 days after inoculation, and continuing usually for about 10 days. Conjugation most commonly takes place between 2 adjacent segments of the stouter mycelial filaments (fig. 27–38), though rather slender branches are included in some reproductive units. An open passageway is established usually in a lateral protrusion at the junction of the paired cells, so that in profile view an aperture 3–4 μ wide can often be seen at the periphery of the dividing cross-wall (fig. 27, 34, 37, 38). A globose swelling is formed at the end of one segment and immediately adjacent to the aperture. It gradually enlarges as it receives protoplasmic materials from both cells. Successive stages in the transfer of materials are accompanied by formation of retaining walls (fig. 28, 29, 35, 36) in both the contributory and the receptive segment. When the contributory segment has become emptied the passageway is closed by deposition of a membrane which at first (fig. 30, 35) is noticeably out of alignment with the main cross-wall but later merges indistinguishably with it (fig. 31, 32, 36). After the filamentous portion



of the receptive segment has also yielded up its contents a wall is laid down across the full width of the hypha as a definitive boundary of the fusion cell (fig. 33, 36). Most often the fusion cell, or young zygospore, is delimited earlier from the contributory segment than from the filamentous portion of the receptive segment (fig. 30, 35), but in some instances (fig. 38) this sequence is reversed. In either event the fusion cell thereupon rather slowly undergoes the internal reorganization entailed in maturation. The ripe zygospores show less uniformity of structure than those of congeneric species. When formed under cultural conditions apparently favorable for normal development they commonly reveal near the center a somewhat lustrous body 4–5 μ in diameter, and disclose less distinctly many smaller globules distributed haphazardly through the granular protoplasm (fig. 39–47; 48a,b; 49a–c).

Certainly with respect to their internal structure the resting zygospores of *Conidiobolus incongruus* differ conspicuously from the homologous reproductive bodies produced by the 10 other members of the genus whose sexual development has been observed. In all these 10 congeners—they include besides *C. utriculosus* Brefeld (1884) and *C. brefeldianus* the 8 species I described (Drechsler, 1953a, 1954, 1955b, 1957a) under the binomials *C. lamprauges, C. thromboides, C. rhysosporus, C. osmodes, C. rugosus, C. nanodes, C. paulus,* and *C. undulatus*—the ripe zygospore shows a single large reserve globule lying, often somewhat eccentrically, within a parietal protoplasmic layer of nearly homogeneous texture. A large reserve globule and a clear parietal layer were figured by Brefeld (1881) and Thaxter (1888) in illustrating the zygospores of *Entomophthora sphaerosperma* Fres. (= *E. radicans* Bref.); by Thaxter, further, in illustrating the zygospores of his *E. apiculata*, his *E. americana*, and his *E. rhizospora;* and more recently by Hall and Dunn (1957) in illustrating the resting spores of the parasites they described under the binomials *Entomophthora obscura, E. ignobilis, E. exitialis,* and *E. virulenta.* Internal structure much like that usual in the zygospores of *C. incongruus* is found rather commonly in *Basidiobolus ranarum* Eidam (1886) as well as in the congeneric *B. meristosporus* Drechsler (1955a, fig. 2, T, W, Z) and *B. haptosporus* Drechsler (1956, fig. 4, K, L), for many zygotes of these fungi remain long in a globuliferous state during their resting period. Since the figures that Fairchild (1896, pl. 14, fig. 15, 16) prepared from stained specimens give adequate reason for recognizing the globose body visible near the center in unstained living zygospores of *B. ranarum* as the fusion nucleus, the similar globose body in unstained living zygospores of *C. incongruus* would seem to invite a like interpretation. At all events the sexual spores here differ so markedly from those of congeneric species that a term expressive of disagreement may serve appropriately as specific epithet.

In many cultures of *Conidiobolus incongruus* are found some apparently immature zygospores (fig. 50–51a,b), which, though surrounded by a fairly thick wall, are still filled, except in their clear polar regions, with protoplasm of finely granular texture. Near the center of the finely granular protoplasm 2 or 3 slightly lustrous parts are indistinctly visible, their position suggesting that they may be of moment in forming the nucleus-like globose body present in mature specimens.

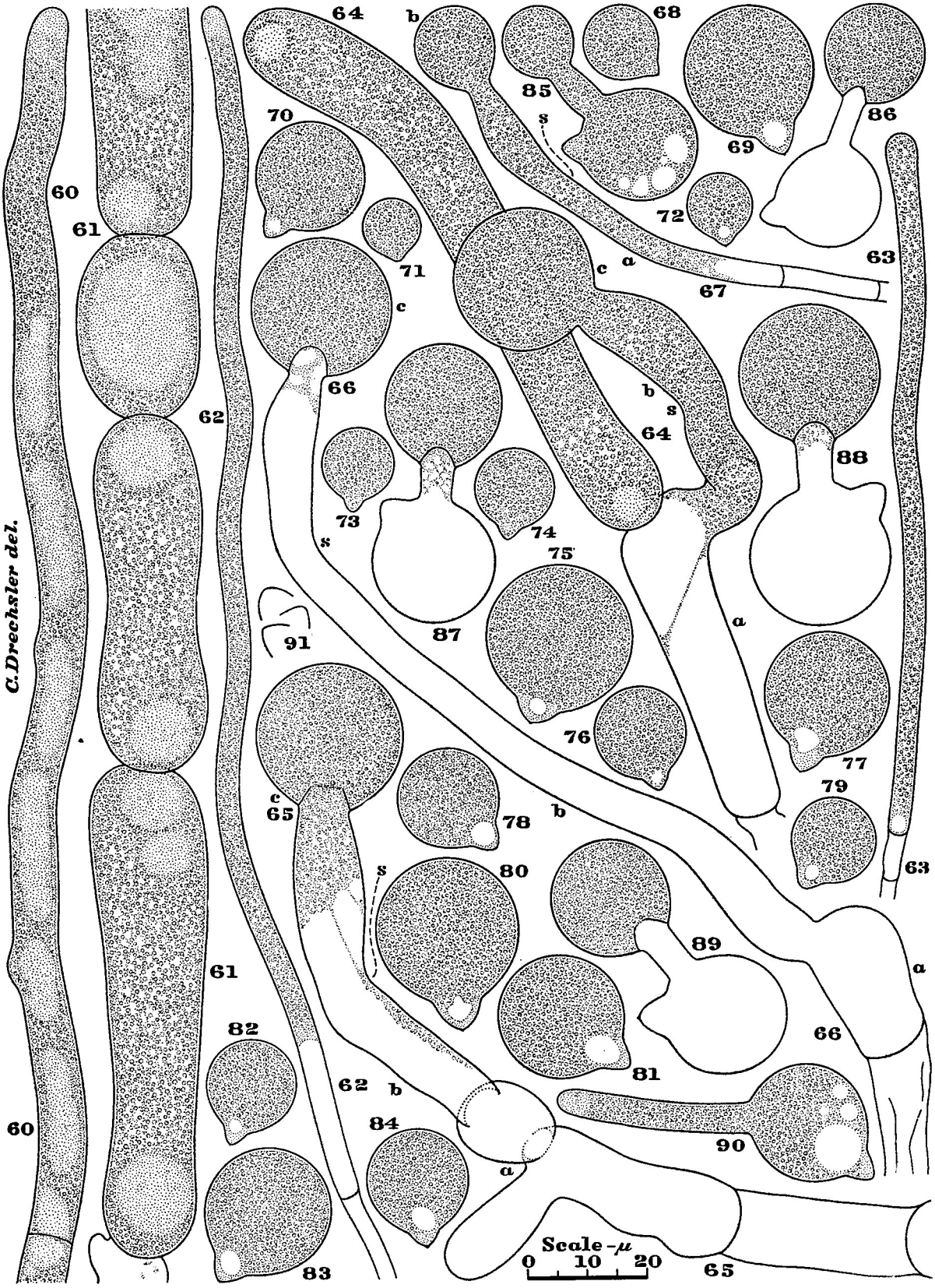
Zygospores filled with strongly globuliferous protoplasm and surrounded by 2 walls (fig. 52–57) are often encountered in old Petri-plate cultures of *Conidiobolus incongruus.* It seems probable that loss of water from the substratum leads to shrinkage of zygospore contents, thereby requiring deposition of a second wall. In aging cultures, too, a conidium occasionally gives rise to a zygospore in the proximal portion of a germ hypha 25–50 μ long (fig. 58). A zygote of such origin (fig. 59) bears a collapsing conidial envelope at one end and an empty tubular hyphal membrane at the other.

CONIDIOBOLUS **multivagus** sp. nov.[4]—Mycelium inconspicuous to the naked eye; assimilative hyphae colorless, filamentous, branched, near the center of a mycelium composed partly of distended cells 10–20 μ wide, in their radiating courses giving off

[4] Mycelium oculo nudo inconspicuum; hyphae assumentes incoloratae, filiformes, ramosae, in medio mycelio partim in cellulis inflatis 10–20 μ crassis constantes, in margine mycelii in cellulam vulgo 200–350 μ longam et 6–9 μ latam abeuntes quae cellulas paenultimas 30–150 μ longas deinceps abscidit; hyphae vagae ex ramulis mycelii et tubulis conidiorum germinantium numerosissime oriundae, continuae, simplices, saepius quasi rectae, plerumque 50–300 μ longae, 1.8–4.5 μ latae; chlamydosporae et aliae inertes cellulae rotundo-cylindraceae vel globosae, plerumque 20–70 μ longae et 10–25 μ latae; hyphae fertiles incoloratae, saepe simplices, in aerem vulgo 20–75 μ ad lucem protendentes, in parte aeria aliquid inflatae, plerumque 10–15 μ subter apicem latissimae, ibi 7–12 μ latae, alibi 4–9 μ latae; conidia violenter absilientia, incolorata, globosa sed basi papilla plerumque 2–5 μ alta et 4–8 μ lata praedita, primo ex toto 12–29 μ longa et 10–25 μ lata, mox deinceps renascentia, postremo aliquando tantum 5 μ longa et 4 μ lata.

Habitat in ramulis putridis *Casuarinae equisetifoliae* prope Bradenton, Florida. Typus: National Fungus Collection 71630; American Type Culture Collection 13646.

Fig. 50–59. *Conidiobolus incongruus* as found in maize-meal-agar plate cultures; drawn at a uniform magnification with the aid of a camera lucida; ×1000.—Fig. 50, 51. Two portions of hyphae, each bearing 2 zygospores, a and b, filled with granular rather than with globuliferous protoplasm.—Fig. 52–57. Zygospores from cultures 47 days old, showing globuliferous contents surrounded by a secondary wall formed loosely within the primary zygospore wall.—Fig. 58. Conidium that after putting forth a short germ hypha served as the contributing cell of a sexual reproductive unit.—Fig. 59. Same conidium 20 min. later, after definitive delimitation of the young zygospore.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some lateral branches 2–6 μ wide, at the margin of a mycelium growing by apical elongation of a terminal cell commonly 200–350 μ long and 6–9 μ wide, from which are successively delimited penultimate segments, mostly 30–150 μ long, that in many instances through withdrawal of contents from one or both ends become contracted into somewhat inactive bodies (rounded cylindrical cells and globose chlamydospores) mostly 20–70 μ long and 10–25 μ wide; migratory hyphae filamentous, unicellular, usually 50–300 μ long and 1.8–4.5 μ wide, in many instances formed early and abundantly as branches on assimilative segments and as germ hyphae extended from detached conidia; conidiophores arising singly from assimilative hyphal segments and chlamydospores, usually extending 20–75 μ into the air toward the main source of light, 7–12 μ in diameter in widest part 10–15 μ below attachment of conidium, elsewhere 4–9 μ wide; conidia colorless, springing off forcibly, commonly 10–25 μ in width and 12–29 μ in total length inclusive of a sharply demarcated dome-shaped basal papilla 2–5 μ high and 4–8 μ wide, but after many generations of repetitional development sometimes only 5 μ long and 4 μ wide.

Conidiobolus multivagus was isolated from a pinch of well-rotted detritus taken on April 15, 1959, from a bed of fallen twigs forming a thick ground cover under a dense windbreak of beefwood (*Casuarina equisetifolia* Linn.) trees at Cortez, near Bradenton, Florida. Its young mycelia were detected by the lustrous appearance that the areas occupied by them presented when the canopied isolation plate cultures were examined by reflected light. The mycelial hyphae and asexual reproductive apparatus it forms on Lima-bean agar (fig. 60–91) seem approximately as normal as those produced on maize-meal agar (fig. 92–128), though on the richer substratum some related species show pronounced vacuolation and early degeneration. On both substrata the main hyphae at the periphery of an expanding mycelium are usually about 7.5 μ wide. In general the elongating segments terminating these hyphae are shorter and more crooked in Lima-bean agar cultures (fig. 60) than in maize-meal agar cultures. Some hyphal segments at the center of a mycelium that has developed on the richer substratum may measure fully 20 μ in width (fig. 61), whereas on maize-meal agar few distended segments will ordinarily exceed a diameter of 15 μ.

While a mycelium of *Conidiobolus multivagus* is still actively expanding many hyphal segments only a few millimeters from the advancing forefront withdraw their contents from one or both of their ends. In Petri-plate cultures this contraction soon results in numerous plump resting cells (fig. 92a,b; 93a,b; 94a,b; 95–99) of rounded cylindrical shape, whose increased width commonly equals one-fourth to one-half of their diminished length. Here and there, especially in test-tube cultures, the contraction of contents, with attendant deposition of successive retaining walls, continues until the living cell has acquired the prolate ellipsoidal or globose shape (fig. 100–105) usual in chlamydospores. Because of their granular rather than globuliferous contents the resulting bodies resemble more closely the chlamydospores of *C. chlamydosporus* Drechsler (1955c) than those of *C. inordinatus* Drechsler (1957b). Owing to their usually intercalary origin they resemble somewhat also the hyphal bodies discussed and illustrated by Thaxter (1888, p. 167, fig. 92) in the account of his *Empusa caroliniana*.

As the portions of tubular membrane emptied in the contraction of hyphal segments gradually evanesce the mycelium presents a more and more disconnected appearance. In many though not in all cultures the disconnected state is soon augmented through the production of numerous migratory hyphae (fig. 62, 63, 106–111). These hyphae originate in *Conidiobolus multivagus* not only as germ hyphae extended from conidia that have fallen on substratum already occupied by the fungus, but also as branches given off by assimilative filaments. They elongate at the tip by constantly withdrawing protoplasmic materials from the proximal end, apparently not replenishing their substance by absorbing nutrients from the agar surrounding them. As they move forward they necessarily leave behind an empty tubular membrane, which at once becomes subject to disintegration. The rapidity with which the membrane disintegrates has such relation to the rate of forward movement that the portion of hyphal envelope remaining visible at the rear of migrating cells commonly varies in length between 25 and 100 μ. In many cultures 5 days old, the migratory cells taken together would seem greatly to exceed in volume all other living parts. Wholly detached

Fig. 60–91. *Conidiobolus multivagus* as found in Lima-bean-agar plate cultures; drawn at a uniform magnification with the aid of a camera lucida; ×1000.—Fig. 60. Terminal segment of an elongating hypha at the margin of a growing mycelium.—Fig. 61. Hypha with strongly distended segments found in central region of a mycelium 20 mm. in diameter.—Fig. 62, 63. Migratory hyphae in culture 11 days old.—Fig. 64–66. Asexual reproductive units at different stages of development, each consisting of a hyphal segment, a, from which has been extended a conidiophore, b, bearing a conidium, c; s, surface of substratum.—Fig. 67. Smaller conidiophore, a, with its young conidium, b, formed terminally on a hypha that may have concluded a period of migration.—Fig. 68–84. Detached conidia showing usual variations in size and shape.—Fig. 85. Conidium giving rise to a secondary conidium.—Fig. 86–89. Conidia that have each given rise to a secondary conidium, which now is ready to spring off.—Fig. 90. Detached conidium with short germ tube.—Fig. 91. Convex membranous pieces, each representing the distal wall of a denuded conidiophore after evanescence of the tubular envelope.

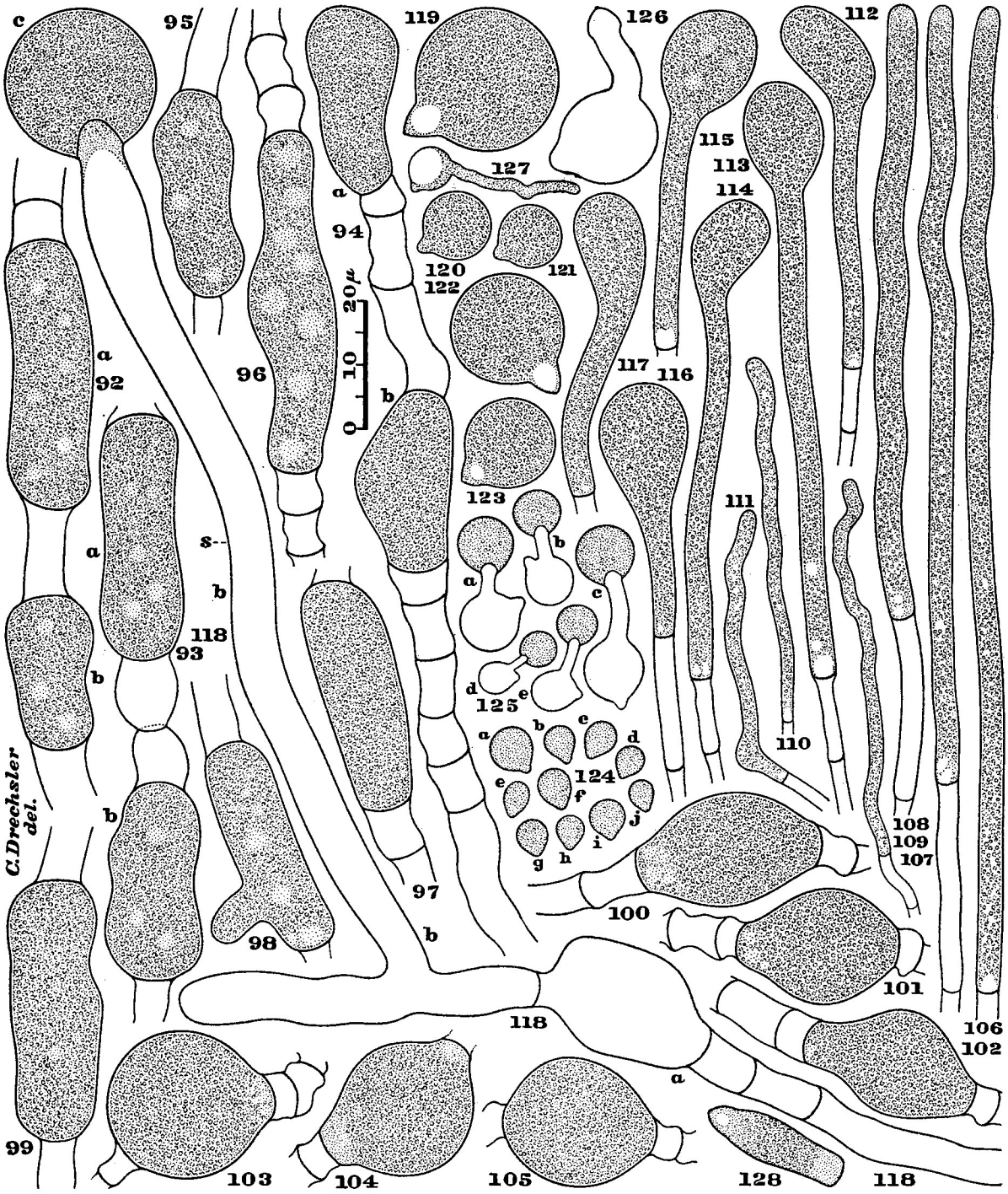

Fig. 92–128. *Conidiobolus multivagus* in maize-meal-agar cultures; drawn with aid of a camera lucida; ×1000.—Fig. 92–94. Portions of hyphae in plate culture 13 days old, each showing 2 contracted inactive cells, a–b.—Fig. 95–99. Portions of hyphae from same culture, each with an inactive cell.—Fig. 100–105. Chlamydospores from tube culture 15 days old.—Fig. 106–108. Migratory hyphae from plate culture 11 days old.—Fig. 109–111. Small migratory hyphae from culture 25 days old.—Fig. 112–117. Clavate hyphae from a plate culture 13 days old, each presumably having concluded a period of migration.—Fig. 118. Empty envelope of a chlamydospore, a, which after removal from a 15-day-old tube culture and shallow irrigation with distilled water, extended a conidiophore, b, now bearing a conidium, c; s, surface of substratum.—Fig. 119–123. Detached conidia.—Fig. 124. Small conidia, a–j, from plate culture 25 days old.—Fig. 125. Small conidia, a–e, from same 25-day-old culture, each supporting a smaller secondary conidium.—Fig. 126. Empty denuded envelope of parent conidium after daughter conidium sprang off.—Fig. 127. Small conidium with slender germ tube.—Fig. 128. Cell formed in distal portion of a denuded conidiophore.

from their respective origins, they move through the staled substratum in rather disorderly array and with apparently haphazard orientation. After several days of migration they may form an enlargement at the tip and come to rest as clavate bodies of various shapes and sizes (fig. 112–117). On being transferred to a fresh nutrient substratum they promptly resume growth and give rise to new mycelia. Asexual reproduction by development of conidiophores and conidia commonly ensues when portions of old agar cultures containing either filamentous migratory cells or clavate bodies are irrigated with distilled water. Following such irrigation any contracted resting cell or any chlamydospore (fig. 118a) present in the substratum may likewise put forth a conidiophore (fig. 118b) bearing a globose conidium (fig. 118c).

In *Conidiobolus multivagus*, as in most related fungi, asexual reproduction begins early, when scattered hyphal segments (fig. 64–66a) in young assimilative mycelia give rise to single phototropic conidiophores (fig. 64–66b; 67a) which resemble those of *C. incongruus* and *C. polytocus* in being inflated some little distance below the attachment of the globose conidium (fig. 64–66c; 67b). After springing off through eversion of the basal membrane the conidia (fig. 68–84, 119–123) show further resemblance to the 2 species mentioned in the sharp demarcation between the main globose contour and the contour of the dome-shaped papilla. With respect to dimensions the papilla here differs little from that of *C. polytocus*, but is noticeably less prominent than that of *C. incongruus*. Multiplicative reproduction by development of plural microconidia, which is especially abundant in *C. polytocus*, has not so far been observed in *C. multivagus*, though in maize-meal-agar cultures 20–30 days old it is not unusual to observe conidia that are smaller (fig. 124a–j) than the primary microconidia of congeneric fungi. Evidently these minute spores result from the prolonged sequence of repetitional development that begins with the production of secondary conidia from large primary ones (fig. 85–89), and continues through many successive generations until the descendants are of conspicuously small size (fig. 125a–e). The empty membranous envelope of each parent conidium (fig. 126) retains its shape for some time, but later collapses and eventually disappears. Whether it is large (fig. 90) or small (fig. 127) a conidium of any generation may germinate by putting forth a vegetative hypha, which on fresh substratum grows into a young mycelium, but in an old culture, as has been intimated, usually goes forth as a migratory cell. On the surface of cultures at least a few days old are occasionally found scattered some membranous cap-like pieces (fig. 91), each consisting of the distal wall of a denuded conidiophore. In such cultures can likewise be observed now and then an elongated living cell that from its bullet-shaped tip (fig. 128) manifestly represents the distal part of a denuded conidiophore in which a considerable quantity of protoplasm was retained.

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