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A WORLD-MONOGRAPH OF THE GENERA ASCOBOLUS AND SACCOBOLUS (ASCOMYCETES, PEZIZALES)

BY

J. VAN BRUMMELEN

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INTRODUCTION

Since the genus *Ascobolus* was established in 1791, several more genera of Ascobolaceae with coloured ascospores became known, each with a fair number of species.

Some species previously described in other genera were later recognized to belong to the Ascobolaceae and a large number of new species, subspecies, varieties and forms have been described through the years. Numerous species of *Ascobolus* have been described as new simply because the same fungus was found on a different substratum or because its asci opened by an operculum. Others were described several times under different names because of the lack of a complete survey and inadequate knowledge of specific variability. This has also led to many erroneous interpretations and identifications.

For these reasons it has appeared that many specific names have to go into synonymy.

As most of the descriptions are insufficient to recognize the species, a study of the original material was necessary. Only in recent times a beginning has been made with the revision of such material.

In the present work a revision is given of the taxa belonging to the genera *Ascobolus* and *Saccobolus*, two genera forming a sharply delimited, natural group in the Ascobolaceae. Special attention has been paid to the development and the microscopic structures of these fungi in connection with the relationships within the genera.

In many cases authentic specimens have been seen by the author. In cases where obviously no type specimens are in existence illustrations and descriptions sometimes have helped in recognizing the species. Several species, however, are only known from short descriptions in which essential characters are lacking. Their names are included in the list of nomina dubia.

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A. GENERAL PART

CHAPTER I

HISTORICAL SURVEY

The genus *Ascobolus* was established by Persoon in 1791 for *Ascobolus pezizoides*, a dung-inhabiting cup-fungus, which differed from species of *Peziza* in possessing clearly visible and far protruding coloured tips of ripe asci. The generic name *Ascobolus* was given by Persoon, because he was of the opinion that the asci were shot away in toto.

In 1794 Persoon added two other species, while two years later he described *Ascobolus carneus*, a species with hyaline ascospores. Further species were incorporated in the genus by other workers such as von Albertini & von Schweinitz (1805), Bivona Bernardi (1816), and Schmidt (1817).

In 1822 Persoon included seven species in *Ascobolus* and in the same year Fries enlarged the number to eleven. Gradually the genus was extended with some more species by Fries (1828), Wallroth (1833), Berkeley (1836), and Preuss (1851).

Mycological interest was focused on the genus *Ascobolus* in 1857 when the Crouan brothers discovered species of this genus in which the opening mechanism of the ascus was by means of a terminal operculum. The numerous investigations in different countries that followed after this discovery greatly increased the number of species described in this genus.

The Crouan brothers (1857, 1858), who contributed so much to the knowledge of the genus *Ascobolus*, considered the presence of an operculum at the apex of the ascus to be the distinguishing character of this genus. All species which they found possessing asci with an operculum were put into the genus *Ascobolus*. Owing to this, among the species of *Ascobolus* they described from Finistère, several elements were introduced which did not show a direct relationship with the original species.

Karsten (1861) gave a brief survey of the species found in Finland.

Coemans (1862) made a study of the species found in Belgium. He was the first to describe the development of the fruit-bodies and the staining of the ascus wall with iodine in a number of species.

Cooke (1864) listed fifteen species for Britain, and divided the genus in three "subdivisions" according to the nature of the surface of the fruit-bodies.

De Notaris (1864) described three new species from Italy.

Berkeley & Broome (1865) reported seventeen species from the British Isles among which two were new to the genus.

Among the twenty-four species recorded by Fuckel (1866b) from the surroundings

of Oestrich in Germany seven were new to the genus. Most of his species had been distributed earlier in his "Fungi rhenani exsiccati".

In a flora of Finistère the Crouan brothers (1867) again described five new species.

From the surroundings of Leipzig in Germany Auerswald (1868) described three species from the dung of dogs.

By far the best monograph on these fungi has been written by Boudier (1869). His "Mémoire sur les Ascobolés" has been the base for most of the later studies in this group. It is still a most valuable source of information, especially on account of the accurate illustrations.

Boudier succeeded in isolating a natural group from the heterogeneous agglomeration of species that had been classified in *Ascobolus*. He also grouped the species that seemed to be intermediate between the 'true Ascobolei' and the "Pezizes".

The "Ascobolei" were characterized by the possession of large operculate asci the tips of which protrude above the hymenium. He divided the "Ascobolei" into two groups: the "Ascobolei genuini" with coloured ascospores and the "Ascobolei spurii" with hyaline ascospores. Under the "Ascobolei genuini" he placed the genera *Angelina*, *Ascobolus*, and *Saccobolus*. Under the "Ascobolei spurii" he placed the genera *Thecotheus*, *Rhyparobius*, and *Ascophanus*.

The genus *Angelina* was known to Boudier only from literature and he rightly doubted the correctness of its classification in this group. He restricted the genus *Ascobolus* to those species which have free ascospores. Sometimes these ascospores become glued together but they are never surrounded by a common membrane. The genus *Saccobolus* was introduced for those species in which the ripe ascospores are surrounded by such a membrane. Besides, the paraphyses in *Saccobolus* are shorter than those in *Ascobolus*. In the genera *Ascobolus* and *Saccobolus* several new species were described by Boudier.

In his "Symbolae mycologicae", Fuckel (1870), ignorant of Boudier's work, placed the genus *Ascobolus* in the family "Bulgariacei", distinguishing its species according to the colour of the ascospores and the structure of the outside of the fruit-bodies.

Shortly after Boudier's monograph Karsten (1870) published a monograph of the species of *Ascobolus* from Finland, in which twenty-two species and five subspecies were described. Most of his new species were already published and distributed in his "Fungi Fenniae exsiccati" (Karsten, 1866–1868). Although unaware of the work of Boudier and Fuckel, he also classified the species according to the colour of the ascospores. The genus was restricted to a rather sharply delimited natural group of fungi. In his "Mycologia fennica" Karsten (1871) restricted *Ascobolus* to the species with coloured ascospores, while the species that Boudier placed under *Ascophanus* and *Rhyparobius* were brought to *Peziza* and *Pezizula* respectively. Not until many years later did Karsten (1885) adopt the generic names of Boudier.

Under the name *Peziza cunicularia* Boudier (1869: 258) described a species which differs from all other "Ascobolei" in the mechanism of dehiscence of the asci. Instead of an operculum, in this species the ascus possesses a bilabiate slit at the tip.

A number of species with a similar bilabiate fissure at the apex of the asci were found by Renny (1871, 1873). He classified these fungi in a special section *Ascozonus* of the genus *Ascobolus*.

Besides numerous small contributions to the knowledge of the coloured-spored Ascobolaceae, the work of the following authors deserves special mention because they gave a more or less complete survey of the species occurring in a restricted area: Hansen (1877) for Denmark; Spegazzini (1878) for Italy; Oudemans (1882, 1886) and Boedijn (1918) for the Netherlands; Quélet (1873, 1878, 1880, 1881, 1886), Boudier (1881, 1888, 1896, 1904–1911, 1913) and Grelet (1944) for France; Cooke (1871), Phillips (1887), Massee (1895), and Salmon & Massee (1901, 1902) for Great Britain; Heimerl (1889) for Austria; Schroeter (1893) and Rehm (1896) for Germany; Velenovský (1934, 1939, 1947) and Svrček (1957, 1959, 1963) for Czechoslovakia; Seaver (1911, 1916, 1928) for the United States.

Boudier (1885) introduced the generic name *Sphaeridiobolus* for species that differ from species of *Ascobolus* in the spherical shape of the ascospores and raised his Ascobolei to the rank of a family.

Saccardo (1889) put species of *Ascobolus* in which hairs had been recorded into a special subgenus, *Dasyobolus*. Later Saccardo (1895) raised this subgenus to the rank of a genus.

One of the great merits of Boudier was that he recognized the importance of the dehiscence-mechanism of asci in a classification of the Discomycetes and thus (1879, 1885, 1907) laid the basis for a natural classification of these fungi.

In his classification of the European Discomycetes Boudier (1907) subdivided the family of the Ascobolaceae into two tribes. In the tribe with the coloured-spored species he placed the genera *Ascobolus*, *Dasyobolus*, *Sphaeridiobolus*, *Saccobolus* and after Saccardo (1889) also the genus *Boudiera*.

Seaver (1927, 1928) gave a classification which was mainly based on artificial characters and in which, too often, related species were placed in taxonomically far remote groups.

Velenovský (1934) introduced the genera *Ornithascus* and *Anserina* and later (Velenovský, 1947) also the genus *Leporina* in the coloured-spored Ascobolaceae. The criteria for the introduction of these genera, however, are quite obscure.

Le Gal (1947) excluded the genus *Boudiera* from the Ascobolaceae and transferred it to the Humariaceae.

Until recently no attempt has been made to revise the numerous coloured-spored species of Ascobolaceae. Le Gal (1953b, 1961) examined many original collections in the herbarium of the Crouans, while the present author (van Brummelen, 1962a) investigated the collections and types in the herbarium of Spegazzini.

Several species of the genus *Ascobolus* were studied both morphologically and karyologically. Studies of the last type have led to many contradictory observations and hypotheses, and the problems in this field are still far from being solved.

As a result of systematic examination of optimum germination of the ascospores (Dodge, 1912a; Yu, 1954) and of optimum fructification and vegetative growth

(Yu-Sun, 1964) some species of *Ascobolus* became promising objects for genetical investigation.

In recent time the problem of the origin of the pigment of the ascospores was carefully studied with microscopical and simple histochemical methods. There are two theories on the origin of this pigment, which seem to be strongly contradictory. Le Gal (1942, 1947, 1963a) maintains that the layer of pigment is formed by precipitation on the ascospore-wall of two types of extremely fine granules from the ascoplasma. Chadefaud (1942b) and Malençon (1962) on the other hand assume that the pigment is present on the wall of the ascospores in the form of a leucoderivative which is converted into the violet form by simple oxidation.

CHAPTER II

MATERIALS AND METHODS

Living material was studied whenever possible, as this gives the most reliable image of the development and of the variation of the species. In some cases fruit-bodies were conserved in liquid or as microscopical preparations. The major part of the material studied consisted of dried specimens. Each kind of material required its own methods in order to obtain the maximum amount of information from it.

LIVING MATERIAL.—Since most species of the genera studied are coprophilous, a great number of samples of dung of different origin were collected and incubated to isolate fungi growing on them. Samples were taken from animals living under natural condititions, from domesticated ones as well as from those living in zoological gardens. Dung of herbivorous animals proved to be a substratum especially favoured by species of *Ascobolus* and *Saccobolus*. Fruit-bodies of a number of species were collected on the substratum in the field and taken to the laboratory for further investigation. This is in fact the only way to obtain living material of species on soil, leaves or wood.

The best method for obtaining coprophilous species is to take samples of dung to the laboratory and there watch the different organisms in culture. A layer of fresh or humidified dung, 1–4 cm thick was put into petri-dishes containing several sheets of wet filter paper. To eliminate drying up of the substratum in longlasting cultures the filter paper was placed on a layer of wet quartz-sand.

Precaution against contamination with soil-inhabiting organisms was taken by heat-sterilization of the materials used. In most of these cultures freshly collected samples of dung were used, but moderately dried samples collected during expeditions were also used after moistening. Samples not too intensely dried at temperatures not exceeding 30 °C showed a good development of coprophilous fungi when moistened, even after a period of three or four months. If the samples were preserved dry for still longer periods the number of species appearing after moistening decreased with time. After preservation in the dried state for more than a year, in general, no fruit-bodies of Discomycetes appeared after moistening. The petri-dishes with substratum were placed at temperatures between 15 and 20 °C in a room or at a temperature of 23 °C in an incubator. The dishes were so placed that they were exposed to daylight, but protected against direct sunlight.

The development of organisms in the cultures was followed from day to day. If dishes with fresh dung were incubated, the initial stages of fruit-bodies of species

of *Ascobolus* and *Saccobolus* became visible with a magnifying glass between the fifth and the eighth days.

The sequence in which the first fruit-bodies of the different species appear is always the same. Often fruit-bodies of different species were found growing intermingled, but sometimes rather large parts of the surface of the substratum were found covered with fruit-bodies of a single species.

In mixed cultures apothecia can often be found of which the hymenium and the excipulum are covered with spores shot on to them from surrounding fruit-bodies. In the past this led in some cases to confusion, as spores were ascribed to fruit-bodies of an alien species. The outside of apothecia may also be covered with hyphae and conidiophores of Hyphomycetes and, in species of which the initial stages of the fruit-bodies grow immersed in the substratum, the excipulum of the mature apothecia may still be covered with small parts of the substratum. This may sometimes give these fruit-bodies a hairy or warted appearance.

It is almost impossible to obtain homogeneous collections of species of *Ascobolus* and *Saccobolus* without the assistance of a binocular dissecting microscope with a magnification of 30 to 60 times. For the isolation of the very small fruit-bodies found in many species of these genera, microscopic investigation at even higher magnification is very desirable. If fruit-bodies of different species with closely resembling macroscopic appearances are growing together, it is essential to isolate the fruit-bodies one by one and check their identity under a microscope.

To preserve the specimens, fruit-bodies attached to a piece of substratum were dried in ascending dry air at temperatures varying between 30 and 45 °C. After drying the material was fumigated for at least twenty-four hours with carbon tretachloride to kill insects which might be present.

CULTURE PROCEDURES.—For various aspects of the study of these fungi it was desirable to have pure cultures available. For the study of the morphology and the variation of species it was not necessary to use pure cultures. In most cases a moderate purification was sufficient. A simple purification of the material was obtained by isolating a fragment of a superficially clean young fruit-body and by placing it on the sterilized substratum. Under favourable conditions mycelium developed on which young fruit-bodies were formed. Such isolates were often still contaminated with other fungi and bacteria. Often fruit-bodies of Ascobolaceae developed abundantly after such a first isolation.

The Hyphomycetes, Mucorales, and bacteria, which also grew in these cultures, rarely interfered with the structural studies of apothecia. After repeated isolation by means of a part of a fruit-body, fructification remained good in most species. With this method it was also possible to get pure cultures, if antibiotics like terramycin, streptomycin and penicillin were added to the substratum to reduce the growth of bacteria.

Another method used to isolate these fungi is based on the mechanism by which the ascospores are shot away over relatively long distances. A petri-dish with a layer

of a suitable sterilized nutrient medium was placed upside down over an apothecium or a group of apothecia with mature asci. At regular intervals the dish was turned, so that some ascospores were shot to different sectors of the dish. Sometimes the ascospores were first shot against sterilized coverglasses and from these transported one by one or in groups to the nutrient medium. After incubation of these petri-dishes with ascospores only in a few cases apothecia were formed directly. In most species of *Ascobolus* and *Saccobolus* the ascospores did not germinate without special treatment.

Janczewski (1871: 261) had already realised that for the germination of ascospores of coprophilous Discomycetes a special combination of factors is needed, i.e. those existing in the intestinal canal of animals such as a rabbit. He knew that during the passage through the intestine the ascospores swelled greatly and the exospore disappeared. He also found that spores isolated from dung germinated easily.

Zukal (1889: 570) did not succeed in bringing to germination the ascospores of *Ascobolus immersus*. Even if ascospores were given with bread to a rabbit, which was kept isolated and was fed with bread for a long time, the ascospores did not germinate. Ramlow (1915) also failed in bringing the ascospores of the same species to germination. Many other investigators (e.g. Boudier, 1869; Dodge, 1912a;Welsford, 1907) were unsuccesful with the germination of the ascospores of this and other species. Contrasting in this respect were the results of Green (1931). In his cultures the ascospores of four different species, among which was also *Ascobolus immersus*, germinated promptly without any preliminary treatment at 22 °C on the lids of petri-dishes.

Experiments by Salmon & Massee (1901, 1902) demonstrated that ascospores of a great number of coprophilous fungi pass through the intestinal canal of rabbits and sheep without any harm. Many ascospores of *Ascobolus perplexans* and *A. albidus* germinated during incubation for twenty hours at 80 °F (= 26.7 °C) in hanging drops of tap-water or dung decoction At 60 °F (= 15.6 °C) no germination could be observed. The percentage of germinating ascospores at 80 °F was considerably higher when 1 % pepsin was added to the medium.

In *Ascobolus carbonarius*, a species growing in burnt places, Dodge (1912a) found that the most favourable temperature for the induction of ascospore-germination was between 65 and 75 °C. After a treatment for three minutes at those temperatures the percentage of germinating ascospores was close to one hundred per cent. The result of experiments by Betts (1926) with the same species mainly agreed with those of Dodge, except that the optimum temperature was found to be slightly higher, at 80 °C, and the treatment was continued for a much longer period—"overnight".

According to Schweizer (1923) the optimum temperature for the induction of spore-germination of coprophilous species is between 38 and 40 °C. The treatment was continued for five or six hours. These conditions are quite similar to those existing during the passage through the intestinal canal of a rabbit, where the spores are exposed to temperatures from 39 to 40 °C during five or six hours.

In a series of more systematically planned experiments Yu (1954) studied the

most favourable conditions for ascospore-germination in some coprophilous species of *Ascobolus*. If ascospores of *Ascobolus magnificus* and *A. stercorarius* were first immersed for twenty minutes in a dilute solution of sodium-hydroxide and then incubated for twenty-four hours at 37 °C, it was found that 80–99 % germination occurred. In In *Ascobolus viridulus*, *A. immersus*, and *A. winteri* 80–99 % of the ascospores germinated at 37 °C without a preliminary treatment in an alkaline solution.

Once a pure culture was obtained it was maintained by making subcultures by means of inoculae consisting of a piece of the substratum with mycelium or with a part of a young fruit-body.

CULTURE MEDIA.—The knowledge of the different nutrients required in culture media for Ascobolaceae is still rather restricted and fragmentary. Apart form the work of Yu-Sun (1964) most of the culture work with *Ascobolus* and *Saccobolus* was carried out upon so-called natural media. Since the culture work in these genera was almost restricted to the coprophilous species, most work was done with decoctions of horse and sheep dung variously diluted and stiffened with agar.

The primary aim of my studies was to obtain a rich fructification of the species under observation rather than to analyse the factors for optimum growth. In most cases good fructification of coprophilous species was obtained on sterilized dung of horse, sheep, and rabbit. In order to kill spore-forming bacteria, 'discontinuous sterilization' according to Tyndall was applied to these substrata.

On agar media, fructification generally was rather poor, only on very thin layers and near the margin fruit-bodies were produced more frequently. The production of fruit-bodies on agar media containing decoctions of dung was greatly stimulated by placing a disk or pieces of sterile cellulose (filter-paper) on the surface (cf. Gwynne Vaughan & Williamson, 1932). When a 3 % solution of yeast extract (Difco) was added to the medium still better fructification resulted. About the same result was reached by pouring diluted decoctions of dung, enriched with yeast extract (under sterile conditions) over a thick layer of filter-paper or a beer-spill in a petri-dish.

The form and the mode of growth of fruit-bodies developed on such solid surfaces show great similarity with those of fruit-bodies found in the field. In petri-dishes having an atmosphere saturated with water vapour, air-mycelium and superficial hyphae of fruit-bodies develop more strongly. In species that possess pigment in the excipulum and among the tips of paraphyses in the hymenium, more pigment was formed in fruit-bodies collected from exposed places in the field than in fruit-bodies of the same species cultivated in the laboratory. This phenomenon was most evident in *Ascobolus roseopurpurascens* and *Saccobolus versicolor*.

Fruit-bodies developed on the semi-solid surface of agar media often deviated still more from the forms found in the field. Deficiency of certain nutrients may also cause some of the aberrations. Besides a reduced production of fruit-bodies, the size of the fruit-bodies was generally smaller also. In cases where they grew immersed in the agar medium the orientation was sometimes very irregular.

For a good fructification the acidity of the media should remain between certain

limits. On clearly acid media less fruit-bodies were produced than on neutral or weakly alkaline media. In most media the pH was between 6.0 and 7.5.

Although fruit-bodies were formed at a rather wide range of temperatures, the optimum temperature for many coprophilous species seemed to be at about 23 °C.

The formation of fruit-bodies was stimulated by light and for the production of the violet pigment on the ascospores an exposure to light during the maturation of the asci was necessary. Even in a rather late phase of maturation of the asci, when the episporia were already precipitated on the walls of the ascospores, a short exposure to light induced a change in colour of the episporial layer from greenish hyaline, through pink, to violet.

Molliard (1903a–b) found that fructification of *Ascobolus furfuraceus* was better in cultures infected by bacterial growth than in pure culture.

On most media for fructification, used thus far, the number of fruit-bodies formed in each generation gradually diminished after a certain number of isolations. A method by which the formation of fruit-bodies in species of *Ascobolus* could be maintained, made use of roll-cultures, as described by Doyer & van Luyk (1918). A thin layer of dung decoction cherry-agar was applied to the inner wall of small cylindrical culture vessels. These vessels were then inoculated with rather large parts of a fruit-body. When apothecia had formed on the inner wall of these roll-cultures a sterilized piece of the stem of lupin covered with dung decoction cherry-agar was introduced in the vessel. After some time the stem was densely covered with fruit-bodies. Further inoculation occurred by putting the stem with fruit-bodies in another vessel with an agar layer. With this method of roll-cultures a rich production of fruit-bodies could be maintained for unlimited time.

Schweizer (1923) found that in cultures of *Ascobolus citrinus* on rabbit dung decoction-agar the number and the size of the fruit-bodies was greatly increased by adding a very small quantity of egg-albumin to the medium. On places where drops of albumin were placed after about four days giant fruit-bodies appeared. Addition of asparagine or inulin to the medium (Schweizer, 1932) also strongly increased the fructification.

Another method of obtaining rich fructifications of coprophilous fungi was described by Schweizer (1929). Roughly ground dung tablets were pressed, so that they neatly fitted into a petri-dish. These tablets were covered by a layer of mull and sterilized dry. Before inoculation the tablets were moistened with water or with a nutrient solution.

Of great importance for the study of species of *Ascobolus* is the recent description by Yu-Sun (1964) of a synthetic nutrient medium for optimum vegetative growth and formation of fruit-bodies of two compatible strains of *Ascobolus immersus*. Both strains she used were deficient in the synthesis of biotine and thiamine. She was able to show that dextrine, soluble starch, glucose and mannose were satisfactory carbon sources for both vegetative growth and apothecial formation.

Neither of the strains could utilize lactose, sucrose, sorbose, mannitol, sorbitol,

and inulin. As a source of nitrogen potassium nitrate could be used, but better results were obtained with asparagine, aspartic acid, glutamic acid, and urea.

The nitrogen-carbon ratio proved to be of importance for both the vegatative growth and the formation of fruit-bodies. Provided the proper nitrogen source of correct concentration was used, the formation of fruit-bodies in *Ascobolus immersus* was favoured by a relatively high concentration of carbohydrate.

If the fructification on this medium does not diminish after many generations, then Yu's formula may form a basis for biochemical and genetic analysis of *Ascobolus immersus*.

MICROSCOPIC EXAMINATION OF FRESH MATERIAL.—For microscopic examination small fragments of living fruit-bodies were isolated, mounted in a drop of water on a slide, and the elements were spread out by gentle pressure. A 1 % solution of glucose in tap-water allowed the preparations to be studied for at least five minutes without any serious structural changes. Cell-structures and cell-inclusions of suitable objects were studied with phase-contrast microscopy. The development of asci was studied with supravital stains. Very small quantities of neutral red and brilliant cresyl blue, dissolved in an isotonic solution of glucose, were especially valuable in this respect. The staining with these dyes was easier when the solution was made very weakly alkaline with sodium hydroxide.

For anatomical and morphological examinations fruit-bodies were fixed in Hollande's fluid of the following composition:—

picric acid	4 g
cupric acetate	2.5 g
formalin (formaldehyde 40%)	10 ml
acetic acid, glacial	1.5 ml
distilled water	100 ml

The material was fixed for twenty-four hours in this fluid and then washed in 70 % alcohol until most of the yellow coloration, due to picric acid, was extracted. Awaiting further processing the material was preserved in 70 % alcohol. Afterwards dehydrating, clearing, embedding, and sectioning took place in the usual way.

For the study of cytological details living material was fixed for about twenty-four hours in Flemming's weak solution, freshly prepared according to Taylor's formula:—

10 % chromium troxide in water	1.5 ml
2 % osmium tetroxide in 2 % aquous chromium trioxide	5.0 ml
10 % aquous acetic acid	1.0 ml
distilled water	96.5 ml

Sections of 7 or 10 μ thick were made with a rotary microtome. For morphological examinations the sections were generally stained in a 0.1–0.5 % solution of methyl blue (R.A.L.) or trypan blue (E. Gurr). Methyl blue was used instead of cotton

blue C4B of Poirrier. [1] Besides their affinity for callose, methyl blue and trypan blue stained the cytoplasm and in some degree the hyphal walls also. Trypan blue, used as recommended by Boedijn (1956), gave a slightly more intense staining of the hyphal walls, as compared with methyl blue.

As a general stain for the study of cytological detail, Heidenhain's haematoxylin method as recommended for fine structures (Conn & *al.*, 1962: 210) was used. In the case of microtome sections designed to show early stages in the development of fruit-bodies, saffranin followed by fast green gave very satisfactory preparations.

HERBARIUM MATERIAL.—The major part of the material studied in this work consisted of dried specimens.

Herbaria, from which material was examined, are indicated in the text by the following abbreviations, as far as possible borrowed from Lanjouw & Stafleu (1959). Foreign institutes which I visited personally have been marked with an asterisk (*).

B, Botanisches Museum, Berlin-Dahlem, Germany *.
BAFC, Universidad de Buenos Aires, Departamento de Biología, Buenos Aires, Argentina.
BM, British Museum (Natural History), London, Great Britain *.
BPI, The National Fungus Collections, Beltsville, Maryland, U.S.A.
BR, Jardin Botanique de l'Etat, Bruxelles, Belgium.
BRSL, Instytut Botaniczny, Wrocław, Poland.
C, Institut for Sporeplanter, Botanisk Laboratorium, København, Denmark.
CMI, Commonwealth Mycological Institute, Kew, Great Britain *.
CONC, Laboratoire de Biologie Marine du Collège de France, Concarneau, France *.
CP, Herbarium of the Department of Plant Pathology, København, Denmark.
DAOM, Mycological Herbarium, Division of Botany and Plant Pathology, Ottawa, Canada.
E, Royal Botanic Gardens, Edinburgh, Scotland, Great Britain.
FH, Farlow Library and Herbarium of Cryptogamic Botany, Harvard University, Cambridge, Massachusetts, U.S.A.
G, Conservatoire et Jardin Botaniques, Genève, Switzerland.
GRO, Botanisch Laboratorium, Afdeling Systematische Botanie, Groningen, Netherlands.
H, Botanical Museum, Helsinki, Finland.
HBG, Staatsinstitut für allgemeine Botanik, Hamburg, Germany.
K, The Herbarium, Royal Botanic Gardens, Kew, Great Britain *.
L, Rijksherbarium, Leiden, Netherlands.

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[1] The production of cotton blue C4B of Poirrier, especially indicated for staining of ornamentation of ascospores in Discomycetes, was discontinued. "Bleu de Méthyle", R.A.L. actually proved to be the brand of dye used for many years by Dr. M. Le Gal for this purpose. Of the many dyes tested this French brand gave the best results.

LE, Herbarium of the Department of Systematics and Plant Geography of the Botanical Instutute of the Academy of Sciences of the U.S.S.R., Leningrad, U.S.S.R.
LPS, Instituto de Botánica "C. Spégazzini", La Plata, Argentina.
M, Botanische Staatssammlung, München, Germany.
MEL, National Herbarium of Victoria, Melbourne, Australia.
Melbourne University, Department of Botany, Melbourne, Australia.
NY, The Herbarium of the New York Botanical Garden, New York, U.S.A.
PAD, Istituto e Orto Botanico dell'Universita, Padova, Italy.
PC, Muséum National d'Histoire Naturelle, Laboratoire de Cryptogamie, Paris, France *.
PR, Botanické oddělení Narodní Museum, Praha, Czechoslovakia *.
PRC, Botanický ústav university Karlovy, Praha, Czechoslovakia.
S, Naturhistoriska Riksmuseet, Botaniska Avdelningen, Stockholm, Sweden.
TRTC, Cryptogamic Herbarium, University of Toronto, Toronto, Canada.
UPS, Universitets Institution för Systematisk Botanik, Uppsala, Sweden.
URM, Instituto de Micologia, Universidade do Recife, Recife, Pernambuco, Brasil.
W, Naturhistorisches Museum, Wien, Austria.
ZT, Institut für spezielle Botanik der Eidgenössischen Technischen Hochschule, Zürich, Switzerland.

Dried fleshy apothecia show a brown colour and are considerably shrunken and deformed. For microscopic examination dried apothecia were humidified and as far as possible swollen to the original shape and size. The usual procedure of swelling in a 5 % solution of potassium hydroxide had several great disadvantages in the Ascoboloideae. With this technique the pigments of the ascospores and of the excipulum, which furnish very important characters for the identification, are dissolved. An additional disadvantage is caused by the very strong swelling of tissues, which leads to wrong measurements. However, very old, brittle or poorly dried material could only be studied in this way. Also delicate structures like tips of paraphyses are often revealed better in diluted solutions of potasium hydroxide or ammonia. To those alkaline solutions 1 % Congo red or 1 % erythrosin were added for staining.

A very suitable medium for the fungi concerned, proved to be lacto-phenol, prepared according to Amman. After heating of the dried specimens in this fluid a swelling was reached up to the sizes found in the original fresh material. In difficult cases previous heating of the specimens in water with some synthetic detergent (e.g. 'Teepol') facilitated the swelling.

To simplify the procedures for obtaining good permanent microscopic preparations of dried specimens, lacto-phenol was used in a modified composition to which polyvinyl alcohol (P.V.A.) was added. Lubkin & Carsten (1942) described some of the properties of P.V.A. for use in microtechnique. Under the name 'polyvinyl

lacto-phenol' Downs (1943) introduced a medium which consisted of P.V.A. and lactophenol.

The formula for polyvinyl lacto-phenol is:—

P.V.A. stock solution in water	56 % by volume
lactic acid	22 % by volume
phenol	22 % by volume

The stock solution of P.V.A. is prepared by adding 15 grams of P.V.A. (grade RH-349) powder slowly to 100 ml of cold water in a glass beaker. The mixture is then continuously stirred and heated in a water bath at a temperature of about 80 °C. This is continued until the solution becomes clear and attains the viscosity of thick molasses. If necessary the solution is filtered through a double layer of cheese cloth. In mixing, the lactic acid must be added to the P.V.A. stock solution before phenol is added, otherwise the P.V.A. will turn into a soft white sticky mass. Huber & Caplin (1947) recommended the use of polyvinyl lacto-phenol as a permanent mounting medium for fungi and small arthropods in dermatology.

Some of the good properties of polyvinyl lacto-phenol can be summarized as follows: (1) it quickly penetrates the tissues; (2) under careful heating it gives good swelling and clearing; (3) pigments of Ascobolaceae are not dissolved in it; (4) it is miscible with water in all proportions; (5) it is a very good embedding medium to make 5–20 μ thick sections with a freezing microtome; (6) with 0.02 to 0.05 % methyl blue or trypan blue good staining of sections and squash preparations is obtained; (7) it has still rather good optical properties ($N_D = 1.410$, $\nu = 47.1$); (8) it is a good mounting medium for sections and thin squashes.

The material should be mounted in an excessive amount of this medium. After one or two days the medium has plastified so far that the coverglass is firmly fixed. If it recedes under the coverglass during drying, more medium is added. For permanent mounts it is advisable to seal the edges of the coverglass with colourless nail lacquer (Cutex) to prevent the evaporation of phenol and water.

CHAPTER III

THE DEVELOPMENT OF THE FRUIT-BODY

THE DEVELOPMENT.—It is as a rule rather easy to follow the development of fruit-bodies in coprophilous fungi. Fruit-bodies can be isolated and fixed or studied alive in all stages of the development.

Coemans (1862: 79) was the first author to give a description of the development of the fruit-body in a species of *Ascobolus*. Janczewski (1871) studied very accurately the development of *Ascobolus furfuraceus*. His pertinent diagram has been reproduced in most handbooks.

The development of the fruit-bodies of species of *Ascobolus* and *Saccobolus* has been subjected to a special study only in very rare cases. Most information on the morphological development of the ascocarp in these genera can be gathered form some of the more extensive, published studies on the sexuality, compatibility and cytology of these fungi: the type of development can sometimes be determined from descriptions and pictures of different stages, accompanying these studies.

The following species of *Ascobolus* are more or less well known in this respect: *Ascobolus immersus* (Zukal, 1889; Ramlow, 1915); *A. strobolinus* (Schweizer, 1923); *A. furfuraceus* (Janczewski, 1871: Zukal, 1888; Dangeard, 1907; Gäumann & Dodge, 1928; Gamundí & Ranalli, 1962); *A. citrinus* (Schweizer, 1923); and *A. magnificus* (Dodge, 1920; Gäumann & Dodge, 1928; Gwynne Vaughan & Williamson, 1932).

Knowledge of the development of the fruit-bodies in species of *Saccobolus* is restricted to the observations on *Saccobolus violascens* made by Dangeard (1907).

From published studies and from my own in this field it may be concluded that in the Ascobolaceae the most diverging types of development occur and that *Ascobolus* in particular contains species with clearly distinct developmental types. In this respect the developmental phase in which the hymenium becomes exposed is of great importance.

The development of the fruit-body in *Ascobolus* may be summarized as follows.

After a sexual process, whether or not parthenogenetic (cf. Chapter VI), ascogenous hyphae grow from the fertile part of a naked or sheathed ascogonium, toward the base of the paraphyses. (In most cases paraphyses are already differentiated before this stage.) With the exception of *Ascobolus scatigenus*, *A. castaneus*, *A. aglaosporus*, and probably *A. reticulatus* and *A. pusillus* where it develops unsheathed, the ascogonium is covered by investing hyphae which originate from tissues near the base of the ascogonium in all species studied thus far. These investing hyphae

first form a prosenchyma which upon further growth forms some pseudoparenchymatous layers at the outside.

The paraphyses also develop from these investing hyphae. From some of the thicker ones around the ascogonium other wide and plasm-rich hyphae branch off and form a pseudoparenchymatous layer at some distance above the ascogonium. From this layer, which is very variable in thickness, paraphyses with free ends grow out upward. At this stage a closed, subglobular or elongated body has been formed or the ascogonium is situated uncovered on the substratum. When the ascogenous hyphae are about to reach the groundfloor of the layer of paraphyses they produce many horizontal branches and form a dense layer of interweaving hyphae from which the croziers develop. The latter then develop into young asci with large fusion- nuclei. The growth of paraphyses is monopodial and distal while the formation of crozier initials proceeds sympodially and centrifugally followed by the subsequent maturation of the asci in the same mode.

In a very early phase of the development a differentiation between the flesh and the excipulum sets in. The flesh surrounds the remains of the ascogonium and fills the space between excipulum and hymenium. Normally it consists of intermingled hyphae with relatively thin-walled cells with strongly vacuolated protoplasm. It also includes the ascogenous hyphae and the elements from which the paraphyses were formed. Sometimes the flesh is restricted to a very narrow zone near the base of the fruit-body. The excipulum, which forms the outer protection of the fruit-body, consists of more or less radially growing, intermingled hyphae with rather large, thick-walled cells showing large vacuoles. The older cells on the outside are often dead.

In species with a closed type of development the excipulum persists for some time as a many-layered roof over the hymenium.

Under certain conditions superficial excipular cells may proliferate and grow downwards into the substratum and form a so-called secondary mycelium. Especially in cases that fruit-bodies grow immersed or under very humid conditions secondary mycelium may be rather abundant.

When all elements of the fruit-bodies are differentiated further development is mainly an increase in volume of the flesh, the excipulum, and the hymenium. The hymenium greatly expands, as a result of intercalation of new elements and the subsequent strong inflation of the ripening asci.

From the margin of the subhymenium new elements may be formed in the direction of both the hymenium and the excipulum by means of the activity of a marginal growing-zone (Corner, 1929a). In some species of *Ascobolus* sect. *Ascobolus* this marginal growing zone may have a very short period of activity. In species of *Ascobolus* sect. *Dasyobolus* and *Ascobolus* sect. *Sphaeridiobolus* there is no indication at all of any activity of this zone. Only in *Ascobolus* sect. *Gymnascobolus* there is clearly a longer period of activity.

During this period the asci in the hymenium continue to ripen and generations occur in waves. Especially the last phase of maturation of the asci of one wave is

synchronous. During the last phase the asci greatly increase in volume, the ascospores become covered by a layer of pigment which is here called episporium and the asci finally protrude above the level of the paraphyses. The mature asci of a wave shoot away their contents simultaneously or individually.

In some, probably abnormal, cases asci ripen without the ascospores being shot away.

Within a single species of *Ascobolus* the development of the fruit-bodies may vary and abnormalities can be found in almost any culture. Dangeard (1907, pl. 62 f. 4) found in cultures of *Ascobolus furfuraceus* a fruit-body that had developed laterally of the ascogonium, while I found twin fruit-bodies with a common base and two separate hymenia in *Ascobolus albidus*, *A. immersus*, and *A. stictoideus* that had developed from a single ascogonium.

The development of fruit-bodies of species of *Saccobolus* mainly agrees with that of *Ascobolus*. In *Saccobolus* it occurs rather often that one fruit-body contains more than one ascogonium. Also the individuality of the fruit-bodies is more easily lost and thus smaller or larger complexes are formed. Some species may even form crusts. In general the flesh and the excipulum are less developed, while there never is a marginal growing-zone. The paraphyses are comparatively shorter than in *Ascobolus* and the asci are relatively broad. Consequently in *Saccobolus* the asci protrude above the hymenium in an earlier phase than in *Ascobolus*.

A striking phenomenon found during many developmental studies of species of *Ascobolus*, is sudden inhibition of the development. Inhibition may occur in cultures in almost every phase of development. Especially when in the same culture more than one generation of fruit-bodies is formed, the second generation often shows certain inhibitions in the development.

It occurs sometimes that in species of *Ascobolus* with a 'closed' type of development the fruit-bodies do not open, even when asci and ascospores have ripened. The ascospores in these cleistothecia are set free by decay only. Another phase in which inhibition is very frequent, although less conspicuous, is in the ascogonium phase. A great number of ascogonia are formed but no or only a very few fruit-bodies develop. Also in normal cases only a small part of the many ascogonia formed will develop into a fruit-body. The ascogonia that do not develop further are often surrounded by some investing hyphae and can be found on the substratum afterwards without any structural change.

TYPES OF DEVELOPMENT.—The developmental types in Pezizales are mainly characterized by the development of the hymenium. The developmental phase in which the hymenium becomes exposed is of great importance. In this connection strongly diverging types of development occur in the Ascobolaceae.

Hitherto it has been the custom to distinguish two extreme types of development. When the hymenium of the fruit-body develops superficially from the beginning (Corner, 1929b; Reijnders, 1948; Snell & Dick, 1957) or when it is exposed at least during the ripening of the spores (Jackson, 1949; Ainsworth, 1961) the development

is called 'gymnocarpic'. The development of a fruit-body is called 'angiocarpic' when the hymenium starts its development in a closed space. The precise phase in which the hymenium would become exposed in an 'angiocarpic' fruit-body greatly differs in the definitions of various authors (cf. Corner, 1929b; Jackson, 1949; Reijnders, 1948; Snell & Dick, 1957; Ainsworth, 1961).

A few authors (Singer, 1951; Jackson, 1949; Gamundí & Ranalli, 1963) use the term 'hemi-angiocarpic' to indicate the type of development in which the hymenium is first enclosed but becomes exposed before the spores reach maturity. Other authors (Corner, 1929b; Reijnders, 1948) include this type of development in the 'angiocarpic', while the term 'hemi-angiocarpic' as applied by Corner (1929b) refers to that early state in which hyphae of limited growth arch over the ascogonium without forming a closed sheath during the further development.

In the past the value of these different developmental types was often overrated, until Dodge (1912a) proved that both 'angiocarpic' and 'gymnocarpic' development occurred within *Ascobolus*, a genus generally considered a homogeneous natural taxon. This has led to the conclusion that the type of development is only of importance at the species level. In relation to apothecial development and form certain series can be recognized within some natural groups of the Pezizales, as shown in comparative studies by Corner (1929b, 1930).

A more detailed distinction between the different types is desirable in comparative studies of developmental types in the Pezizales.

Apart from the different applications of each of the terms 'angiocarpic', 'hemi-angiocarpic', and 'gymnocarpic', the use of these terms in the Ascomycetes is fundamentally incorrect. They do not relate to the fruit-body as a whole, as their etymology would suggest, but to the hymenium in certain phases of fruit-body development.

To avoid further confusion, a new set of descriptive terms for the development of the fruit-bodies of Discomycetes is suggested. It leaves room for extension and for application to other groups.

As an unambiguous term for any sporocarp producing asci Wallroth's term 'ascoma' is here taken up.

The following phases can be distinguished in chronological order in respect to the hymenium during the development of an ascoma.

1. The archihymenial phase: before the initials of the hymenium (which normally are the paraphyses) are being formed.
2. The prohymenial phase: paraphyses are present but no croziers are as yet formed. — In cases where paraphyses are formed rather late, this phase may be very short or may even be omitted.
3. The mesohymenial phase: the hymenium is in progress of ripening, but no asci have as yet ripened. — As this may be a relatively long phase covering many important processes, it is further divided into:
   a. The early mesohymenial phase, characterized by the formation of croziers.

b. The mid-mesohymenial phase, in which the croziers proliferate, nuclear divisions take place in the asci, and ascospores are being formed in the asci that are most advanced.
c. The late mesohymenial phase, in which in the most advanced asci the ascospores are ripening. — As in hymenia with more than one ascus the growth and the development of the asci in the hymenium is sympodial and in centrifugal direction; the ripening of all asci is never simultaneous. Therefore the hymenial phases of the ascomata are distinguishable by the development of the most advanced asci.

4. The telohymenial phase: mature asci are present. Normally it is in this phase that the ascospores are discharged.
5. The posthymenial phase: the hymenium becomes overripe or obsolete and decomposes.

With regard to the hymenial development two main types of ascomata can be distinguished.

I. Cleistohymenial ascoma (ascoma cleistohymeniale): the hymenium is enclosed, at least during its early development. — The cleistohymenial ascomata may again be subdivided according to the hymenial phase when they open to expose the hymenium.

II. Gymnohymenial ascoma (ascoma gymnohymeniale): the hymenium exposed from the first until the maturation of the asci. — The gymnohymenial ascomata may be subdivided according to the degree of investment of the ascogonium by investing hyphae.
   a. Paragymnohymenial ascoma (ascoma paragymnohymeniale): the ascogonium over-arched by hyphae of limited growth, not forming a closed sheath during further development.
   b. Eugymnohymenial ascoma (ascoma eugymnohymeniale): the ascogonium not over-arched. — As to the eugymnohymenial ascomata two different types can be distinguished, one in which an excipulum is formed and another lacking an excipulum altogether.

The types of ascomata that can be distinguished accordingly are summarized in the following scheme for the Ascobolaceae only (see Plate 17).

I. Cleistohymenial ascoma
   a. Remaining permanently closed
   b. Opening
      1. Opening during the telohymenial phase
      2. Opening during the mesohymenial phase
      3. Opening during the prohymenial phase
II. Gymnohymenial ascoma
   a. Paragymnohymenial ascoma

b. Eugymnohymenial ascoma
   1. With an excipulum
   2. Without excipulum

The following is a Latin translation of the above.

I. Ascoma cleistohymeniale
   a. Semper clausum
   b. Aperiens
      1. Tempore telohymeniali aperiens
      2. Tempore mesohymeniali aperiens
      3. Tempore prohymeniali aperiens

II. Ascoma gymnohymeniale
   a. Ascoma paragymnohymeniale
   b. Ascoma eugymnohymeniale
      1. Excipulatum
      2. Abexcipulatum

Cleistohymenial ascomata that remain closed, do not release their ascospores until the decomposition of their wall tissues. This type of ascomata is only occasionally found in cultures of *Ascobolus immersus*, *A. siamensis* and *A. stictoideus*. As already mentioned (p. 24) sometimes inhibition of the development may also result in the production of ascomata of this type.

Cleistohymenial ascomata that open in the telohymenial phase normally occur in all species of *Ascobolus* sect. *Dasyobolus* and also in the genera *Thelebolus* Tode per Fr. and *Rhyparobius* Boud. As a rare exception they are also produced in *Ascobolus albidus* and *A. furfuraceus*, in which especially the smallest ascomata with only a few asci may be of this type.

Cleistohymenial ascomata that open in the mesohymenial phase occur as a rule in all species studied thus far of *Ascobolus* sect. *Sphaeridiobolus* and *Ascobolus* sect. *Sphaeridiobolus* and *Ascobolus* sect. *Ascobolus*. By intercalation of new hymenial elements and subsequent growth of asci and paraphyses, the excipular roof originally covering the incipient hymenium becomes thus torn up. There is some variation between the different species of *Ascobolus* sect. *Ascobolus* as to the moment of this rupture. The rule is, the larger the ascomata in a certain species, the earlier the rupture will happen. This normally takes place in the late mesohymenial phase in species of *Ascobolus* sect. *Dasyobolus*.

Cleistohymenial ascomata that open in the prohymenial phase are rather difficult to recognize as such, because in this phase the paraphyses are often only visible with difficulty and few in number. Such ascomata belong to the potentials of *Saccobolus versicolor*. They might also occur in *S. obscurus* and *S. beckii*.

Paragymnohymenial ascomata probably occur in some species of *Saccobolus* sect. *Saccobolus* and *Saccobolus* sect. *Eriobolus*. Such ascomata are already open in the prehymenial phase.

Eugymnohymenial ascomata with an excipulum are found in *Ascobolus* sect. *Gymnascobolus*, sect. *Heimerlia*, sect. *Pseudosaccobolus* and in many species of *Saccobolus*. In *Ascobolus* sect. *Gymnascobolus* excipulum and flesh are well developed, but in *Ascobolus* sect. *Heimerlia* and sect. *Pseudosaccobolus* and in species of *Saccobolus* the development of these tissues is often very restricted. Their remains may be difficult to find in mature ascomata (e.g. in *Saccobolus saccoboloides*).

Eugymnohymenial ascomata without an excipulum do not occur in *Ascobolus* and *Saccobolus*. They are found in the related genus *Ascodesmis* Tiegh. and in *Pyronema* Carus.

CHAPTER IV

THE STRUCTURE OF THE FUNGUS

In this chapter species of both *Ascobolus* and *Saccobolus* are dealt with, because of the great similarity in structure.

MYCELIUM AND CONIDIAL STAGES.—In the Ascoboloideae the hyphae of the mycelium are septate and branched. In cultures with rich fructification the mycelium is usually of restricted growth and sometimes rather inconspicuous. Soon after the germination of the ascospores anastomoses may often be found between branches of the mycelium and ascogonia are also often formed.

The segments of the mycelium are coenocytic. Ten or more nuclei may occur in each segment, while the terminal ones usually contain a smaller number (Dangeard, 1907; Berthet, 1964).

The colour of the mycelium is very pale or almost white. Berthet described in *Ascobolus carbonarius* a yellow-green prostrate mycelium and pale yellowish air-mycelium.

The septa between the segments are perforated by a central pore. A thin ring-shaped zone in the septa stains intensely with trypan blue. In thick hyphae of the mycelium and in hyphae of the fruit-body this zone is clearly visible. Near the pores small, rounded, light-refractive bodies are located. Of these so-called Woronin bodies (Buller, 1933: 127) 1–5 may be found per septum. This type of septum is clearly visible also in many other Discomycetes.

Recent electron microscope studies of the septum in fungi (Moore & McAlear, 1962) indicated that in *Ascobolus*, as well as in other Ascomycetes, the septum is a simple uniporous disk. Here the evidences of the light and electron microscope fully agree.

Intrahyphal mycelium was found by Dodge in cultures of *Ascobolus scatigenus* (1915) and *A. carbonarius* (1920). In *A. scatigenus* intrahyphal mycelium was found in cultures in which the *Papulospora*-stage was present. This was found connected with the mycelium of the species of *Ascobolus* by a complicated system of intrahyphal mycelium ("Durchwachsungen"). Dodge (1915, 1920) thought that these papulospores might even belong to an intrahyphal parasite of the species of *Ascobolus* concerned. Since these papulospores often develop directly from branches of the hyphae of *A. scatigenus* Dodge's supposition is apparently not correct. Especially media rich in starch (like oatmeal agar and potato agar) are favourable for an abundant development of mycelium and papulospores. These media are not appropriate for the development of fruit-bodies.

According to Lohwag (1927: 729; 1941: 342) the papulospores might very well be archicarps that are inhibited in further development. Such archicarps are also found in cultures of other species, where their structure is strikingly similar to that of the papulospores.

Zukal (1889: 571) described *Stemphylium*-like gemmae for *Ascobolus immersus*. This observation, however, has not been repeated.

Oidia were found in *Ascobolus furfuraceus* (Green, 1931), *A. denudatus*, and *A. citrinus* (Gäumann & Dodge, 1928: 338). Of *A. carbonarius* small conidia on hyphal branches are known (Gäumann & Dodge, 1928: 338).

FRUIT-BODY.—In the Ascoboloideae different types of ascomata may be formed dependent on the type of development. In *Ascobolus* sect. *Dasyobolus* and in a few rare and abnormal cases in some species of sections *Sphaeridiobolus* and *Ascobolus* perithecioid fruit-bodies are formed. These fruit-bodies might equally well be called perithecia or apothecia.

Normal apothecia, with exposed hymenia, are formed in most species of *Ascobolus* sect. *Sphaeridiobolus* and sect. *Ascobolus*; they always occur in *Saccobolus* and in *Ascobolus* sect. *Pseudosaccobolus*, sect. *Heimerlia*, sect. *Pseudascodesmis*, and sect. *Gymnascobolus*. As may be concluded from the chapter on the development of the ascomata (p. 22) in the Ascobolaceae rather gradual transitions occur between cleistothecia, perithecioid forms, and apothecia. Different developmental types of apothecia may also be distinguished. These fruit-bodies are referred to as apothecia in the descriptive text, except for the relatively rare cleistothecia. Their shape may vary from perithecioid via turbinate, pyriform, cylindrical, cupulate, scutellate, discoid, and lenticular to pulvinate.

The fruit-bodies of only a few species of *Ascobolus* sect. *Ascobolus* are stalked. In *A. crenulatus*, *A. epimyces*, *A. lineolatus*, *A. singeri*, and *A. foliicola* the stalk is sometimes rather short and may be seen only as a narrow base. In such species as *A. lignatilis*, *A. costantinii*, and *A. michaudii* the stalk is always clearly differentiated.

Functionally and morphologically the fruit-body consists of two main parts: the disk and the receptacle. The disk is the spore-producing part of the fruit-body, viz. the hymenium. The receptacle is the hymenium supporting structure, in which usually two different tissues have been differentiated, the excipulum (or cortex) and the flesh (or medulla).

Immediately beneath the hymenium a layer of hyphal tissue is differentiated in which the ascogenous hyphae branch strongly before the formation of croziers. This is called the hypothecium.

A median section of the fruit-body is necessary for the study of the different layers of tissue.

EXCIPULUM.— This term is applied to the outer part of the receptacle. In the Ascoboloideae this layer is always clearly differentiated from the flesh and usually consists of rather large, thick-walled elements.

In cleistohymenial ascomata the excipulum covers the initials of the hymenium as a roof. Normally this excipular roof sooner or later ruptures. In species of *Ascobolus* sect. *Ascobolus*, fragments of the roof may accidentally be found covering the hymenium in the telohymenial phase. Fruit-bodies of species of this section and of section *Sphaeridiobolus* show a membranous, irregularly denticulate margin in the late mesohymenial phase. This thin margin, which consists of the remains of the excipular roof, often disappears during the telohymenial phase; this is the rule in *Ascobolus denudatus* and most of the terrestrial and pyrophilous species of *Ascobolus* section *Ascobolus*. An entire margin is present in species with gymnohymenial ascomata; especially in *Ascobolus scatigenus* it is often very conspicuous.

The excipulum is usually much thicker towards the base of the fruit-body than near the margin. The size of the cells may differ considerably in both these regions. When a stalk is present the delimitation of excipulum and flesh may be rather irregular in this part. Closely compacted relatively narrow hyphae sometimes form an enlarged basal plate on the substratum.

Radiating hyphae may extend into the substratum from all living parts of the excipulum that are in contact with the substratum. Those rhizoid attachments which form the so-called secondary mycelium are normally restricted to the base of the receptacle, but in some species of *Ascobolus* section *Dasyobolus*, which develop and grow partly or fully immersed in the substratum, they occur over the whole surface. In some of the latter species the secondary mycelium forms a thin layer of appressed hyphae, which may be rather wide and thick-walled.

Excipular hairs, as illustrated for *Ascobolus immersus* by Boudier (1869: *pl. 8 f. XVII 14*) and Le Gal (1961: *f. 6 D*), could not be found in collections or cultures of any species of *Ascobolus*.

In species of *Saccobolus* the excipulum is rather restricted and sometimes not traceable in the mature fruit-bodies. The excipulum of *Saccobolus caesariatus* is covered with flexuous bundles of septate hyphae.

Excipular pigments occur in at least four different forms. In *Ascobolus* and *Saccobolus* sect. *Eriobolus* a purplish or brownish, intercellular, amorphous pigment in the outer parts of the excipulum is most common. Only in *Ascobolus carbonarius* a second deeper layer of this pigment often occurs near the margin of the fruit-body. When this type of pigment is found in the excipulum, it is usually also present among the tips of the paraphyses in the hymenium.

The amount of pigment and the intensity of its colour were, in certain cases, found to depend on the exposure to light and the kind of substratum.

An intracellular reddish-brown to purplish-brown pigment was only found in the excipular cells of *Ascobolus castaneus*.

In *Ascobolus siamensis*, besides reddish-brown intercellular amorphous pigment in the excipular scales, a yellow one is found in the cell-walls of the deeper excipular layers. Also in other species of *Ascobolus* with yellow receptacles such a yellow pigment occurs in the cell-walls of the excipulum (e.g. *A. michaudii*, *A. crenulatus*, *A. lignatilis*, and *A. costantinii*).

A rusty brown pigment is often formed in the cell walls in furfuraceous particles on the excipulum of some species of *Ascobolus* sect. *Ascobolus* (e.g. *A. denudatus*, *A. epimyces*, *A. foliicola*, and *A. behnitziensis*).

Many species of *Ascobolus* are more or less rough on the outside of the receptacle due to the presence of warts or scales. These structures arise in an early stage of development from the outer layers of the excipulum as a result of differences in velocity of growth and stretching capacity of the different layers. Usually the outer layers break into warts or scales in a regular or irregular manner. The furfuraceous particles largely consist of rather thick-walled subglobular cells. The larger cells are finally mostly filled with air, which causes the particles to be white coloured.

Especially in species with more regular particles, in the beginning some growth is found within them. Regular or pyramid-shaped particles are found in e.g. *A. boudieri*, *A. siamensis*, *A. denudatus*, *A. foliicola*, and *A. singeri*. Irregular and scaly particles occur as a rule in *A. furfuraceus*, *A. michaudii*, *A. lignatilis*, *A. costantinii*, and *A. epimyces*.

In species of *Saccobolus* the excipulum is always very thin and its surface never rough.

Excipular texture or the arrangement and the shape of cells of the excipulum proved to be a constant and valuable character in species of *Ascobolus* and *Saccobolus*. Especially in *Ascobolus* sect. *Ascobolus* some species can easily be distinguished by a particular hyphal structure of the excipulum.

Starbäck's terminology (1895: 11), as emended by Korf (1951: 137; 1958: 13), has proved to be very efficient in indicating the various types of hyphal tissues. Although originally intended to designate hyphal tissues in Helotiales, it appears to be also useful in Pezizales.

Lagarde's criticism (1906: 135) against the terminology of Starbäck with its possibilities of subtle descrimination, is mainly based on his dislike of a special terminology for fungi. Lagarde prefers the use of more general, but consequently more controversial, terms, like pseudo-parenchyma (de Bary), prosemchyma (Rehm), etc. "Les distinctions subtiles établies par [Starbäck] ne paraissent pas suffisamment justifiées et je n'ai pas cru devoir le suivre dans cette voie. Les résultats essentiels de l'étude anatomique, destinés à figurer dans la diagnose des Unités Systématiques peuvent être exprimés dans un langage simple, sans avoir recours à une terminologie spéciale, toujours susceptible d'être mise en défaut par quelqu'une des innombrables combinaisons réalisées dans la Nature."

The following is Korf's emendation of Starbäck's key to hyphal tissue types. For a diagram see Figure 1.

I. Short-celled tissue: the separate hyphae not easily distinguishable.
  A. Cells round to polyhedral, almost isodiametric.
    1. Cells rounding up, with intercellular spaces: *textura globulosa*.

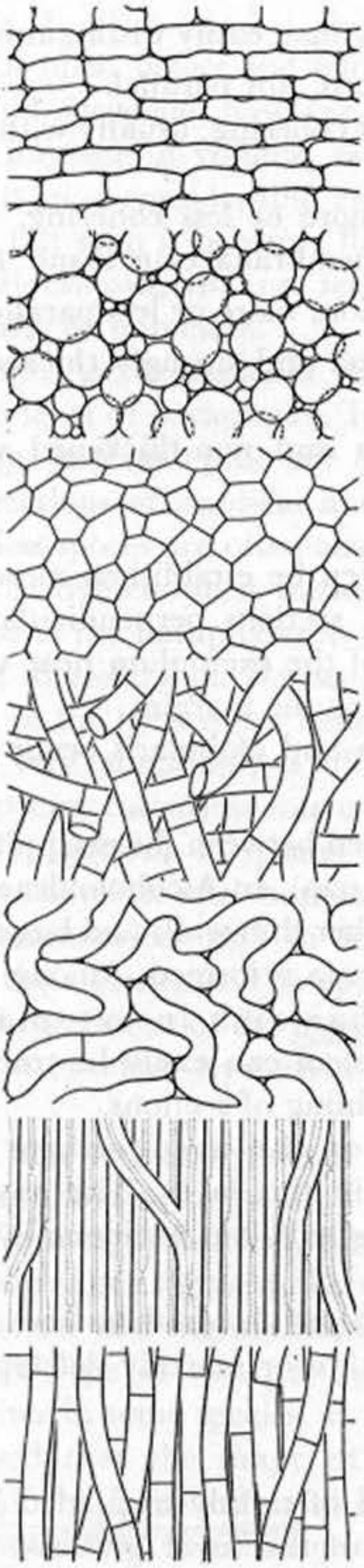

Fig 1. — Arrangement of cells in fungal tissues.

2. Cells polyhedral by mutual pressure, no intercellular spaces: *textura angularis*.

B. Cells more or less rectangular in section, not isodiametric: *textura prismatica*.

II. Long-celled tissue: the separate hyphae easily distinguishable.

C. Hyphae running in all directions, not parallel.

3. Hyphae with their walls not cohering, usually with distinct interhyphal spaces: *textura intricata*.

4. Hyphae with their walls more or less cohering, without interhyphal spaces, usually forming a membranaceous tissue: *textura epidermoidea*.

D. Hyphae running in one direction, more or less parallel.

5. Hyphae with narrow lumina and strongly thickened walls, cohering: *textura oblita*.

6. Hyphae with wide lumina and non-thickened walls, not cohering: *textura porrecta*.

The texture of the excipulum can often be established merely after a glance at the outer surface. Sometimes, however, sections perpendicular to the surface are necessary. In some cases the structure of the excipulum near the base of the fruit-body differs from that higher up and near the margin.

Transitions between textura angularis and globularis occur rather frequently.

FLESH.—This is the soft tissue enclosed between the excipulum and the hypothecium; it is also called medulla (Corner, 1929). In Ascoboloideae it consists of colourless, oblong or isodiametric cells with rather thin walls and large intercellular spaces. Sometimes hyphal tissue of textura intricata is formed. Among the rather large cells with large vacuoles, a system of hyphae rich in cytoplasm occurs, which is connected with the paraphyses. This system can easily be traced in species with a thick layer of flesh by cytoplasmatic staining of sections.

In young fruit-bodies the remains of the ascogonium and of some ascogenous hyphae may also be found in this layer. The ascogonial remains are usually found in the basal part near the axis, but accidentally they may be found strongly excentrically situated.

The flesh is rather abundantly developed in *Ascobolus* sect. *Sphaeridiobolus*, sect. *Ascobolus*, and sect. *Gymnascobolus*. It is thin or scarcely deleloped in *Saccobolus* and in the other sections of *Ascobolus*.

HYPOTHECIUM.—This is the system of tightly entangled hyphae immediately beneath the hymenium. The elements of this layer give rise to the asci and the paraphyses. It consists of small plasm-rich cells. These cells are isodiametric or only slightly elongated in section.

In most species the hypothecium is a rather sharply delimited layer. Sometimes, however, it is very thin or discontinuous.

HYMENIUM.—The hymenium of the Ascobolaceae varies strongly in shape and composition, depending on the number of ripening asci and the increase in volume during this ripening. Hymenia with only a few asci, like they may occur in *Ascobolus immersus*, *A. stictoideus*, *A. albidus*, and *A. furfuraceus*, are restricted to cleistohymenial ascomata that do not open before the telohymenial phase. The hymenia of most species of *Ascobolus* and *Saccobolus*, however, contain numerous asci.

The asci strongly increase in volume, especially after meiosis. In hymenia with many asci this results in a considerable enlargement. At first the surface of these hymenia is concave, but soon it becomes flat or convex. Consequently in *Saccobolus* and *Ascobolus* sect. *Pseudascodesmis* and sect. *Pseudosaccobolus* the shape of mature fruit-bodies is lenticular or pulvinate.

Characteristic of the Ascobolaceae is the strong protrusion of the tips of ripe asci above the level of paraphyses. In *Ascobolus* sect. *Dasyobolus* and in *Saccobolus* sect. *Eriobolus* ripe asci may protrude for more than 50 % of their length. This is less in the other sections of *Ascobolus* and *Saccobolus*. In species of *Saccobolus* the asci with still colourless spores are often already clearly protruding.

The thickness of the hymenium is measured from the bases of the asci and the paraphyses to the tips of the paraphyses in ripe hymenia.

In many species of *Ascobolus* sect. *Dasyobolus* and sect. *Ascobolus* a mucilaginous substance is found in the hymenium besides asci and paraphyses. This substance, which sometimes is very abundant, is of a yellowish or greenish-yellow colour. However, in some species colourless mucus also occurs. The coloured mucus may contain crystals of pigment in species of *Ascobolus* sect. *Ascobolus*. Occasionally these crystals show a characteristic shape and size (e.g. in *A. denudatus*).

Under certain circumstances asci in hymenia may reach complete maturity without discharging their contents. The episporia of the ascospores in such asci are always brownish and the colour of the hymenial mucus also changes into brownish. Consequently these over-ripe hymenia are brownish or olive coloured.

PARAPHYSES.—These sterile hymenial elements develop before the asci and sooner or later during the development of the fruit-body the tips become exposed. They are mostly filiform or cylindrical, simple or branched, always septate with a varying number of nuclei per segment (Berthet, 1964). In *Saccobolus* the paraphyses are comparatively shorter and slightly broader than in *Ascobolus*.

The shape of the tips of the paraphyses has been considered a valuable distinguishing character in some species. It proved to be of little or no value.

Experiments showed that the shape of the tip is strongly influenced by the developmental type of the fruit-body and by environmental conditions during the development. The humidity of the air appeared to be of great influence.

No enlargement of the tips ever occurs in species in which the hymenium does not become exposed before the telohymenial phase, as is the case in species of *Ascobolus* sect. *Dasyobolus*. Hymenia that become exposed in an earlier phase may show paraphyses with more or less enlarged tips.

In cultures of *Ascobolus denuatus*, *A. furfuraceus*, *A. michaudii*, *A. crenulatus*, and *A. roseopurpurascens* thickened tips were formed in a part of the paraphyses under dry conditions. When in a later phase hymenial mucus was formed or the humidity of the air was raised until saturated, many of the clavate tips, formed during the dry period, grew out with very slender, filiform protuberances (Figs. 26g, 27i).

The most unusual types of paraphyses may be found in over-ripe or alkaline hymenia, recognizable by the brownish colour of the episporia and the occurrence of many swollen ascospores. Paraphyses with ellipsoid or subglobular cells are sometimes rather frequent.

Of *Saccobolus thaxteri* and certain developmental forms of *S. versicolor*, ascomata were found that looked as if closed in the prohymenial and early mesohymenial phase. Further investigation of these stages showed that the swollen tips of paraphyses formed what was seemingly a continuation of the excipular layer. Both excipular cells and paraphysal tips were covered with a thin layer of purplish or pinkish amorphous pigment. Also in both species paraphyses without swollen tips were formed afterwards.

The same phenomenon was observed in *Ascophanus microsporus* (B. & Br.) E. C. Hansen and *A. coemansii* Boud.

Amorphous, purplish or brownish pigment is found between the tips of the paraphyses in many species of *Ascobolus* and *Saccobolus* sect. *Eriobolus*. In *Saccobolus versicolor* it is commonly found surrounding the swollen tips.

Paraphyses with coloured contents are restricted to *Saccobolus* sect. *Saccobolus* and *Ascobolus* sect. *Pseudosaccobolus*. Here the contents of terminal and subterminal segments are coloured yellowish or amber.

Asci.—The asci of the Ascobolaceae are characterized by an extraordinary increase in volume of the asci, mainly during the last phase of ripening. The wall of the ascus then is stretched enormously. At maturity the asci strongly protrude beyond the surface of the hymenium.

Broadly clavate to saccate asci are found in *Ascobolus* sect. *Dasyobolus* and sect. *Sphaeridiobolus*. More cylindrical-clavate asci occur in *Ascobolus* sect. *Ascobolus*, sect. *Heimerlia*, and sect. *Gymnascobolus*, while they are relatively short and broadly clavate in *Saccobolus* and *Ascobolus* sect. *Pseudascodesmis* and *Pseudosaccobolus*.

The ripe asci become more or less curved as a response to positive phototropism of the upper part of the ascus (Zopf, 1880: 33; Zopf, 1890: 205; Buller, 1934: 264). In a few species of *Ascobolus* the asci have already begun to curve towards the light during an early phase of the process of stretching. Sometimes as much as the upper third part or even more of each ripe ascus becomes curved.

The blue staining of the wall of the ascus with iodine was already observed by Coemans (1862) in *Ascobolus immersus* and *Saccobolus glaber* and by de Bary (1866: 108) in *A. furfuraceus*. The outer layer of the wall stains blue especially in the young asci. The staining is less intensive or may even be absent in the ripe asci. The measure of intensity of staining is constant for each species although great

differences exist between related species. All species of *Saccobolus* and of *Ascobolus* sect. *Sphaeridiobolus*, sect. *Heimerlia*, sect. *Gymnascobolus*, and sect. *Pseudosaccobolus*, show a blue staining of the ascus-wall with iodine. In all species of *Ascobolus* sect. *Dasyobolus*, except *A. siamensis*, the staining is intensely blue. Several, mainly terrestrial and lignicolous, species of *Ascobolus* sect. *Ascobolus* show only a very faint staining or none at all. In *Ascobolus* sect. *Pseudascodesmis*, as well as in *Ascodesmis* Tiegh, no blue staining of the asci has been observed.

Melzer's reagent was used for this purpose as an iodine-containing solution. Because of the relatively high concentration of iodine, this fluid still gives a perceptable staining when most of the other iodine-containing reagents fail. The formula used was: iodine 1 g, potassium iodine 3 g, distilled water 40 g, and chloral hydrate 44 g.

The wall of the ascus in Ascoboloideae consists of two different layers, which however are never found to be separable. With the light microscope these layers are only visible after more or less selective staining of living, ripe asci. Species with large asci, like *Ascobolus immersus*, *A. stictoideus*, *A. degluptus*, *A. furfuraceus*, *A. albidus*, *Saccobolus versicolor*, and *S. verrucisporus* appeared favourable objects.

The outer layer, which is of rather uniform thickness, shows greater affinity to neutral red and Congo red while it stains blue with iodine. The inner layer is less uniform in thickness and shows greater affinity to methyl blue and trypan blue. In the operculum and near the opercular annulus this layer is scarcely perceptible. Especially in the zone of the ascus-wall indicated by Chadefaud (1942a) as "bourrelet sous-apicale de la tunique interne", the inner layer is rather thick and clearly visible (Pl. 2, figs. A–C).

During the last phase of maturation of the asci, after the formation of ascospores and sometimes after these became pigmented, a large operculum is formed at the tip of the ascus by an internal ring-shaped thickening of the wall. This annulus is the place where the operculum will tear away from the rest of the ascus-wall. The operculum usually remains attached to the ascus-wall on one side. Sometimes, however, it is completely torn apart and shot away together with the contents of the ascus.

Shortly before maturity of the asci the operculum has a characteristic shape depending on the taxon. It is dome-shaped in *Ascobolus* sect. *Dasyobolus* and sect. *Sphaeridiobolus*, and more or less flattened or truncate in *Ascobolus* sect. *Ascobolus* and *Saccobolus*. Even during observations in various liquids, umbonate, angular, or irregular tips may be caused in ripe asci by changes of turgidity.

In the related genus *Ascodesmis* Tiegh., Moore (1963) could not find any differences in electron transparency between different parts of the ascus-wall.

The apical structure of the ascus in *Ascobolus* is very simple. It was studied by Chadefaud (1942a: 85; 1960: 548).

After discharge the walls of the empty asci collapse and shrivel.

The contents of the ascus-mothercell consist of a rather dense cytoplasm with a large vacuole near the base. A few large vacuoles are soon formed in the upper

part also. The very dense cytoplasm between these vacuoles contains the large fusion nucleus. After meiosis and sporogenesis the epiplasm becomes strongly vacuolated with some large vacuoles in the lower part. It is dense along the wall of the ascus and around the young ascospores.

The cytoplasm near the base of the young asci and the epiplasm around the ascospores in later stages are especially rich in glycogen (Errera, 1882a; 1886; Guillermond, 1903a). Small quantities of glycogen are also present in cells of the hypothecium and the flesh.

The glycogen of the asci is recognizable by a strong greenish opalescence and an intense brownish-red staining with iodine. This staining disappears after gentle heating and returns after cooling. The composition of the iodine-containing reagent was: iodine 0.1 g, potassium iodine 0.3 g, and distilled water 45 g.

During the development of the ascospores glycogen is present in vacuoles throughout the epiplasm, where it concentrates around the spores. After the formation of the ornamentation on the spores glycogen disappears completely from the epiplasm.

The metachromatic bodies described by Guillermond (1903b: 203) are present in the asci of all species of Ascoboloideae. They can be stained in sections of fixed material with polychrome methylene blue according to Unna or supravitally with brilliant cresyl blue.

During maturation of the ascus more of these bodies are formed. As a result of fixation and changes preceeding or accompanying the staining, these bodies agglutinate more or less in masses. The outer part of the bodies stains more intensely than the centre. Sometimes only the centre stained metachromatically and the outer part orthochromatically. A great deal of training is needed to obtain more or less constant results with these stainings.

During the pigmentation of the ascospores these metachromatic bodies disappear completely from the epiplasm.

Ascospores.—Of the three nuclear divisions of the fusion nucleus occurring in the ascus the third is mitotic; this results in the formation of eight haploid nuclei (Wood, 1953; Zuk & Swietlinska, 1965). The delimitation of the ascospores has already begun during the last nuclear division. As a rule the spores are uninucleate and no further divisions in the spores have been observed.

At first the spores are rather small, subglobular vesicles. However, they soon obtain their more or less final shape. In this stage the spore wall is very thick and strongly light-refractive. During the further development this primary ascospore wall becomes thinner and the spores reach almost their final size.

In abnormal cases some of the ascospores are abortive, and binucleate ascospores (due to additional mitosis) may occur (Zuk & Swietlinska, 1965). In some strains of *Ascobolus immersus* these aberrations were found rather frequently.

The shape of the ascospores is very characteristic for most species of the Ascoboloideae, excepting considerable variation in certain species of *Ascobolus*. Species with globular, subglobular, ellipsoid, cylindrical-ellipsoid, and fusoid spores are

found in *Ascobolus*. In *Saccobolus* the spores are more or less ellipsoid and often slightly asymmetrical or truncate. Only in *Saccobolus versicolor* were some asci with eight globular spores very rarely observed (Figs. 63e, 64b).

In asci with less than eight spores the well-formed spores are larger than those in 8-spored asci. They should be left out of consideration for measuring purposes.

During the maturation of the spores a layer of pigment is precipitated from the epiplasm on the spores resulting in a characteristic pattern of ornamentation.

From inside outwards the following layers are distinguishable in the ripe ascospore:

a. The cytoplasmic membrane, which is very thin and only visible after plasmolysis or cytoplasmic stainings.

b. The primary ascospore wall, which is rather thick and light-refractive. It shows no affinity to any of the stains commonly used.

c. The investing spore membrane (cf. Moore, 1963), which is very thin and stains clearly with trypan blue and brilliant cresyl blue. It forms the outer limitation of the ascospore proper.

d. The episporium is a more or less thick extra-sporal layer. In the Ascoboloideae it is formed by epiplasmic pigment. It may be occasionally absent, but none the less the ascospores retain their germinal force and vitality. This layer can be removed mechanically or chemically without harm.

In the measurements of the ascospores the episporium is included if nothing to the contrary is stated. This was the practice of the older authors (e.g. Berkeley, Broome, Karsten, Boudier, Fuckel, Rehm, and Phillips) and also of modern mycologists working on fungi of this group (Le Gal, 1953a: 72; Gamundí & Ranalli, 1966).

The ascospores of many coprophilous species of *Ascobolus* and *Saccobolus* possess adhering mucilaginous substance. This is surrounded by a very delicate membrane. It is often already present before the episporial pigment is precipitated. After the discharge of the asci the mucilaginous substance swells strongly in water and is soon dissolved.

In *Ascobolus* the mucilage may be present in the shape of an unilateral cap (e.g. *A. furfuraceus*), a girdle (*A. degluptus*) or an enveloping layer (*A. immersus*). Some species of *Saccobolus* sect. *Saccobolus* have a layer of mucilage surrounding the whole package of ascospores. Most species of *Saccobolus* sect. *Eriobolus* have a single, large, unilateral cap or several smaller appendages to the packages. In both *Ascobolus* and *Saccobolus* species occur in which no mucilage is formed. As a rule it is absent in species inhabiting soil and wood.

Certain fixative mixtures with formalin and alkaline solutions bring about a considerable swelling of the episporium. In old fruit-bodies with over-ripe hymenia ascospores with a swollen episporium may also be found. Boudier (1869) considered this to be a kind of hypertrophy, but this is incorrect. Le Gal (1953a: 76) and Malençon (1962: 117) also described swollen episporia. However, Malençon stated that this swelling can be effected in different stages by means of alkaline solutions.

In these solutions, the episporium also discolours while it dissolves in higher concentrations.

The contents of the ascospores are optically rather homogenous. Besides a single nucleus with a large nucleolus the plasm of the ripe spore contains only a few granules and vacuoles. Glycogen can be demonstrated in the sporoplasm.

ARRANGEMENT OF ASCOSPORES.—In *Ascobolus* the spores are mutually free. At first they are usually arranged in a single row. But when the ascus stretches there often becomes space available for a double row of longitudinally disposed spores or a single row of obliquely disposed ones. Sometimes the very thick, mucilaginous substance adhering to the spores prevents the formation of a double row.

Very large asci, such as occur in *Ascobolus* sect. *Dasyobolus* and sect. *Sphaeridiobolus*, often show an irregular disposition of the spores in more than two rows.

In the ripe ascus, in optimal condition for the discharge of its contents, the spores have been shifted towards the axis of the ascus just behind the operculum. In this phase the spores are contained in a very large vacuole that may almost completely fill the ascus. The spores are never regularly arranged, according to a fixed pattern, in *Ascobolus*.

In *Saccobolus* the spores are only very rarely free. Mostly they are regularly united into a cluster and cemented together by the episporial pigment. In cases where this pigment was already precipitated before the spores were pressed together, they remain free; this is the case in *S. saccoboloides*. Sometimes the episporial pigment forms only a weak connection; it may be partly soluble in water. As result, the spores of *S. globuliferellus*, *S. geminatus*, and *S. infestans* may easily come apart.

The 'common hyaline sack' which is found in some species of *Saccobolus* sect. *Saccobolus* scarcely plays a role in keeping the spores together, as was supposed by Boudier (1869).

The following patterns of arrangement of the spores are distinguishable in species of *Saccobolus*.

Pattern I (Fig. 2a–b): with four rows of two longitudinally disposed spores, and two longitudinal planes of symmetry. This is typical of *Saccobolus* sect. *Saccobolus*.

Pattern Ia (Fig. 2c): a longitudinally contracted form of pattern I (e.g. *S. truncatus*).

Pattern II (Fig. 2f–g): with two rows of three and one row of two spores, and a single longitudinal plane of symmetry. The axes of the spores are about parallel to the axis of the package (e.g. *S. caesariatus*, *S. beckii*, and *S. verrucisporus*).

Pattern III (Fig. 2h): with two terminal pairs of spores parallel to the axis of the package and two median pairs of obliquely disposed spores (together with pattern II in *S. versicolor* and *S. depauperatus*).

Pattern IIIa (Fig. 2i): a longitudinally contracted form of pattern II or III; often rather irregular (*S. portoricensis* and *S. globuliferellus*).

Pattern IV (Fig. 2j): a subglobular package (*S. dilutellus*).

Pattern V: with only four spores in a package,

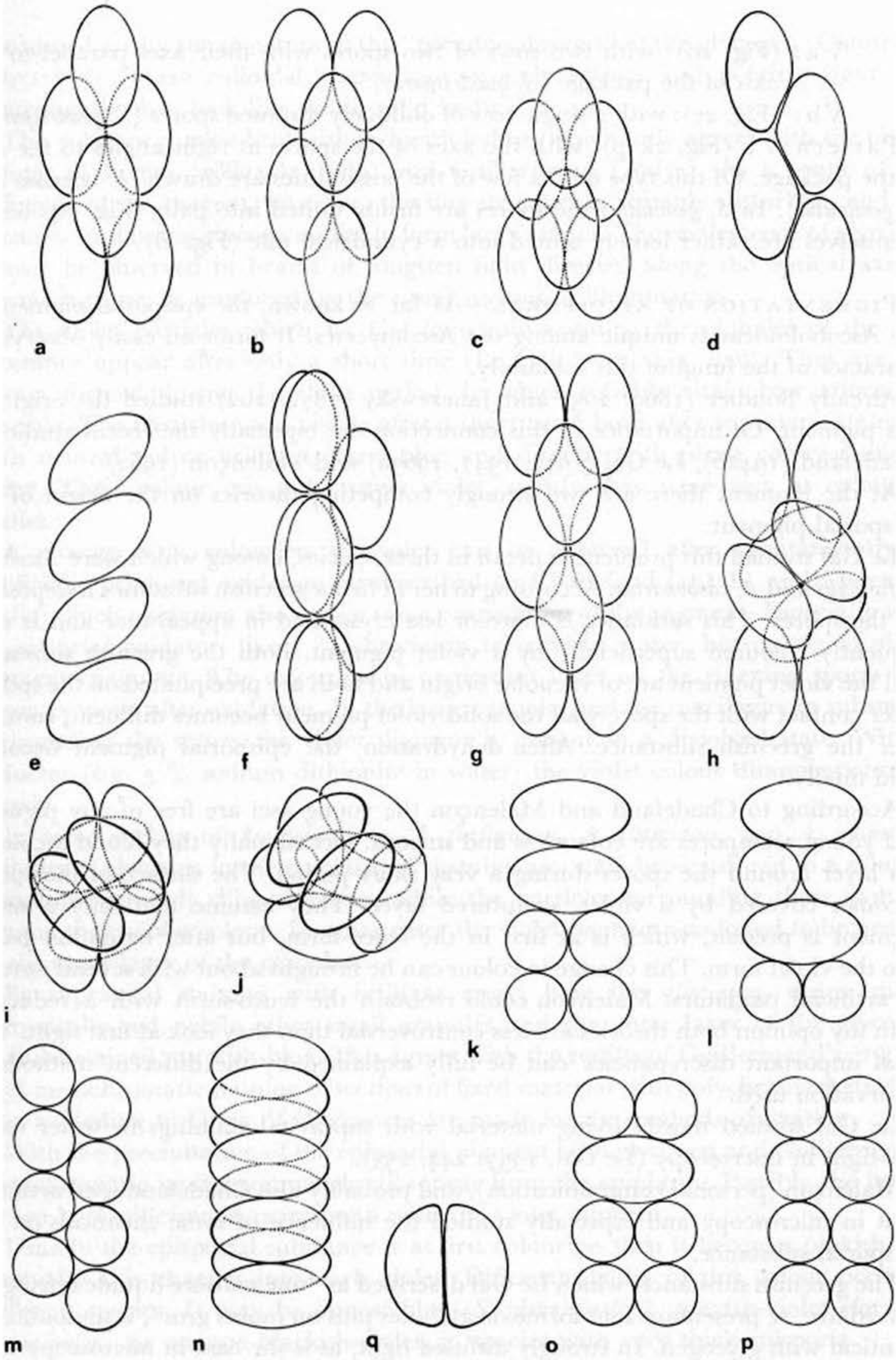

Fig. 2. — Arrangement of ascospores in *Saccobolus*. For explanation see text.

Va: (Fig. 2d): with two rows of two spores with their axes parallel to the axis of the package (*S. quadrisporus*).

Vb: (Fig. 2e): with a single row of obliquely disposed spores (*S. quadrisporus*).

Pattern VI (Fig. 2k–p): with the axes of the spores at right angles to the axis of the package. Of this type only a few of the possibilities are drawn (*S. infestans* and *S. geminatus*). In *S. geminatus* the spores are firmly united into pairs (Fig. 2q) which themselves are rather loosely united into a cylindrical pile (Fig. 2l).

PIGMENTATION OF ASCOSPORES.—As far as known, the episporial pigment of the Ascoboloideae is unique among the Ascomycetes. It forms an easily observable character of the fungi of this subfamily.

Already Boudier (1869: 203) and Janczewsky (1872: 202) studied the origin of this pigment. Of importance in this connection are especially the recent studies of Chadefaud (1942b), Le Gal (1942, 1947, 1963a) and Malençon (1962).

At the moment there are two strongly competing theories on the origin of the episporial pigment.

Le Gal studied this problem in detail in three species, among which were *Ascobolus furfuraceus* and *A. carbonarius*. According to her at first a greenish substance is deposited on the spores. This substance is more or less crystalloid in appearance and is subsequently coloured superficially by a violet pigment. Both the greenish substance and the violet pigment are of vacuolar origin and both are precipitated on the spores. After contact with the spore-wall the solid violet pigment becomes diffluent, running over the greenish substance. After dehydration, the episporial pigment becomes solid finally.

According to Chadefaud and Malençon the young asci are free of any pigment and young ascospores are colourless and smooth. Occasionally they found a colourless layer around the spores during a very short period. The surface of the spores becomes covered by a violet, sculptured layer. They assume that only a single pigment is present, which is at first in the leuco-form, but after oxidation passes into the violet form. This change in colour can be brought about with several natural or artificial oxidators. Malençon could reobtain the leuco-form with a reductor.

In my opinion both theories are less controversial than they look at first sight. The most important discrepancies can be fully explained by the different methods of observation used.

Le Gal studied mostly living material with supravital stainings in water using day-light in microscopy (Le Gal, 1957: 244, 253).

Malençon (personal communication), and probably also Chadefaud used artificial light in microscopy and especially studied the influence of some chemicals on the episporial substance.

The greenish substance, which Le Gal described as "une matière liquide réfringente verdâtre, se présentant sous forme de globules plus ou moins gros", is undoubtedly identical with glycogen. In strongly diffused light, as is the case in microscopy with day-light, the green opalescence is very conspicuous. The crystalloid appearance is

accounted for by the structure of the "pseudo-solutions" of the glycogen (Clautriau, 1895: 234). These colloidal suspensions strongly refract and polarize light and consequently they look like small, solid bodies.

This substance stains brownish-red with iodine, which fully agrees with the observations of Errera (1882a–b, 1886) and Guillermond (1903a). As a result of the influence of the reagent, however, the fine structure is strongly disturbed, and the vacuoles containing glycogen unite to form large masses. The opalescence of glycogen cannot be observed in beams of tungsten light directed along the optical axis of the microscope, as produced by the usual systems of illumination.

The violet particles which Le Gal found surrounding the globules of the first substance appear after only a short time (Le Gal, 1947: 244, 249). They are not always formed during the short period, in which reliable vital observations are possible. The particles were visible after a short time, both after supravital stainings with neutral red or brilliant cresyl blue and directly with phase contrast microscopy. Their colour was only rarely violet, mostly they were seen as colourless bodies.

A change from colourless to violet can be observed after spontaneously or artificially produced oxidation, as described by Chadefaud (1942b) and Malençon (1962). Such oxidation also causes some coagulation of the pigment. Especially with an artificial oxidator, like 1 % chromium trioxide in water, big masses of violet pigment coagulate. The colourless or opalescent layer on the ripening spores also becomes violet after oxidation. In the large vacuoles and the mucilaginous substance surrounding the spores the violet pigment is present in a dissolved state. With a reductor (e.g. 5 % sodium dithionite in water) the violet colour disappears immediately.

In some species of *Ascobolus* (e.g. *A. furfuraceus*, *A. stictoideus*, and *A. immersus*) globules of glycogen in the epiplasm of ripening asci stain brownish-red in a solution containing strongly diluted iodine, while the particles surrounding these globules assume their violet colour. In other cases the violet pigment was found to be present in the outer layer of the globules.

By supravital staining with brilliant cresyl blue the glycogen stains metachromically red, while other small granules and the outer layer of the glycogen globules stained purplish-blue. This agrees with the results of Guillermond's (1903b: 203) metachromatic staining of sections of fixed material with polychrome methylene blue according to Unna, if allowances are made for the methods of fixation.

With the precipitation of the episporial pigment both glycogen and Guillermond's metachromatic bodies completely disappear from the epiplasm. Possibly the bodies shown by Guillermond correspond with the violet pigment.

Usually the episporial substance is at first colourless then it becomes pinkish and gradually this changes into dark violet. Different shades of this colour occur in different species. It may be almost blue (*S. globuliferellus*), greyish-violet (form of *S. versicolor*), or opaque blackish-violet, in species with very thick episporia.

The violet spores are fully mature and ready to be discharged. Often however,

the violet colour of the episporium changes into purplish-brown in the ascus. As noticed by Boudier (1869) and Malençon (1962) this final change of colour can also be brought about by heating the spores. This discolouration is accompanied by a chemical change of the pigment.

The violet form immediately dissolves and discolours in diluted alkali (e.g. 0.5 % sodium hydroxide), leaving behind a colourless or greenish opalescent layer, which stains red with iodine. This layer also dissolves gradually in alkali.

The brown form is resistant against diluted alkali and reductors.

Conclusion.—From vital observations and the progress of chemical reactions in ten species of *Ascobolus* and six species of *Saccobolus* it may be concluded that in the pigmentation of the ascospores of Ascoboloideae at least two components are involved. One of these is glycogen, which precipitates in great quantities on the spores.

At the same time the other component precipitates on the spores in the form of very small particles or in a soluble state. On the surface of the glycogen this component becomes diffluent or dissolves. Its colour and aspect depend on the redox-potential and the acidity. Usually the change of colour into violet occurs immediately after the precipitation. By further and slower oxidation the episporium becomes purplish-brown.

The course of the pigment-formation is subject to many variable environmental factors.

No evidence could be found for Malençon's (1962: 114) hypothesis that in a single species in addition to 'chromogenous' races also 'leucogenous' races might occur.

A detailed chemical analysis of the process of pigmentation is urgently needed.

Ornamentation of ascospores.—The episporial pigment is precipitated on the spores as very small granules. The form in which it precipitates is the primary pattern of ornamentation. As a rule it is determined genetically and is rather constant for each species.

Those parts of the episporium that during pigmentation are covered with mucilaginous substance or are in contact with other spores may show a thinner layer of pigment or a disturbed pattern of ornamentation.

The following primary patterns of ornamentation may be distinguished in the Ascoboloideae: (i) completely smooth (*Ascobolus castaneus*); (ii) smooth with only a single or a few crevices (*Ascobolus scatigenus*, *A. immersus*); (iii) with more or less longitudinal, anastomosing crevices, sometimes accompanied by small pits or irregular short crevices (e.g. *A. furfuraceus*, *A. crenulatus*); (iv) with a net-work of crevices (*A. behnitziensis*, *A. subglobulosus*, *Saccobolus portoricensis*, *S. quadrisporus*, and *S. beckii*); (v) with coarse warts (*Ascobolus carbonarius*, *A. archeri*, *A. stictoideus*, *Saccobolus obscurus*, and *S. verrucisporus*); (vi) with small warts or spines (*Ascobolus xylophilus*, *A. hawaiiensis*, *A. brassicae*, *A. aglaosporus*, *Saccobolus citrinus*, *S. globuliferellus*, and *S.*

geminatus); (vii) with very fine granules (e.g. *Ascobolus amoenus*, *A. elegans*, and *A. cainii*); (viii) with a net-work of pigment (*Ascobolus reticulatus*).

The primary pattern of ornamentation may become more complicated afterwards by secondary crevices, as a result of stretching, growth, or swelling (cf. Figs. 14 o, 23b, 24e, l, 34e–g, 51e, f). Especially in over-ripe hymenia secondary crevices may be very frequent in the swollen episporia. Episporia may separate from the primary ascospore wall and show irregular swellings as a result of the over-ripe hymenium becoming alkaline (Malençon, 1962).

The thickness of the episporial pigment is rather variable. It varies from about 0.5 μ in *Ascobolus scatigenus* and *A. castaneus* to more than 2 μ in *A. carbonarius*, *A. demangei*, and *Saccobolus beckii*. In *Ascobolus carbonarius* the pigment is considerably thicker at the poles than at the sides, while in *A. viridis* and a form of *A. denudatus* irregular thickenings may occur everywhere in the layer. In *Saccobolus beckii* the pigment is very thick and irregular and often the individual spores are not easily observed.

In asci with less than eight spores the pigment is thicker than in 8-spored asci. Especially in 1- or 2-spored asci the pigment may be very thick and the pattern of ornamentation abnormal.

Anisospory.—In almost all species of *Ascobolus* cases of anisospory may be observed. Boudier figured some of these cases as early as 1869. So far anisospory within one and the same ascus has not been found in *Saccobolus*.

The types of anisospory most frequently met in *Ascobolus* are as follows.

(a) Atrophy or abortion of some of the spores within an ascus. The degenerated remains are found in the ripe ascus. These are not very conspicuous because of their small size and lack of pigment (cf. Boudier, 1869: *pl. 6 f VI; pl. 7 f. XII 4*). In *A. immersus* this type of anisospory is sometimes rather frequent (cf. Rizet, 1941).

(b) The episporium is absent in some of the spores. The spores remain colourless and smooth. Most colourless spores in ripe asci are of this type (cf. Pl. 4, fig. F).

(c) The episporium is present but it remains colourless, while other spores in the same ascus are violet (cf. Boudier, 1869: *pl. 6 f. VI 18*). This type is very rare. After more powerful artificial oxidation these spores sometimes turn pinkish. With a diluted iodine-containing solution the colourless episporia stain brownish-red.

Cases of anisospory in which the pigmentation of some of the spores of an ascus is retarded with respect to the other part, probably also belong to this type.

(d) The pigment is precipitated on some spores in the form of small or large, irregular lumps (cf. Figs. 12g, 20e, 24m, 53q; Pl. 6, fig. c, Pl. 8, fig. E). The characteristic pattern of ornamentation is absent.

(e) Within the same fruit-body or even within a single ascus with normally pigmented ascospores, different patterns of ornamentation occur (cf. Boudier, 1869: *pl. 7 f. XIII*; Figs. 28b–i, 15f). Especially in *A. albidus* and *A. denudatus* this type of anisospory is rather frequent.

The frequency of anisospory is usually relatively low. When anisospory occurs, segregations of two or more types of spores are often encountered in the contents of a single ascus. The various ripe asci in a fruit-body were never found to be constant with respect to their contents in such cases.

In a species of *Ascobolus* Bistis (1956a) ascertained that both ascospore-abortion and tan spore colour are inherited by a single pair of Mendelian allelomorphs. Also in *A. immersus* several cases of anisospory were found to depend on a single genetic factor (Rizet, 1941; Rizet & *al.*, 1960a–b; Lissouba & *al.* 1962; Makarewicz, 1964).

Owing to the complexity of the pigmentation, the great number of different types of abnormal ascospores in *Ascobolus* is scarcely astonishing (Lissouba & *al.*, 1962). More detailed study of the ascospore-mutants may help solving the problems of the pigmentation.

Because of the mostly low frequency of anisospory, ascospore characters can be used in *Ascobolus* to distinguish between species. In some cases, however, certain strains or collections show an accumulation of abnormal types. *Ascobolus cubensis* is probably based on such material.

CHAPTER V

CYTOLOGY

Several species of *Ascobolus* have been used in karyologic studies. Since the fusion-nucleus in the ascus is relatively large for this group of fungi, they are very suitable for studying meiosis.

The existence of a double nuclear fusion in *Ascobolus* and some allied genera has been a matter of debate for many decades.

According to Harper (1895), Welsford (1907), Fraser (1909), Fraser & Brooks (1909), and Gwynne Vaughan & Williamson (1932) the first nuclear fusion occurs in the ascogonium of species of *Ascobolus* studied by them. [2] This is followed by the generally accepted karyogamy in the ascus.

The first nuclear division in the ascus is meiotic, but according to the authors cited also the second or the third division would be meiotic (brachymeiosis).

Other investigators, like Dangeard (1907), Ramlow (1915), Moreau (1930), and Schweizer (1923, 1931, 1932), who studied the same and also other species [2], strongly deny the existence of a double nuclear fusion and of brachymeiosis. Some of them observed pairing of nuclei (karyonymphy) in the ascogonium of these fungi, but never karyogamy.

Cytological observations of these stages are difficult because of the very small nuclei and chromosomes. The results may be influenced by fixation (Ramlow, 1915).

Recent cytological investigations by Olive (1949b, 1950), Hirsch (1950), Wood (1953a–b), Bistis (1956b), and Zuk & Swietlinska (1965) are all strongly in favour of Dangeard's point of view. Also from a genetical point of view there are no indications of the existence of brachymeiosis in these fungi. In *A. scatigenus* (Wood, l.c.) and *A. furfuraceus* (Zuk & Swietlinska, l.c.) meiosis was studied in detail.

The number of chromosomes (n) in several species of *Ascobolus* was found to be eight, e.g. in *A. immersus* (8–9 according to Zuk & Swietlinska, 1965), *A. scatigenus* (Wood, 1953a), *A. furfuraceus* (Harper, 1895; Fraser & Brooks, 1909). A review of literature concerning the nucleus in fungi (e.g. in Pezizales) was given by Olive (1953: 513).

The karyology of the mycelium and the vegetative parts of the fruit-body is scarcely known. Some work has been done in this respect by Zuk & Swietlinska (1965) on *A. immersus*, by Dangeard (1907) on *A. furfuraceus* and *Saccobolus versicolor*, and by Berthet (1964) on *Ascobolus carbonarius* and *A. furfuraceus*.

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[2] As a result of taxonomic confusion in the genus *Ascobolus*, it is mostly impossible to ascertain on which species the preceding authors made their observations. They did not give adequate descriptions and figures of their material. Only very rarely material has been preserved to enable later investigators to verify the identifications.

CHAPTER VI

SEXUALITY AND COMPATIBILITY

Species of *Ascobolus* are favourable objects for the study of developmental cycli (ontogeny) and problems of sexuality and compatibility. Several species have been studied. As these problems are rather complicated and beyond the scope of this taxonomic monograph, they are merely fleetingly mentioned here.

Ascobolus scatigenus (Dodge, 1920; 1936), *A. carbonarius* (Betts, 1926), *A. furfuraceus* (Dowding, 1931; Bistis, 1956a), *A. immersus* (Rizet, 1939), and *A. geophilus* (Betts & Meyer, 1939) are heterothallic. *Saccobolus saccoboloides* (Dodge & Seaver, 1946) and some other species [3] of *Ascobolus* and *Saccobolus* (Dodge, 1912a; Schweizer, 1931; Gwynne Vaughan & Williamson, 1933) are homothallic.

For the earlier work in this field, concerning species of *Ascobolus* or *Saccobolus*, the following publications are of importance: Dodge (1912a), Lohwag (1927), Kniep (1928), Gäumann & Dodge (1928), Moreau (1930), Gwynne Vaughan & Williamson (1932), Drayton (1932), Dodge (1936), Dodge & Seaver (1946), Whitehouse (1949), Langeron (1952), Olive (1954b).

For modern research in this field the work of Bistis (1956a, 1956b, 1957), Bistis & Raper (1963), Esser & Kuenen (1965), and Esser (1967) are particularly important.

The earliest ontogeny of only a very few species is rather well known. In *Ascobolus carbonarius* Dodge (1912a) described that a long trichogyne grows into the direction of an antheridial conidium from a different mycelium and coils around it.

In *Ascobolus scatigenus* (Gwynne Vaughan & Williamson, 1932) ascospores of types A and B are formed, from which mycelia develop of types A and B. The only difference between the two types of mycelia is in their behaviour with respect to the other strain. Male branches are formed on the younger hyphae and female branches on the older hyphae of both strains, A and B. Consequently, there is no difference of sex between both strains. They are monoecious but not homothallic. A-antheridia only unite with B-oogonia, and B-antheridia only with A-oogonia. After plasmogamy the male nuclei move through the many-celled trichogyne towards the ascogonium. This is called physiological heterothallism.

Among Ascobolaceae, sexual behaviour has been most extensively studied in *Ascobolus furfuraceus*. [4] This is a heterothallic species in which the mating type is established by a single locus of probably two alleles. The individual strains are

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[3] See foot-note 2 on p. 47.

[4] Identified as *Ascobolus stercorarius* (Bull. per St-Amans) Schroet. by the authors concerned.

hermaphrodite, but self-incompatible and reciprocal cross-compatible (Bistis, 1956a).

In the sexual process of this species a donor or fertilizing agent and a receptor element are involved. Bistis (1956b, 1957) proved that non-germinated oidia can function as fertilizing elements after undergoing a physiological change, which is called "sexual activation".

Experiments by Bistis & Raper (1963) with growing hyphal fragments demonstrated that "sexual activation" also involves a minor morphological change, viz. a dilation of the apical regions of the hypha. As in the case of activated not germinated oidia, the oogonia develop only in the direct surroundings of the dilated apices.

The activated, hyphal tips are both morphologically and functionally antheridia and should be so considered. In a sexual reaction the non-germinated oidia function as antheridia. However, they lack the morphological differentiation and are not attached to the hyphal system from which they originate. "Sexual activation" is the same as "antheridial differentiation". In reality the sexual mechanism in this species is a gametangial-gametangial system.

Olive (1954b) pointed out, that many investigations indicated that the sexual process in the fungi is much more labile and variable than was presumed by early investigators. Heterokaryosis, heterozygosity, and segregation may occur freely in homothallic as well as in heterothallic fungi.

CHAPTER VII

GENETICS

When B. O. Dodge (1936: 40), the later geneticist, started monographing the Ascobolaceae, he was so fascinated by the reproductive and genetic problems of this group, that he was soon deeply involved in these problems and abandoned his taxonomic interests for them.

Some species of *Ascobolus* have proven to be favourable objects for genetic investigations. Rizet (1939, 1941) showed the suitability of *A. immersus* for this type of work. The ontogeny and cytology of this species are rather well known (Ramlow, 1915; Zuk & Swietlinska, 1965). At present it is an important genetic object. For a review of the modern genetic literature concerning this species the following authors should be consulted: Rizet & *al.* (1960a–c), Lissouba & *al.* (1962), Gajewski & *al.* (1963), Rizet & Rossignol (1963), Rossignol (1964), Yu-Sun (1964), Paszewski & Surzyski (1964), Makarewicz (1964, 1966), and Paszewski & *al.* (1966).

Among the species of *Ascobolus* studied, Dodge & Seaver (1946) considered *A. magnificus* and *A. furfuraceus* to be the most favourable objects for genetic work. Of both species the life cycles and the cytology are well known (Dangeard, 1907; Dodge, 1920; Dowding, 1931; Gwynne Vaughan & Williamson, 1932; Schweizer, 1932; Wood, 1953a–b; Bistis, 1956a–b, 1957; Bistis & Raper, 1963), while the technique of inducing the germination of the ascospores has also been considerably improved (p. 15). Of the two species only *A. furfuraceus* has since been used in some genetic investigations concerning sexuality and compatibility by Bistis & Olive (1954) and Bistis (1956a).

Ascobolus albidus might also be a suitable object in my opinion for genetic studies in relation to the pigmentation and ornamentation of the ascospores.

CHAPTER VIII

ECOLOGY

Most species of the Ascoboloideae are coprophilous. The ascospores of the coprophilous species pass through the intestinal canal of animals without harm, as was proven by Massee & Salmon (1902: 57) who opened the intestines of rabbits and sheep under aseptic conditions and isolated the contents in a sterile bell-jar. They published a list of the species developing from these contents.

On the other hand it has been found that ascospores often do not germinate without passing through the intestinal tract of an animal or without having been exposed to conditions found in the intestines. Treatment with diluted pepsin or alkaly combined with a raised temperature (38–40 °C) has proved to be very effective (p. 00).

In *Ascobolus carbonarius*, a pyrophilous species, the germination of the ascospores was greatly improved after a treatment at temperatures between 65 and 80 °C (Dodge, 1912a; Betts, 1926).

All normal ascospores of *Ascobolus* and *Saccobolus* are covered with a layer of dark pigment. In many other genera with predominantly coprophilous species, a dark layer in the walls of spores or sporangia occurs too.

Durrell (1964) studies the composition and structure of walls of dark spores in species found in desert soil. Under certain conditions colourless spores are formed. These spores are much more easily killed by ultra-violet radiation. It is possible that the layer of pigment surrounding the ascospores in Ascoboloideae protects the contents against ultra-violet radiation when the spores are exposed.

The shooting away of the spores is another characteristic of many coprophilous fungi. Coemans (1862) already noticed a very regular daily periodicity in the discharge of the asci of *Ascobolus*.

During the last phase of the maturation of the ascus light is necessary. At first the maturation of the asci is quite different from the final phase: the most advanced asci are more or less synchronous in development by the periodicity of the light. Under very constant conditions the ripe asci are accumulated in a hymenium until a stimulus causes their simultaneous discharge. Under certain other conditions the the asci may be discharged one after another. Especially in species with large hymenia simultaneous discharge is observed frequently. In species with small hymenia, like those of *Ascobolus* sect. *Dasyobolus* and of *Saccobolus*, the discharge is only rarely simultaneous.

During the final and enormous stretching of the asci their tips curve towards the maximal light intensity: they are positively phototropic (Zopf, 1880; Falck, 1923).

The violent discharge of the contents of the ascus has attracted the attention of several investigators. The ballistics of the ascospores were studied by Buller (1909: 251; 1933: 359), Ingold (1961), and Walkey & Harvey (1966).

The eight spores in each ascus of *Ascobolus immersus* are relatively very large. They are somewhat glued together by the thick mucilaginous layer covering them. Together with the contents of vacuoles and some epiplasm they form a large projectile. This can be shot away over a horizontal distance of 30 cm and vertically over 35 cm, which is about 500 times the length of the stretched ascus.

In species of *Saccobolus* the spores are also firmly united, but in many species of *Ascobolus* the spores do not stick together during the discharge of the ascus.

Buller (1933: 365) divided the coprophilous fungi with regard to the dissemination of the spores into two groups. In the first, which contains for instance *Ascobolus furfuraceus* and *A. scatigenus*, the spores are shot away one by one over a relatively short distance, just sufficient to enable air currents to carry them away. Many of these spores are thus transported to dry and unfavourable places, but some of them will settle on herbage in pastures and are then likely to be swallowed by herbivorous animals. After passing through the intestinal canal they are finally deposited in fresh dung where they can germinate, produce mycelia, and fructify.

In the species of the second group, like *Ascobolus immersus* and all species of *Saccobolus*, air currents do not play a role as an agent of dispersal of the spores. Here the spores of an ascus stick together to form a large projectile, which is very violently discharged and shot over relatively long distances directly against the surrounding vegetation. Such places are even more favourable than those in the first group because herbivorous animals were there before and are likely to return.

Walkey & Harvey (1966) calculated that in *Ascobolus furfuraceus* the mean number of spores in a projectile is 1.05 and that these are shot over distances from 1 to 16 cm, most shots being over a distance between 3 and 7 cm.

The species of *Ascobolus* and *Saccobolus* are mainly found on dung of herbivorous and omnivorous animals. Among the coprophilous species studied no strong correlation or specialization toward a specific substratum could be established. Only a few species appeared to be more frequent on dung of birds or small rodents than on other excrements. The season during which the substratum was collected proved to be also of little or no importance to the composition of the yield of coprophilous fungi.

Several species of *Ascobolus* are found growing on rotten leaves, rotten wood, moist paper, dirty walls, soil, burnt soil and charcoal, while some species of *Saccobolus* may occur on rotten textile fabrics and other dirtied substrata. In none of these cases can pollution with animal excreta be fully excluded. The terrestrial and pyrophilous species in particular are never found on dung. These species certainly belong to the group of fungi in which the ascospores are disseminated by air currents. The dispersal of the spores in these species by rodents was suggested by Boudier (1869), but could not be proven.

In the genera studied, the mucilaginous substance to the ascospores is restricted to the coprophilous species, although it does not occur in all of them.

CHAPTER IX

DISTRIBUTION

It is as yet difficult to say much about the distribution of the species of *Ascobolus* and *Saccobolus*, because they are only rarely collected and studied.

From incubated samples of dung of different parts of the world it is clear that both genera are very widely distributed.

Most specimens were collected in western and central Europe, the United States, and the south-eastern part of Canada. Asia, South and Middle America are rather poorly known in this respect, while Australia and Africa are still completely unexplored continents.

With our present rather poor and one-sided knowledge it appeared impossible to form more or less definite conclusions on distribution, but in some very common or conspicuous species some generalities may be formulated.

Species like *Ascobolus immersus*, *A. stictoideus*, *A. furfuraceus*, *A. crenulatus*, *A. denudatus*, *A. foliicola*, *A. carbonarius*, *Saccobolus depauperatus*, *S. versicolor* (Fig. 5), and *S. glaber* seem to be cosmopolitan. *Ascobolus albidus*, *A. lignatilis* and *A. brassicae* are perhaps restricted to Europe and North America or conceivably to the northern temperate region.

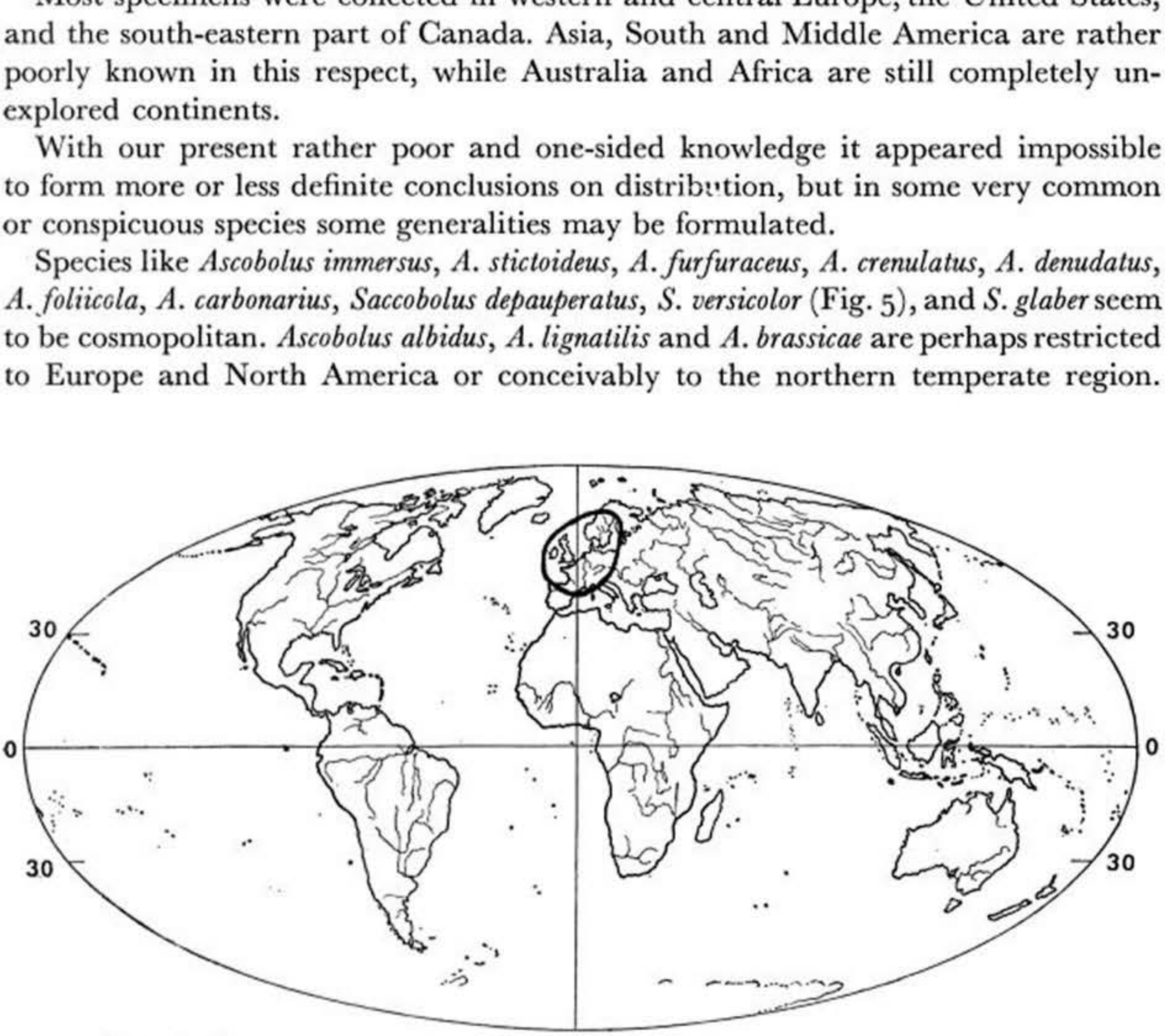

Fig. 3. — Distributional limits of *Ascobolus roseopurpurascens*.

Ascobolus roseopurpurascens (Fig. 3), *A. viridis* (Fig. 4), and *Saccobolus dilutellus* have not yet been found outside Europe.

Saccobolus globuliferellus and *S. dilutellus* may be considered as vicarious species of which the former occurs in North and South America and the latter in Europe (Fig. 6).

Ascobolus scatigenus, the species with the most conspicuous fruit-bodies is restricted to the tropical and warmer temperate regions of both hemispheres (Fig. 7).

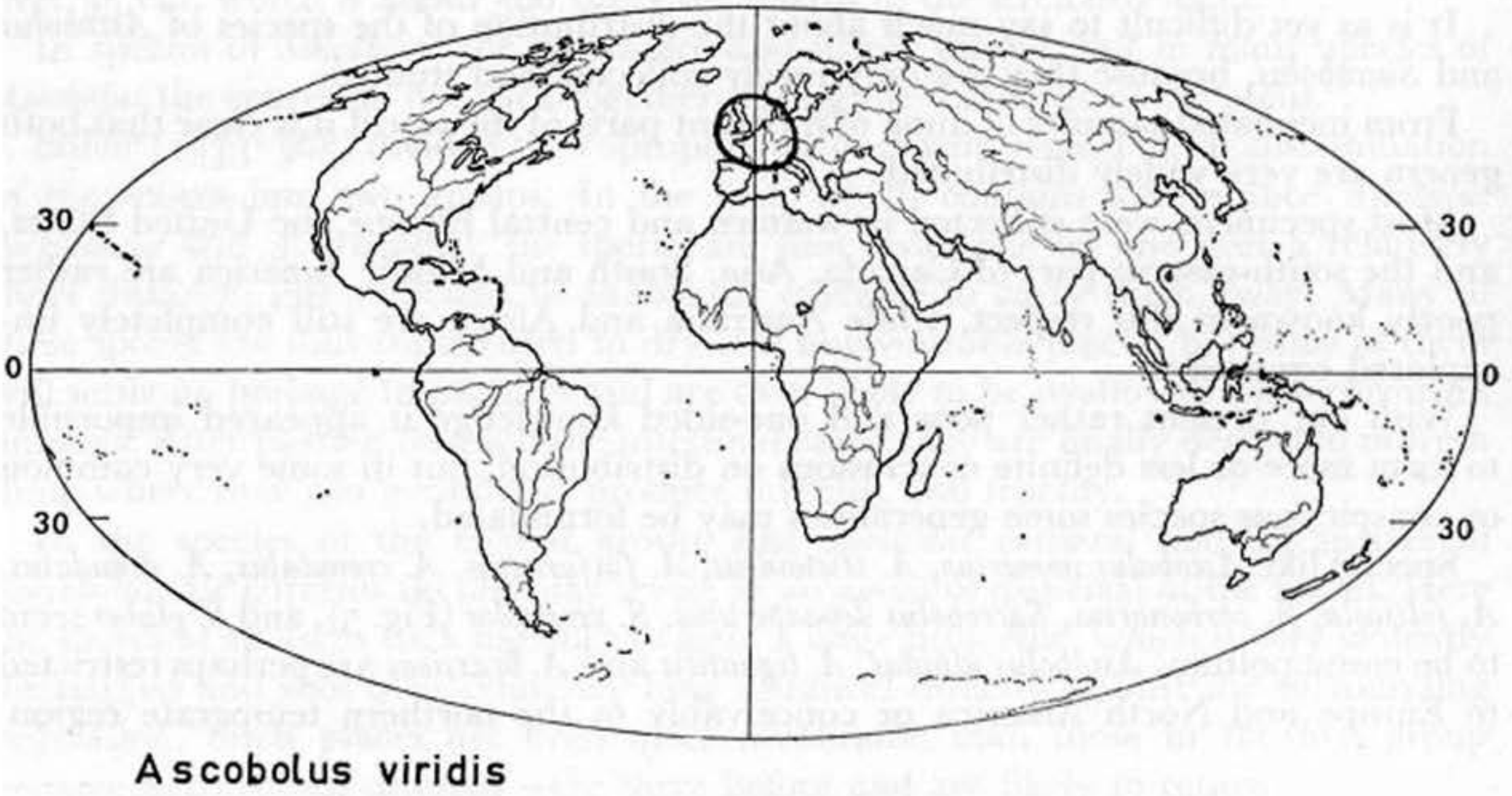

Fig. 4. — Distributional limits of *Ascobolus viridis*.

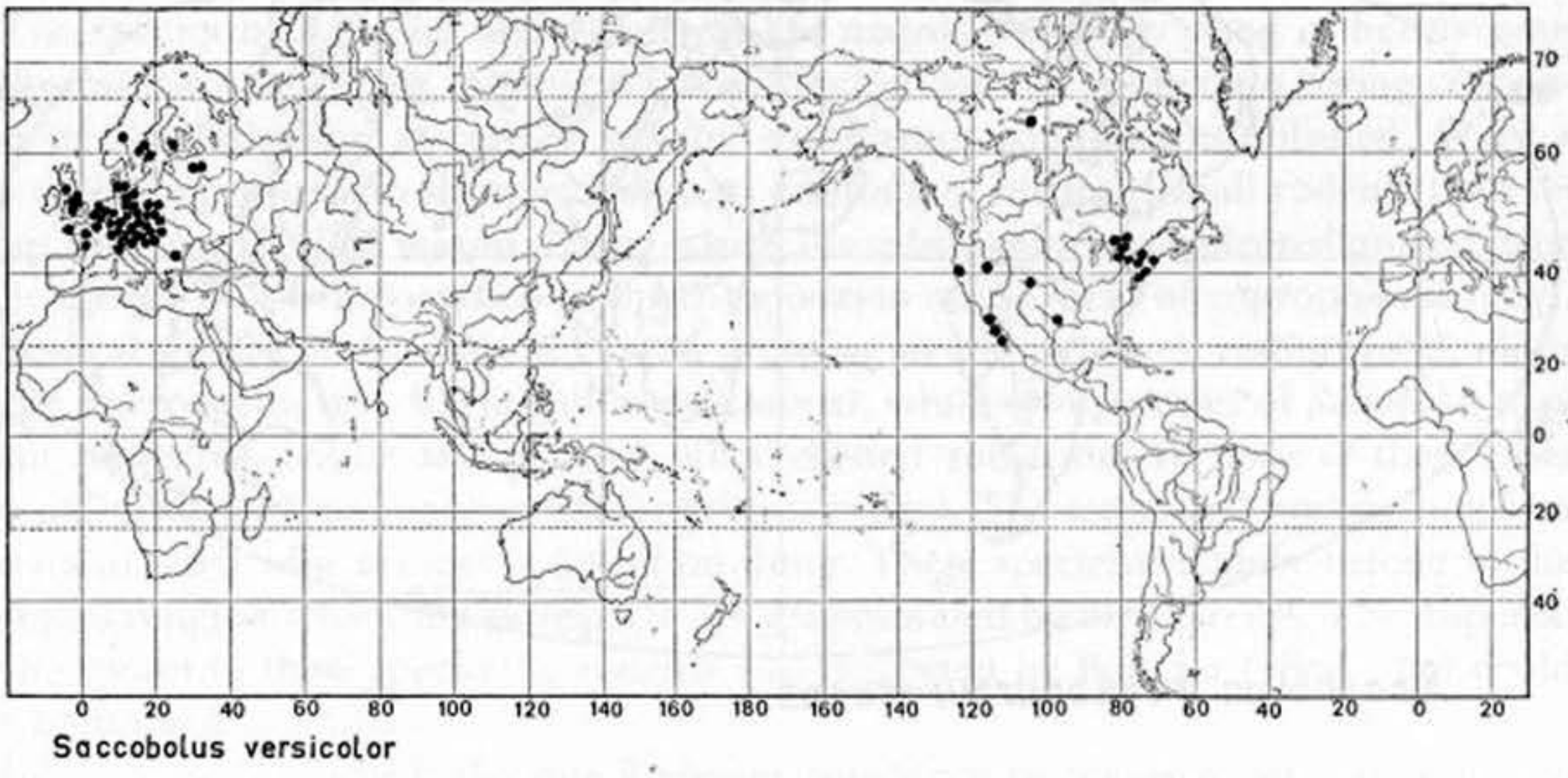

Fig. 5. — Distribution of *Saccobolus versicolor*.

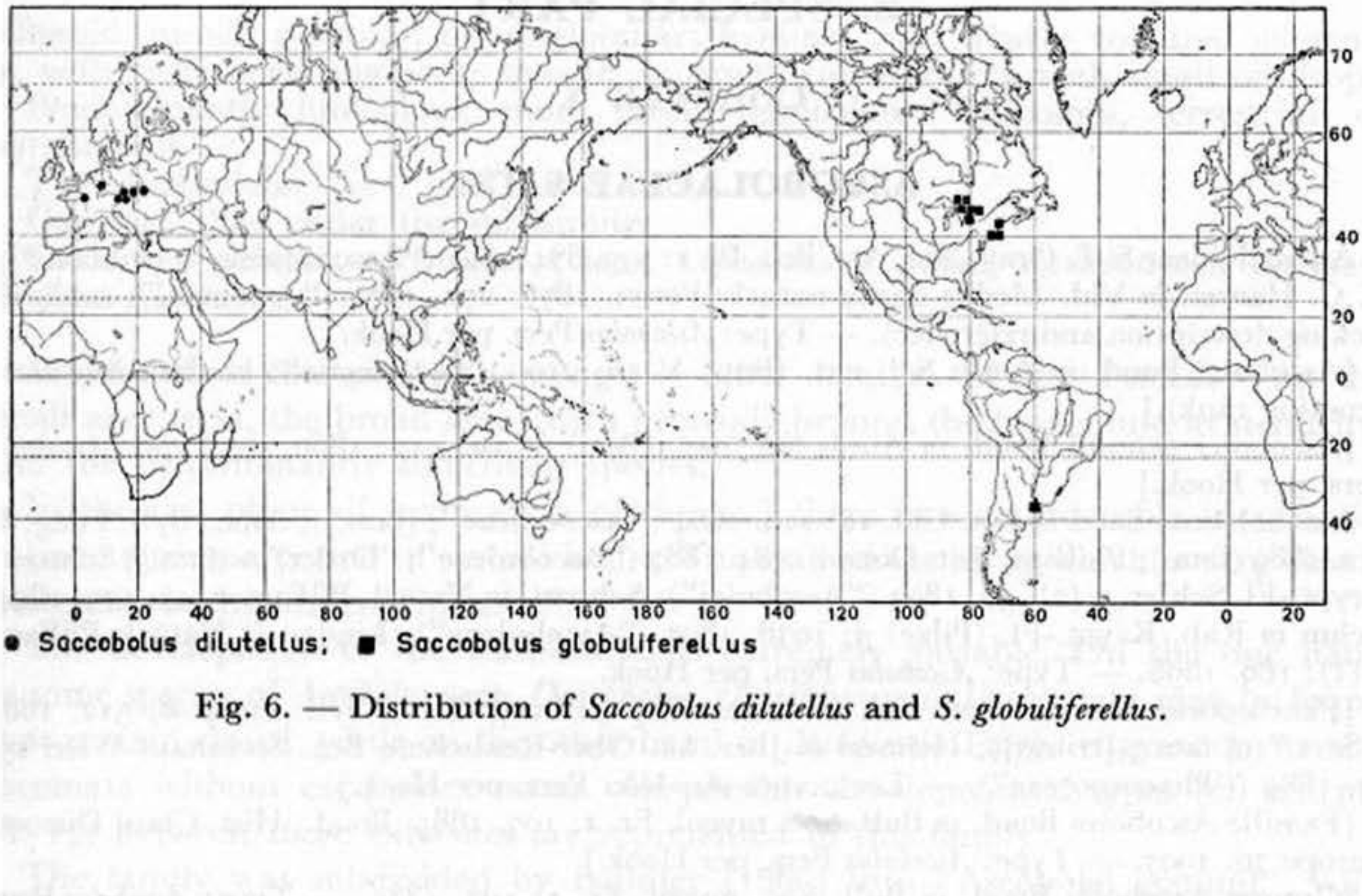

Fig. 6. — Distribution of *Saccobolus dilutellus* and *S. globuliferellus*.

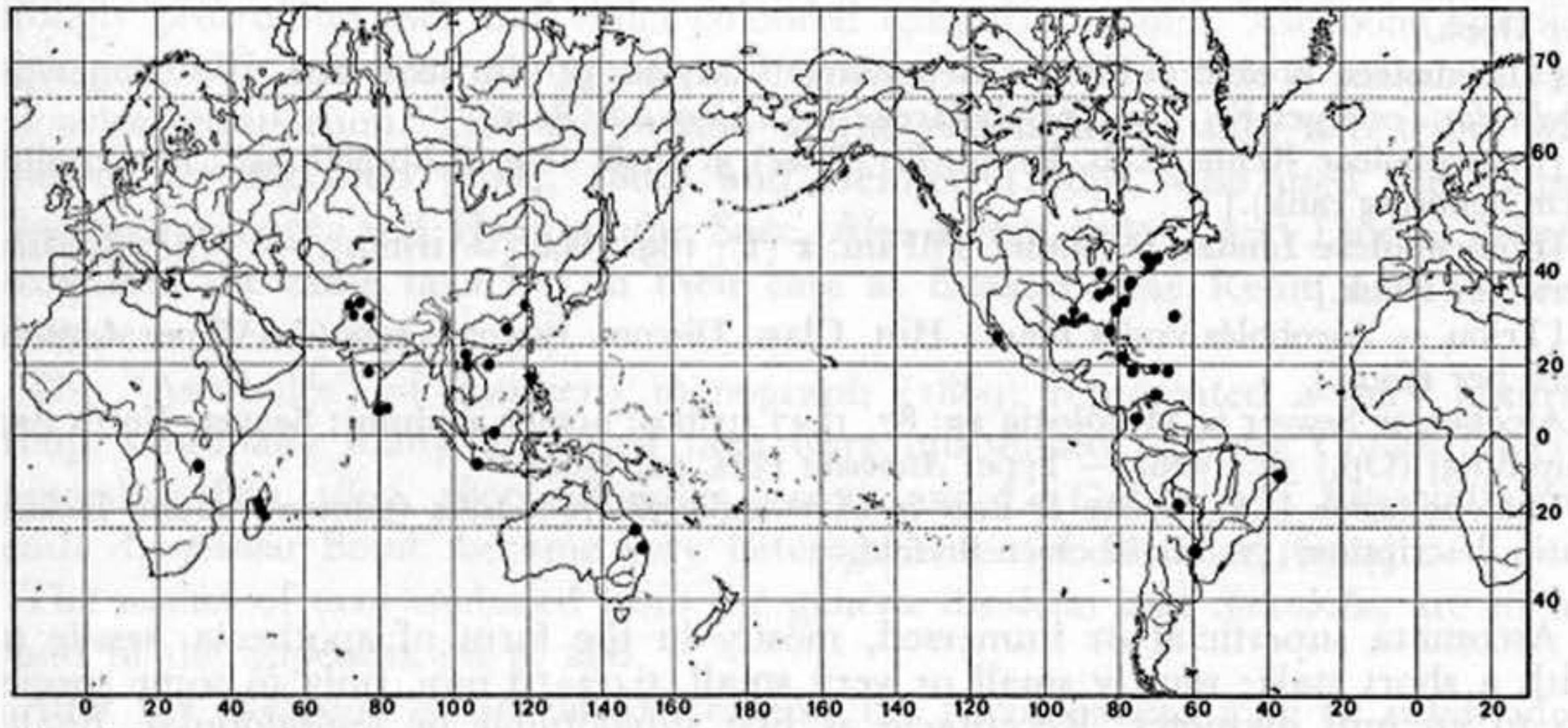

Fig. 7. — Distribution of *Ascobolus scatigenus*.

B. SPECIAL PART

CHAPTER X

ASCOBOLACEAE SACC.

Ascoboloideae S. F. Gray, Nat. Arr. Brit. Pl. **1**: 599, 674. 1821 ("Ascobolideae"; [subfam.[5]]); E. C. Hansen *in* Vid. Meddr dansk naturk. Foren. 1876: 272. 1877 ("Ascobolei"; subfam.; lacking description and reference). — Type: *Ascobolus* Pers. per Hook.

[Ascobolei Boud. *in* Annls Sci. nat. (Bot.) V **10**: 210. 1869 ("sectio": inadmissible term denoting rank).]

[Ascobolei genuini Boud. *in* Annls Sci. nat. (Bot.) V **10**: 212. 1869. — Type: *Ascobolus* Pers. per Hook.]

Ascobolaceae Sacc. *in* Bot. Cbl. **18**: 219. 1884 ("Ascoboleae"; [fam.]); Sacc., Syll. Fung. **8**: 512. 1889 (fam.); Phillips, Brit. Discom. 284. 1887 ("Ascoboleae"; "Order" = fam.); Schroet., Krypt.-Fl. Schles. **3** (2): 50. 1893 ("Ascobolei"); Schroet. *in* Natürl. PflFam **1** (1): 175. 1894; Rehm *in* Rab. Krypt.-Fl. (Pilze) **3**: 1078. 1895 ("Ascoboleae"); Lindau *in* Natürl. PflFam. **1** (1): 188. 1896. — Type: *Ascobolus* Pers. per Hook.

[Phaeosporae Sacc. *in* Bot. Cbl. **18**: 220. 1884 [tribus]; Sacc., Syll. Fung. **8**: 512. 1889 ("Sect." of fam.; [tribus]); Heimerl *in* Jber. kk. Ober-Realschule Bez. Sechshaus Wien **15**: 12. 1889 ("Phaeosporeae"). — Lectotype: *Ascobolus* Pers. per Hook.]

[Famille Ascobolés Boud. *in* Bull. Soc. mycol. Fr. **1**: 107. 1885; Boud., Hist. Class. Discom. Europe 70. 1907. — Type: *Ascobolus* Pers. per Hook.]

[Groupe Ascobolés Boud. *in* Bull. Soc. mycol. Fr. **1**: 107. 1885. — Type: *Ascobolus* Pers. per Hook.]

[Theleboleen Brefeld *in* Unters. Gesammtgeb. Mykol. **9**: 116. 1891 (fam.). — Monotype: *Thelebolus* Tode per Fr.]; → Thelebolaceae J. C. Cooke & Barr.

[Euascoboleae Rehm, Rab. Krypt.-Fl. (Pilze) **3**: 1078. 1895 ("Abtheilung"; inadmissible term denoting rank).]

[Euascoboleae Lindau *in* Natürl. PflFam. **1** (1): 189. 1896 (= tribus). — Type: *Ascobolus* Pers. per Hook.]

[Tribu — Ascobolés vraies Boud., Hist. Class. Discom. Eur. 71. 1907. — Type: *Ascobolus* Pers. per Hook.]

Ascoboleae Seaver *in* Mycologia **19**: 87. 1927 (tribus; nomen nudum); Seaver, North Am. Cup-fungi (Op.) 39. 1928. — Type: *Ascobolus* Pers. per Hook.

Thelebolaceae J. C. Cooke & Barr *in* Mycologia **56**: 768. 1964 (nomen nudum: lacking Latin description); ≡ Theleboleen Brefeld.

Ascomata superficial or immersed, mostly in the form of apothecia, sessile or with a short stalk; mostly small or very small, 0.03–10 mm, only in some species up to 30 mm diameter. Receptacle at first subglobular or semiglobular, finally subglobular, pyriform, obconical, cup-shaped, pulvinate, lenticular or saucer-shaped; surface smooth, furfuraceous, villose or hairy. Disk roughened by the protruding tips of ripe asci. Asci obovoid, saccate, clavate or cylindric-clavate, always broad or rather so, often with a rather short stalk; with a dome-shaped, rounded truncate or rarely conical apex; opening by a large or very large operculum, a bilabiate slit, or an irregular fissure in the upper part; at maturity always protruding beyond the hymenium; wall more or less blued or not stained with iodine. Ascospores biseriate, irregularly disposed, or united in a single cluster;

[5] These taxa of S. F Gray below the rank of a family with the suffix -ideae were treated as subfamilies by Donk (1964).

ellipsoid, fusoid, globular, or subglobular; hyaline, with weakly coloured contents or with extrasporal pigment; smooth or ornamented; rarely with small oil-drops.

Predominantly fimicolous, more rarely lignicolous, foliicolous, terrestrial, or pyrophilous.

TYPE.—*Ascobolus* Pers. per Hook.

GENERA.—See under the subfamilies.

EXCLUDED GENERA.—*Pyronema* Carus, *Aphanoascus* Zukal, *Ramsbottomia* Buckley, *Boudiera* Cooke.

This family is characterized among the other families of the Pezizales by the small apothecia, the broad asci which protrude beyond the hymenium at maturity, and the predominantly fimicolous species.

In the last phase of maturation of the asci there is a considerable increase in volume during a period of several hours. The wall of the ascus which is very elastic stretches sometimes enormously.

The development of the fruit-bodies is extremely variable. On the one hand in some species of *Ascobolus* sect. *Dasyobolus*, cleistohymenial ascomata may be found that remain closed, while on the other hand in *Ascodesmis* Tiegh. eugymnohymenial ascomata without excipulum occur. All possible developmental types (cf. scheme Pl. 17) between those extremes are represented in this family.

The family was subdivided by Boudier (1869) into "Ascobolei genuini", with strongly protruding asci and violet coloured episporium, and "Ascobolei spurii", with generally less protruding asci and hyaline ascospores with a membranous, colourless episporium. This subdivision of the Ascobolaceae into two tribes was followed by Saccardo (1884, 1889) and Heimerl (1889), who used the names Phaeosporae Sacc. and Hyalosporae Sacc. Also Rehm (1895) and Lindau (1896) recognized the same taxa but in their case as Euascoboleae Rehm and Pseudo-ascoboleae Rehm respectively.

The "Ascobolés" of Boudier's monograph (1869) represented a very natural group. Gradually many unrelated taxa were introduced, e.g. by Cooke (1877), Saccardo (1889, 1892, 1899), Boudier (1907), and Le Gal (1947). Especially the genus *Ascophanus* Boud. became very heterogeneous (cf. Boudier, 1907).

The names of taxa excluded from the genera *Ascobolus* and *Saccobolus* are to be found in the appendix on p. 206.

After the exclusion of unrelated elements the Ascobolaceae may be subdivided into three groups, which are treated as subfamilies. These are the Ascoboloideae, Ascodesmidoideae, and Thleboloideae; they can be separated on the basis of the presence or absence of flesh and excipulum in the ascomata, the colour and the formation of episporial pigment, and the shape of the ascogonium.

KEY TO THE SUBFAMILIES

1. Episporium thick and pigmented. Episporial pigment pinkish, violet, purplish or brownish:
   2. Flesh and excipulum present. Episporial pigment at first pinkish, violet or

purplish, finally often passing into purplish-brown or brown; precipitated on the outside of the ascospores in the form of a crust that may be discontinuous in various ways . . . . . Ascoboloideae, p. 58

2. Flesh and excipulum absent. Episporial pigment permanently brownish or purplish-brown; formed on the outside of the ascospores in the form of an elevated reticulum that may be reduced to a pattern of crests, spines or even warts . . . . . Ascodesmidoideae, p. 59

1. Episporium membranous and colourless.[6] Flesh and excipulum present Theleboloideae, p. 59

Ascoboloideae

Ascoboloideae S. F. Gray, Nat. Arr. Brit. Pl. **1**: 599, 674. 1821 ("Ascobolideae"; [subfam.]); E. C. Hansen *in* Vid. Meddr dansk naturk. Foren. 1876: 272. 1877 ("Ascobolei"; subfam.; lacking description and reference). — Type: *Ascobolus* Pers. per Hook.

For further synonymy see under the family.

Receptacle smooth, furfuraceous or villose, without true hairs. Flesh and excipulum present, although sometimes rather reduced. Asci saccate-clavate to cylindric-clavate, with a large operculum; at maturity the tips strongly protruding above the hymenium. Ascospores normally 8, rarely 7–1; biseriate, irregularly disposed or united in a single cluster; ellipsoid, fusoid, globular or subglobular; with a thick, coloured episporium; smooth or ornamented. Episporial pigment of vacuolar origin, at first sometimes colourless (or greenish opalescent in diffuse light), then violet or purplish (rarely pinkish or bluish), finally often passing to purplish-brown or brown.

Predominantly fimicolous, more rarely lignicolous, foliicolous, terrestrial, or pyrophilous.

Type.—*Ascobolus* Pers. per Hook.

Genera.—*Ascobolus* Pers. per Hook., *Saccobolus* Boud. — Of uncertain position: *Anserina* Vel.

This subfamily is the principal subject of the present study. It is a very natural and sharply delimited taxon. Characteristic of it is the violet coloured episporial pigment. This pigment is precipitated from small vacuoles in the extrasporal ascoplasm on the ascospore wall in the form of a more or less discontinuous crust.

KEY TO THE GENERA OF THE ASCOBOLOIDEAE

1. Ascospores free, not regularly arranged in the form of a package during any phase of the maturation . . . . . *Ascobolus*, p. 61

1. Ascospores firmly united into a cluster, cemented into a more or less regular pattern (fig. 00) by the episporial pigment, or more rarely at first loosely united according to such a pattern and finally free or partly free . . *Saccobolus*, p. 166

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[6] Colourless ascospore-mutants of Ascoboloideae are left out of consideration. Such mutants were never found homozygous in nature. They can only be maintained in culture after isolation.

Ascodesmidoideae Brumm., *subfam. nov.*

Ascodesmidaceae Schroet. *in* Krypt.-Fl. Schles. **3** (2): 31. 1893 ("Ascodesmidacei"; fam.). — Type: *Ascodesmis* Tiegh.

Ascomata eugymnohymenalia, minutissima. Receptaculum (caro et excipulum) nullum. Asci obovoidei, saccati vel late clavati, operculo latissimo, maturitate manifeste protrusi. Ascosporae breviter ellipsoideae usque globulares. Episporium brunneum, sporigenum, echinulatum, verrucosum vel reticulum irregulare sat elevatum formans. Fimicola. Typus: *Ascodesmis* Tiegh.

Receptacle (flesh and excipulum) absent. Asci obovoid, oblong-obovoid, saccate or broadly clavate; with a very large operculum; at maturity strongly protruding above the hymenium. Ascospores 8 or rarely a reduced number; multiseriate or irregularly disposed; mutually free; shortly ellipsoid, subglobular or globular; with an irregularly thickened, coloured episporium. Episporial pigment of sporal origin; brownish or purplish-brown; partially filling up the interstices of more or less irregularly disposed vacuoles around the ascospores, thus forming an irregular, rather elevated reticulum or a pattern of crests, spines or warts.

Fimicolous.

TYPE.—*Ascodesmis* Tiegh.

GENUS.—*Ascodesmis* Tiegh. (inclusive of *Cubonia* Sacc.).

The ascogonia of *Ascodesmis* Tiegh. are considerably narrower than in the Ascoboloideae or Theleboloideae. The septation of the ascogonium occurs in a rather late phase.

Theleboloideae Brumm., *subfam. nov.*

[Ascobolei spurii Boud. *in* Annls Sci. nat. (Bot.) V **10**: 235. 1869. — Lectotype: *Ascophanus* Boud.]

[Hyalosporae Sacc. *in* Bot. Cbl. **18**: 219. 1884 [= tribus]; Sacc., Syll. Fung. **8**: 512. 1889; Heimerl *in* Jber. kk. Ober-Realschule Bez. Sechshaus Wien **15**: 12. 1889 ("Hyalosporeae"). — Lectotype: *Ascophanus* Boud.]

[Groupe Pseudoascobolés Boud. *in* Bull. Soc. mycol. Fr. **1**: 108. 1885. — Lectotype: *Ascophanus* Boud.]

[Theleboleen Brefeld *in* Unters. Gesammtgeb. Mycol. **9**: 116. 1891 (fam.). Monotype: *Thelebolus* Tode per Fr.]: → Thelebolaceae J. C. Cooke & Barr.

[Pseudoascoboleae Rehm *in* Rab. Krypt.-Fl. (Pilze) **3**: 1078. 1895 ("Abtheilung" [= tribus]); Lindau *in* Natürl. PflFam. **1** (1): 188. 1896. — Lectotype: *Ascophanus* Boud.]

[Tribu Pseudo-ascobolés Boud., Hist. Class. Discom. Europe 75. 1907. — Lectotype: *Ascophanus* Boud.]

Thelebolaceae J. C. Cooke & Barr *in* Mycologia **56**: 768. 1964 (nomen nudum: lacking Latin description) ≡ Theleboleen Brefeld.

Asci obovoidei, saccati, clavati vel cylindrico-clavati, operculo vel fissura bilabiali vel irregulari apicali instructi, maturitate hymenium superantes. Ascosporae 8 vel multipliciter 8, usque plus quam mille, laeves vel ornamentaceae. Episporium membranaceum, sine colore. Fimicola, lignicola vel terrestris. Typus: *Thelebolus* Tode per Fr.

Receptacle smooth, furfuraceous, villose or hairy. Flesh and excipulum present, although sometimes rather reduced. Asci obovoid, saccate, clavate or cylindric-clavate; with an operculum, a bilabiate slit or an irregular fissure near the apex;

at maturity the tips more or less strongly protruding above the hymenium. Ascospores 8 or a multiple of 8, up to over a thousand; biseriate, irregularly disposed or more or less united in a loose cluster; ellipsoid, fusoid, ovoid, globular or subglobular; with a thin, membranous, colourless episporium; smooth or ornamented; sometimes with yellowish or pale brownish contents.

Especially fimicolous, but also foliicolous, lignicolous and terrestrial.

TYPE.—*Thelebolus* Tode per Fr.

GENERA.—*Ascophanus* Boud. (inclusive of *Leporina* Vel.), *Thecotheus* Boud., *Rhyparobius* Boud. (inclusive of *Pezizula* P. Karst. and *Zukalina* O. Kuntze sensu Vel.), *Lasiobolus* Sacc., *Thelebolus* Tode per Fr. (inclusive of *Trichobolus* Kimbr.), *Ascozonus* (Renny) E. C. Hansen (inclusive of *Streptotheca* Vuill.). Of uncertain position: *Boudierella* Sacc. apud March. (not *Boudierella* Cost.), *Comesia* Sacc., *Zukalina* O. Kuntze, *Selenaspora* Heim & Le Gal.

This subfamily badly needs a thorough revision. [7]

[7] Recently this subfamily has been the subject of a study by Kimbrough (1966a–b). A synopsis of the genera and species has been given by Kimbrough & Korf (1967).

CHAPTER XI

THE GENERA ASCOBOLUS AND SACCOBOLUS

ASCOBOLUS Pers. per Hook.

Ascobolus Pers. *apud* Gmel., C. Linn. Syst. Nat. **2**: 1461. 1791 ("Pers. Fungi ined."); Pers. *in* Neues Mag. Bot. **1**: 115. 1794 [= Tent. 35. 1797]; Pers., Obs. mycol. **1**: 33. 1796; (devalidated name). — *Ascobolus* Pers. *per* Hook.[8], Fl. scot. **2**: 33, May 1821; Fries, Syst. mycol. **2** (1): 161. 1822. — Monotype: *Ascobolus pezizoides* Pers. apud Gmel.

Phaeopezia subg. *Crouaniella* Sacc. *in* Bot. Cbl. **18**: 218. 1884. — *Crouaniella* (Sacc.) Lamb., Fl. mycol. Belg., Suppl. **1**: 320. 1887. — Monotype: *Phaeopezia murina* (Fuck.) Sacc.

Sphaeridiobolus Boud. *in* Bull. Soc. mycol. Fr. **1**: 108. 1885. — *Ascobolus* subg. *Sphaeridiobolus* (Boud.) Quél., Ench. Fung. 295. 1886; Boud. *in* Bull. Soc. mycol. Fr. **14**: 126. 1898. — Monotype: *Ascobolus hyperboreus* P. Karst.

[Libérispores Boud. *in* Bull. Soc. mycol. Fr. **1**: 108. 1885. — Representative species: *Ascobolus furfuraceus* Pers. per Hook.]

[Junctispores Boud. *in* Bull. Soc mycol. Fr. **1**: 108. 1885. — Representative species: *Ascobolus immersus* Pers. per Pers.]

[*Phaeopezia* sect. *Eu-Phaeopezia* Sacc., Syll. Fung. **8**: 471. 1889 (type of *Phaeopezia* Sacc. not included). — Lectotype: *Phaeopezia murina* (Fuck.) Sacc.]

[*Ascobolus* subg. *Eu-Ascobolus* Sacc., Syll. Fung. **8**: 514. 1889. — Lectotype: *Ascobolus furfuraceus* Pers. per Hook].

Ascobolus subg. *Dasyobulus* Sacc., Syll. Fung. **8**: 523. 1889. — *Dasyobolus* (Sacc.) Sacc., Syll. Fung. **11**: 421. 1895. — Type: *Ascobolus immersus* Pers. per Pers.

Phaeopezia Sacc. & Syd. *in* Syll. Fung. **16**: 738. 1902. [with exclusion of the type of *Phaeopezia* (Sacc.) Sacc.]; not *Phaeopezia* (Sacc.) Sacc. *in* Bot. Cbl. **18**: 218. 1884. — Lectotype: *Phaeopezia murina* (Fuck.) Sacc.

Seliniella Arx & Müll. *in* Acta bot. neerl. **4**: 118. 1955. — Monotype: *Seliniella macrospora* Arx & Müller.

Apothecia superficial or immersed, sometimes with a short stalk; mostly small, 0.3–10 mm, in one species up to 30 mm diameter. Receptacle subglobular, pyriform, obconical, cup- or saucer-shaped, rarely lenticular; surface smooth, furfuraceous villose or downy. Asci saccate-clavate or cylindric-clavate; at maturity the tips strongly protruding above the hymenium; with a rounded, dome-shaped or slightly truncate apex. Ascospores biseriate or irregularly disposed; free, neither clustered nor arranged according to a regular pattern (as illustrated in fig. 00) during any phase of the maturation. Paraphyses slender, cylindrical; often embedded in colourless, yellowish or yellowish-green mucus.

Predominantly fimicolous, but also foliicolous, lignicolous, terrestrial and pyrophilous.

ETYMOLOGY.—From Greek ἀσκοσ, leather sack and βαλλω, to throw.

TYPE.—*Ascobolus pezizoides* Pers.

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[8] For the use of "per "see Donk *in* Taxon **6**: 255. 1957.

Within the Ascoboloideae this genus is characterized by its mutually free ascospores, viz. they are never cemented together by episporial pigment. Sometimes, however, in *Ascobolus immersus* the gelatinous sheaths around the ascospores may cause them to stick together to a slight degree. This has probably been the reason for the introduction of Boudier's taxon "Junctispores" and for the fact that this species has even been described as a species of *Saccobolus*.

Ascobolus pusillus, which occupies an isolated position in the genus, shows considerable resemblance to *Saccobolus*, except that the ascospores are neither cemented together nor arranged according to patterns characteristic of that genus. Together with *Saccobolus saccoboloides*, in which ripe ascospores are free, it might represent a transition between *Ascobolus* and *Saccobolus*.

In artificial classifications species with spherical and ellipsoid ascospores are often placed in different genera, only because of the shape of the ascospores. Thus the genus *Sphaeridiobolus* was separated from *Ascobolus* by Boudier (1885). However, when Boudier (1898) described *A. crosslandii*, he considered the spherical shape of the ascospores less important. In my opinion the possession of spherical ascospores alone is not sufficiently important to separate *Sphaeridiobolus* from *Ascobolus*. Even the maintenance of a subgenus or a section only on the basis of this character appears not justified in this case. In some ellipsoid-spored species spherospory was found as a very rare mutation.

Ascobolus crosslandii is closely related to such species as *A. furfuraceus* and *A. crenulatus*, with ellipsoid ascospores, and must be placed in their neighbourhood. *Ascobolus brassicae* and *A. nodulosporus*, with spherical ascospores, are mutually related and do not suggest direct relationship with any of the other species of *Ascobolus*. These are retained here in *Ascobolus* sect. *Sphaeridiobolus*.

Ascobolus reticulatus has ascospores which are spherical or subglobular in the young state only and it recalls species of *Ascodesmis* in more ways than one. It differs from that genus in the episporial pigment, which is of the type characteristic of Ascoboloideae, and in the possession of an excipulum. *Ascobolus* sect. *Pseudascodesmis* is proposed for this species.

Globular and subglobular ascospores may also occur in *A. immersus*. Such variations were described as *A. globularis* Roll. and *A. immersus* var. *brevisporus* Oud.

Another group was artificially separated from *Ascobolus* as *Dasyobolus* (Sacc.) Sacc. The taxa united in this genus were described as having hairs on their receptacles. It was extremely heterogeneous (Saccardo, 1895; Boudier, 1907; Le Gal, 1961). The species with true hairs proved to be based on material belonging to species of *Lasiobolus* Sacc., *Cheilymenia* Boud., and *Scutellinia* (Cooke) Lamb., sometimes covered with ascospores of species of *Ascobolus* (cf. list on p. 206). In the remaining species no hairs have been found. Probably secondary mycelium and superficial hyphae of orginally immersed fruit-bodies were described as hairs.

Ascobolus sect. *Dasyobolus* is maintained here for a strongly emended group, which has only the type in common with *Dasyobolus*.

In my opinion a very natural subdivision of *Ascobolus* is obtained if the species

are arranged according to the types of development, described in chapter III. Such a subdivision is supported by other characters, like the type of ascospore ornamentation, the shape of the receptacle, the activity of a secondary marginal growing zone, the shape of the ascus, and the type of hymenial pigment. The following sections are distinguished: *Ascobolus* sect. *Dasyobolus*, *Ascobolus* sect. *Sphaeridiobolus*, *Ascobolus* sect. *Ascobolus*, *Ascobolus* sect. *Pseudascodesmis*, *Ascobolus* sect. *Pseudosaccobolus*, *Ascobolus* sect. *Heimerlia*, and *Ascobolus* sect. *Gymnascobolus*.

In most species the developmental type can be easily established, but in a few species this has not yet been found because of the lack of appropriate material. Species that consequently cannot be placed with certainty are: *A. candidus*, *A. asininus*, *A. masseei*, *A. moellerianus* and *A. xylophilus*. Material of *A. xylophilus* was available but unfortunately without the necessary young fruit-bodies.

Below two keys are given for determining the sections of *Ascobolus*. Key A makes use of the taxonomic criteria of the sections and can be used in all cases where young fruit-bodies are available to establish the developmental type. Key B makes use of other taxonomic characters and can be used in cases where the developmental type of the fruit-bodies cannot be established.

A. SYNOPTIC KEY TO THE SECTIONS OF ASCOBOLUS

1. Ascomata cleistohymenial. Excipulum of textura angularis, globulosa, or epidermoidea when seen from outside:
   2. Ascomata opening in the telohymenial phase or rarely not opening at all; immersed or superficial, never stalked, the surface often covered with appressed, thick hyphae; diameter rarely exceeding 1 mm. Ascospores ellipsoid or rarely subglobular. Asci saccate to cylindric-clavate, with large dome-shaped apex. Episporium smooth, granular, or warted, sometimes with irregular cracks, never with a pattern of anastomosing striae. On dung
      I. *Ascobolus* sect. *Dasyobolus*, p. 66
   2. Ascomata opening in the mesohymenial phase; superficial; smooth or furfuraceous, sometimes covered with fine divaricating hyphae in the lower part or with secondary mycelium near the base; diameter 0.3–12 mm. Ascospores ellipsoid, subglobular or globular. Asci cylindric-clavate. Episporium with anastomosing striae, with a net-work of striae, or warted, rarely smooth or granular:
      3. Ascomata opening in the late mesohymenial phase; diameter 0.3–1.5 mm. Ascospores globular. Episporium with rounded warts. Asci clavate-cylindrical or cylindric-clavate. . II. *Ascobolus* sect. *Sphaeridiobolus*, p. 89
      3. Ascomata opening in the early or mid-mesohymenial phase; diameter 0.3–12 mm. Ascospores ellipsoid, fusiform, subglobular or globular. Episporium with anastomosing striae, with a net-work of striae or warted, rarely smooth or granular. If ascospores globular then episporium not with rounded warts. Asci cylindric-clavate III. *Ascobolus* sect. *Ascobolus*, p. 94

1. Ascomata eugymnohymenial or paragymnohymenial. Excipulum often with other types of textures:
   4. Ascomata paragymnohymenial, with the habit of *Ascodesmis*; very small, 0.1–0.5 mm diameter. Asci relatively short; the wall not blue with iodine. Ascospores globular or subglobular. Episporium consisting of a reticulum of pigment. On dung . . . . . IV. *Ascobolus* sect. *Pseudascodesmis*, p. 153
   4. Ascomata paragymnohymenial or eugymnohymenial; small or large, 0.3–30 mm diameter. Ascus-wall stains blue with iodine. Ascospores ellipsoid, not with a reticulum of pigment:
      5. Ascomata paragymnohymenial or eugymnohymenial, with the habit of *Saccobolus*. Asci short with a broad base. Ascospores fusiform-ellipsoid, often with blunt ends and asymmetrical. Episporium at first smooth or granulated, then with a net-work of fine crevices or warted. Paraphyses with yellowish contents. On burnt places
      V. *Ascobolus* sect. *Pseudosaccobolus*, p. 155
      5. Ascomata eugymnohymenial, not with the habit of *Saccobolus*. Asci oblong-clavate to cylindric-clavate. Ascospores symmetrical, ellipsoid, without any tendency to aggregate. Paraphyses without coloured contents:
         6. Apothecia small, up to about 1 mm diameter; without marginal growing zone. Excipulum scarcely developed. Episporium echinulate or warted
         VI. *Ascobolus* sect. *Heimerlia*, p. 157
         6. Apothecia large or medium-sized; 0.8–30 mm diameter; a marginal growing zone with distinct activity. Excipulum well-developed. Episporium smooth or finely punctate
         VII. *Ascobolus* sect. *Gymnascobolus*, p. 158

B. ARTIFICIAL KEY TO THE SECTIONS OF ASCOBOLUS

1. Ascospores globular or subglobular:
   2. Ascospores exactly globular:
      3a. Ascospores warted. . . . . II. *Ascobolus* sect. *Sphaeridiobolus*, p. 89
      3b. Ascospores smooth, sometimes with some fine irregular crevices
      I. *Ascobolus* sect. *Dasyobolus*, p. 66
      3c. Ascospores with subparallel anastomosing crevices
      23. *Ascobolus crosslandii*, p. 121
      3d. Ascospores with a net-work of pigment
      IV. *Ascobolus* sect. *Pseudascodesmis*, p. 153
   2. Ascospores subglobular:
      4a. Ascospores with a net-work of pigment
      IV. *Ascobolus* sect. *Pseudascodesmis*, p. 153
      4b. Ascospores smooth, sometimes with some fine irregular crevices
      I. *Ascobolus* sect. *Dasyobolus*, p. 66
      ↓4c. Ascospores with isolated fine warts . . I. *Ascobolus* sect. *Dasyobolus*, p. 66

4d. Ascospores with longitudinal anastomosing crevices or with a net-work of crevices . . . . . III. *Ascobolus* sect. *Ascobolus*, p. 94

1. Ascospores ellipsoid or fusoid:
   5. Episporium smooth or finely granular when just formed, sometimes with one or a few fine fissures; in old ascospores an irregular net-work of crevices is sometimes found, rarely becoming warted:
      6. Apothecia scutellate; 1–30 mm diameter:
         7. On dung or on wood . . . VII. *Ascobolus* sect. *Gymnascobolus*, p. 158
         7. On soil . . . . . 36. *Ascobolus geophilus*, p. 140
      6. Apothecia globular, semiglobular, lenticular, pulvinate or turbinate; 0.2–1.0 mm, rarely up to 1.5 mm diameter:
         8. Young fruit-bodies not closed; habitus and form of asci similar to certain species of *Saccobolus*. Ascospores often asymmetrical and somewhat ventricose . . . . . V. *Ascobolus* sect. *Pseudosaccobolus*, p. 155
         8. Young fruit-bodies at first closed; not similar to *Saccobolus*. Ascospores mostly symmetrical:
            9. Ascospores 9–10 μ long. Episporium finely granular
               28. *Ascobolus cainii*, p. 126
            9. Ascospores more than 10 μ long:
               10. Apothecia turbinate, superficial. Receptacle white; surface white furfuraceous; margin rather regular and smooth, although thin. Disk white. Ascospores 13–17 × 7.5–8.5 μ. Episporium at first smooth, finally mostly with an irregular net-work of fine fissures, rarely becoming apparently warted
                  27. *Ascobolus carletonii*, p. 125
               10. Apothecia subglobular or pyriform, immersed or superficial; white or variously coloured. Receptacle smooth, tomentose or furfuraceous (if furfuraceous then not white). Margin of excipulum irregularly torn by the protruding ripe asci
                  I. *Ascobolus* sect. *Dasyobolus*, p. 66
   5. Episporium neither smooth nor finely granular when just formed:
      11. Episporium with a pattern of subparallel, anastomosing crevices, or with irregular, short, curved, non-anastomosing crevices, or with longitudinal ridges of pigment separated by rather broad crevices; in old or over-ripe ascospores often changing into a net-work of crevices
         III. *Ascobolus* sect. *Ascobolus*, p. 94
      11. Episporium with another type of ornamentation:
         12. Episporium warted or echinulate:
            13. On dung:
               14. Apothecia subglobular or pyriform, often immersed; white or variously coloured. Excipular margin irregularly torn by the protruding ripe asci. Episporium not echinulate
                  I. *Ascobolus* sect. *Dasyobolus*, p. 66

14. Apothecia pulvinate or lenticular, superficial; white. Excipular margin regular and smooth. Episporium echinulate or more rarely with isolated warts
VI. *Ascobolus* sect. *Heimerlia*, p. 157
13. On rotten wood, on soil or on burnt places:
15. Full-grown apothecia lenticular or discoid. Habit of apothecia and shape of asci as in *Saccobolus*. Ascospores often asymmetrical or somewhat ventricose; less than 15 μ long. On burnt places.. . V. *Ascobolus* sect. *Pseudosaccobolus*, p. 155
15. Full-grown apothecia scutellate and flattened. Habit of apothecia and shape of asci not as in *Saccobolus*. Ascospores mostly symmetrical; more than 15 μ long:
16. On soil or burnt places. Ascospores 17–28 × 11–15 μ.
III. *Ascobolus* sect. *Ascobolus*, p. 94
16. On rotten wood. Ascospores 32–37 × 13–16 μ
43. *Ascobolus xylophilus*, p. 152
12. Episporium with a net-work of crevices from the beginning:
17. Apothecia lenticular or discoid; similar to those in *Saccobolus*. Ascospores often asymmetrical or somewhat ventricose; less than 15 μ long. On burnt places
V. *Ascobolus* sect. *Pseudosaccobolus*, p. 155
17. Apothecia not lenticular or discoid; not similar to those in *Saccobolus*. Ascospores mostly symmetrical; more than 15 μ long. Not on burnt places:
18. Ascospores more than 35 μ long. On dung:
19. Apothecia umbilicate, with a prominent margin. Ascospores 40–45 × 21–23 μ . . cf. *Ascobolus asininus*, p. 208
19. Apothecia subglobular, without a prominent margin. Ascospores (35–)58 × 71(–81) × (24–)28–36 μ
1. *Ascobolus immersus*, p. 68
18. Ascospores less than 25 μ long. On humid soil
III. *Ascobolus* sect. *Ascobolus*, p. 94

I. **Ascobolus** sect. **Dasyobolus** (Sacc.) Brumm., *comb. nov.*

Ascobolus subg. *Dasyobolus* Sacc., Syll. Fung. **8**: 523. 1889 (basionym). — *Dasyobolus* (Sacc.) Sacc., Syll. Fung. **11**: 421. 1895. — Type: *Ascobolus immersus* Pers. per Pers.
For further synonyms see under generic name (p. 61).

Ascomata cleistohymenial, opening in the telohymenial phase or rarely not opening at all; immersed or superficial, sessile; 0.2–1.0 mm, rarely up to 1.5 mm diameter. Receptacle subglobular or pyriform; surface smooth or furfuraceous, often covered with appressed, rather wide, thick-walled, branching hyphae; margin

lacking. Hymenium with only a rather restricted number of asci. Flesh rather thin. Excipulum of only a few layers of angular or rounded cells; of textura angularis or globulosa when seen from outside. Asci saccate to cylindric-clavate, often curved, very broad, with large dome-shaped apex and very large operculum; the wall in all but one species staining blue with iodine. Ascospores 8 or less (very rarely more than 8), multiseriate or irregularly disposed; ellipsoid, cylindric-ellipsoid, subglobular or rarely globular; with surrounding, unilateral or girdle-shaped gelatinous mass. Episporium smooth, granular or warted, sometimes with secondary, irregular cracks. Paraphyses simple, slender, cylindrical, not enlarged upwards; often embedded in a yellowish or colourless mucilaginous substance without crystals.

Fimicolous.

ETYMOLOGY.—From Greek, δασυς, shaggy, hairy and βαλλω, to throw.

TYPE.—*Ascobolus immersus* Pers. per Pers.

The ascomata in this section might be more correctly called perithecia or cleistothecia than apothecia. But, as may be deduced from the diagrams of the different developmental types (Pl. 17), there are gradual transitions between these types of 'thecia', which make their distinction less fundamental than is often thought.

The same 'perithecial' forms can be found in the genera *Thelebolus* Tode per Fr. and *Rhyparobius* Boud. in the Theleboloideae.

Within the genus *Ascobolus* this section is sharply delimited by the developmental type of the fruit-body. A few species of sections *Sphaeridiobolus* and *Ascobolus*, in which fruit-bodies with a very reduced number of asci incidentally occur, may show a similar developmental type. Such species can easily be distinguished by their ascospores.

Among the species of *Ascobolus* the largest asci occur in *Ascobolus* sect. *Dasyobolus*. The increase in volume of the asci during the last phase of maturation reaches a maximum in this section.

KEY TO THE SPECIES OF ASCOBOLUS SECT. DASYOBOLUS

1. Episporium smooth or finely granular:
   2. Ascospores globular or subglobular; more than 33 μ long; with all-sided gelatinous envelope . . . . . 1. *Ascobolus immersus*, p. 68
2. Ascospores ellipsoid:
   3. Ascospores more than 50 μ long and surrounded by a gelatinous envelope. Episporium smooth or with some irregular fine crevices 1. *Ascobolus immersus*, p. 68
   3. Ascospores less than 50 μ long:
      4. Ascospores more than 17 μ long:
         5. Excipulum smooth, tomentose or rarely finely powdery; not brown; not furfuraceous. Hymenial mucus greenish-yellow:
            6a. Ascospores 29–38(–48) × 14–18(–21) μ 5. *Ascobolus amoenus*, p. 80
            6b. Ascospores 23–29 × 12–17 μ. . . . . 6. *Ascobolus elegans*, p. 82

6c. Ascospores (17.5–)19–23(–24) × 10–12(–13) μ
7. *Ascobolus mancus*, p. 84
6d. Ascospores 42–48 × 20–25 μ . . . . . cf. "*A. quezelii*", p. 74
5. Excipulum rich with brown intercellular pigment; in the upper part covered with brown warts. Hymenial mucus vivid sulphur-yellow. Ascospores 20–25 × 11–13 μ . . . . . 8. *Ascobolus boudieri*, p. 85
4. Ascospores less than 17 μ long:
7. Ascospores 15–16 × 6–7 μ . . . . cf. *Ascobolus masseei*, p. 226
7. Ascospores 11–13 × 6–8 μ . . . . cf. *Ascobolus candidus*, p. 210
1. Episporium warted or with a net-work of irregular fine crevices:
8. Ascospores ellipsoid. Ascus-wall staining blue with iodine:
9. Episporium with a reticulum of irregular fine crevices. Ascospores more than 50 μ long . . . . . 1. *Ascobolus immersus*, p. 68
9. Episporium warted:
10. Ascospores 50–60 × 30–36 μ . . . . . 2. *Ascobolus bistisii*, p. 75
10. Ascospores less than 50 μ long:
11. Apothecia with a thick margin. Ascospores 40–45 × 21–33 μ
cf. *Ascobolus asininus*, p. 208
11. Apothecia without a prominent margin. Ascospores less than 40 μ long:
12. Apothecia immersed. Ascospores more than 25 μ long:
13. Episporium with a regular pattern of warts. Ascospores 26–31 × 15–17.5 μ . . 3. *Ascobolus stictoideus*, p. 76
13. Episporium besides having a pattern of warts also with large and thick caps of pigment and a submedian pigment-free zone. Ascospores 30–34 × 16–18 μ
4. *Ascobolus degluptus*, p. 78
12. Apothecia superficial. Ascospores 18.5–21 × 10–11.5 μ
9. *Ascobolus hawaiiensis*, p. 87
8. Ascospores subglobular to very shortly ellipsoid; 17–20 × 15–17 μ. Ascus-wall not blue with iodine . . . . . 10. *Ascobolus siamensis*, p. 88

1. ASCOBOLUS IMMERSUS Pers. per Pers.—Figs. 8, 9; Pl. 1, figs. A–I, Pl. 2, figs. A–D

Ascobolus immersus Pers. *in* Neues Mag. Bot. **1**: 115. 1794; Obs. mycol. **1**: 35 *pl. 4 f. 7 d–e.* 1797 (devalidated name). — *Ascobolus immersus* Pers. per Pers., Mycol. Eur. **1**: 341. 1822; Fries, Syst. mycol. **2**: 164. 1822. — *Dasyobolus immersus* (Pers. per Pers.) Sacc., Syll. Fung. **11**: 421. 1895. — Type: not known to be in existence; represented by the description of Persoon (1794: 115); type locality, presumably Germany.

Ascobolus macrosporus Crouan *in* Annls Sci. nat. (Bot.) IV **7**: 173 *pl. 4B fs. 5–8.* 1857. — *Ascobolus immersus* var. *macrosporus* (Crouan) Rehm, Rab. Krypt.-Fl., (Pilze) **3**: 1128. 1896. — Lectotype: *Crouan*, on old cow dung, near Brest, France, autumn (CONC-A2428).[9]

[9] For a more accurate indication of herbarium specimens, especially when insufficiently labelled, the usual abbreviation of the herbarium is followed by the author's revision-number.

Ascobolus gigasporus De Not. *in* Comm. Soc. critt. ital. **1**: 360. 1864; *in* Hedwigia **4**: 67. 1865. — Type: not known to be in existence; type locality, Italy.

Ascobolus immersus var. *brevisporus* Oud. *in* Ned. kruidk. Arch. II **4**: 262 *pl. 6 f. 12*. 1885. — Type: represented by Oudemans, l.c.: type locality, Netherlands.

Ascobolus globularis Rolland *in* Bull. Soc. mycol. Fr. **4**: 57 *pl. 15 f. 2*. 1888. — *Boudiera globularis* (Rolland) Speg. *in* Anal. Mus. nac. B. Aires 1899: 307. 1899. — *Sphaeridiobolus globularis* (Rolland) Boud., Hist. Class. Discom. Eur. 73. 1907. — Type: represented by Rolland, l.c., *pl. 15 f. 2*; type locality, Botanical Garden, Paris, France.

Ascobolus megalospermus Speg. *in* Anal. Mus. nac. B. Aires **6**: 307. 1899 (nomen confusum). — Holotype: LPS 28164 (consisting of apothecia of *A. scatigenus* covered with ascospores of *A. immersus*).

Ascobolus immersus var. *andinus* Speg. *in* Anal. Mus. nac. B. Aires **19**: 452. 1909. — Type: represented by a small drawing and some notes on a cover paper (LPS 26115); type locality, Mendoza, Cacheuta, Argentina.

Ascobolus cuniculorum Batista & Pontual *in* Bolm Agr., Pernambuco **15**: 30. 1948. — Type: without label (Herb. Batista No. 196: A3276); type locality, Brazil.

Saccobolus exiguus Batista & Pontual in Bolm Agr., Pernambuco **15**: 33 *f. 8* opposite page 32. 1948. — Type: not known to be in existence; represented by protologue (Batista & Pontual l.c.); type locality, Brazil.

Seliniella macrospora Arx & Müll. *in* Acta bot. neerl. **4**: 119 *fs. 3–4*. 1955. — Type: *Müller & Richle*, on cow dung, Eygliers, Val Queyras Aiguilles, France, 10.VI.1954 (ZT-A76).

?*Ascobolus quezelii* Faurel & Schotter *in* Rev. Mycol. **30**: 336 *f. 3*. 1966 (not validly published: lacking indication of type). — Type locality: Algeria.

Misapplied name.—*Ascobolus elegans* J. Klein *in* Verh. zool.-bot. Ges. Wien **20**: 566 *pl. 10 fs. 18–20*. 1870 (in part, exclusive of lectotype). The large-spored form = *Ascobolus immersus*.

Apothecia scattered or gregarious, at first often immersed or partly immersed, then erumpent or superficial, sessile, 0.5–1.0(–1.5) mm diameter, 0.5–0.7 mm high. Receptacle globular or pear-shaped, at first closed, then irregularly opening near the top, yellowish- or greenish-brown or yellowish, rarely with a reddish or purplish hue; smooth or covered with a thin layer of downy colourless hyphae, more rarely subfurfuraceous; without margin. Disk flat or convex, yellow or greenish-yellow, with only a few ripe asci protruding far above the surface. Hymenium usually with only a few asci. Hypothecium very thin, of isodiametric cells 3–10 μ diameter. Flesh rather thin; of subglobular or slightly oblong cells 7–19 μ diameter, accompanied by hyphae which are about 3 μ wide; hyaline. Excipulum about 25 μ thick; of only two or three layers of subglobular or somewhat angular, thick-walled cells 6–20 μ diameter (textura angularis or globulosa), pale brownish, covered with colourless hyphae about 5 μ wide, very rarely with hairs (fide Boudier 1869: 227 and Le Gal 1961: 455). Asci 1–40 per fruit-body, broadly clavate, 490–720 × 100–130 μ, with a short stalk, rounded above, 8-spored, but very often with only a part of the spores developed; the wall stains deep blue in Melzer's reagent. Ascospores biseriate or irregularly disposed; oblong-ellipsoid, more rarely cylindrical or subglobular, rounded at the ends; at first hyaline, then purple or violet, finally sometimes purplish-brown; (35–)58–71(–81) × (24–)28–36(–40) μ; smooth or with one or a few lines which occasionally anastomose, sometimes with a coarse or fine net-work of narrow lines; a thick gelatinous envelope surrounding each spore. Paraphyses simple or branched, septate, filiform, 2–3 μ thick, not enlarged at the tip, hyaline, embedded in abundant greenish-yellow mucus.

On dung of cow, horse, sheep, goat, nilgai, antelope, elephant, dog, hare, and rabbit.

Etymology.—From Latin, immersus, plunged, below the surface.

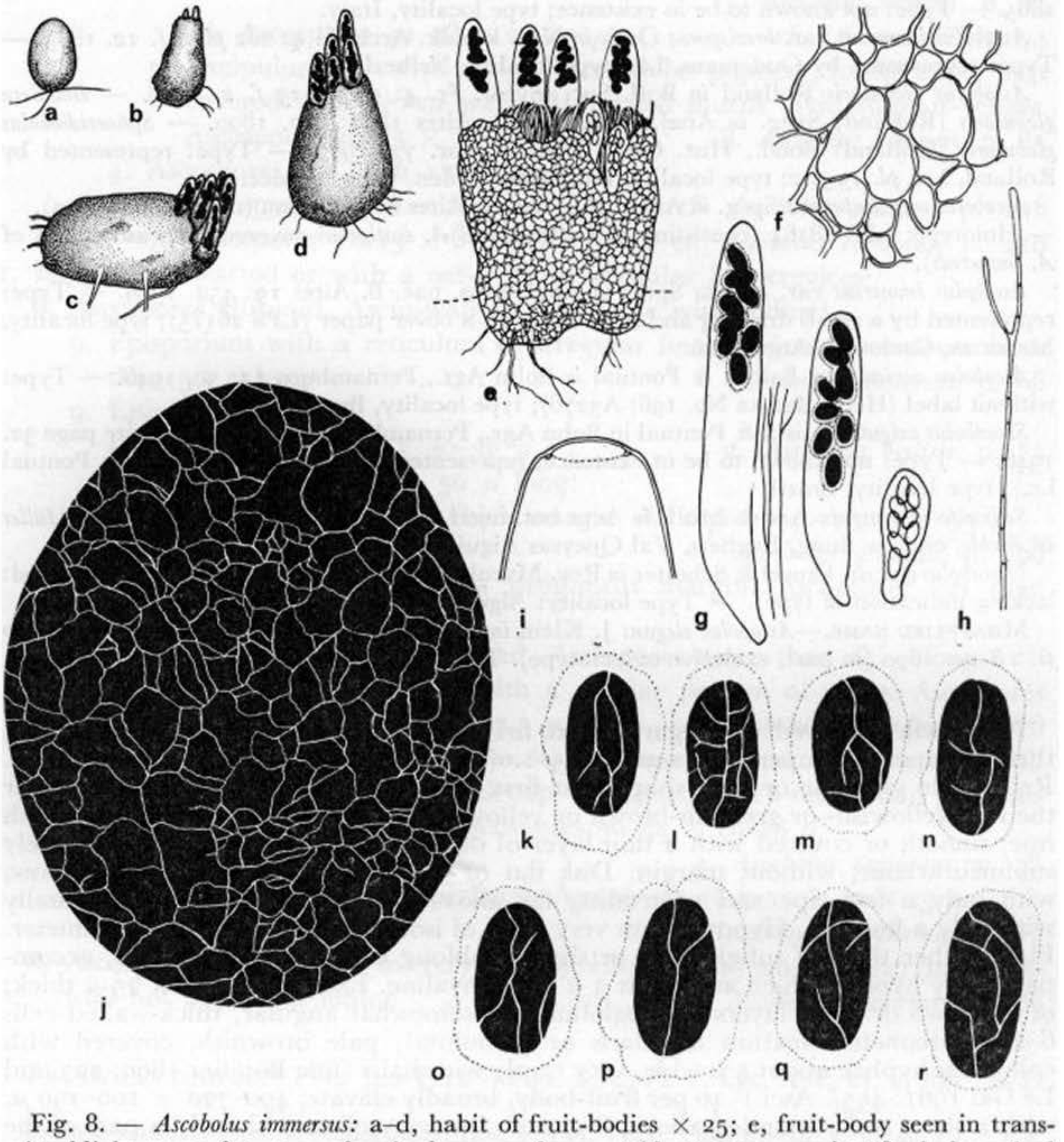

Fig. 8. — *Ascobolus immersus:* a–d, habit of fruit-bodies × 25; e, fruit-body seen in transmitted light × 40; f, texture of excipulum seen from outside × 275; g, asci × 65; h, branched paraphysis × 275; i, top of ascus × 275; j, shortly ellipsoid ascospore with reticulated episporium × 1600 (from TRTC 32060); k–r, ascospores × 275. (a–i, k–r, from *van Brummelen 641.*)

Illustrations.—von Arx & Müller *in* Acta bot. neerl. **4**: 119–120 *fs. 3–4.* 1955 (*Seliniella macrospora*); Berkeley & Broome *in* Ann. Mag. nat. Hist. III **15**: *pl. 15 f. 33.* 1865 (*A. macrosporus*); Borzi *in* Nuovo G. bot. ital. **10**: *pl. 3 f. 15.* 1878; Boudier *in* Annls Sci nat. (Bot.) V **10**: *pl. 8 f. 17,* 1869; Chelchowski *in* Physiogr. Denkschr., Warschau **12**: *pl. 11 f. 14.* 1892 (*A. macrosporus*); Cooke *in* J. Bot. (Lond.) **2**: 153 *f. 7.* 1864 (*A. macrosporus*); Crouan *in* Annls Sci. nat. (Bot.) IV **7**: pl. 4 *f. B 5–8.* 1857(*A. macrosporus*); Dennis, Brit. Cup Fungi *pl. VIII*

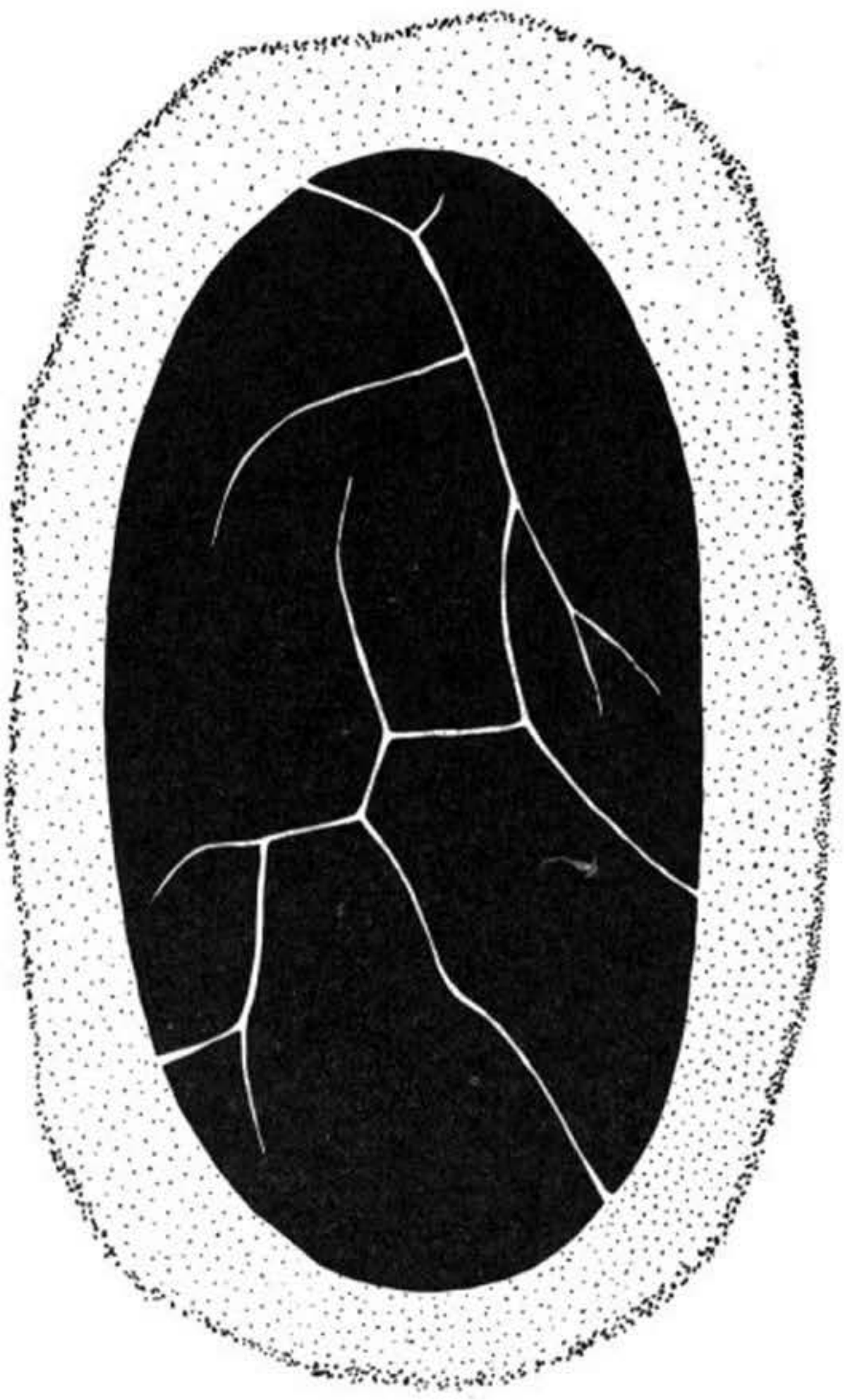

Fig. 9. — *Ascobolus immersus*, ascospore × 1600 (from *van Brummelen 641.*)

f. C. 1960 *(Dasyobolus immersus)*; Errera in Rec. Inst. bot. Bruxelles (ed. L. Errera) **1**: *pl. 4 f. 31.* 1905 (cytochemical); J. Klein *in* Verh. zool.-bot. Ges. Wien **20**: *pl. 10 fs. 19 and 20b.* 1870; Le Gal *in* Annls Sci. nat. (Bot.) XI **8**: 241 *f. 64C.* 1947 (*Dasyobolus immersus*); Le Gal *in* Annls Sci. nat. (Bot.) XII **1**: 465 *f. 6.* 1961 (*A. macrosporus*); Lindau *in* Natürl. PflFam. I, **1**: 192 *f. 154 D–F.* 1897; Nees, System Pilze Schwämme *pl. 39 f. 297*, only the most right figure. 1817 (*A. glaber*); Nylander *in* Notis. Sällsk. Fauna Fl. fenn. Förh. **10**: *pl. 2 f. 3.* 1868; Oudemans *in* Ned. kruidk. Arch. II **4**: *pl. 6 f. 12.* 1885 (*A. immersus var. brevisporus*); Persoon, Obs. mycol. **1**: *pl. 4 f. 7.* 1796; Ramlow *in* Mycol. Cbl. **5**: 187–188 *fs. 6–10 pl. 2 fs. 37–61.* 1914; Rehm, Rab. Krypt.-Fl., (Pilze) **3**: 1112 *fs. 4–5.* 1896; Seaver *in* Bull. Lab. nat. Hist. State Univ. Iowa **6**: *pl. 31 f. 1.* 1905; Seaver, N. Am. Cup-fungi (Operc.) *pl. 7 f. 5.* 1928; Zukal *in* Sber. Akad. Wiss. Wien (Math.-naturwiss. Kl., Abt. I) **98**: *pl. 4 fs. 20–27.* 1889.

SPECIMENS EXAMINED.— **Iceland**: *Davidsson 1564*, Hofé Hörgárdal, 23.IV. 1901 (C).
Finland: *Karsten*, Mustiala, 19.VIII.1869 (H).
Great Britain: *Broome*, Bathford Down. IX.1863 (E); *Broome*, *s. loc.*, X.1863 (K-A2526);

Broome, Hanham near Bristol, XI.1863 (UPS); *Broome*, near Bath, X.1864, *in* Rabenhorst Fungi eur. 779 (BRSL, FH, G, HBG, K, LE, PRC, W, ZT); *Broome*, Bathford Down, Somerset-Wiltshire Border, 22.X.1864 (K); *Broome*, Bathford, 15.XI.1864 (K); *Broome*, *s. loc.*, *s. dat.* (K-A2527); *Crossland*, Hardcastle near Hebden Bridge, 6.VII.1899 (K); *Cooke*, Forden, *s. dat.*, *in* Fungi brit. ed. 2, 397 (E, K, PAD), *in* Fungi brit. ed. 2, 399 (*Ascobolus kerverni*, PAD); *Grove*, Clent Hills, Worcestershire, 16.VI.1888 (BM); *Hawkins*, Richmond Park, IX.1957 (CMI 70911); *Phillips*, Shrewsbury, *s. dat.*, *in* Elv. brit. 46 (*A. furfuraceus*, PAD); unknown collector, Shrewsbury, *s. dat.*, *in* Cooke Fungi exs. sel., (K-A2524).

Netherlands: *van Brummelen 641*, Elspeet, 25.VII. 1958 (L); *van Brummelen 652*, Elspeet, 10.IV.1959 (L); *van Brummelen 689*, Elspeet, 19.VI.1959 (L); *van Brummelen 694*, Zoological Garden, Amsterdam, 1.VII.1959 (L); *van Brummelen 1445*, Elspeet, 23.III.1962 (L); *Oudemans*, *s. loc.* V. 1882. (GRO).

Belgium: *Marchal*, Laiken, II.1884 (BR); *Mouton*, Beaufays, July (BR).

Luxemburg: *Marchal*, Ebly, VI.1884 (PAD).

France: *Boudier*, Bois de Beauchamp, IX.1884 (PC); *Boudier*, Bois de Beauchamp, XI.1884 (PC); *Brevière*, Ambert, Puy-de-Dôme, 17.VIII.1900 (S); *de Croculs*, Dardennes, near Toulon, III. 1927 (PC); *Crouan*, on cow dung, near Brest, 29.VI.1857 (PC); *Crouan*, on cow dung, near Brest, autumn (lectotype of *Ascobolus macrosporus*, CONC-A2428); *Crouan*, on dog-dung, in the dunes of Plovan, 10. IX.1865 (CONC); *Gaillard*, Angers, VI.1900 (PC); *Müller & Richle*, Eygliers, Val Queyras, Aiguilles, 10.VI.1954 (type of *Seliniella macrospora*, ZT); *Rizet*, culture on agar., Cluny, Saône & Loire, *s. dat.* (PC); unknown collector, Ecouen, VIII.1890 (PC-A2224, PC-A2226, PC-A2227).

Denmark: *Hansen*, *s. loc.*, 11.VI.1874 (C-A64); *Hansen*, *s. loc.*, *s. dat.*, (BM-A2838).

Germany: *Ade*, Schammendorf near Weismain, IX.1907 (S); *Ade*, in Allgäu, 4.VII.1909, (S); *Ade*, near Obersdorf in Allgäu, 5.VII.1909 (S); *Fuckel*, Oestrich, *s. dat.* (G-A1014); *Fuckel*, Oestricher Wald, autumn, *in* Fungi rhen. 1847 (GRO, LE, M, W), *in* Herb. Barbey-Boissier 1311 (BPI, FH, S, W); *Fuckel*, Oestrich, XI (G-A1016); *Fuckel*, Oestricher Wald, autumn, *in* Fungi rhen. 1848 (*A. macrosporus*, GRO, LE, M, W), *in* Herbier Barbey-Boissier 1312 (*A. immersus* var. *macrosporus*, BPI, FH, S, W); *Fuckel*, Oestricher Wald, autumn, *in* Fungi rhen. 1852 (*A. vinosus*, BM); *Rehm*, near Obernesselbach, Sugenheim, III. 1869 (S); *Rehm*, near Obernesselbach, XI.1870, *in* Ascom. 102b (E, L, M, NY, PAD, S, W); *Rehm*, Obernesselbach, 1870 (S-A620); *Rehm*, Obernesselbach, II.1871 (S-A563); *Rehm*, near Planegg, VIII. 1900 (S); *Rehm*, between Griesen and Eibsee under the Zugspitz, X.1900 (S); *Rehm*, Hinterstein, Allgäu, IX.1909 (S); *Rehm*, Obernesselbach, *s. dat.* (S-A495); *Rehm*, Hinterstein, Allgäuer Alpen, *s. dat.* (S-A485); *Schroeter*, Rastatt, 10.V.1876 (BRSL); *Sydow*, Zehlendorf near Berlin, VII.1882 (S), *in* Myc. march. 361 (HBG, S, W); *Wagner*, on dung of *Antilope bubalis*, zoo, Dresden, IX. 1892 (S); *Winter*, Halle a. Saale, VI.1873 (E); *Winter*, Ilmenau, Thüringen, VII.1873 (BM, GRO); *Winter*, Halle a. Saale, IX.1873 (HBG); *Winter*, Halle a. Saale, VI.1875 (S); unknown collector, Nymphenburg, München, II.1927 (M).

Poland: *Lojka*, Galizien, 1869 (S); *Schroeter*, Oswitz, V.1870 (BRSL); *Schroeter*, Breslau (= Wrocław), VII.1880 (BRSL); *Schroeter*, Mädelkamm in Riesen-Gebirge (= Krknose), 4.VI.1882 (BRSL); *Schroeter*, on elephant dung, *s. loc.* XI. 1885 (BRSL); *Schroeter*, zoo (= Wrocław), 22.V.1886 (BRSL).

Czechoslovakia: *Niessl*, near Brünn (= Brno). *s. dat.* (M 15800, M 15802); *Niessl*, Schreibwald near Brünn (= Brno), *s. dat.* (M. 15801); *Niessl*, Gr. Niemtschitz, *s. dat.* (M 41418); *Petrak*, M. Weisskirchen (= Hranice), Bartelsdorf, V. 1923 (ZT); *Vacek*, Černošice, Bohemia, 1.XII.1947 (PR); *Velenovský*, Mnichovice, Božkov, VIII.1924 (PR).

Switzerland: *Müller*, Aufstieg zur Pierre à Voir, Verbier, Wallis, 30.V.1955 (ZT); *Müller & Schnepp*, Speergebiet, St. Gallen, 25.V.1955. (ZT).

Austria: *Demelius 1109*, Unterwaltersdorf, 7.IX.1916 (W); *Niessl*, near Wienerbruck, VIII.1914 (M 15799); *Niessl*, near Wienerbruck, VII.1915, (M); *Niessl*, near Voitsberg a. Kainach, *s. dat.* (M 41416); *Rechinger*, near Aussee, Steiermark, 1921, *in* Weese, Eumyc.

sel. 592 (M); *Rehm*, near Kühstei, Oetz, Tyrol, VIII.1872, *in* Ascom. 102a (E, L, M, NY, PAD, S, W); *Sauter*, near Mittersill (according to Keissler), *s. dat.* (W 982).

Italy: *Cavara*, Mombolone near Papia, *s. dat.*, *in* Fungi Long. 163 (*A. macrosporus*, BPI, L, PAD, S, W); *Rehm*, Monte Pellegrino near Palermo, Sicilia, X.1894, *in* Ascom. 1169 (*A. globularis*, FH, HBG, M, PAD, PC, S, W, ZT); *Rehm*, near Palermo, X.1894 (S-A623); *Saccardo*, Selva, 30.VIII.1877 (PAD); *Saccardo*, Giavera, VIII.1877 (PAD).

U.S.S.R.: *Ivanitskaja*, Katun near Biysk, 29.VII.1911 (only ascospores) LE; *Tiryveko 278*, *s. loc.*, 11.VIII.1903 (LE).

Pakistan: *Ahmad 2948*, Changla gali, 26.IX.1949 (BPI).

India: *Lacy*, Patna, X.1937 (TRTC).

New Guinea: *van Brummelen 1287*, Ifar near Hollandia, 26.VI.1961 (L).

Australia: Queensland: *Simmonds*, Brisbane River, Brisbane, VII.1912 (K).

Hawaii: *van Brummelen 1459, 1451*, Puuhookomo, Mauna Kea, 7–10.V.1962 (L).

Canada: *Cain*, Lucknow, Bruce Co., Ontario, 10.VII.1930 (TRTC); *Cain*, North Bay, Nipissing Co., Ontario, 3.IX.1931 (TRTC); *Cain*, New Durham, Brant Co., Ontario, 8.X.1933 (TRTC); *Cain 6948*, Pine River, Lac. St. Joseph. Quebec, 26.VIII.1938 (TRTC); *Cain 12193*, S.E. of Camillo, Dufferin Co., Ontario, 25.X.1948 (TRTC); *Cain 12213*, Nashville, York Co., Ontario, 1.XI.1948 (TRTC); *Cain*, Nashville, York Co., Ontario, 28.IX.1952 (TRTC, ZT); *Cain*, Nashville, York Co., Ontario, 9.V.1954 (TRTC); *Jackson*, Bear Island, Lake Timagami, Ontario, IX.1929 (NY, TRTC); unknown collector, Melissa, Muskoka, Ontario, 2.VIII.1932 (TRTC 34682).

U.S.A.: Oregon: *Kienholz K 82*, Hood River, 10.XI.1932 (NY). Arizona: *Cain*, Mt. Humphrey, Flagstaf, 21.VI.1955 (TRTC, small-spored form). Colorado: *Seaver & Bethel*, Geneva Creek Canyon, IX.1910 (NY). Iowa: *Seaver 61 and 61-b*, Iowa City, 17.III.1905 (BPI, NY, S). Maine: *Thaxter 518*, Kittery Point, 18.VI.1886 (FH). New York: *Cook*, Clyde, X. 1887 (NY-A1346, NY-A1353); *Gerard*, Po'keepsie, I.1872 (NY). Massachusetts: *Sturgis*, Cambridge, III. 1891 (NY). Connecticut: *Sturgis*, New Haven, I.1893 (NY). New Jersey: *Ellis*, Newfield, VIII.1890, *in* Ellis & Everhardt N. Am. fungi ser. 2, 2620 (*A. vinosus*, L). Virginia: *Meyer 14727*, Mountain Lake Biological Station (in moist chamber), 6.VIII.1942 (BPI, TRTC).

Bermuda: *Brown et al. 1363*, XI–XII. 1912 (NY); *Brown et al.1546* (culture), XI-XII-1912 (NY); *Brown et al.1599* (culture), XI–XII.1912 (NY); *Dodge, 1911* (NY-A1204); *Seaver & Whetzel*, Morgan's Island, 9.II.1926 (NY).

Puerto Rico: *Fink*, Mayaguez, VIII.1920 (NY-A1355); *Seaver, s. loc., s. dat.*, (NY-A1203); *Wilson 237*, Luquillo Mountains, 14.VII.1902 (NY).

Brazil: *Theobald*, Sao Leopoldo, Rio Grande do Sul, 11.III.1936 (TRTC).

Argentina: *Calviello*, Capital Federal, 9.V.1962 (BAFC 21293); *Spegazzini*, Recoleta, Buenos Aires 10.III.1880 (LPS 26124); *Spegazzini*, Colonia Resistencia, Chaco, I.1887 (in part, only ascospores; type of *A. megalospermus*, LPS 28164); *Spegazzini*, La Plata, 17.VI.1908 (LPS 26127).

This species is probably one of the commonest members of the genus and its distribution seems to be limited only by the occurrence of herbivorous mammals. It can be easily recognized by the very large ascospores with a thick gelatinous envelope surrounding each spore. The fruit-bodies grow more or less immersed, the depth depending on the structure of the substratum. On semi-solid or soft surfaces and on substrata with superficial, small cavities they will grow fully immersed with only the ripe asci protruding. On very dense, solid surfaces they may develop also superficially.

The immersed parts of the walls especially are clothed with a thin layer of appressed

hyphae. These hyphae may be rather wide and show rigid walls. Similar clothing occurs in all species of section *Dasyobolus*.

Some authors (e.g. Boudier, 1869; Phillips, 1887; Saccardo, 1889; Heimerl, 1889; Le Gal, 1961) described hairs from the surface of the excipulum of *Ascobolus immersus*. However, in the many thousands of fruit-bodies of this species studied by me, among which were also specimens studied by these authors, no excipular hairs, like those illustrated by Boudier and Le Gal could be found.

The ascospores of *A. immersus* are very variable. Besides the normal oblong-ellipsoid ascospores, cylindrical and subglobular ascospores also occur. The form with subglobular ascospores has been described as *A. immersus* var. *brevisporus* Oud. and as *A. globularis* Rolland. Of this form excellent material was distributed in Rehm's "Ascomycetes exsiccati", No. 1169.

Rather frequent mutant-forms with only four ascospores per ascus have been described under the names *A. immersus* var. *andinus* Speg. and *Saccobolus exiguus* Batista & Pontual. *Ascobolus gigasporus* De Not. with 2–5 ascospores is perhaps another such mutant-form.

Occasionally the number of ascospores in an ascus varies even in the same fruit-body from eight to one.

Asci with more than eight ascospores occur only very rarely. Ramlow (1915) found an ascus with sixteen ascospores, while Zuk & Swietlinska (1965) illustrated an ascus with fifteen ascospores. Here an additional mitosis took place in the ascus.

Of *A. immersus* more than 2000 ascospore-mutants are known only differing from the wild-type strain by a single gene (Lissouba & al., 1962). Segregations for ascospore colour or other episporium phenotypes can often be observed in the asci.

The species is heterothallic and a favourable object for genetical and cytological studies (Rizet, 1939, 1941; Rizet *& al.*, 1960a–c; Lissouba *& al.*, 1962; Zuk & Swietlinska, 1965; Paszewski *& al.*, 1966; Makarewicz, 1966).

In some cultures of *A. immersus* 'cleistothecia' were formed in which the ascospores were only set free by decay. These cleistothecial forms are probably inhibited in their development and not comparable with cleistothecial mutants like those described by Maniotis (1965) for *Gelasinospora calospora* (Mouton) C. & M. Moreau. Rizet (1939) also described sclerotia in cultures of *A. immersus*, which resembled immature fruit-bodies. Unfortunately the microscopic structure of these sclerotia was not described.

Zukal (1889) described for this species gemmae resemblin conidia of the hyphomycetous genus *Stemphylium* Wallr. At the ends of short, often sickle-shaped branches (consisting of 4–6 cells), are the apical cells which are surrounded by a brownish membrane and finally become separated as conidia. This observation has never been repeated.

Ascobolus quezelii Faurel & Schotter, of which the type could not yet be studied, probably represents a form of *A. immersus* with reddish to purplish receptacles, small asci ["250–350(–400) × 50–70 μ"], and small ascospores ("42–48 × 20–50 μ").

2. Ascobolus bistisii Gamundí & Ranalli — Fig. 10; Pl. 2, figs, E, F

Ascobolus bistisii Gamundí & Ranalli *in* Nova Hedwigia **10**: 347 *pl. 107 108 110 f. 1 111.* 1966. — Holotype: BAFC 21293 (C-2178).

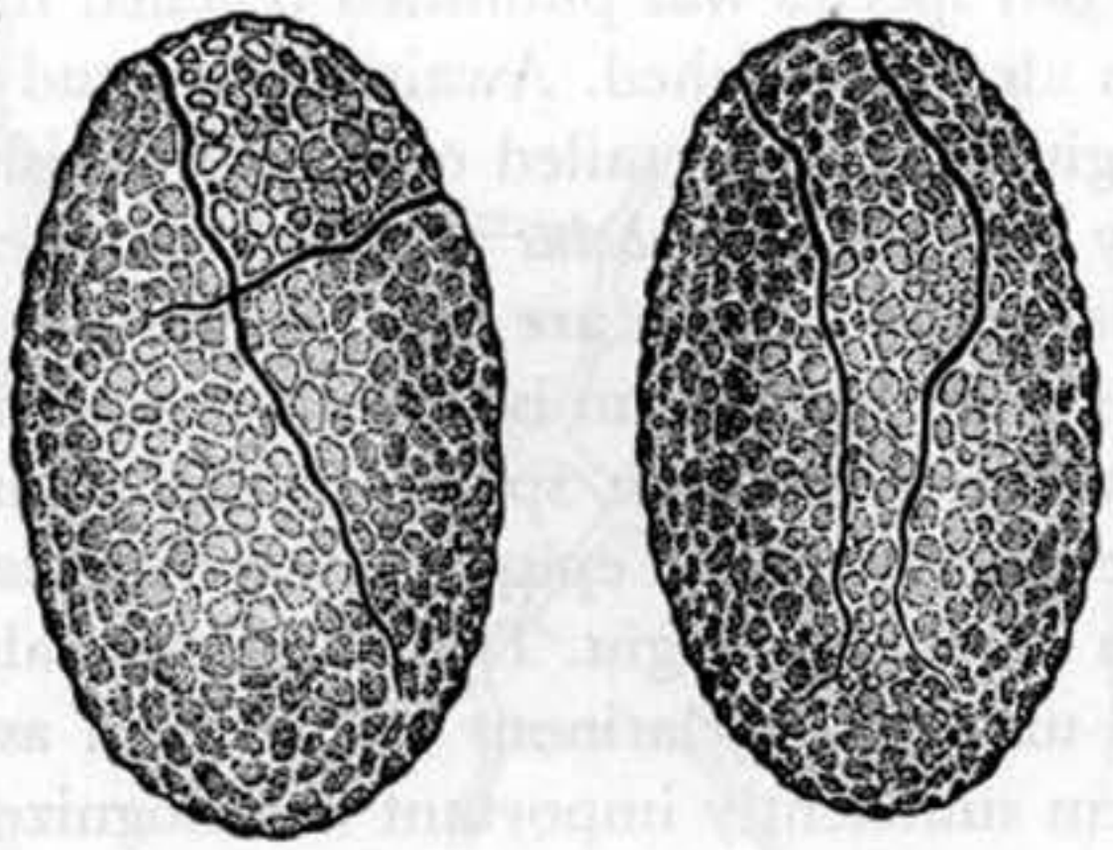

Fig. 10. — *Ascobolus bistisii*, ascospores × 800 (after Gamundí & Ranalli, 1966.)

Apothecia small, half buried in the substratum, globular, with very few (2–6) asci, the latter simultaneously emerging from the convex hymenial surface like the fingers of a glove in different directions; young apothecia of a light green colour (= "flavovirens" of Saccardo) and surrounded by hyaline aerial hyphae; the apothecia first remain in the substratum, but emerge later making the aerial hyphae less conspicuous; margin hardly noticeable; outside in fully ripe state glabrous, of a light green colour, sometimes with an ochraceous hue. Consistency fleshy and soft. Diameter: 560–960 μ. Asci with 8 spores, claviform, abruptly ending at the base, with an apical central operculum in the form of a dome, where the wall of the ascus is much thinner; having a weak amyloid reaction in the ascus-wall, and with many light-refracting vacuoles. Occasionally asci with 2 and 6 ascospores; 370–480 × 64–80 μ. Paraphyses filiform, with numerous septa, containing light-refracting greenish granules, embedded in a light green mucilage, amyloid reaction manifest in both their walls and contents. Diameter: 2.5–4 μ at the apex. Ascospores irregularly arranged in the ascus, ellipsoidal (relation between length and width: 2:1), at first hyaline, uninuclear and with a thick light-refracting wall, later purplish, finally chestnut brown; the pigment of the episporium being irregularly distributed, forming papillate tubercles; the latter in the form of low elevations but with irregular margin, and of dark chestnut colour which is lighter at the base of the tubercle in the fully mature ascospores, giving the impression of a net-work of the type found in *Ascobolus americanus*, but more irregular and less conspicuous. Fissures 1–3, generally median or oblique, sometimes joined transversally by a few other fissures which are wavy and follow the grooves between the papillae; with a lenticular mass of mucilage laterally; 50–60 × 30–36 μ. Medulla (= flesh) of "textura globulosa", with collapsed cells mixed with connective hyphae of a dense content, which unite the basal cells of the cortex with the subhymenium; globular cells of 16–32 μ diameter. Context of "textura globulosa" to "angularis" when seen from outside, formed by cells with walls of light green colour, with contents, 16–32 μ diameter.

Oidia present in the aerial mycelium, hyaline, cylindrical, 12–15 × 4 μ.
Only known from dung of horse.
ETYMOLOGY.—After Dr. G. Bistis, the American geneticist.

ILLUSTRATIONS.—Gamundí & Ranalli, l.c.

The paper in which this species was published reached me when the manuscript of this monograph was already finished. Awaiting the study of authentic material, above a translation is given of the detailed original Spanish description.

This species is closely related to *Ascobolus immersus*, but there are some differences in the spores. In the latter the spores are oblong ellipsoid or subcylindrical with rounded or obtuse ends. The episporium is smooth or with some irregular crevices, and a gelatinous mass surrounds each spore. In *A. bistisii* the spores are more regularly ellipsoid. The pigment of the episporium is irregularly distributed forming papillate tubercles with irregular margin. The episporium also shows some irregular crevices and there is a unilateral gelatinous cap to each ascospore.

These differences seem sufficiently important to recognize two distinct species. [10]

3. ASCOBOLUS STICTOIDEUS Speg.—Fig. 11; Pl. 2, figs. G, H

Ascobolus stictoideus Speg. *in* Michelia **1**: 474. 1879. — *Ascobolus brunneus* var. *stictoideus* (Speg.) Heimerl *in* Jber. kk. Ober-Realschule Bez. Sechshaus Wien **15**: 14. 1889. — Holotype: LPS 26119.

Apothecia scattered, gregarious or closely crowded, completely immersed or rarely superficial, 350–600 μ diameter, 400–650 μ high. Receptacle at first closed and globular or pyriform, then opening by irregular rupturing of the wall, watery-white, greenish-yellow or olive in colour; thinly tomentose or rarely smooth; without a margin. Disk flat or slightly concave, pale olivaceous to almost colourless, with a few almost black, ripe asci strongly protruding. Hymenium 230–280 μ thick, containing up to 40 asci. Hypothecium very thin, of isodiametric cells 6–12 μ diameter. Flesh not sharply differentiated or very thin. Excipulum about 15 μ thick, of more or less isodiametric, polygonal, thick-walled cells 9–25 μ diameter (textura angularis), with pale yellowish cell-walls, often covered with a thin layer of interwoven, cylindrical, irregularly branched, hyaline, 4–9 μ wide hyphae. Asci clavate or clavate-saccate, gradually tapering downwards into a rather thick base, rounded above, 150–400 × 39–55 μ, 8-spored; the wall deep blue in Melzer's reagent. Ascospores biseriate or irregularly disposed, ellipsoid; at first hyaline, then pale violet, finally dark violet, (25.5–)26.5–30.5(–32) × (14.5–)16–17.5 μ, ornamented with rather coarse, rounded warts; pigment often rather thick up to 1.5 μ; with

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[10] Through the kindness of Dr. I. Gamundí de Amos, the type specimen of *A. bistisii* could recently be studied. This material agrees with the above description. The size of most ascospores was found to fall within 55–60 × 30–33 μ. The shape of the spores is not significantly different from that in *A. immersus*. Generally the episporium is clearly rough, but in some fruit-bodies it was found to be almost smooth. Sometimes spores were rough on one side and smooth on the opposite side. The presence of an unilateral gelatinous cap to each spore remains a very outstanding character of this fungus, the constancy of which cannot be studied in dried material, however.

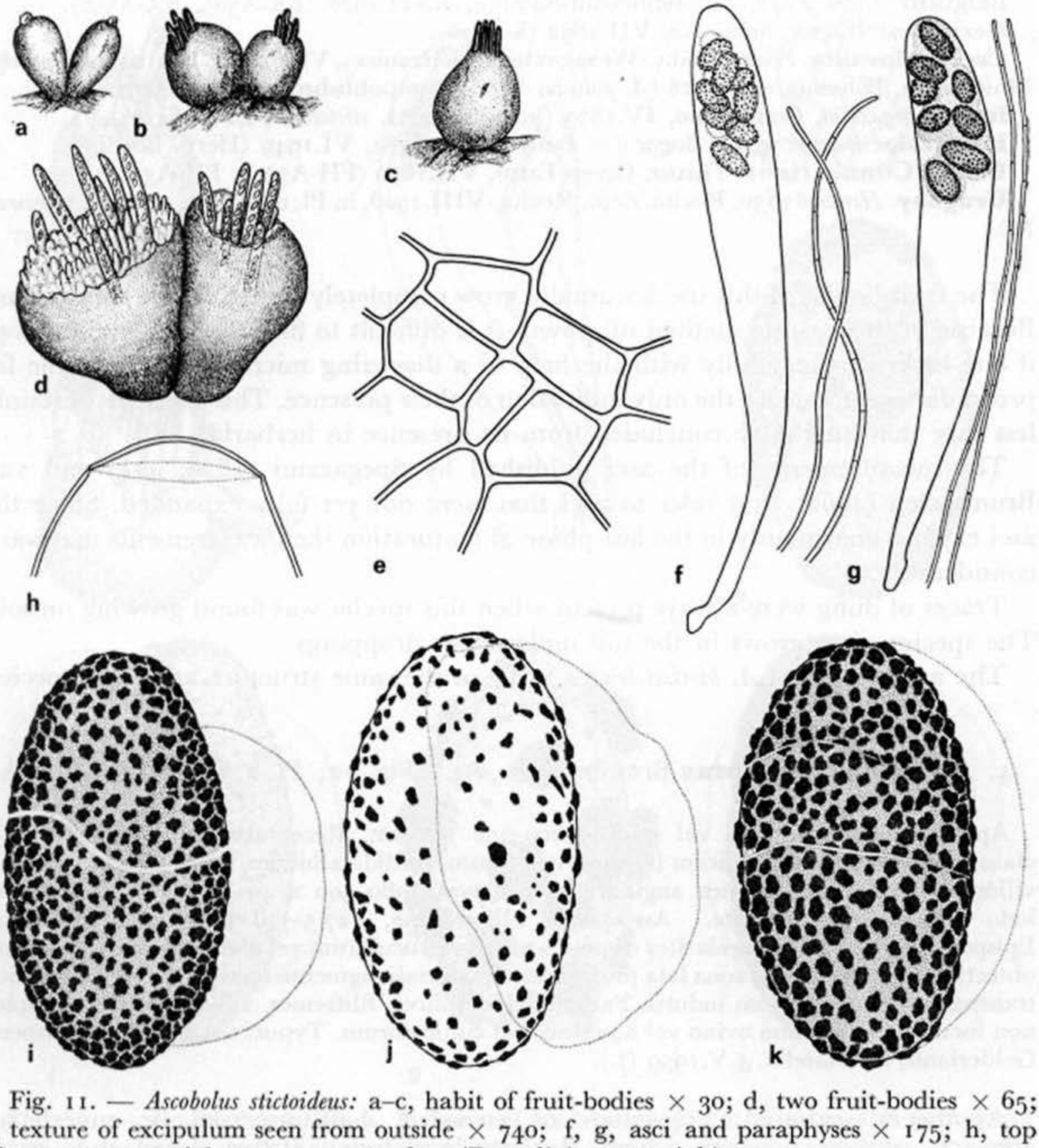


Fig. 11. — *Ascobolus stictoideus:* a–c, habit of fruit-bodies × 30; d, two fruit-bodies × 65; e, texture of excipulum seen from outside × 740; f, g, asci and paraphyses × 175; h, top of ascus × 1000; i–k, ascospores × 1600. (From living material.)

unilateral, mucilaginous substance. Paraphyses filiform, simple, septate, 2.8–3.8 μ thick, not enlarged upwards, sometimes slightly narrowed at the tip 2.5–3.2 μ thick, hyaline, embedded in pale yellowish or colourless mucus.

On dung of cow, horse, sheep, dog, rabbit, muskrat, and goose, also on soil dirtied with dung.

ETYMOLOGY.—From Greek, στικτος, punctured and ἐιδος, like.

ILLUSTRATION.—van Brummelen *in* Persoonia **2**: 196 *f. 2.* 1962.

SPECIMENS EXAMINED.—**Netherlands**: *van Brummelen*, Pinetum, Putten, 3.V.1958 (slide, L); *van Brummelen* 59.3, Vierhouten, 20.IV.1959 (slide, L).

Belgium: *Culot 2348*, Montignies-sur-Sambre, 2.XII.1926 (BR-A305, BR-A358).
Germany: *Wagner*, Schmilka, VII.1892 (S-A626).
Czechoslovakia: *Petrak*, Mähr.-Weisskirchen (= Hranice), VI.1924 (ZT-A104); *Velenovský*, Mnichovice, Bohemia, 1.V.1928 (*A. pallidus* Vel., an unpublished name, PR 150266).
Italy: *Spegazzini*, Conegliano, IV.1879 (holotype of *A. stictoideus*, LPS 26119).
Indonesia: *Boedijn 4934*, Bogor (= Buitenzorg), Java, VI.1949 (Herb. Boedijn).
U.S.A.: Connecticut: *Thaxter*, Green Farm, VII.1890 (FH-A3109, FH-A3111).
Uruguay: *Herter 83630*, Rocha, dept. Rocha, VIII.1928, in Pl. urug. exs. 1222 (*A. brunneus*, M).

The fruit-bodies of this species usually grow completely buried in the substratum. Because of this cryptic method of growth it is difficult to find the fruit-bodies, even if one looks very carefully with the help of a dissecting microscope. Often the far protruding ripe asci are the only indication of their presence. This species is certainly less rare than might be concluded from its presence in herbaria.

The measurements of the asci published by Spegazzini (1879: 474) and van Brummelen (1962: 197) refer to asci that were not yet fully expanded. Since the asci expand enormously in the last phase of maturation the measurements may vary considerably.

Traces of dung were always present when this species was found growing on soil. The species often grows in the soil underneath droppings.

The episporium of *A. bistisii* seems to be of the same structure as in this species.

4. **Ascobolus degluptus** Brumm., *spec. nov.*—Fig. 12; Pl. 2, fig. I, Pl. 3, fig. A

Apothecia semi-immersa vel sessilia, 200–450 μ diam. Receptaculum globulare, initio clausum, denique prope apicem irregulariter fissum, sordide albidum, laeve vel pilis hyalinis villosum. Excipulum textura angulari. Asci clavati, 380–500 × 49–56 μ, 8-spori, pariete iodo intense caerulescente. Ascosporae ellipsoideae, (27.5–)30–33.5(–35) × 16–18 μ. Episporium pigmento irregulariter disposito modo verrucularum vel globularum irregularium obtectum, ascosporis ipsis zona lata plus minus equatoriali pigmento quasi destituta cinguloque transparente mucilaginoso indutis. Paraphyses simplices, filiformes, 2.8–4.0 μ crassae, apice non incrassatae. In fimo ovino vel anserino, vel cuniculorum. Typus: *van Brummelen*, Elspeet, Gelderland, Neerlandia, 5.V.1959 (L).

Apothecia scattered, gregarious or crowded, half-immersed or superficial, 200–450 μ across, 300–350 μ high. Receptacle globular, at first closed, then irregularly opening, dirty whitish or pale brownish, smooth or clothed with some hyaline hyphae, especially near the base, without a prominent margin. Disk flat, watery-white, with the dark purplish-violet tips of ripe asci far protruding. Hymenium about 200 μ thick. Hypothecium very thin, of isodiametric cells 8–11 μ diameter. Flesh very thin, of rounded isodiametric cells 8–12 μ diameter, colourless. Excipulum 12–15 μ thick, of more or less isodiametric, polygonal cells 9–30 μ diameter (textura angularis), colourless or pale brownish especially near the base, often covered with a thin layer of hyaline, cylindrical, irregularly branched hyphae, about 4 μ thick. Asci clavate, with a short stalk, rounded above, 380–500 × 49–56 μ, 8-spored; the wall deep blue in Melzer's reagent. Ascospores biseriate or irregularly disposed; ellipsoidal; at first hyaline, then pale brownish-violet, finally very dark purplish-

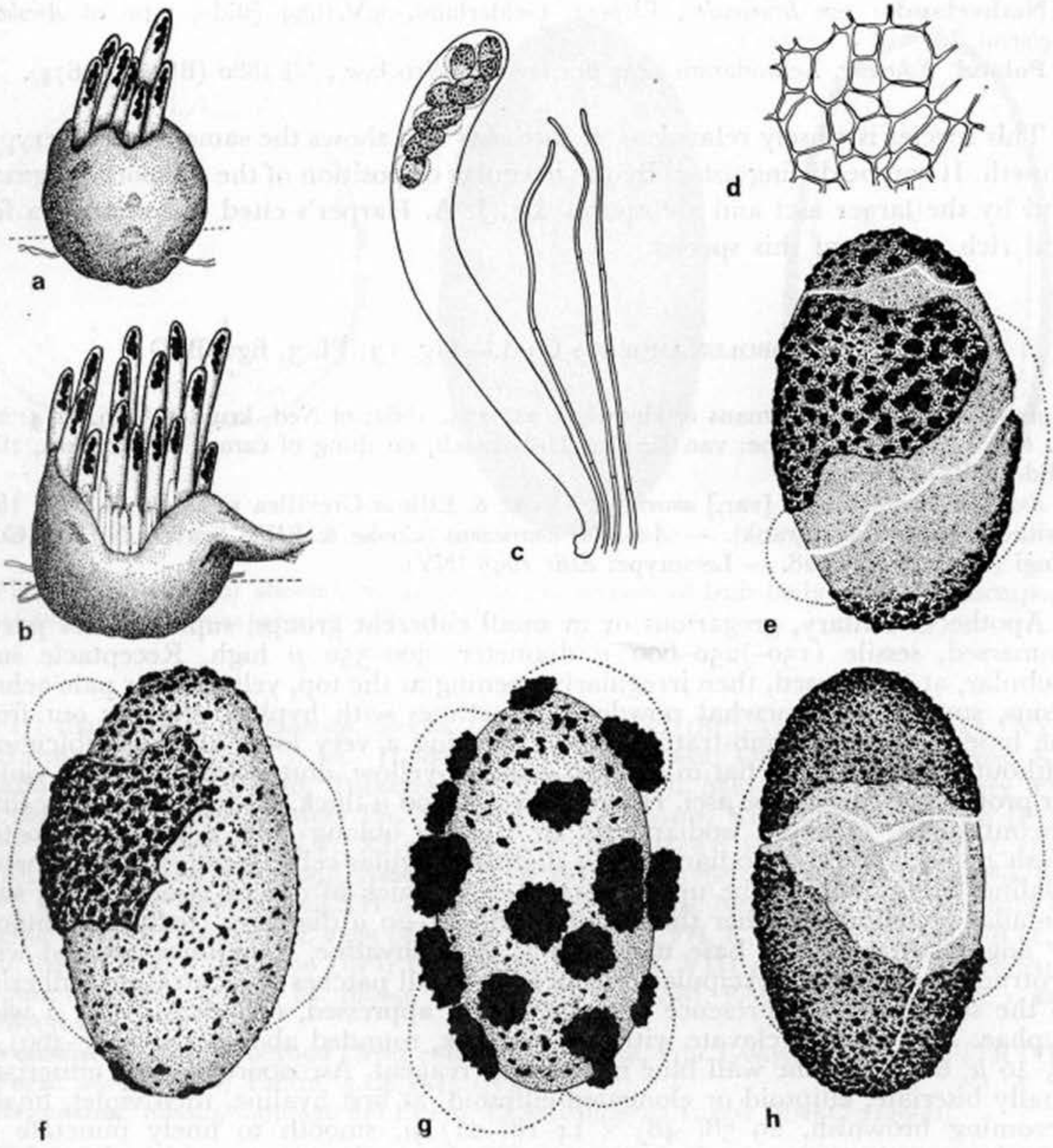


Fig. 12. — *Ascobolus degluptus:* a, b, habit of fruit-bodies × 75; c, ascus and paraphyses × 460; d, texture of excipulum seen from outside × 275; e–h, ascospores × 1600 (g, a rare, abnormal type of ornamentation). (From type.)

violet; (27·5–)30–33·5(–35) × 16–18 μ; partly covered with irregularly disposed pigment, in the form of caps or warts; usually with a broad zone in which pigment is almost absent; pigment up to 2 μ thick; each spore with sub-equitorial transparent, mucilaginous cap or girdle. Paraphyses simple, septate, filiform, 2.8–4.0 μ thick, not thickened above, hyaline, embedded in colourless, somewhat granular mucus.

On dung of sheep, rabbit and goose.

ETYMOLOGY.—From Latin, deglubo, to peel off the skin.

SPECIMENS EXAMINED.—**Great Britain**: *Harper*, Clumber Park, Worksop, Nottinghamshire, 10.V.1960 (L).

Netherlands: *van Brummelen*, Elspeet, Gelderland, 5.V.1959 (slide, type of *Ascobolus degluptus*, L).
Poland: *Schroeter*, Lehmdamm near Breslau (= Wrocław), VI.1880 (BRSL-A1674).

This species is closely related to *A. stictoideus* and shows the same mode of cryptic growth. It can be distinguished by the irregular disposition of the episporial pigment and by the larger asci and ascospores. Dr. J. A. Harper's cited collection is a fine and rich sample of this species.

5. Ascobolus amoenus Oud.—Fig. 13; Pl. 3, figs. B–D

Ascobolus amoenus Oudemans *in* Hedwigia **21**: 165. 1882; *in* Ned. kruidk. Arch. II **4**: 262 *pl. 6 f. 13*. 1886. — Type: van Ledden Hulsebosch, on dung of camel, Amsterdam, 1852 (slide, GRO-A2000).
Ascobolus leveillei Boud. [var.] *americanus* Cooke & Ellis *in* Grevillea **5**: 52 *pl. 80 f. 20*. 1876 (without indication of rank). — *Ascobolus americanus* (Cooke & Ellis) Seaver, N. Am. Cup-fungi (Operc.) 85. 1928. — Lectotype: *Ellis 1096* (NY).

Apothecia solitary, gregarious or in small coherent groups, superficial or partly immersed, sessile (150–)250–600 μ diameter, 300–550 μ high. Receptacle subglobular, at first closed, then irregularly opening at the top, yellowish or pale ochraceous, smooth or somewhat powdery; sometimes with hyphae growing out from the base towards the substratum, rarely forming a very loose kind of subiculum; without a margin. Disk flat to convex, greenish-yellow, dotted with the dark violet, far protruding tips of ripe asci. Hymenium 200–300 μ thick. Hypothecium very thin, discontinuous, of small isodiametric or slightly oblong cells 4.5–6 μ diameter. Flesh 45–60 μ thick, of isodiametric or slightly irregular cells 13–20(–32) μ diameter, hyaline. Excipulum in the upper part 22–29 μ thick of one or two layers of subglobular or angular, rather thick-walled cells 14–20 μ diameter (textura globulosa or angularis), near the base up to 80 μ thick, hyaline, sometimes covered with protruding superficial, excipular cells or with small patches of substratum, adhering to the surface by the presence of more or less appressed, cylindrical, 2–4 μ wide hyphae. Asci broadly clavate with a short stalk, rounded above, 170–300(–400) × 35–40 μ, 8-spored; the wall blue in Melzer's reagent. Ascospores at first uniseriate, finally biseriate, ellipsoid or elongated-ellipsoid, at first hyaline, then violet, finally becoming brownish, 29–38(–48) × 14–18(–21) μ, smooth to finely punctate or densely granular; pigment in a very regular layer about 1.2 μ thick. Paraphyses simple, with only a few septae, filiform, about 2.5 μ thick, not enlarged upwards, hyaline, embedded in greenish-yellow mucus.
On dung of cow, horse, camel, goat, rabbit and muskrat.
Etymology.—From Latin, amoenus, charming, lovely.

Illustrations.—Cooke & Ellis *in* Grevillea **5**: *pl. 80 f. 20*. 1876 (*A. leveillei* Boud. var. *americanus*); Oudemans *in* Ned. kruidk. Arch. II **4**: *pl. 6 f. 13*. 1886.

Specimens examined: **Netherlands**: *van Ledden Hulsebosch*, Amsterdam, 1882 (slide, type of *Ascobolus amoenus*, GRO-A2000).
Canada: *Dearness 3330*, S. E. shore of Lake Huron, Ipperwash, Ontario, 13.VIII.1911 (DAOM, S).
U.S.A.: Kansas: *Bartholomew 1767*, Kansas, 20.VII.1895 (NY); *Bartholomew 1882*, Kansas,

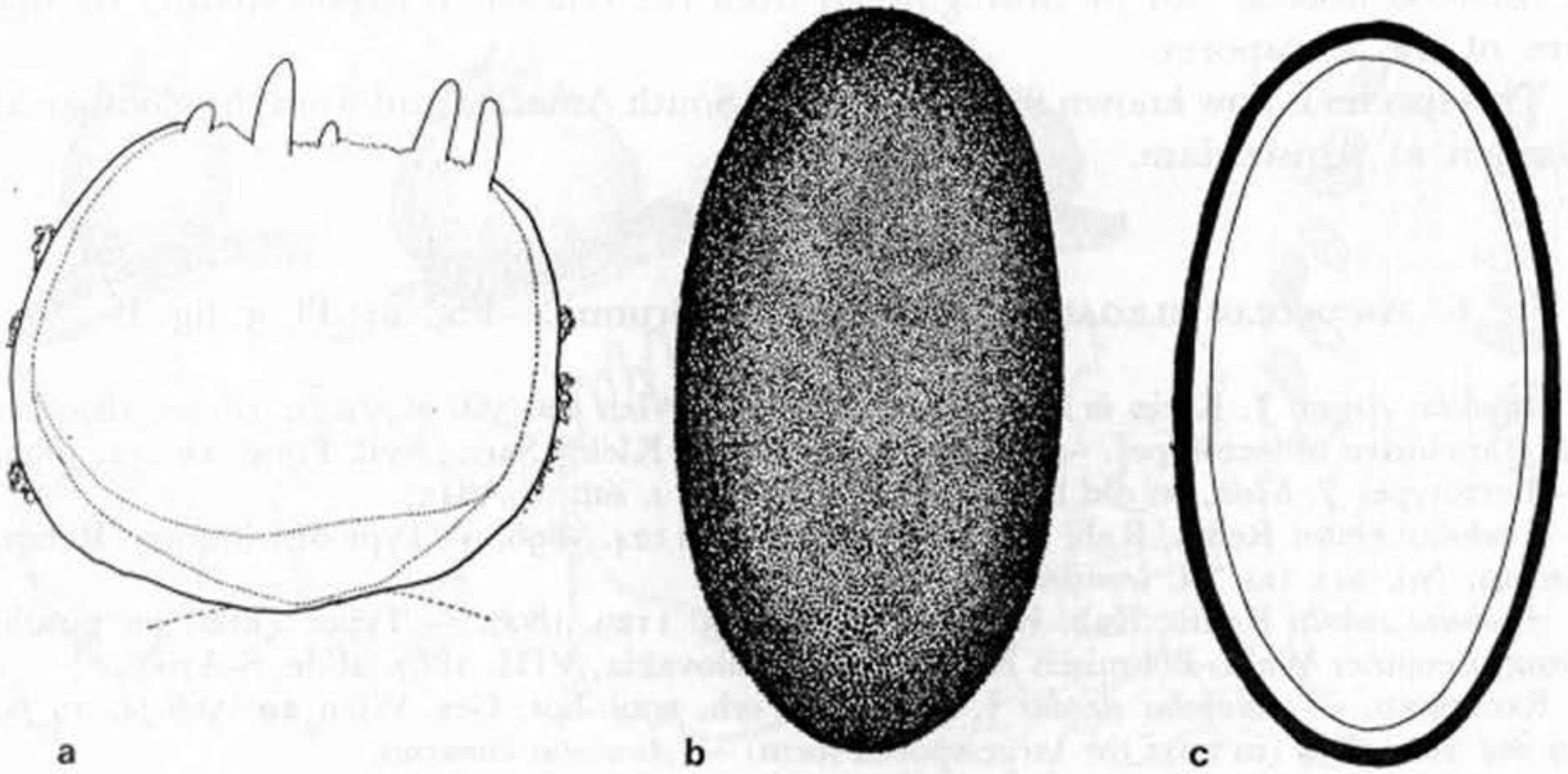


Fig. 13. — *Ascobolus amoenus:* a, diagrammatic section of fruit-body × 80; h, ascospore × 1600; c, id. in optical section. (From *Ellis 1096.*)

8.VIII.1895 (NY); *Bartholomew*, Rooks Co., 5.IX.1895, (BPI-A1541, BPI-A1543, NY). Oklahoma: *Rorer 6448, s. loc.*, II.1901 (culture, *A. amoenus* Oud., det. Oudemans, K). Alabama: *Carvar* (?) *248*, Tuskegee, 24.VI.1897 (NY). Maine: *Thaxter*, Kittery Pt., IX.1891 (FH); *Thaxter*, Kittery Pt., XII.1899 (FH); *Thaxter*, Kittery Pt., IX. 1900 (PC). New York: *Seaver*, Bronx N.Y., XI.1914 (NY). Connecticut: *Sturgis*, New Haven, I. 1893 (NY). New Jersey: *Ellis 1096*, Newfield, XII. 1874 (lectotype of *A. leveillei* var. *americanus*, NY); *Ellis 2386*, Newfield, 28.XII.1874 (BPI, FH, K); *Ellis*, Newfield, VI.1889, *in* Ellis & Everhart, N. Am. fungi ser. 2, 2333 (*A. glaber*, BM, BPI, G, FH, K, L, M, NY, PAD, TRTC); *Ellis*, New Field, VIII. 1890 (BPI, NY); *Ellis*, Newfield, VIII.1890, *in* Ellis & Everhart, N. Am. fungi, ser. 2, 2620 (*A. vinosus*, BM, BPI, G, K, L, M, PAD); *Ellis*, Newfield, *s. dat.* (FH-A3173).

Venezuela: *Whetzel*, beyond Ortez entrance to Llanos, Edo. Guarico, 7.IV.1939 (TRTC).
Peru: *Martin 6270*, Talara, 5.IX.1945 (NY).
Argentina: *Ranalli*, Santiago del Estero, El Salvador, 23.I.1962 (BAFC 21299b).

The type consists of a poor slide that showed just sufficient characters after remounting to identify it.

This species has been ignored probably because of the inaccurate original description. The drawing of an ascus with warted ascospores accompanying Oudemans' original description (1886: *pl. 6 f. 3*) gives a deceptive impression of the ascospores. In fact these are almost smooth or very finely granular and measured 30–36.5 × 16–19(–20) μ in the type specimen.

In the Kew herbarium a collection (*J. B. Rorer 6448*) is preserved with the annotation: "*Ascobolus amoenus* Oud. Examined by Oudemans and accepted as his sp.". In this collection, which is in good condition, the ascospores measured 30.5–36.5 × 16–17.5 μ. Both collections belong to the same species.

Ascobolus amoenus can be distinguished from the related *A. elegans* mainly by the size of the ascospores.

This species is now known from North and South America and from the Zoological Garden at Amsterdam.

6. Ascobolus elegans J. Klein emend. Brumm.—Fig. 14; Pl. 3, fig. E

Ascobolus elegans J. Klein *in* Verh. zool.-bot. Ges. Wien **20**: 566 *pl. 10 fs. 18–20.* 1870 (in part; inclusive of lectotype). — *Ascophanus elegans* (J. Klein) Sacc., Syll. Fung. **10**: 32. 1892. — Lectotype: *J. Klein*, on old horse dung, München, *s. dat.* (S-A645).

Ascobolus winteri Rehm, Rab. Krypt.-Fl. (Pilze) **3**: 1124. 1896. — Type distribution: Rehm, Ascom. No. 211 (as "*A. leveillei* ?").

Ascobolus zukalii Rehm, Rab. Krypt.-Fl. (Pilze) **3**: 1129. 1896. — Type: *Zukal*, on giraffe dung, Leojaner Wald, Böhmisch Röhren, Czechoslovakia, VIII. 1887 (slide, S-A760).

Excluded. — *Ascobolus elegans* J. Klein *in* Verh. zool.-bot. Ges. Wien **20**: 566 *pl. 10 fs. 19 and 20b.* 1870 (in part the large-spored form) = *Ascobolus immersus.*

Apothecia gregarious or closely crowded, superficial or partly immersed, sessile, sometimes formed on a kind of subiculum, 200–470 μ diameter, 200–530 μ high. Receptacle at first subglobular, sometimes with a broad base, finally often more or less hemispherical, yellowish-brown or brownish; smooth or more rarely thinly tomentose, without a margin. Disk flat, greenish-yellow or pale yellowish-brown, dotted with the violet protruding tips of ripe asci. Hymenium 200–240 μ thick. Hypothecium scarcely differentiated, very thin, of isodiametric cells 7–15 μ thick, sometimes almost lacking, of subglobular cells 9–20 μ diameter or of intertwined branched hyphae 4.5–7.5 μ wide, with cells 15–30 μ long, hyaline. Excipulum 19–26 μ thick, of isodiametric or oblong, often somewhat angular cells (8–)12–25 (–35) × (4.5–)7–15(–19) μ (textura globulosa, epidermoidea or angularis), colourless or pale brownish, sometimes covered with a thin layer of 3–4 μ wide hyphae. Asci cylindric-clavate, tapering downwards into a rather short stalk, rounded above, 170–300 × 28–35(–38) μ, 8-spored; the wall deep blue in Melzer's reagent. Ascospores biseriate, ellipsoid, at first hyaline, then pale violet, finally violet or purplish-brown, 23–29(–32) × 11.5–17.5 μ, smooth or extremely fine granular; the pigment in a very uniform layer; with unilateral or concentric mucilaginous substance. Paraphyses simple or branched, septate, filiform, about 3 μ thick, not or scarcely enlarged above, hyaline, embedded in abundant greenish-yellow or somewhat brownish mucus.

Known from dung of horse, cow, zebra, giraffe, rabbit, hare, and goose.

Etymology.—From Latin, elegans, elegant, graceful.

Illustrations.—J. Klein *in* Verh. zool.-bot. Ges. Wien **20**: *pl. 10 f. 20a.* 1870.

Specimens examined.—**Sweden**: *Starbäck*, Uppsala, Uppland, IX.1895 (S-A675).

Great Britain: *Broome*, Spye Park, Wiltshire, *s. dat.*, *in* Rabenhorst Fungi eur. 230 (*A. vinosus*, W).

Denmark: *Hansen*, *s. loc.*, 4.VI. 1875 (C-A57).

Germany: *J. Klein*, München, *s. dat.* (type of *A. elegans*, S-A645); *Winter*, Gaschwitz near Leipzig, VII. 1872, *in* Rehm Ascom. 211 (as "*A. leveillei* ?", type distribution of *A. winteri*, E, FH, G, M, PAD, S, W).

Poland: *Schroeter*, Zoologischer Garten, Wrocław, IV.1884 (BRSL-A1675).

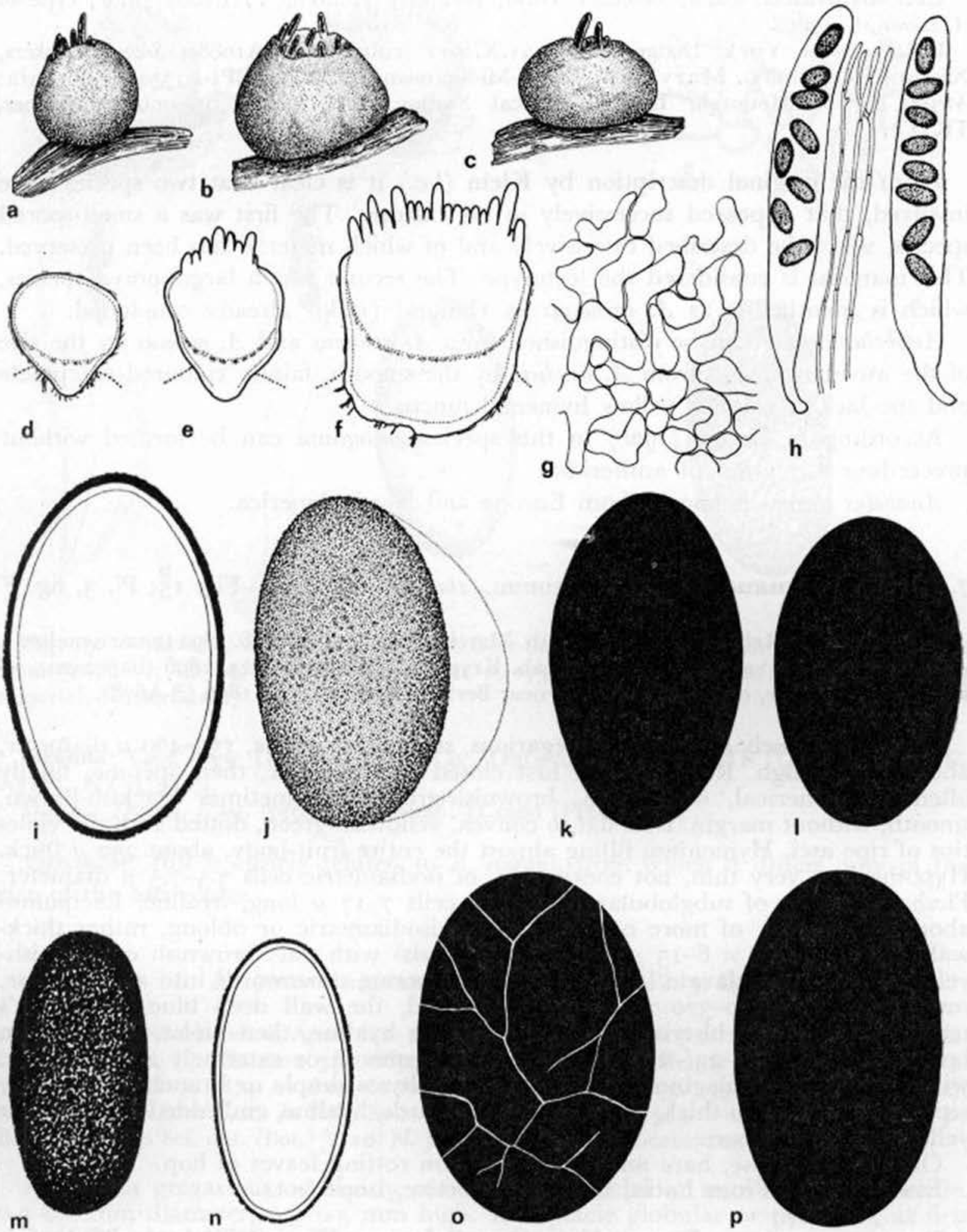


Fig. 14. — *Ascobolus elegans:* a–c, habit of fruit-bodies × 80; d–f, diagrammatic sections of fruit-bodies × 65; g, texture of excipulum seen from outside × 600; h, asci and paraphyses × 175; i, n, ascospores in optical section × 1600; j–m, o–p, ascospores × 1600. (a–c, g–j, from living material; d–f, k–n, from lectotype of *A. elegans;* o, p, from Rehm, Ascom. 211, E.)

Czechoslovakia: *Zukal*, Leojaner Wald, Böhmisch Röhren, VIII.1887 (slide, type of *A. zukalii*, S-A760).
U.S.A.: New York: Dodge, *s. loc.*, 21.X.1911 (culture, NY-A1088); *Seaver*, Yonkers, XI.1915 (NY-A1087). Maryland: *Young*, Middeltown, XI. 1932 (BPI-A1554). Virginia: *Meyer 14726*, Mountain Lake Biological Station, 5.VIII.1942 (in moist chamber, TRTC).

From the original description by Klein (l.c.) it is clear that two species were involved, that appeared successively in his cultures. The first was a small-spored species, which he described extensively and of which material has been preserved. This material is considered the lectotype. The second was a large-spored species, which is identifiable as *A. immersus* as Heimerl (1889) already concluded.

Ascobolus elegans can be distinguished from *A. amoenus* and *A. mancus* by the size of the ascospores, and from *A. boudieri* by the smooth, faintly coloured receptacle and the lack of sulphur yellow hymenial mucus.

According to Dodge (1920) in this species ascogonia can be formed without preceeding formation of antheridia.

Ascobolus elegans is known from Europe and North America.

7. **Ascobolus mancus** (Rehm) Brumm., *stat. & comb. nov.*—Fig. 15; Pl. 3, fig. F

Ascobolus mancus Rehm *in* Sydow, Mycoth. March. Cent. 37, No. 3676. 1892 (nomen nudum). — *Ascobolus winteri* var. *mancus* Rehm, Rab. Krypt.-Fl. (Pilze) **3**: 1124. 1896 (basionym). — Holotype: *P. Sydow*, on dung of rabbit, near Berlin, Germany, 3.X.1892 (S-A678).

Apothecia closely crowded or gregarious, superficial, sessile, 150–400 μ diameter, about 300 μ high. Receptacle at first closed and globular, then opening, finally often hemispherical, olive-green, brownish-green or sometimes blackish-brown, smooth, without margin. Disk flat to convex, yellowish-green, dotted with the violet tips of ripe asci. Hymenium filling almost the entire fruit-body, about 230 μ thick. Hypothecium very thin, not continuous, of isodiametric cells 3.5–7.5 μ diameter. Flesh very thin, of subglobular or oblong cells 7–17 μ long, hyaline. Excipulum about 15 μ thick, of more or less angular, isodiametric or oblong, rather thick-walled cells 10–30 × 6–15 μ (textura angularis) with pale brownish or greenish-yellow walls. Asci clavate, slightly curved, tapering downwards into a short base, rounded above, 230–320 × 29–32 μ, 8-spored, the wall deep blue in Melzer's reagent. Ascospores biseriate, ellipsoid, at first hyaline, then violet, finally often brownish, (17.5–)19–23(–24) × 10–12(–13) μ, smooth or extremely fine granular, with unilateral mucilaginous substance. Paraphyses simple or branched, with few septa, filiform, 2–3 μ thick, not enlarged upwards, hyaline, embedded in abundant yellowish-green mucus.

On dung of horse, hare and rabbit, also on rotting leaves of hop.

ETYMOLOGY.—From Latin, mancus, defective, imperfect.

SPECIMENS EXAMINED.—**France**: *Meslin*, Caen, Calvados, 4.IX.1938 (PC-A2327, PC-A2364).
Germany: *Staritz*, near Ziebigk – Dessau, IX.1907 (S-A548); *Sydow*, Lichterfelde near Berlin, VIII.1887, *in* Myc. march. 1578 (*A. glaber*, BM, HBG, K, S); *Sydow*, Lichterfelde near Berlin, IX.1892, *in* Myc. march. 3676 (*A. mancus*, BM, HBG, S); *Sydow*, *s. loc.*, 3.X.1892 (lectotype of *A. mancus*, S-A678).

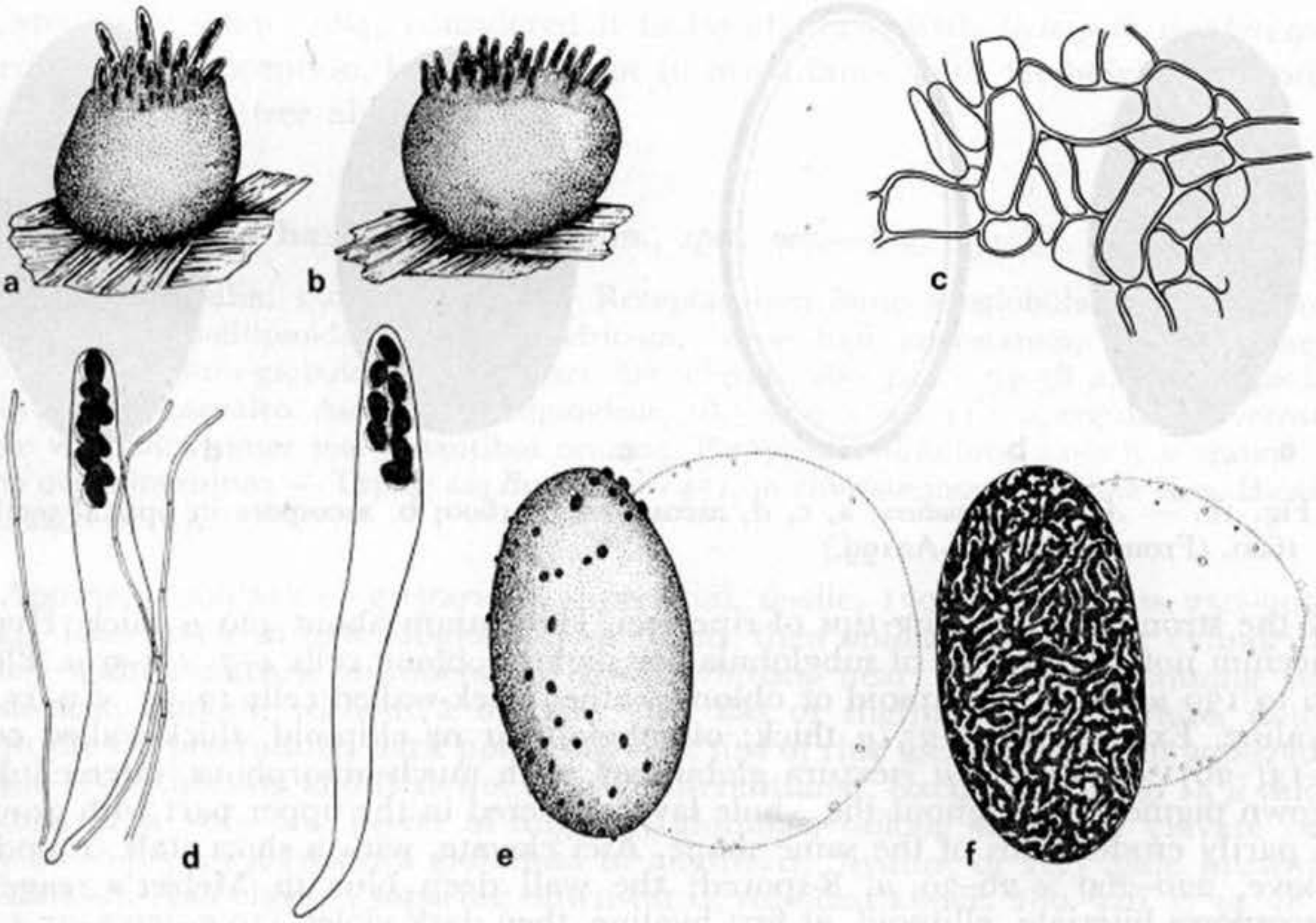


Fig. 15. — *Ascobolus mancus:* a, b, habit of fruit-bodies × 50; c, texture of excipulum seen from outside × 600; d, asci and paraphyses × 175; e, f, ascospores × 1600. (From living material, Netherlands.)

Canada: *Cain*, New Durham, Brant Co., Ontario, 24.V.1930 (TRTC-A2162, TRTC-A2173, NY-A1340).
U.S.A.: *Thaxter, s. loc.* (probably Maine), II.1900 (FH-A3145).

Obviously this is closely related to *A. elegans*, from which it differs only in the size of the ascospores.

8. Ascobolus boudieri Quél.—Fig. 16; Pl. 5, fig. B

Ascobolus leveillei Boud. *in* Annls Sci. nat. (Bot.) V **10**: 225 *pl. 7 f. 16. 1869*; not *Ascobolus leveillei* Crouan, Fl. Finistere 57. 1867; nor *Ascobolus leveillei* Renny *in* J. Bot., Lond. **12**: 356 *pl. 154 fs. 1–5.* 1874. — *Ascobolus boudieri* Quél., Ench. Fung. 293. 1886 (name change); not *Ascobolus boudieri* Lort. *in* Bull. Soc. mycol. Fr. **30**: 223. 1914. — Type: represented by Boud. in Annls Sci. nat. (Bot.) V **10**: *pl. 7 f. 16.* 1869; type locality, near Paris, France.

Apothecia gregarious or closely crowded, superficial or semi-immersed, sessile, 0.3–0.6 mm diameter, 0.3–0.5 mm high. Receptacle globular or pyriform, at first closed, then irregularly opening at the top, often with a narrow base, rather dark brown; surface finely warted or furfuraceous, especially in the upper half; margin not very prominent but often apparently so because of the sharp colour-differences between excipulum and hymenium. Disk flat or convex, sulphur yellow, roughened

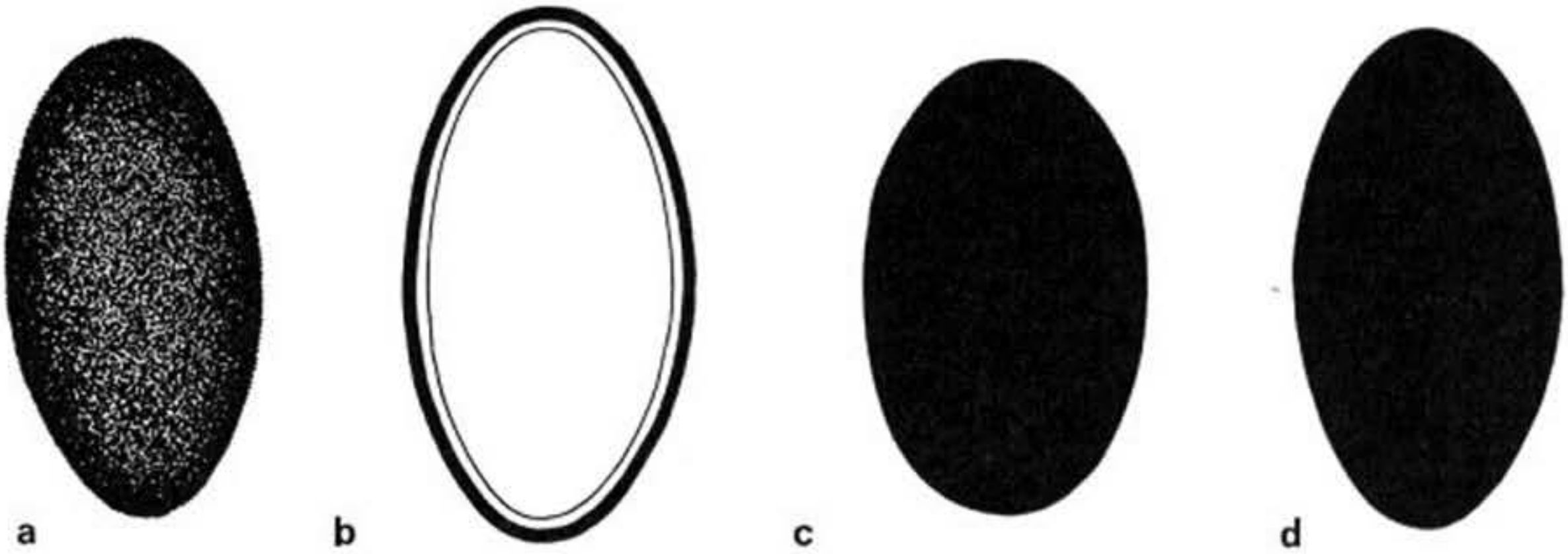


Fig. 16. — *Ascobolus boudieri:* a, c, d, ascospores × 1600; b. ascospore in optical section × 1600. (From *Hertier* PC-A2199.)

by the strongly protruding tips of ripe asci. Hymenium about 220 μ thick. Hypothecium not continuous, of subglobular or slightly oblong cells 4–7 × 4–9 μ. Flesh up to 130 μ thick, of ellipsoid or oblong, rather thick-walled cells 12–35 × 9–15 μ, hyaline. Excipulum 13–25 μ thick; of subglobular or ellipsoid, thick-walled cells 7–13(–26) × 5–8(–20) μ (textura globulosa), with much amorphous, intercellular, brown pigment throughout the whole layer, covered in the upper part with groups of partly eroded cells of the same shape. Asci clavate, with a short stalk, rounded above, 220–260 × 26–30 μ, 8-spored; the wall deep blue in Melzer's reagent. Ascospores biseriate, ellipsoid, at first hyaline, then dark violet, (19.5–)20.5–25.5 × (10–)11.5–13 μ, smooth or extremely fine granular, with lateral mucilaginous substance. Paraphyses simple, septate, filiform, 1.5–2.0 μ thick, not enlarged at the tip, hyaline, embedded in abundant sulphur yellow mucus.

On dung of cow, horse, hare, rabbit; but also on mushroom compost, on rotten wood and on mud from a manure-pit.

Etymology.—After the great French mycologist, Mr. J. L. É. Boudier.

Illustrations.—Boudier *in* Annls Sci. nat. (Bot.) V **10**: *pl. 7 f. 16.* 1869 (*A. leveillei* Boud.).

Specimens examined.—**Great Britain**: *Arbuthnot*, Isle of Rhum, Inverness-shire, Scotland, II.1962 (L); *Currey*, s. loc., VIII.1855 (BM-A2994); *Pelengbridge*, *s. loc.*, 18.I.1935 (K-A2462); *Soppitt*, Skircoat Moor, Halifax, 4.XI.1898 (K-A2460, K-A2461, NY-A1337).

Netherlands: *van Brummelen 1993*, Horst, Limburg, 5.I.1967 (L).

Belgium: *Mouton*, Bois de Dolembreux, IX (BR-A322).

France: *Boudier*, Presles near Paris, 1898 (FH-A3144); *Boudier*, Carnelle, X.1899 (PC-A2198); *Hertier*, Bois de Verrières, IX.1899 (PC); *Lamy* (Desmazières 639), Sainte-Claire, near Limoges, *s. dat.* (*A. prophyrosporus*, BM-A2850, FH-A3199, K-A1975, PC-A2322, PC-A2354); *Meslin*, Poligny, Calvados, 5.IV.1939 (PC).

Czechoslovakia: *Petrak*, Mähr.-Weisskirchen (= Hranice), Olspitz, VIII. 1925, *in* Fl. Boh. Mor. ser. 2, 2150 (*A. glaber*, BM, BPI, E, M, S); *Petrak*, Mähr.-Weisskirchen (= Hranice), 1924 (M11501, ZT-A131); *Petrak*, Mähr.-Weisskirchen (= Hranice), VIII.1927 (ZT-A105); *Petrak*, Olspitz near Mähr.-Weisskirchen (= Hranice), IX.1930, *in* Myc. gen. 507 (*A. glaber*, BM, CMI, E, G, M, S, UPS, ZT).

This species, which is only known from Europe, is clearly characterized by the dark brown, partly warted or furfuraceous receptacle and the presence of sulphur yellow hymenial mucus.

Montagne (1836: 284) considered it to be identical with *Octospora porphyrospora* Hedw. This conception, however, is not in accordance with Hedwig's description and illustrations (see also p. 234).

9. **Ascobolus hawaiiensis** Brumm., *spec. nov.*—Fig. 17; Pl. 3, fig. G, H

Apothecia sessilia, 150–250 μ diam. Receptaculum initio subglobulare vel ovoideum, deinde oblongo-ellipsoideum vel cylindricum, saepe basi angustatum, albidum, laeve. Excipulum textura globulosa vel angulari. Asci clavati, 280–320 × 34–38 μ, 8-spori, pariete iodo saturate caeruleo. Ascosporae ellipsoideae, 18.5–21.0 × 9.8–11.5 μ, regulariter verruculosae vel punctis inter sese distantibus ornatae. Paraphyses filiformes, 2.0–2.5 μ crassae. In fimo ovino invenitur. — Typus: *van Brummelen 1451*, in clivitate montis Mauna Kea, Hawaii, alt. 2400 m (L).

Apothecia solitary or gregarious, superficial, sessile, 150–250 μ across, 250–300 μ high. Receptacle at first subglobular or ovoid, then oblong-ellipsoid or cylindrical, often with a narrow or obconical base, whitish, near the base becoming pale brownish, smooth, without a margin. Disk flat or slightly convex, white, dotted with the far protruding, dark purplish-violet tips of ripe asci. Hymenium 200–230 μ thick. Hypothecium and flesh not clearly differentiated. Excipulum up to 15 μ thick; of one or a very few layers of angular, globular, oblong or rarely clavate cells 6.5–20 × 6.5–13 μ (textura globulosa or angularis), hyaline or very pale brownish or pinkish. Asci clavate, tapering downwards, rounded above, 280–320 × 34–38 μ,

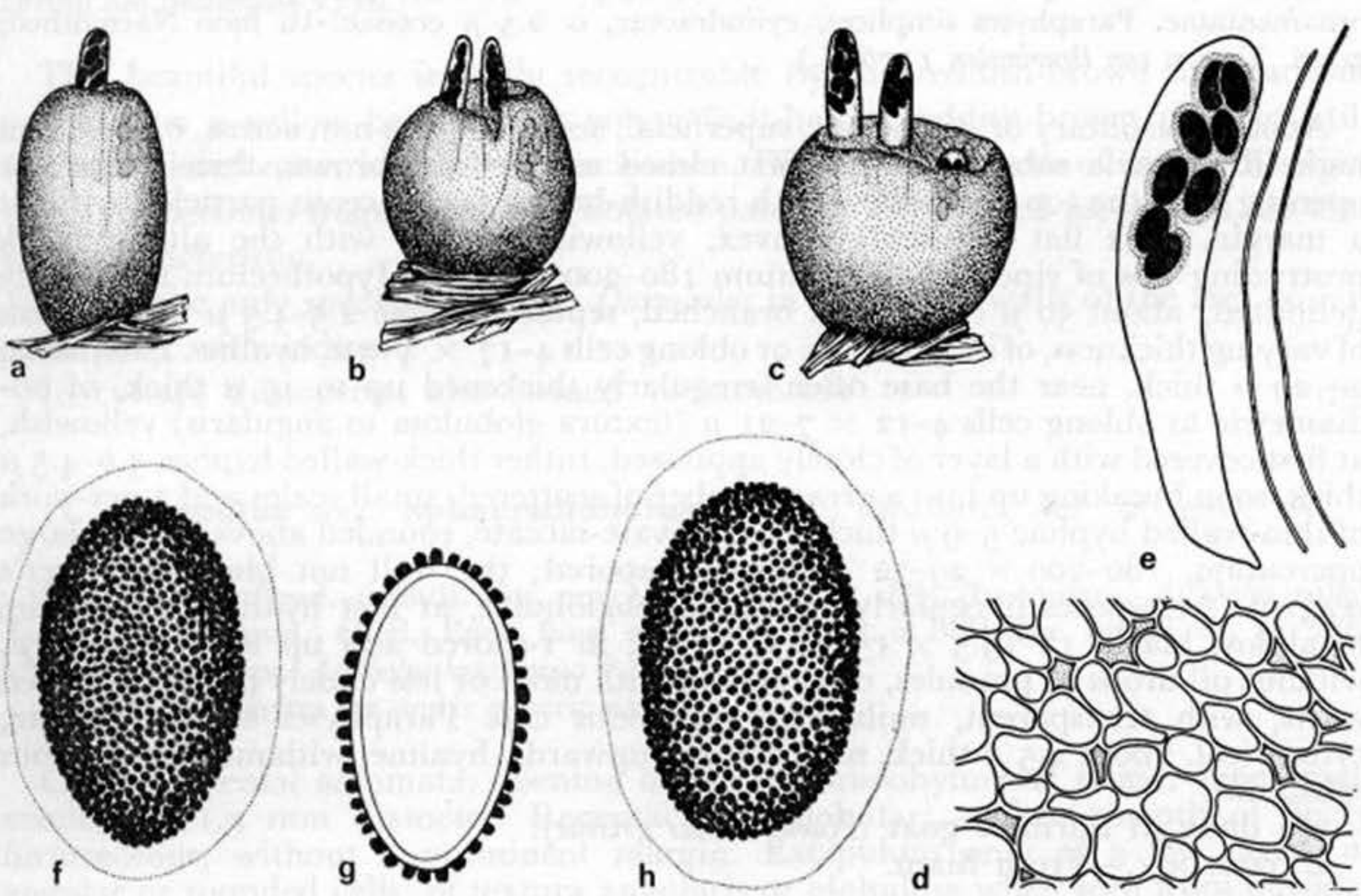


Fig. 17. — *Ascobolus hawaiiensis:* a–c, habit of fruit-bodies × 80; d, texture of excipulum seen from outside × 600; e, ascus and paraphyses × 275; f, h, ascospores × 1600; g, ascospore in optical section × 1600. (From holotype, slides, L.)

8-spored; the wall deep blue in Melzer's reagent. Ascospores biseriate, ellipsoid, at first hyaline, then purplish-violet, finally purplish-brown, 18.5–21 × 10–11.5 μ, ornamented with a regular pattern of very fine warts or isolated punctae; pigment in a layer of uniform thickness; surrounded by a thick gelatinous envelope. Paraphyses simple or branched, filiform, with few septae, 2.0–2.5 μ thick, not enlarged above, hyaline, without mucus.

Known only from dung of sheep.

ETYMOLOGY.—After Hawaii.

SPECIMEN EXAMINED. — **Hawaii**: *van Brummelen 1451*, on sheep dung, Puuhookomo, Mauna Kea, 10.V.1962, substratum sent by Dr. H. O. Sleumer (type of *A. hawaiiensis*, L).

Apparently this is a very rare species. It is sufficiently characterized by the very small fruit-bodies and the warted or punctate ascospores. Like in *A. immersus* the ascospores are surrounded on all sides by a thick gelatinous layer.

10. **Ascobolus siamensis** Brumm., *spec. nov.*—Fig. 18; Pl. 3, fig. I, Pl. 4, figs. A–G, Pl. 5, fig. A

Apothecia sessilia, 0.3–0.9 mm diam. Receptaculum subglobulare, primo clausum et rubro-brunneum, denique prope apicem irregulariter fissum, luteum, particulis rubro-brunneis furfuraceis adspersum, margine nullo. Discus luteus. Excipulum textura globulosa usque angulari. Asci clavato-saccati, 180–200 × 29–32 μ, usque ad 8-spori, pariete iodo haud caerulescente. Ascosporae subglobulares, 17–19.5 × 15–16.5(–17) μ, verrucis rotundis ornamentatae. Paraphyses simplices, cylindraceae, c. 2.5 μ crassae. In fimo Naemorhedi grisei. Typus: *van Brummelen 1776* (L).

Apothecia solitary or gregarious, superficial, sessile 0.3–0.9 mm across, 0.3–0.6 mm high. Receptacle subglobular, at first closed and reddish-brown, then irregularly opening near the top and yellow with reddish-brown furfuraceous particles, without a margin. Disk flat to slighly convex, yellowish, dotted with the almost black protruding tips of ripe asci. Hymenium 180–200 μ thick. Hypothecium not clearly delimited, about 30 μ thick, with branched, septate hyphae 2.5–4.5 μ thick. Flesh of varying thickness, of isodiametric or oblong cells 4–17 × 4–9 μ, hyaline. Excipulum 20–29 μ thick, near the base often irregularly thickened up to 45 μ thick, of isodiametric to oblong cells 4–12 × 7–21 μ (textura globulosa to angularis) yellowish, at first covered with a layer of closely appressed, rather thick-walled hyphae 3.0–4.5 μ thick, soon breaking up into a great number of scattered, small scales and a net-work of thin-walled hyphae 5–9 μ thick. Asci clavate-saccate, rounded above, with a large operculum, 180–200 × 29–32 μ, up to 8-spored; the wall not blue in Melzer's reagent. Ascospores irregularly biseriate, subglobular, at first hyaline, then violet to almost black, 17–19.5 × 15–16.5(–17) μ, in 1-spored asci up to 31.5 × 29 μ, without oil drops or granules, ornamented with more or less closely placed, rounded warts, with transparent, unilateral, gelatinous cap. Paraphyses simple, septate, cylindrical, about 2.5 μ thick, not enlarged upwards, hyaline, without mucilaginous substance.

On dung of Burmese goat (*Naemorhedus griseus*).

ETYMOLOGY.—From Siam.

SPECIMEN EXAMINED.—**Thailand**: *van Brummelen 1776*, cultured on dung of Burmese goat (collected by Dr. H. O. Sleumer), limestone massif of the Pha Nok Khao, ca. 800 m, South of Loey, Prov. Udawn, 13.XI.1963 (type of *A. siamensis*, L).

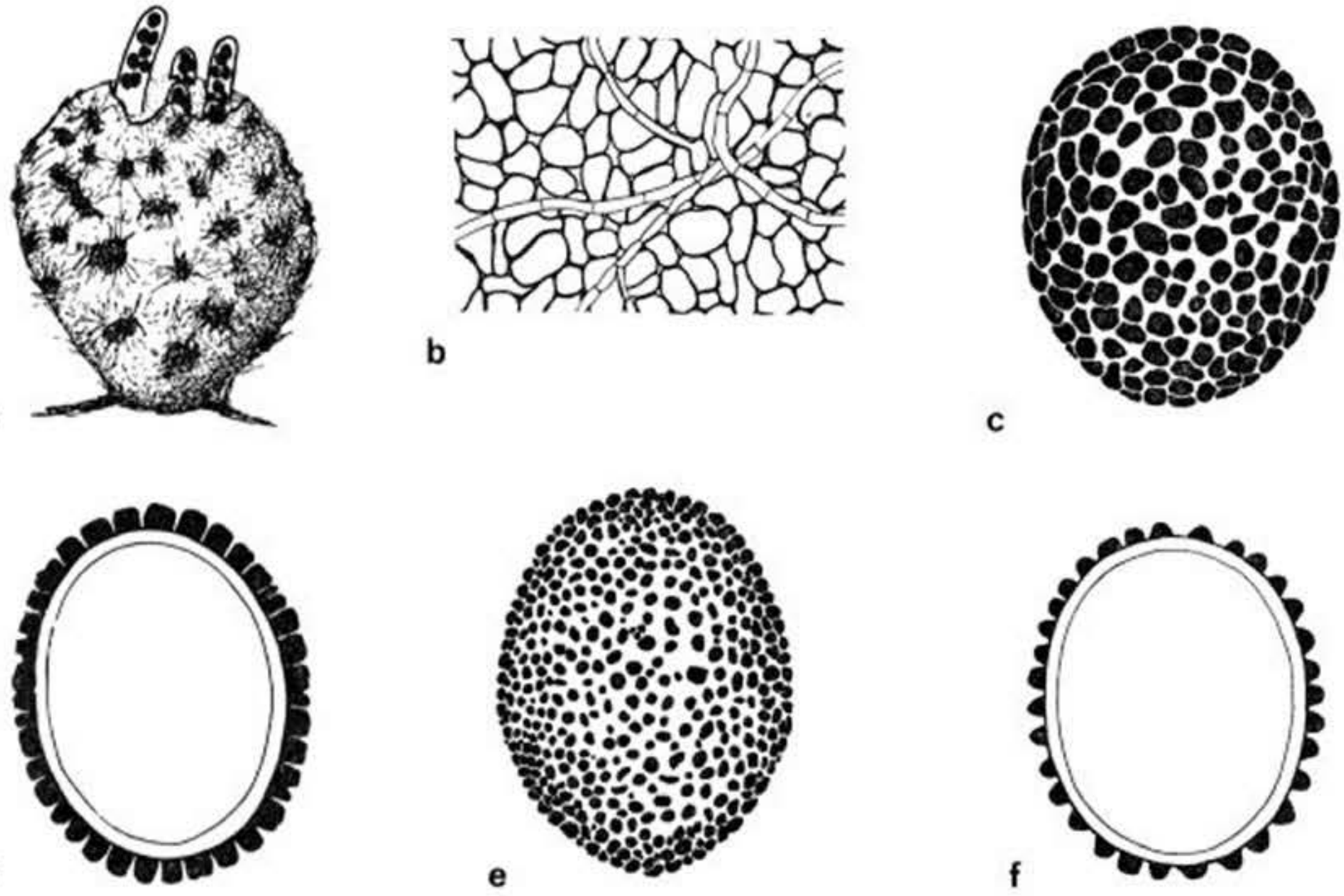


Fig. 18. — *Ascobolus siamensis:* a, habit of fruit-body × 50; b, texture of excipulum seen from outside × 160; c, e, ascospores × 1600; d, f, ascospores in optical section × 1600. (From *van Brummelen 1776.*)

This beautiful species is easily recognizable by the reddish-brown furfuraceous particles on a yellow base. In the young fruit-bodies reddish-brown particles still form the closed outer layer of the excipulum. During the growth of the fruit-bodies this layer becomes fragmented into isolated patches. The warted ascospores are also very characteristic.

This is the only species of section *Dasyobolus* in which the walls of the asci do not stain blue with iodine.

In culture this species also formed 'cleistothecia'.

II. **Ascobolus** sect. **Sphaeridiobolus** (Boud.) Brumm., *stat. & comb. nov.*

Sphaeridiobolus Boud. *in* Bull. Soc. mycol. Fr. **1**: 108. 1885 (basionym). *Ascobolus* subg. *Sphaeridiobolus* (Boud.) Quél., Ench. fung. 295. 1886; Boud. *in* Bull. Soc. mycol. Fr. **14**: 126. 1898. — Monotype: *Ascobolus hyperboreus* P. Karst.

For other synonyms see under generic name (p. 61).

Cleistohymenial ascomata, opening in the late mesohymenial phase; superficial, sessile; 0.3–1.5 mm diameter. Receptacle subglobular; surface smooth of finely furfuraceous; without a prominent margin. Excipulum only of a few layers of angular or rounded cells; of textura angularis or globulosa when seen from outside. Asci clavate-cylindric or cylindric-clavate; the wall staining blue with iodine. Ascospores 8, multiseriate or irregularly disposed; spherical. Episporium with rounded warts.

Fimicolous, rarely on owl-pellets and rotten vegetable debris.

ETYMOLOGY.—From Greek, σφαιρα, ball, globe; -ίδιον, diminutive suffix; and βαλλω, to throw.

TYPE: *Ascobolus hyperboreus* P. Karst. [= *A. brassicae* Crouan].

Of the species of *Ascobolus* with spherical ascospores, only two species belong to this section (see p. 62). Apart from the spherical ascospores, this section is mainly characterized by the developmental type of the fruit-bodies and the round-warted episporium. On account of the developmental type of the fruit-bodies, *Ascobolus* sect. *Sphaeridiobolus* occupies an intermediate position between the sections *Dasyobolus* and *Ascobolus*. Such a position is also supported by other characters, like the form of receptacles, asci, and paraphyses, and the development of flesh and excipulum.

KEY TO THE SPECIES OF ASCOBOLUS SECT. SPHAERIDIOBOLUS

1. Apothecia 0.5–1.5 mm diameter. Receptacle finely furfuraceous, rarely smooth. Ascospores 10.5–13.5 μ diameter. Episporium of small, isolated, rounded warts
11. *Ascobolus brassicae*, p. 90

1. Apothecia 0.3–0.5 mm diameter. Receptacle smooth. Ascospores 17–20 μ diameter (pigment included). Episporium consisting of a rather regular pattern of semi-globular knobs 1.8–4.0 μ diameter, together with very fine rounded warts only 0.2–0.4 μ diameter . . . . . 12. *Ascobolus nodulosporus*, p. 92

11. ASCOBOLUS BRASSICAE Crouan—Fig. 19; Pl. 4, fig. H, Pl. 5, figs. C, D

Ascobolus brassicae Crouan *in* Annls Sci. nat. (Bot.) IV **7**: 174 *pl. 4 C fs. 9–14*. 1857. — *Boudiera brassicae* (Crouan) Sacc., Syll. Fung. **8**: 513. 1889. — *Sphaeridiobolus brassicae* (Crouan) Boud., Hist. Class. Discom. Eur. 74. 1907. — Type: *Crouan*, on rotten cabbage-stem, in the neighbourhood of Brest, France (CONC-A2401).

Peziza murina Fuck., Fungi rhen. No. 1597. 1865. — *Plicaria murina* (Fuck.) Fuck. *in* Jb. nassau. Ver. Naturk. **23–24**: 326. 1870. — *Phaeopezia* (*Crouaniella*) *murina* (Fuck.) Sacc. *in* Bot. Cbl. **17**: 218. 1884; (*Eu-Phaeopezia*) Sacc., Syll. Fung. **8**: 471. 1889. — *Crouaniella murina* (Fuck.) Lamb., Fl. mycol. Belg., Suppl. **I**: 320. 1887. — *Humaria murina* (Fuck.) Quél., Ench. Fung. 290. 1886. — *Sphaeridiobolus albofuscus* var. *murinus* (Fuck.) Boud., Hist. Class. Discom. Eur. 74. 1907. — *Sphaeridiobolus murinus* (Fuck.) Moser *in* Gams, Kleine Krypt.-Fl. **IIa**: 116. 1963 (illegitimate name: incomplete reference). — Type distribution: *Fuckel*, Fungi rhen. No. 1597.

Ascobolus caninus Fuck. *in* Hedwigia **5**: 3 *f. 1*. 1866; not *Ascobolus caninus* Auerswald *in* Hedwigia **7**: 52. 1868. — *Boudiera canina* (Fuck.) Schroet. *in* Krypt.-Fl. Schles. (ed. Cohn) **3** (2): 55. 1893. — Type: not known to be in existence, represented by Fuckel l.c.; type locality, near Oestrich, Germany.

Peziza albofusca Crouan, Fl. Finistère 54. 1867. — *Ascobolus albofuscus* (Crouan) Quél., Ench. Fung. 295. 1886. — *Sphaeridiobolus* (Crouan) Boud., Hist. Class. Discom. Europe 74. 1907. — *Phaeopezia albofusca* (Crouan) Sacc., Syll. Fung. **8**: 472. 1889. — Holotype: *Crouan*, on dung of wood-mouse in a marsh, Gouesnou near Brest, France, 13.X.1854 (CONC-A2431).

Ascobolus hyperboreus P. Karst. *in* Notis. Sällsk. Fauna Fl. fenn. Förh. **11**: 204. 1870. — *Sphaeridiobolus hyperboreus* (P. Karst.) Heimerl *in* Jber. k.k. Ober-Realschule Bez. Sechshaus

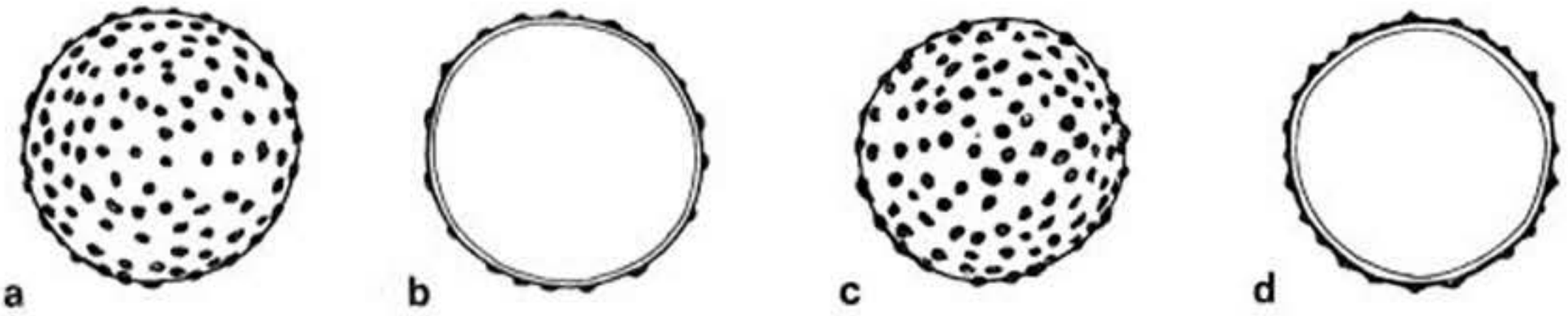


Fig. 19. — *Ascobolus brassicae:* a, c, ascospores; b, d, id. in optical section. (All × 1600; a, b, from type of *A. brassicae* CONC-A2401; c, d, from *Hertier*, PC-A2221.)

Wien **15**: 12. 1889. — *Boudiera hyperborea* (P. Karst.) Sacc., Syll. Fung. **8**: 513. 1889. — Types: *P. Karsten*, on dung of lemming, near Kola, Finland. 27.VII.1861 (H-A2746).

Ascobolus niveus Quél. *in* Bull. Ass. franç. Avanc. Sci. **9**: 14 *pl. 9 f. 18.* 1881; Quél. *in* Rev. mycol. **4**: 63. 1882; not *Ascobolus niveus* Fuck. *in* Hedwigia **5**: 4. 1866. — *Sphaeridiobolus hyperboreus* var. *niveus* (Quél.) Boud., Hist. Class. Discom. Eur. 73. 1907. — *Sphaeridiobolus niveus* (Quél.) Grelet *in* Rev. Mycol. **9**: 32. 1944. — Type: not known to be in existence, represented by Quélet *in* Bull. Ass. franç. Avanc. Sci. **9**: 14 *pl. 9 f. 18.* 1881. — Type locality: Doubs, France.

[*Ascobolus boudieri* Renny in litt. ad Phill. cum icon. —] *Ascophanus boudieri* Renny *apud* Phill., Brit. Discom. 304. 1887. — *Cubonia boudieri* (Renny apud Phill.) Sacc., Syll. Fung. **8**: 528. 1889. — Type: represented by a copy of Renny's drawing by Phillips (BM). — Type locality: Hereford, British Isles.

Boudiera kirschsteinii P. Henn. *in* Verh. bot. Ver. Prov. Brandenburg **40**: XXVI. 1898. — *Sphaeridiobolus kirschsteinii* (P. Henn.) Boud., Hist. Class. Discom. Eur. 73. 1907. — Type: *Kirschstein*, on dung of mouse, Dammsche Wiesen, Rathenow, Germany, V.1898 (S-A516).

Excluded.—*Sphaeridiobolus hyperboreus* (P. Karst.) Heimerl sensu Heimerl *in* Rehm, Ascom. No. 1014. 1891 = *Ascodesmis microscopica* (Crouan) Seaver sensu Crouan (non Seaver).

Apothecia gregarious or closely crowded, superficial, sessile, 0.5–1.5 mm diameter (according to Crouan 1–3 mm), 0.3–0.6 mm high. Receptacle at first closed and spherical, then opening at the top and hemispherical, lenticular or slightly obconical, finally often scutellate on a small base, white or pale yellowish-brown, very finely furfuraceous, rarely smooth, with a very prominent membranaceous or crenulate margin. Disk flat, white, then pale flesh-colour or brownish, dotted with the pale brownish-violet tips of ripe asci. Hymenium up to 200 μ thick. Hypothecium not clearly differentiated. Flesh 140–200 μ thick, of rather broad hyphae with ellipsoid or elongated, swollen cells, 10–28 × 6–11 μ, hyaline. Excipulum about 20 μ thick near the margin, up to 50(–110) μ near the base, of isodiametric and ellipsoid, often somewhat flattened or angular cells 15–46(–70) × 9–30 μ (textura angularis or globulosa); in the furfuraceous particles and at the extreme margin globular or pear-shaped cells 6–18(–26) μ diameter; colourless. Asci at first cylindrical, then cylindric-clavate, with a rather thick base, rounded above, 145–229 × 22–30 μ, 8-spored; the wall blue in Melzer's reagent. Ascospores at first uniseriate, finally multiseriate or irregularly disposed, brownish-violet, 10.5–13.5(–15) μ diameter, ornamented with small, isolated, round or angular warts 0.3–0.7 μ diameter, without any gelatinous substance. Paraphyses branched, especially near the tip, septate, filiform-cylindrical, 2.5–3.5 μ thick, not or slightly enlarged up to 6 μ at the tip, embedded in colourless mucus.

On dung of fox, lemming, rabbit, hare, and mouse, also on owl-pellets and rotten stems of cabbage.

Etymology.—From *Brassica*.

Illustrations.—Crouan *in* Annls Sci. nat. (Bot.) IV **7**: *pl. 4 C fs. 9–14.* 1857; Fuckel *in*

Hedwigia **5**: *pl. 1 f. 1.* 1866 (*A. caninus* Fuck.); Le Gal *in* Annls Sci. nat. (Bot.) XI **8**: 241 *f. 64A.* 1947 (*Sphaeridiobolus hyperboreus*); Le Gal *in* Annls Sci. nat. (Bot.) XII **1**: 466 *f.7.* 1961; Quélet *in* Bull. Ass. franç. Avanc. Sci., Congr. Reims 1880: *pl. 9 f. 18.* 1880 (*A. niveus* Quél.).

SPECIMENS EXAMINED.— **Finland**: *Karsten*, near Kola, 27.VII.1861 (as *A. lapponicus*, also containing the type of *A. hyperboreus*, H-A2746).

Great Britain: Berkeley, *s. loc.*, 9.III.1874 (K-A1993); *Harper*, Sherburn Hill, Co. Durham, 1.I.1962 (L); *Travis 209*, Liverpool, *s. dat.* (BM); *Travis 356*, Walton, Liverpool, 3.II.1929 (BM).

Netherlands: *de Groot*, *s. loc.*, 6.I.1946 (icon., L-A3253).

France: *Crouan*, on rotten cabbage-stem, in the neighbourhood of Brest, France (holotype of *A. brassicae*, CONC-A2401); *Crouan*, on dung of wood-mouse in a marsh, Gouesnou near Brest, 13.X.1854 (holotype of *Peziza albofusca*, CONC-A2431); *Crouan*, *s. loc.* (probably near Brest), 18.II.1864 (*A. vulpinus* Crouan, unpublished name, CONC-A2377); *Hertier*, Ecouen, II.1895 (PC-A2221, PC-A2222, S-A558).

Denmark: unknown collector ("*E.R.*"), S. Tokkekøb Hegn, 7.IV.1919 (CP-A1407).

Germany: *Fuckel*, near Oestrich, *s. dat.*, *in* Fungi rhen. 1597 (*Peziza murina*, type distribution, BM, GRO, K); *Kirschstein*, Dammsche Wiesen, Rathenow, V.1898 (type of *Boudiera kirschsteinii*, S-A516); *Schroeter*, near Rastatt, 3.II.1873 (*A. sphaerospermus* Schroet., unpublished name, BRSL-A1709 figure, BRSL-A1712).

Poland: *Schroeter*, near Frankenstein, 4.XI.1883 (BRSL).

Czechoslovakia: *Svrček & Vacek*, Zdice, Bohemia, 1.V.1949 (PR); *Velenovský*, Mnichovice, Hubáčhov, Bohemia, X.1927 (PR 150453); *Velenovský*, Mnichovice, X.1933 (PR 153000, PR 150452).

U.S.A.: California: *Smiley*, *s. loc.*, IV.1915 (culture, FH-A3099). Maine: *Thaxter*, Kittery Pt., II.1894 (FH-A3098); *Thaxter*, Kittery Pt., *s. dat.* (FH-A3100).

Although this species has been collected from different substrata it is most characteristic of droppings of small rodents.

It is sufficiently characterized by the very long asci and the spherical ascospores with isolated, rounded warts.

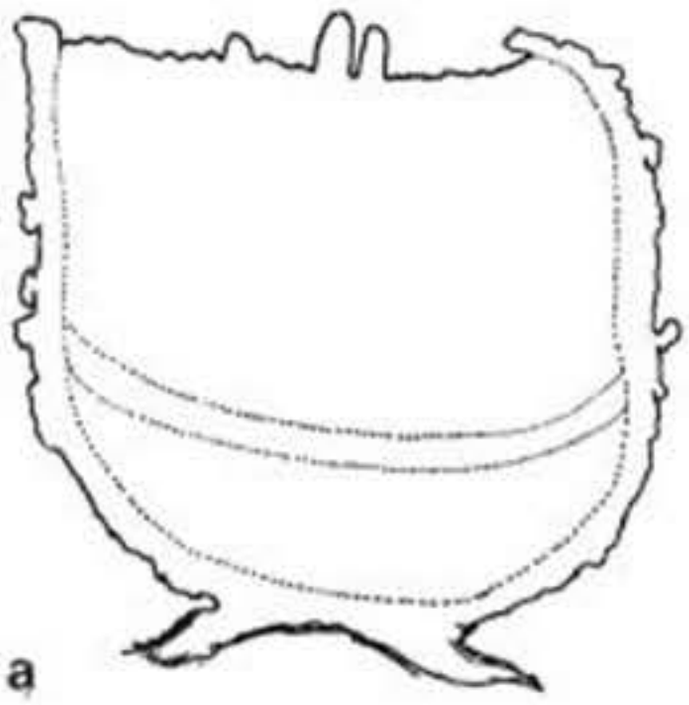
Known from Europe and North America.

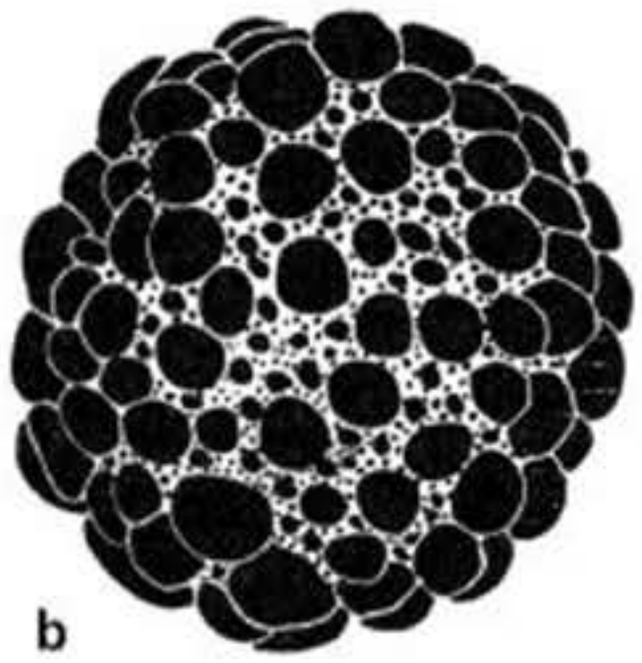
12. **Ascobolus nodulosporus** Brumm., *nom. nov.*—Fig. 20; Pl. 4, fig. I, Pl. 5, fig. E

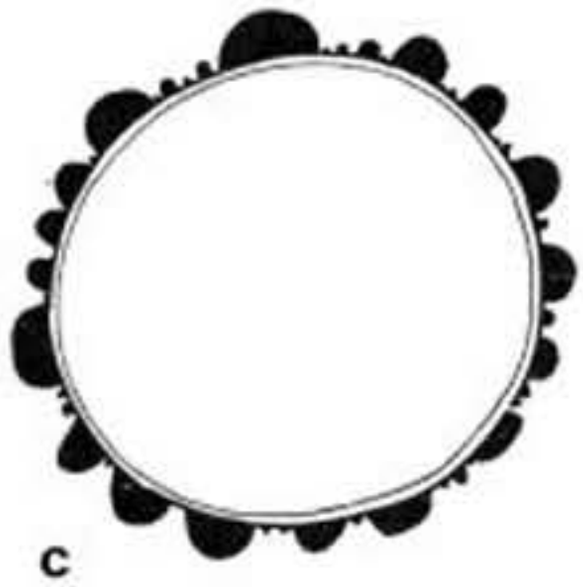
Boudiera marginata Phill. & Harkn. *in* Bull. Calif. Acad. Sci. **1**: 25. 1884 (basionym); not *Ascobolus marginatus* Schum., Enum. Pl. Saell. **2**: 437. 1803 (devalidated name); nor *A. marginatus* Pat. *in* Rev. mycol. **4**: 211. 1882; nor *A. marginatus* Mass. in Grevillea **22**: 98. 1893. — Type: *Harkness No. 2985* (BM).

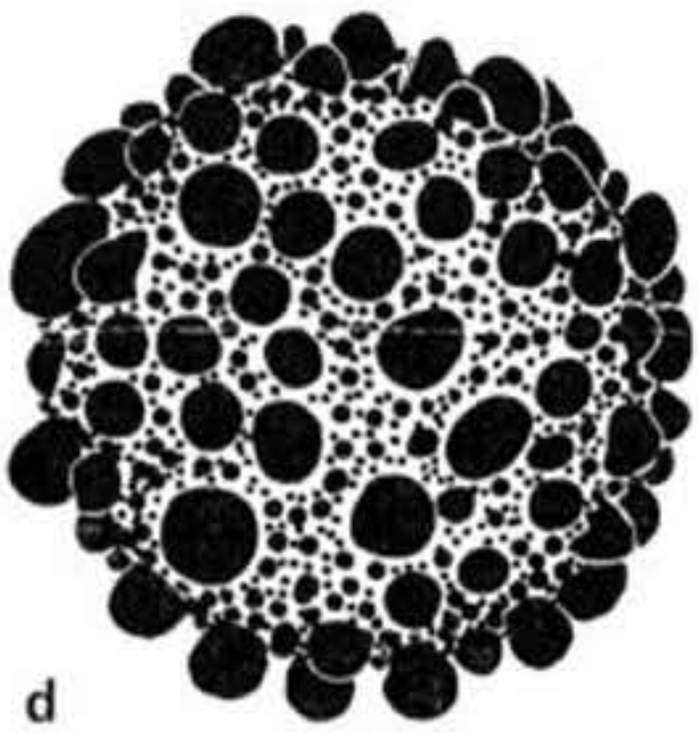
Apothecia sessilia, 0.3–0.5 mm diam. Receptaculum primo globulare, denique hemisphaericum, basi angustatum, pallide brunneum vel sordide luteo-brunneum, laeve, margine serratum. Excipulum textura angulari. Asci clavato-cylindracei, 235–275 × 23–32 μ, 8-spori, pariete iodo pallide caerulescente. Ascosporae sphaericae, (16–) 17–19.5 μ diam. (pigmento incluso), verrucis nodulosis sat regularibus, 1.8–4.0 μ diam., verruculisque rotundatis 0.2–0.4 μ diam. ornatae. Paraphyses ramosae, filiformi-cylindricae, c. 2 μ crassae, apice paulo dilatatae. In fimo muris ratti. Typus: *Harkness 2985* (BM).

Apothecia gregarious or crowded, superficial, sessile, 0.3–0.5 mm across, about 0.3 mm high. Receptacle at first spherical, then hemispherical, on a small base, pale brownish or dirty yellowish-brown, smooth, margin serrate. Disk flat, roughened by the protruding asci. Hymenium about 240 μ thick. Hypothecium not clearly









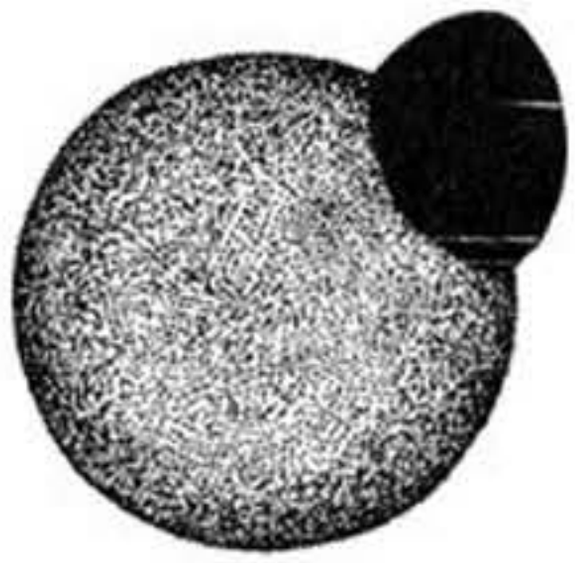


Fig. 20. — *Ascobolus nodulosporus:* a, diagrammatic section of fruit-body × 110; b, d, normal ascospores × 1600; c, ascospore in optical section × 1600; d, very rare, abnormal type of ascospore × 1600. (From type.)

differentiated. Flesh 85–120 μ thick, in the upper part of thin-walled, isodiametric or elongated, angular cells 7–20(–46) × 6–12 μ, in the lower part of remarkably thick-walled, isodiametric cells 5–13 μ diameter (walls up to 3 μ thick), hyaline. Excipulum 19–33 μ thick, of thick-walled, spherical, angular, often somewhat elongated cells 7–20 × 6–14 μ (textura angularis), hyaline. Asci clavate-cylindrical, rounded at the apex, 235–275 × 23–32 μ, 8-spored, the wall pale blue in Melzer's reagent. Ascospores uniseriate, finally irregularly biseriate, spherical, at first hyaline, then purple, finally purplish-brown, (16–)17–19.5 μ diameter (pigment included), ornamented with a rather regular pattern of knobs 1.8–4.0 μ diameter and very fine rounded warts only 0.2–0.4 μ diameter; pigment in a rather thick layer; primary spore-wall very thick (up to 2.6 μ), especially when immature. Paraphyses branched, septate, filiform-cylindrical, about 2 μ thick, at the tip slightly enlarged up to 5 μ, hyaline.

Known only from dung of rat.

ETYMOLOGY.—From Latin, nodulus, a small knot or knob and spora, a seed: with spores possessing small knobs.

SPECIMENS EXAMINED.—**U.S.A.**: California: *Harkness 2985*, probably on rat dung (not on rabbit dung as cited), s. loc., VI. 1882 (type of *Boudiera marginata*, BM); *Smiley*, on dung of woodrat, Stanford (FH-A3105).

A very rare species related to *A. brassicae*. It can be easily distinguished from the latter by the colour of the receptacle, the size of the ascospores, and the ornamentation of the episporium.

III. Ascobolus sect. Ascobolus

For synonymy see under generic name (p. 61).

Cleistohymenial ascomata, opening in the early or mid-mesohymenial phase; superficial, sessile or stalked; 0.3–12 mm diameter. Receptacle at first subglobular or pyriform, then obconical, cup- or saucer-shaped, finally often flattened; surface smooth, furfuraceous, rarely with divaricating hyphae or secondary mycelium. Asci cylindric-clavate; with rounded or slightly truncate apex. Ascospores 8; at first often uniseriate, finally biseriate; ellipsoid, fusoid, subglobular or globular; often with unilateral gelatinous mass. Episporium with a pattern of subparallel anastomosing crevices, with a pattern of irregular, short, curved non-anastomosing crevices, with a net-work of crevices, with longitudinal ridges of pigment, coarsely warted, granular or almost smooth. Paraphyses slender, cylindrical, often with swollen ends; often embedded in a colourless, yellowish or yellowish-green, mucilaginous substance, often containing crystals.

Especially fimicolous, but also foliicolous, lignicolous, terrestrial, and pyrophilous.

The fruit-bodies of most species in this section reach a diameter of one to several millimeters. These dimensions are reached by interstitial growth of both the hymenial elements and the flesh as well as the excipulum. An appreciable activity of a marginal growing zone could not be established in any of the species.

In some cultures of *Ascobolus albidus*, *A. furfuraceus*, and *A. roseopurpurascens* sometimes fruit-bodies were found with only a very few (5–10) ripening asci. In such fruit-bodies the opening of the hymenium was retarded and occasionally even took place in the telohymenial phase. Also certain narrow forms of fruit-bodies of *A. albidus* may remind one of the fruit-bodies in *Ascobolus* sect. *Dasyobolus*. However, such rare, extremely small forms can be easily recognized as belonging to section *Ascobolus* by the form of the asci and the ornamentation of the episporium.

Within this section the species form a very gradual, continuous series. Beginning with *A. albidus* this series may be followed via a number of obligatory coprophilous, and a group of mainly foliicolous and xylophilous to exclusively terrestrial or pyrophilous species. In this series the components show a constant sequence in the degree of expression of certain characters. In the last members of the series the fruit-bodies tend to open earlier in the mesohymenial phase and the ascus-wall tends to stain less intensively blue with iodine than in the first members; while the episporial ornamentation gradually varies from a pattern of subparallel anastomosing striae, via a net-work of striae to a pattern of coarse warts. The terrestrial and pyrophilous species especially show a thick or very thick episporium. The series is too gradual to make a satisfactory subdivision of this section into subsections or series.

The position of only *Ascobolus carletonii* and *A. cainii* is still rather uncertain because of the diverging type of episporial ornamentation.

KEY TO THE SPECIES OF ASCOBOLUS SECT. ASCOBOLUS

1. Ascospores globular or subglobular:
   2. Ascospores globular; 11.5–13.5 μ diameter. Episporium with a pattern of subparallel, rarely anastomosing crevices . 23. *Ascobolus crosslandii*, p. 121
   2. Ascospores subglobular:
      3. Receptacle greenish-yellow, finely furfuraceous. Ascospores 16–19 × 13–16 μ (pigment included). Episporium very thick (2.5–3.0 μ); with a pattern of longitudinal, repeatedly anastomosing or reticulating crevices; with very prominent projections. On soil . . . . 42. *Ascobolus subglobosus*, p. 150
      3. Receptacle grass-green, 'hairy'. Ascospores 18–19 × 16–18 μ. Episporium of normal thickness; with fine, longitudinal anastomosing crevices. On dung cf. *Ascobolus strobolinus*, p. 239
1. Ascospores ellipsoid, fusiform-ellipsoid or fusoid:
   4. Episporium with a pattern of subparallel, anastomosing crevices, or with a pattern of irregular, short, non-anastomosing crevices; in old or over-ripe ascospores sometimes changing into a net-work of crevices (young episporium never smooth or granular):
      5. Episporium with very densely placed subparallel crevices (more than 12 crevices are visible at each view of the ascospore):
         6. Ascospores less than 15 μ long. Episporium with relatively broad transverse or oblique crevices . . . . . 22. *Ascobolus lineolatus*, p. 120
         6. Ascospores more than 20 μ long. Episporium with relatively narrow, about longitudinal crevices:
            7. Ascus-wall clearly blue in Melzer's reagent. Episporium not more than 1.0 μ thick. On dung . . . 17. *Ascobolus laevisporus*, p. 112
            7. Ascus-wall not or scarcely blue in Melzer's reagent. Episporium rather thick, up to 2.2 μ. On soil covered with algae 35. *Ascobolus demangei*, p. 139
      5. Episporium not with such a very dense pattern of crevices:
         8. Receptacle and disk white or whitish:
            9. Receptacle smooth, without a prominent margin. Ascospores 20–36 × 11–14 μ. Episporium with longitudinal occasionally anastomosing crevices or sometimes with short, more or less curved crevices 13. *Ascobolus albidus*, p. 100
            9. Receptacle finely furfuraceous, with a prominent margin. Ascospores 16–20 × 9–10 μ. Episporium with longitudinal anastomosing crevices . . . . . 24. *Ascobolus sacchariferus*, p. 122
         8. Receptacle and disk yellowish, greenish, brownish, vinaceous or purplish:
            10. Receptacle and disk yellowish-brown, brownish, vinaceous or purplish (beware of a covering of coloured ascospores!). Apothecia up to 2 mm diameter:
               11. Receptacle and disk vinaceous, pinkish-red, purplish or purplish-

brown; smooth or finely furfuraceous; with a clearly differentiated margin. Excipulum, when seen from outside, of textura epidermoidea. Vinaceous or purplish intercellular, amorphous pigment in the outer layers of the excipulum and among the tips of paraphyses present. Ascospores ellipsoid with blunt ends, 18–28 × 10–12 μ . . 14. *Ascobolus roseopurpurascens*, p. 103

11. Receptacle and disk yellowish-brown, brownish or blackish-brown; smooth; without a prominent margin. Excipulum, when seen from outside of textura angularis, only rarely in the lower parts of textura globulosa or epidermoidea. Intercellular amorphous pigment brownish if present:

12. Receptacle brownish-yellow to brown. Disk brownish-yellow. Accumulations of intercellular pigment lacking. Ascospores ellipsoid, 12.5–14.5 × 7–8.5 μ. Hymenial mucus yellow . . . . . 21. *Ascobolus minutus*, p. 118

12. Receptacle and disk brown or blackish-brown. Deposits of intercellular pigment in excipulum and hymenium. Ascospores oblong-ellipsoid, (18–)20–36(–39) × (9–)11–14 (–16) μ. Hymenial mucus colourless or brownish 13. *Ascobolus albidus*, p. 100

10. Receptacle and disk yellowish, greenish-yellow, greenish, or olive-coloured:

13. Receptacle in the upper part smooth, yellowish-green, in the lower part densely white-villose. Ascospores normally 25–30 × 13–14 μ, but also considerably larger 45–50 × 18–24 μ 25. *Ascobolus semivestitus*, p. 124

13. Receptacle furfuraceous or smooth, not white-villose in the lower part:

14. Excipulum covered with small regular groups of subglobular or pyriform cells with rust-brown walls:

15. Episporium with a pattern of irregular, short, curved non-anastomosing crevices 32. *Ascobolus singeri*, p. 133

15. Episporium with subparallel, anastomosing crevices:

16. Ascospores fusoid or fusiform-ellipsoid:

17. Ascospores fusoid or ellipsoid with pointed ends, 17.5–19.5 × 7.0–9.0 μ. Episporium with rather narrow longitudinal anastomosing crevices. On rotten wood, leaves, or paper 30. *Ascobolus epimyces*, p. 130

17. Ascospores fusoid, 28.5–37.5 × 11–14 μ. Episporium with longitudinal ridges of pigment, separated by very broad crevices. On humid soil . . . . . 37. *Ascobolus viridis*, p. 142

16. Ascospores ellipsoid with rounded or obtuse ends:
    18. Receptacle stalked; with a permanently furfuraceous margin. Excipular warts of subglobular and pyriform cells. Episporium always with longitudinal anastomosing crevices, often becoming reticulated with age. Ascospores with strong tendency to swell when ripe. On rotten leaves, stalks, wood, and bark
    33. *Ascobolus foliicola*, p. 134
    18. Receptacle sessile; margin only furfuraceous in very young fruit-bodies, but soon smooth. Excipular warts of subglobular cells. Episporium with longitudinal, transverse or oblique anastomosing crevices, sometimes with non-anastomosing very narrow crevices or with locally very thick cap-shaped deposits of pigment. On all kinds of substrata
    34. *Ascobolus denudatus*, p. 136

14. Excipulum smooth or covered with regular or irregular groups of subglobular cells with hyaline or yellowish walls:
    19. Ascospores exceeding 16 μ in length:
        20. Receptacle yellow or lemon-yellow, white or yellow furfuraceous, substipitate or with a short stalk. Disk greenish-yellow. Ascospores 17–22 × 9.5–12 μ. Episporium with only a very few widely spread longitudinal or oblique crevices, that rarely anastomose; 1–6 crevices visible at each view of the ascospore . . . . . 18. *Ascobolus michaudii*, p. 113
        20. Receptacle and disk yellow, yellowish, greenish-yellow or green. Episporium with more closely spaced, subparallel anastomosing crevices, normally 7–12 of which visible at each view of the ascospore:
            21. Apothecia large, 5–12 mm diameter; with a distinct stalk. Ascospores ellipsoid to fusiform-ellipsoid with blunt ends; 16–19.5 × 8.5–10 μ
            29. *Ascobolus lignatilis*, p. 128
            21. Apothecia medium-sized, 0.5–5 mm diameter; sessile or with a very short stalk:
                22. Apothecia sessile or with a very short stalk. Ascospores fusoid or ellipsoid with pointed ends (16–)17.5–19.5(–20) × (6.5–)7–9(–10) μ 30. *Ascobolus epimyces*, p. 130

22. Apothecia without a distinct stalk. Ascospores regularly ellipsoid; 19–28 × 10–14 μ:
    23. Apothecia rather thin, up to 0.3 mm high, substipitate or on a narrow base. Receptacle on the whole surface finely furfuraceous or powdered. Excipulum rather thin, 12–22 μ thick; of one or a few layers of subglobular cells 7–19 μ diameter. Only the walls of young asci pale blue in Melzer's reagent
        15. *Ascobolus perplexans*, p. 105
    23. Apothecia 0.4–0.8 mm high, sessile. Receptacle wholly or partially, coarsely or finely furfuraceous, almost smooth or smooth. Excipulum near the margin 20–50 μ thick, near the base often much thicker; of subglobular, ellipsoid or oblong cells 10–50(–90) × 10–30 (–60) μ. Ascus-wall always clearly blue in Melzer's reagent
        16. *Ascobolus furfuraceus*, p. 106
19. Ascospores not exceeding 16 μ in length:
    24. Apothecia stipitate or substiptate. Receptacle and disk ochraceous or lemon-yellow. Ascospores ellipsoid to fusiform-ellipsoid. On rotten leaves and branches . . . . 31. *Ascobolus costantinii*, p. 132
    24. Apothecia sessile, with a rather broad base, rarely on a narrow base. Receptacle and disk greenish-yellow or olive-coloured. Ascospores ellipsoid:
        25. Receptacle and disk olive-coloured. Ascospores 14.5–16 × 8–9 μ 26. *Ascobolus cervinus*, p. 124
        25. Receptacle and disk greenish-yellow. Ascospores smaller, 10–15 × 6–8 μ:
            26. Receptacle with a prominent margin. Ascospores rather uniform. Episporium ornamented with a regular pattern of longitudinal, rarely anastomosing striae
                19. *Ascobolus crenulatus*, p. 115
            26. Receptacle with a very narrow or scarcely developed margin. Ascospores extremely heterogeneous. Episporium with very different types of ornamentation (see Fig. 28; cf. also *A. lineolatus*, p. 120)
                20. *Ascobolus cubensis*, p. 117

4. Episporium with other types of ornamentation:
   27. Ascospores 9–10 μ long. Episporium finely granular
   28. *Ascobolus cainii*, p. 126
   27. Ascospores more than 10 μ long:
      28. Receptacle and disk white:
         29. Apothecia 0.4–1.0 mm diameter. Ascospores 13–17 × 7.5–8.5 μ. Episporium smooth, but finally often with an irregular net-work of fine lines. On dung . . . . . 27. *Ascobolus carletonii*, p. 125
         29. Apothecia 4–5 mm diameter. Ascospores 20–26 × 12 μ. Episporium warted. On humid soil . . 38. *Ascobolus albinus*, p. 144
      28. Receptacle and disk not white:
         30. Ascospores fusoid or ellipsoid with strongly pointed ends; 28.5–37.5 × 11–14 μ. Episporium consisting of long or short longitudinal ridges of pigment . . . 37. *Ascobolus viridis*, p. 142
         30. Ascospores ellipsoid. Episporium punctate, warted, smooth, granular or with a net-work of crevices from the beginning:
            31. Ascospores punctate or warted. On wood or burnt substrata:
               32. Ascospores 32–37 × 13–16 μ. Episporium punctate or finely warted. On rotten wood
               43. *Ascobolus xylophilus*, p. 152
               32. Ascospores less than 30 μ long. Episporium rather coarsely warted. On charcoal or burnt soil:
                  33. Receptacle almost smooth. Ascospores 17.5–22 × 9–11.5 μ. Episporium with a very regular pattern of round warts 1.0–1.5 μ diameter; without truncate polar thickenings . . . 40. *Ascobolus archeri*, p. 146
                  33. Receptacle finely mealy or scaly. Ascospores 17.5–25 (–27.5) × (11.5–)13–14.5 μ. Episporium with irregular or rounded warts varying considerably in size; with truncate polar thickenings
                  41. *Ascobolus carbonarius*, p. 147
            31. Ascospores smooth, finely granular or with a net-work of crevices. On dung or humid soil:
               34. Ascospores 40–45 × 21–23 μ. On dung
               cf. *Ascobolus asininus*, p. 208
               34. Ascospores 17–27 × 9–15 μ. On humid soil:
                  35. Episporium at first smooth or extremely fine granular then with a pattern of very short, fine crevices in all directions, finally often reticulated or warted
                  36. *Ascobolus geophilus*, p. 140
                  35. Episporium with a fine net-work of crevices from the beginning . . . . 39. *Ascobolus behnitziensis*, p. 145

13. Ascobolus albidus Crouan—Fig. 21; Pl. 5, figs. F-I, Pl. 6, figs. A-D

Ascobolus albidus Crouan *in* Annls Sci. nat. (Bot.) IV **10**: 193 *pl. 13A fs. 1–6.* 1858. — *Ascobolus glaber* var. *albidus* (Crouan) March. *in* Bull. Soc. Bot. Belg. **34**: 131. 1895. — Lectotype: *Crouan*, on old cow dung, near Brittan, France, *s. dat.*, spring (PC-A2333).

Ascobolus glaber var. *lenticularis* Boud. *in* Annls Sci. nat. (Bot.) V **10**: 224 *pl. 7 f. 15.* 1869. — Type: represented by Boud. l.c. *pl. 7 f. 15.*

Ascobolus albidus forma *macrosporus* Svrček *in* Česká Mykol. **13**: 211. 1959. — Type: not available (PR); type locality, Radotín, Bohemia, Czechoclovakia.

Misapplied names.—*Ascobolus glaber* Pers. per Pers. sensu Cooke *in* J. Bot., Lond. **2**: 151 *f. 4.* 1864.

Ascobolus glaber Pers. per Pers. sensu Boud. *in* Annls Sci. nat. (Bot.) V **10**: 223 *pl. 7 fs. 13–15.* 1869.

Apothecia scattered or gregarious, superficial, sessile on a narrow base, 0.3–1.0 (–1.5) mm diameter, 0.4–0.8 mm high. Receptacle at first closed, sybcylindrical or barrel-shaped, then obconical, cylindrical with an obconical base or urceolate, white with pale yellowish-brown base, more or less translucent, finally often entirely yellowish-brown, rarely (only known from the British Isles) wholly blackish-brown or brownish, smooth, without a margin. Disk flat, white, dotted with the strongly protruding tips of ripe asci. Hymenium 240–300 μ thick. Hypothecium very thin or not clearly differentiated, of isodiametric cells, 5–12 μ diameter. Flesh very thin, up to 100 μ thick, of rounded, elongated cells 7–19 × 5–8 μ, hyaline. Excipulum in the upper part 7–13 μ thick, near the base 20–39 μ thick, of isodiametric or slightly elongated, rounded or angular cells 14–43 × 8–29 μ (mostly textura angularis), hyaline. Asci cylindric-clavate, gradually tapering downwards, rounded above, (160–)300–410 × 26–38 μ, 8-spored; the wall deep blue in Melzer's reagent. Ascospores biseriate, ellipsoid-oblong, at first hyaline, then pale violet, finally violet, (18–)20–36(–39) × (9–)11–14(–16) μ; usually with longitudinal occasionally anastomosing striae, sometimes with short more or less curved striae; with thick, transparent, unilateral, gelatinous cap. Paraphyses branched, septate, cylindrical, 1.7–3.2 μ thick, slightly clavate, filiform or forked above, 1.0–4.7 μ thick at the tip, hyaline, embedded in a colourless mucus, which quickly dissolves in water.

Known from dung of cow, horse, sheep, goat, moose, dog, wolf, rabbit, hare, and muskrat.

Etymology.—From Latin, albidus, whitish.

Illustrations.—Berkeley & Broome *in* Ann. Mag. nat. Hist. III **15**: *pl. 16 f. 27.* 1865 (*A. glaber*); Boudier *in* Annls Sci. nat. (Bot.) V **10**: *pl. 7 fs. 13–15.* 1869 (*A. glaber* with var. *lenticularis*); Cooke *in* J. Bot., Lond. **2**: 151 *f. 4.* 1864 (*A. glaber*, poor drawing); Crouan *in* Annls Sci. nat. (Bot.) IV **10**: *pl. 13 A fs. 1–6.* 1858.; Dangeard *in* Botaniste **10**: *pl. 66.* 1907 (*A. glaber*, cytol.); Dennis, Brit. Cup Fungi *pl. VII f. L.* 1960 (*A. glaber*); Le Gal *in* Annls Sci. nat. (Bot.) XI **8**: 242 *f. 65F.* 1947 (*A. glaber*); Le Gal *in* Annls Sci. nat. Bot. XII **1**: 467 *f. 8A.* 1961; Lindau *in* Engl. & Prantl, Natürl. Pflfam. **I** (1): 192 *f. 154 G–H.* 1897 (*A. glaber*); Seaver *in* Bull. Lab. nat. Hist. State Univ. Iowa **6**: *pl. 31. f. 2.* 1905 (*A. glaber*); Velenovský, Monogr. Discom. Boh. **2**: *pl. 4 f. 37.* 1934.

Specimens examined.—**Iceland**: Davidson 1337, Lukasteim, 28.VIII.1900 (C).

Sweden: *Vleugel*, Umeå, 5.VII. 1903 (S).

Great Britain: *Bramley*, Bolton, Percy, Yorkshire, 25.V.1946 (CMI); *Bramley*, Bolton, Percy, Yorkshire, 3.V.1947 (CMI, K); *Broome*, Bathford, Somerset, 14.X.1863 (K-A1916);

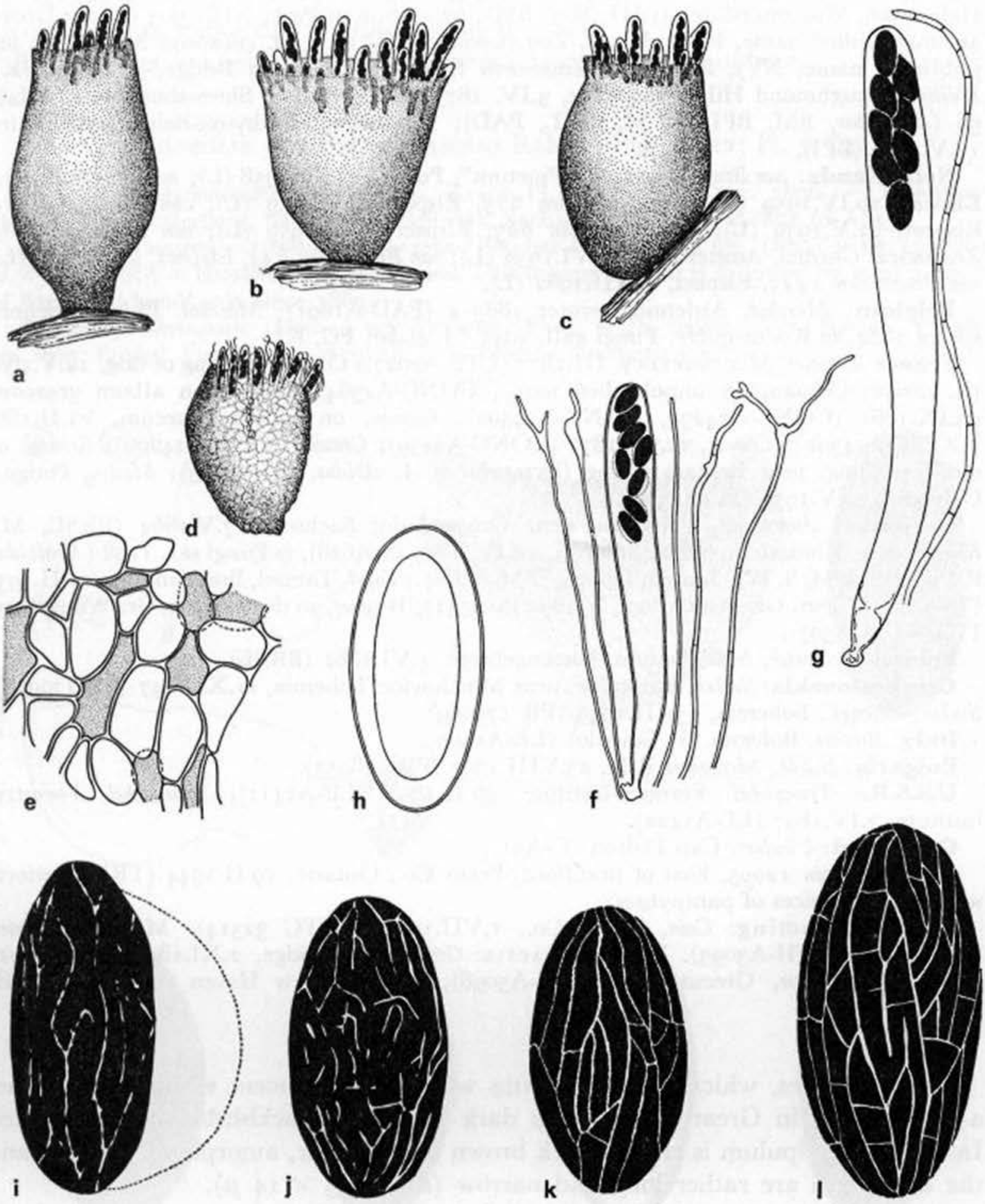


Fig. 21. — *Ascobolus albidus:* a–c, habit of fruit-bodies × 75; d, fruit-body in transmitted light × 65; e, texture of excipulum seen from outside; f, ascus and paraphyses × 175; g, ascus and paraphysis × 275; h, young ascospore in optical section × 1600; i–l, ascospores × 1600. (a–j, from *van Brummelen 678*; k, l, from lectotype of *A. albidus*.)

Broome (K-A1915); *Dennis*, Down behind Westridge, Walton-under-Edge, 3.IV.1951 (K); *Dennis*, West Sandwick, Isle of Yell, Shetland, 5.IX.1952 (K); *Grove*, between Quinton and Halesowen, Worcestershire, 31.III.1883 (BM); *Grove*, Sutton Park, 7.II. 1903 (*A. ater* Grove, an unpublished name, BM); *Massee*, Zoo (London), IV.1901 (*A. cylindricus* Massee, an unpublished name, NY); *Needham*, Crimsworth Dear, near Hebden Bridge, 30.I.1898 (K); *Phillips*, Haughmond Hill, Shropshire, 3.IV. 1873 (BM); *Phillips*, Shrewsbury, *in* Elv. brit. 96 (*A. glaber*, BM, BPI, K, M, MEL, PAD); *Waterhouse*, Kirkby-on-Bain, Lincolnshire, 11.V.1949 (BPI).

Netherlands: *van Brummelen 627*, "Pinetum", Putten, 14.IV.1958 (L); *van Brummelen 652*, Elspeet, 10.IV.1959 (L); *van Brummelen 675*, Elspeet, 8.V.1959 (L); *van Brummelen 678*, Elspeet, 22.V.1959 (L); *van Brummelen 683*, Elspeet, 6.VI.1959 (L); *van Brummelen 685*, Zoological Garden, Amsterdam, 19.VI.1959 (L); *van Brummelen 844*, Elspeet, 2.IV.1960 (L); *van Brummelen 1443*, Elspeet, 23.III.1962 (L).

Belgium: *Marchal*, Ardennes, winter 1883–4 (PAD-A1801); *Marchal*, Ebly, Ardennes, spring 1884, *in* Roumeguère, Fungi gall. 3045 (*A. glaber*, PC, K).

France: *Boudier*, Montmorency, III.1877 (UPS-A2027); *Crouan*, on dung of dog, 12.V.1860 (*A. caninus* Crouan, an unpublished name, CONC-A2384); *Crouan*, on album graecum, 29.IX.1861 (CONC-A2429a, CONC-A2430a); *Crouan*, on album graecum, 22.II.1867 (CONC-A2430b); *Crouan*, 12.III.1870 (CONC-A2439); *Crouan* CONC-A2429b); *Crouan*, on old cow dung, near Brittan, spring (lectotype of *A. albidus*, PC-A2333); *Meslin*, Potigny, Calvados, 5.IV.1939 (PC-A2366).

Germany: *Auerswald*, Ponickau, near Grossenhain, Sachsen, 17.V.1864 (BRSL, M); *Krieger*, near Königstein, Sächs. Schweiz, 10.IV. 1895 (S-A628), *in* Fungi sax. 1178 (*A. albidus*, BRSL, HBG, M, S, W); *Schmidt*, Leipzig (BM-A2804); *Vogel*, Tamsel, Brandenburg, 12.II.1935 (TRTC); *Wagner*, Gr. Winterberg, V.1892 (S-A541); *Wagner*, on dung of fox, Gr. Winterberg, IV.1893 (S-A597).

Poland: *Schroeter*, Mädelkamm, Riesengebirge, 4.VI.1882 (BRSL).

Czechoslovakia: *Svrček*, Strukařov, near Mnichovice, Bohemia, 21.XI.1947 (PR 179013); *Svrček*, Choteč, Bohemia, 13.III.1949 (PR 179069).

Italy: *Beccari*, Bologna (di Covallo) (LE-A1409).

Bulgaria: *Bubák*, Monastir Rila, 23.VIII.1907 (PR 178953).

U.S.S.R.: *Tranzschel*, Forestry-institute, 26.II.1897 (LE-A1411); *Tranzschel*, Forestry-institute, 7.IV.1897 (LE-A1422).

Greenland: *Ulvelort*, Cap Dalton (C-A51).

Canada: *Cain 12095*, East of Brantford, Brant Co., Ontario, 19.II.1944 (TRTC, a form with filiform apices of parapyhses).

U.S.A.: Wyoming: *Cain*, Telon Co., 1.VII.1955 (TRTC 32314). Maine: *Thaxter*, Kittery Point (FH-A3093). Massachusetts: *Groves*, Cambridge, 2.XI.1897 (FH). Connecticut: *Thaxter*, Greens Farms (FH-A3096); *Thaxter*, New Haven (FH-A3075, FH-A3097).

Of this species, which normally forms white or translucent whitish fruit-bodies a form occurs in Great Britain with dark brown or blackish-brown fruit-bodies. In this the excipulum is rich in dark brown intercellular, amorphous pigment and the ascospores are rather long and narrow (about 35 × 14 μ).

Ascobolus albidus can be distinguished from *A. roseopurpurascens* and smooth forms of *A. furfuraceus* by the shape and colour of the receptacle, the texture of the excipulum, and by the absence of an apothecial margin as well as of coloured hymenial mucus.

Boudier (1869: 224) distinguished three forms according to the colour of the fruit-bodies.

As shown by Boudier's illustrations (l.c. *pl. 7 f. 3*), the ornamentation of the ascospores in this species is very variable. Often regular segregations of the different ascospore phenotypes can be observed in the asci.

This species is known from the northern temperate hemisphere.

14. ASCOBOLUS ROSEOPURPURASCENS Rehm—Figs. 3, 22; Pl. 7, fig. G

Ascobolus roseopurpurascens Rehm, Rab. Krypt.-Fl., (Pilze) **3**: 1122. 1896. — Holotype: *Wagner*, Gr. Winterberg, Sächsischen Schweiz, Sachsen, Germany, V.1894 (S-A655).

MISAPPLIED NAMES.—*Ascobolus vinosus* sensu Boudier *in* Annls Sci. nat. (Bot.) V **10**: 221–222 *pl. 6 f. 11*. 1869 = *Ascobolus roseopurpurascens*. This misapplication is followed by most authors of floras and handbooks since 1869.

Ascobolus porphyrosporus (Hedw.) per Fr. sensu Fuck. *in* Jb. nassau. Ver. Naturk. **27–28**: 57. 1873; Fuckel, Fungi rhen. 2679. 1874 = *Ascobolus roseopurpurascens*.

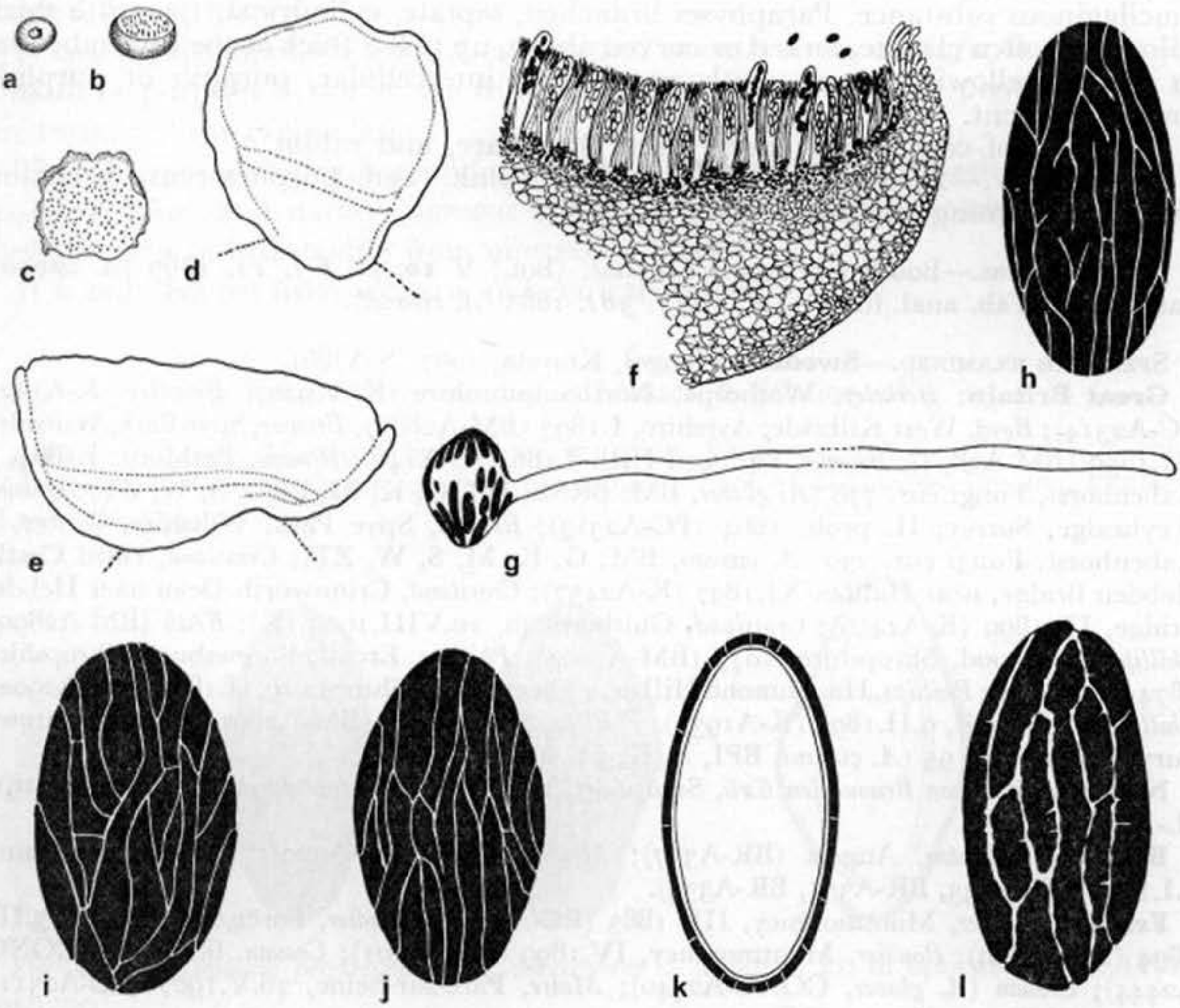


Fig. 22. — *Ascobolus roseopurpurascens:* a–c, habit of fruit-bodies × 12; d, e, diagrammatic sections of fruit-bodies × 65; f, median section through part of fruit-body × 65; g, germinated ascospore × 460; h–j, l, ascospores × 1600; k, ascospore in optical section × 1600. (a–c, f, g, l, from *van Brummelen 424*; d, e, h–k, from holotype, S-A655.)

Apothecia gregarious or crowded, superficial, sessile, 0.3–1.7 mm diameter, 0.3–0.6 mm high. Receptacle at first closed and spherical, then opening and expanding, finally often scutellate, pinkish-red, yellowish-green with a purplish hue, purple or purplish-brown, smooth or rarely finely furfuraceous; margin sometimes irregularly dentate or lobed, membranaceous, finally smooth. Disk flat or slightly concave, finally convex, at first yellowish, pinkish, or pale purplish, then purplish-brown or brown, dotted with the almost black protruding tips of ripe asci. Hymenium 170–220 μ thick. Hypothecium clearly differentiated, 25–30 μ thick, of isodiametric or somewhat elongated cells 5–10 × 4–7 μ. Flesh 25–260 μ thick, of more or less isodiametric cells 8–17 μ diameter, colourless or with amorphous, intercellular, purplish-brown pigment in the outer zone. Excipulum 14–30(–40) μ thick, of irregular, elongate or lobed cells 12–29 × 7–12 μ (textura epidermoidea), with purplish or purplish-brown, amorphous, intercellular pigment, especially near the margin. Asci clavate, rounded above, 175–240 × 20–26 μ, 8-spored; the wall blue in Melzer's reagent. Ascospores biseriate, ellipsoid with blunt ends, at first hyaline, then pinkish-violet, finally violet or brownish-violet, (16–)18–28(–29) × (9–)10–12(–13) μ, ornamented with longitudinal, anastomosing lines, with unilateral mucilaginous substance. Paraphyses branched, septate, cylindrical, 1.5–2.5 μ thick, colourless, often clavate, forked or curved above, up to 8 μ thick at the tip, embedded in a pale yellowish mucus, with amorphous, intercellular, purplish or purplish-brown pigment.

On dung of cow, horse, sheep, deer, dog, hare, and rabbit.

ETYMOLOGY.—From Latin, roseus, rosy, pink, and purpurascens, becoming purple: becoming pinkish-purple.

ILLUSTRATIONS.—Boudier *in* Annls Sci. nat. (Bot.) V **10**: *pl. 6 f. 11.* 1869 (*A. vinosus*); Patouillard, Tab. anal. fung. 1: *pl. 124 f. 381.* 1885 (*A. vinosus*).

SPECIMENS EXAMINED.—**Sweden**: Vleugel, Knivsta, 1987 (S-A788).

Great Britain: *Berkeley*, Wothorpe, Northamptonshire (K-A1926); *Berkeley* (K-A1929, PC-A2314); *Boyd*, West Kilbride, Ayrshire, I.1893 (BM-A2889); *Broome*, Spye Park, Wiltshire, III.1859 (BM-A2894); *Broome*, Bathford Hill, I.1864 (E-A146); *Broome*, Bathford, I.1864, *in* Rabenhorst, Fungi eur. 778 (*A. glaber*, BM, BRSL, FH, G, K, M, PRC, S, W, ZT); *Broome*, Weybridge, Surrey, II. prob. 1864 (PC-A2313); *Broome*, Spye Park, Wiltshire, winter, *in* Rabenhorst, Fungi eur. 230 (*A. vinosus*, BM, G, K, M, S, W, ZT); *Crossland*, Hard Castle, Hebden Bridge, near Halifax XI.1897 (K-A2457); *Crossland*, Crimsworth Dean naer Hebden Bridge, IX.1899 (K-A2456); *Crossland*, Guisborough, 20.VIII.1906 (K); *Keith* (BM-A2890); *Phillips*, Hanwood, Shropshire, 1873 (BM-A3004): *Phillips*, Ercall, Shrewsbury, Shropshire, 1874 (K-A1933); *Phillips*, Haughmond Hill near Shrewsbury, Shropshire, II.1877 (BM-A2902); *Phillips 102*, on soil, 9.II.1899 (K-A1934); *Phillips*, Shrewsbury (BM-A2891); *Phillips*, Shrewsbury, *in* Elv. brit. 95 (*A. vinosus*, BPI, E, K, M, MEL, PAD).

Netherlands: *van Brummelen 626*, Santpoort, 20.I.1958 (L); *van Luyk*, Bussum, IV.1917 (L-A926).

Belgium: *Mouton*, August (BR-A337); *Mouton*, Tilff (BR-A320); *Rousseau*, la Panne, 1.I.1912 (BR-A333, BR-A334, BR-A335).

France: *Boudier*, Montmorency, III. 1883 (PC-A2192); *Boudier*, Forêt de Carnelle, 3.III. 1894 (PC-A2190); *Boudier*, Montmorency, IV.1899 (PC-A2201); *Crouan*, 6.II.1869 (CONC-A2444); *Crouan* (*A. glaber*, CONC-A2440); *Maire*, Parc-sur-Seine, 26.V.1907 (PC-A2311); *Lorton 106*, Clessy, II.1913 (PC).

Germany: *Ade*, near Burgkundstadt (am Main), 9.IV.1912 (S-A622); *Auerswald*, Ponickau near Grossenhain, Sachsen, 25.III.1861 (*A. porphyrosporus*, K-A1977, PR 178969, S-A486, S-A658, W-A203); *Auerswald*, Ponickau, Sachsen, IV.1861 (G-A1025, M-A868); *Auerswald*, Ponickau near Grossenhain, Sachsen, 17.V.1864 (G, S); *Auerswald*, Ponickau near Grossen-

hain, Sachsen (G-A1026); *Auerswald* (PR 178970, LE-A1449); *Fuckel*, near Oestrich, Nassau, winter, *in* Fungi rhen. 2679 (*A. porphyrosporus*, GRO, K, M); *Fuckel*, Oestrich, Nassau, winter, *in* Herbier Barbey-Boissier 1313 (*A. porphyrosporus*, FH, G, S, W); *Fuckel*, Oestrich, Nassau, winter (*A. porphyrosporus*, Symb. Mycol., Nachtr. II, 58, G-A1028, W-A218); *Jaap 157*, Triglitz i.d. Prignitz, 23.VIII. 1903 (S); *Krieger*, near Waltersdorf near Königstein, V.1896, *in* Fungi sax. 1180 (*A. vinosus*, BM, BPI, HBG, M, S, W); *Krieger*, Königstein a. Elbe V.1896 (S-A672, S-A720, S-A742, S-A768); *Krieger*, Pirna, IX. 1904 (S-A752b); *Wagner*, gr. Winterberg, V.1894 (holotype of *A. roseopurpurascens*, S-A655).

Czechoslovakia: *Buchs*, Moravice-valley (= Mohrathal, Oberschlesien) VII. 1906 (S-A731); *Lojka*, Prešov (= Eperjes), 5.X.1869 (S-A503); *Svrček*, Krčshy les near Praha, 23.VI,1945 (PR 179015); *Velenovský*, Mnichovice: "Zíta", Bohemia, 5.VI.1940 (PR 150269).
Switzerland: *Müller*, kl. Glarus, Braunwald, Gumen, 19.VI.1955 (ZT).
Italy: *Jaap 477*, Seiser Alp, *Südtirol*, 15.VII.1907 (S).

This species often has been cited in literature under the misapplied names *A. vinosus* or *A. porphyrospcrus*. It was described in Rehm's work (1896: 1122–3) under three different names.

It can be distinguished from *A. albidus* and smooth forms of *A. furfuraceus* by the pinkish or purplish colour of the fruit-bodies, due to intercellular pigment, and by the texture of the excipulum.

The ascospores are rather uniform with a constant ornamentation of the episporium. More and darker pigment is formed in fruit-bodies growing exposed to sunlight than in fruit-bodies from unexposed places.

It is only known from western and central Europe.

15. Ascobolus perplexans Massee & Salmon—Fig. 23

Ascobolus perplexans Massee & Salmon *in* Ann. Bot., Lond. **15**: 328 *pl. 18 f. 52–55.* 1901. — Lectotype: *Massee & Salmon*, on dung of kangaroo, Zoological Garden, London, England, II.1901 (K-A1990).

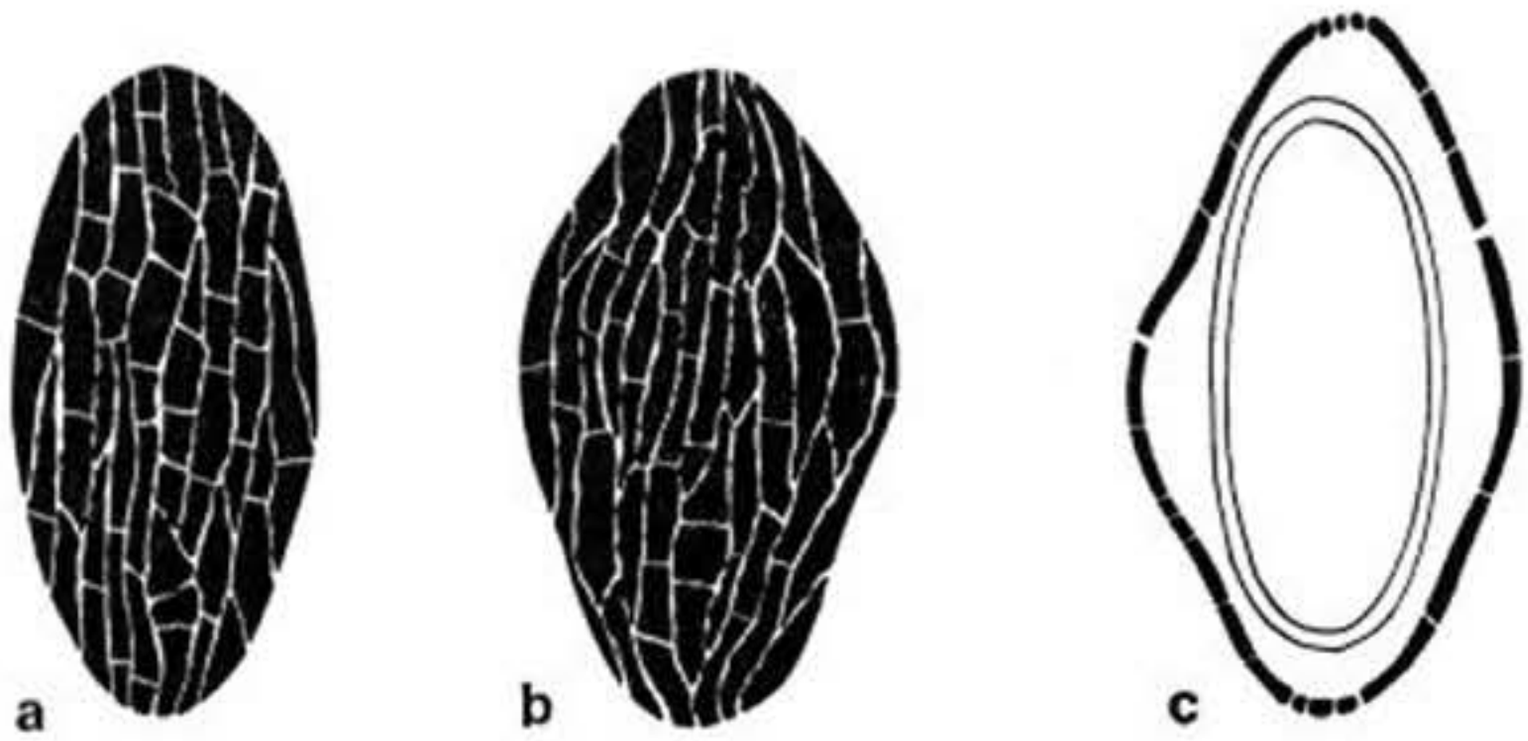


Fig. 23. — *Ascobolus perplexans:* a, b, ascospores × 1600; c, id. in optical section. (From holotype.)

Apothecia scattered or gregarious, superficial, sessile on a small base or substipitate, 0.5–3 mm diameter, up to 0.3 mm high. Receptacle at first pyriform, then expanding and scutellate, finally flattened, greenish-yellow, becoming brownish, finely furfuraceous or powdered, sometimes almost smooth, with an acute or

irregularly dentate margin; stipe up to 170 μ high and 450–700 μ diameter, strongly enlarged at the base. Disk at first slightly concave or flat, finally convex, dirty greenish-yellow, dotted with the almost black protruding tips of ripe asci. Hymenium 140–160 μ thick. Hypothecium not clearly differentiated. Flesh of varying thickness, in the upper part pseudoparenchymatous, in the basal part — especially in the stipe — plectenchymatous, hyaline. Excipulum 12–22 μ thick, of one or a very few layers of subglobular cells 7–19 μ diameter, pale brownish or almost colourless, covered with very small isolated groups of subglobular cells 10–19 μ diameter. Asci clavate-cylindrical, with a narrow base, rounded above, 185–240 × 20–27 μ, 8-spored; only when young the wall pale blue in Melzer's reagent. Ascospores uniseriate to biseriate, ellipsoid, at first hyaline, then violet, finally purplish-brown, 19–22(–25) × 9.5–13 μ; often swollen and showing a loose episporium, ornamented with longitudinal, anastomosing striae, finally often also with short transverse crevices. Paraphyses simple or branched, septate, filiform, 2.5–3.0 μ thick, slightly clavate at the tip, hyaline embedded in greenish-yellow mucus.

On dung of sheep and kangaroo. According to Massee & Salmon (1901: 328) also "on dung of *Raphiceri melanotidis* (Grijs-bok), *Elephantis africani* (Elephant), *Cervi elaphi* (Red Deer), *Ovis vignei* (Ural Wild Sheep) and horse."

ETYMOLOGY.—From Latin, perplexans, causing confusion.

ILLUSTRATION—Massee & Salmon *in* Ann. Bot., Lond. **15**: *pl. 8 fs. 52–55.* 1901.

SPECIMENS EXAMINED.—**Great Britain**: *Cooke*, Ascot, Berkshire, XI.1863 (K-A1917); *Massee & Salmon*, on dung of kangaroo, Zoological Garden, London, II.1901 (holotype of *A. perplexans*, K-A1990).
Netherlands: *van Brummelen*, on sheep dung, Elspeet, VI.1956 (L-A922).

This species is closely related to *A. furfuraceus*, from which it can be distinguished by the rather thin substipitate apothecia, the structure of the excipulum, and the weak blue staining of the ascus-wall with Melzer's reagent.

16. ASCOBOLUS FURFURACEUS Pers. per Hook.—Fig. 24; Pl. 6, figs. E-I, Pl. 7, figs. A-F

Elvella fimetaria Scop., Fungi Hung. *in* Ann. Hist. nat. **4**: 149 *pl. 1 f. 6.* 1770 (devalidated name). — Type: represented by Scopoli l.c. *pl. 1 f. 6*; type locality, "Hungary". — Fide Fries (1822: 163).

Peziza atra Huds., Fl. angl. (ed. 2) 637. 1778 (devalidated name). — *Peziza atra* Huds. *per* With., Arr. Brit. Pl. (ed. 7) **4**: 313. 1830. — Type: represented by the description of Hudson l.c.; type locality, England. — Fide Fries (1822: 163).

Peziza fusca Bolt., Hist. Fung. Halifax **3**: *pl. 109 f. 2.* 1789 (devalidated name). — *Peziza fusca* Bolt. per With., Arr. Brit. Pl. (ed. 7) **4**: 309. 1830. — Type: represented by Bolton l.c. *pl. 109 f. 2*; type locality, near Halifax, England.

Peziza stercoraria Bull., Herb. Fr. *pl. 376 f. 1.* 1787; Bull., Hist. Champ. Fr. 256. 1791 (devalidated name). — *Peziza stercoraria* Bull. *per* St. Amans, Fl. agen. 532. 1821. — *Ascobolus stercorarius* (Bull. per St. Amans) Schroet. *in* Krypt.-Fl. Schles. (ed. Cohn) **3** (2): 56. 1893. — Type: represented by Bull., Herb. Fr. *pl. 376 f. 1.* 1787; type locality, France. → *Peziza stercoraria* var. *lutea* Bull.

Peziza stercoraria var. *lutea* Bull., Hist. Champ. Fr. 256. 1791 (devalidated name). — *Peziza stercoraria* var. *lutea* Bull. *per* St. Amans, Fl. agen. 532. 1821. ≡ *Peziza stercoraria* Bull.

Peziza stercoraria var. *violacea* Bull., Hist. Champ. Fr. 256. 1791 (devalidated name). —

Peziza violacea (Bull.) Relh., Fl. Catabrigiensis, Suppl. **3**: 31. 1793 (devalidated name); not *Peziza violacea* Pers. *in* Neues Mag. Bot. **1**: 113. 1794. — *Peziza stercoraria* var. *violacea* Bull. *per* St. Amans, Fl. agen. 532. 1821. — *Peziza violacea* (Bull. per St. Amans) With., Arr. Brit. Pl. (ed. 7) **4**: 312. 1830. — Type: represented by Bull., Herb. Fr. *pl. 438 f. 4.* 1789 (*Peziza stercoraria*); type locality, France.

Ascobolus pezizoides Pers. *apud* Gmel., C. Linn. Syst. Nat. **2**: 1461. 1791 (devalidated name). ≡ *Ascobolus furfuraceus* Pers.

Ascobolus furfuraceus Pers. *in* Neues Mag. Bot. **1**: 115. 1794 (devalidated name); Pers., Obs. mycol. **1**: 33, *pl. 4, f. 3a*, 4–6. 1796. — *Ascobolus furfuraceus* Pers. *per* Hook., Fl. scot. **2**: 33. May 1821; Fries, Syst. mycol. **2** (1): 163. 1822. — Lectotype: L 910.262.143; type locality, Germany.

[*Ascobolus furfuraceus* var. *α. Dilute viridis* Pers. in Neues Mag. Bot. **1**: 115. 1794 (unnamed variety). —] *Ascobolus furfuraceus* var. *β. flavo-virens* Pers., Obs. mycol. **1**: 33. 1796 (devalidated name). — Type: not known to be in existence; type locality, probably Germany.

[*Ascobolus furfuraceus* var. *β. fuscus* Pers. *in* Neues Mag. Bot. **1**: 115. 1794 (unnamed variety). —] *Ascobolus furfuraceus* var. *α fuscus* Pers., Obs. mycol. **1**: 33. 1796 (devalidated name). ≡ *Ascobolus furfuraceus* Pers.

Ascobolus marginatus Schum., Enum. Pl. Saell. **2**: 437. 1803 (devalidated name); not *Ascobolus marginatus* Pat. *in* Rev. mycol. **4**: 211. 1882; nor *Ascobolus marginatus* Mass. *in* Grevillea **22**: 98. 1893. — Type: not known to be in existence; type locality, Sjaelland, Denmark.

Ascobolus aerugineus Fries, Syst. mycol. **2** (1): 165. 1822. — Type: represented by the description of Fries, l.c.; type locality, probably Sweden.

Peziza fimiputris Fr. *apud* Weinm., Hym.- Gastro- m. ross. 426. 1836. — *Ascobolus fimiputris* (Fr. apud Weinm.) Quél., Ench. Fung. 293. 1886. — *Ascobolus stercorarius* var. *fimiputris* (Fr. apud Weinm.) Boud., Hist. Class. Discom. Eur. 72. 1907. — *Ascobolus furfuraceus* var. *fimiputris* (Fr. apud Weinm.) Grelet *in* Rev. Mycol. **9**: 22. 1944. — Type: not known to be in existence, represented by the description of Fries apud Weinm. l.c.

Peziza subrugulosa P. Karst., Syn. Pez. Ascob. 7. 1861. — Type: *P. A. Karsten*, near Åbo, Finland, 10.V.1860 (H-A2750).

Ascobolus furfuraceus var. *nudus* Kickx, Fl. Crypt. Flanders **1**: 479. 1867; Boud. *in* Annls Sci. nat. (Bot.) V **10**: 220 *pl. 6 f. 10.* 1869. — *Ascobolus stercorarius* var. *nudus* (Kickx) Boud., Hist. Class. Discom. Eur., 72. 1907. — Type: not known to be in existence; type locality, Flanders, Belgium.

Ascobolus furfuraceus var. *coronatus* Boud. *in* Annls Sci. nat. (Bot.) V **10**: 220 *pl. 6 f. 9.* 1869. — *Ascobolus stercorarius* var. *coronatus* (Boud.) Boud., Hist. Class. Discom. Eur., 72. 1907. — Type: represented by Boud. *in* Annls Sci. nat. (Bot.) V **10**: *pl. 6 f. 9.* 1869; type locality, near Paris, France.

Ascobolus furfuraceus var. *fallens* Heimerl. *in* Jber. k.k. Ober-Realschule Bezirke Sechshaus Wien **15**: 13. 1889. — Type: not known to be in existence, represented by the description of Heimerl l.c.; type locality, Austria.

Ascobolus stercorarius retisporus Clements *in* Bot. Surv. Nebraska **5**: 9. 1901. — Type: not known to be in existence; type locality, Nebraska, U.S.A. — Fide Seaver (1928: 82).

Ascobolus glaber var. *caprea* Beeli *in* Bull. Soc. roy. Bot. Belg. **54**: 61. 1924. — Holotype: *Beeli 730* (BR).

Ascobolus stercorarius var. *pusillus* Vel., Monogr. Discom. Boh. 365. 1934. — Lectotype: PR 150303.

Ascobolus minor Vel., Monogr. Discom. Boh. 365. 1934. — Type: not known to be in existence; type locality, near Mnichovice, Bohemia, Czechoslovakia. — Representative specimen: PR 148318 (*A. minor*).

ORTHOGRAPHIC VARIANT. — *Ascobolus purpurascens* Calkins *in* J. Mycol. **2**: 106. 1886; Seaver, N. Am. Cup-fungi (Operc.) 92. 1928. (derived from incorrect spelling of 'furfuraceus' on a label).

EXCLUDED.—*Ascobolus fimiputris* (Fr. apud Weinm.) Quél. sensu Rehm, Rab. Krypt.-Fl. (Pilze) **3**: 1130. 1896 = *Ascobolus denudatus* Fr.

Apothecia solitary or gregarious, superficial, sessile, 0.5–5 mm across, 0.4–0.8 mm high. Receptacle at first closed and subglobular, then opening and hemispherical or cup-shaped, finally saucer-shaped, yellowish-green or yellowish, often becoming olive-green, ochraceous or brownish; wholly or partially, coarsely or finely, whitish furfuraceous, almost smooth or smooth; margin furfuraceous, denticulated, membranaceous or smooth. Disk slightly concave or flat, at first yellowish, greenish or yellowish-green, dotted with the almost black protruding tips of ripe asci, finally often brownish or blackish-brown. Hymenium (120–)150–200(–220) μ thick. Hypothecium 20–50 μ thick, of isodiametric, rounded cells 7–12 μ diameter. Flesh up to 500 μ thick, of subglobular or slightly ellipsoid cells 10–40 μ diameter, accompanied by irregularly undulating, branched hyphae which are connected with the paraphyses, hyaline. Excipulum near the margin 20–50 μ thick, near the base sometimes reaching 170 μ; of globular, ellipsoid or oblong cells 10–50(–90) × 10–30(–60) μ (textura globulosa); hyaline or sometimes with some brownish, amorphous, intercellular pigment; the external zone usually roughened by protruding groups of globular or oblong cells, often with irregular fissures giving rise to eroded groups of cells; sometimes almost smooth. Asci clavate, tapering downwards into a rather short stalk, rounded above, (120–)180–250 × (20–)24–30(–32) μ, 8-spored; the wall blue in Melzer's reagent. Ascospores at maturity biseriate or irregularly disposed, ellipsoid, at first hyaline, then violet, finally often purplish-brown, (16–)19–28(–32) × (9–)10–14(–16) μ; ornamented with more or less longitudinal, occasionally anastomosing striae, rarely swollen and reticulated, with unilateral mucilaginous substance. Paraphyses simple or branched, septate, filiform, 2–4 μ thick, usually scarcely thickened above, only very rarely with ellipsoid, strongly swollen cells up to 21 μ thick, embedded in yellowish or yellowish-green mucus.

On dung of cow, horse, deer, goat, yak, bear, pig, fox, rabbit, and hare, on manured soil, on rotten refuse, and on rotten stems of cabbage.

ETYMOLOGY.—From Latin, furfuraceus, scurfy.

ILLUSTRATIONS.—Bolton, Hist. Fung. Halifax **3**: *pl. 109 f. 2.* 1789 (*Peziza fusca*); Boudier *in* Annls Sci. nat. (Bot.) V **10**: *pl. 6 fs. 6–10.* 1869 (with var. *coronatus* and var. *nudus*); Boudier *in* Annls Sci. nat. (Bot.) V **10**: *pl. 7 f. 12.* 1869 (*A.* '*aeruginosus*'); Bulliard, Herb. Fr. *pl. 376 f. 1, pl. 438 f. 4.* 1787–9 (*Peziza stercoraria*); Cooke *in* J. Bot., Lond. **2**: 150 *f. 1.* 1864; Cooke, Handb. Brit. Fung. **2**: 725 *f. 338.* 1871; Corda, Anleit. Stud. Mykol. *pl. G 64 fs. 24–29.* 1842; Currey *in* Trans. Linn. Soc. Lond. (Bot.) **24**: *pl. 25 fs. 9–10.* 1863; De Bary, Vergl. Morph. Biol. Pilze *f. 45, f. 85, f. 95.* 1884; Delacroix, Malad. Pl. cultiv. Pays chauds *pl. 33 f. 4.* 1911; Dennis, Brit. Cup Fungi *pl. VII, f. H.* 1960; Gillet, Champ. Fr., Discom. *pl. 84 f. 2.* 1883; Greville, Scot. crypt. Fl. 6: *pl. 307.* 1827; Harper *in* Ber. deutsch. bot. Ges. **13**: *pl. 12 fs. 26–29.* 1895; H. Hoffmann, Ic. anal. Fung. (4:) *pl. 24 f. 2.* 1865; Hornemann in Fl. danica, Fasc. 31: *pl. 1856 f. 2.* 1825; Janczewski *in* Bot. Ztg. **29**: *pl. 4.* 1871; Janczewski *in* Annls Sci. nat. (Bot.) V **15**: *pl. 8.* 1872; Krombholz, Naturgetr. Abbild. Beschr. Schwämme **1**: *pl. 5 fs. 45–48.* 1831; Le Gal *in* Annls Sci. nat. (Bot.) XI **8**: 254 *f. 70*, 255 *f. 71.* 1947; Le Gal, Discom. Madagascar *fs. 26–27.* 1953 (*A. stercorarius*); Lindau *in* Engl. & Prantl, Nat. PflFam. **1** (1): 192 *f. 154 J–L.* 1896 (*A. stercorarius*); Linsbauer, Schneiders illustr. Handwörterb. Bot. 59 *f. 30.* 1917; Luerssen, Handb. system. Bot. **1**: 167 *f. 51 C–G.* 1879; Massee, Brit. Fungus-Fl. **4**: 162 *fs. 1–7.* 1895; Payer, Bot. crypt.: 5 *f. 12*, 8 *fs. 24–26* (*Peziza furfuracea*). 1850; Persoon, Obs. mycol. **1**: *pl. 4 fs. 3a, 4, 5.* 1796; Rehm, Rab. Krypt.-Fl. (Pilze) **3**: 1112 *fs. 1–3, 6.* 1896 (*A. stercorarius*); Schneider, Illustr. Handwörterb. Bot. 50 *f. 31.* 1905; Scopoli *in* Ann. Hist.-nat. **4**: *pl. 1 f. 6.* 1770 (*Elvella fimitaria*); Seaver *in* Bull. Lab. nat. Hist. State Univ. Iowa 6: *pl. 29 f. 2.* 1905 (*A. stercorarius*); Seaver, N. Am. Cup-fungi (Operc.) *pl. 45 f. 21.* 1928 (*A. stercorarius*); Sowerby, Colour. Fig. Engl. Fung. *pl. 18, pl. 389 fs. 3–6.* 1796 and 1803 (*Peziza stercoraria*); Zopf, Pilze *f. 59 IV, f. 64 IV.* 1890.

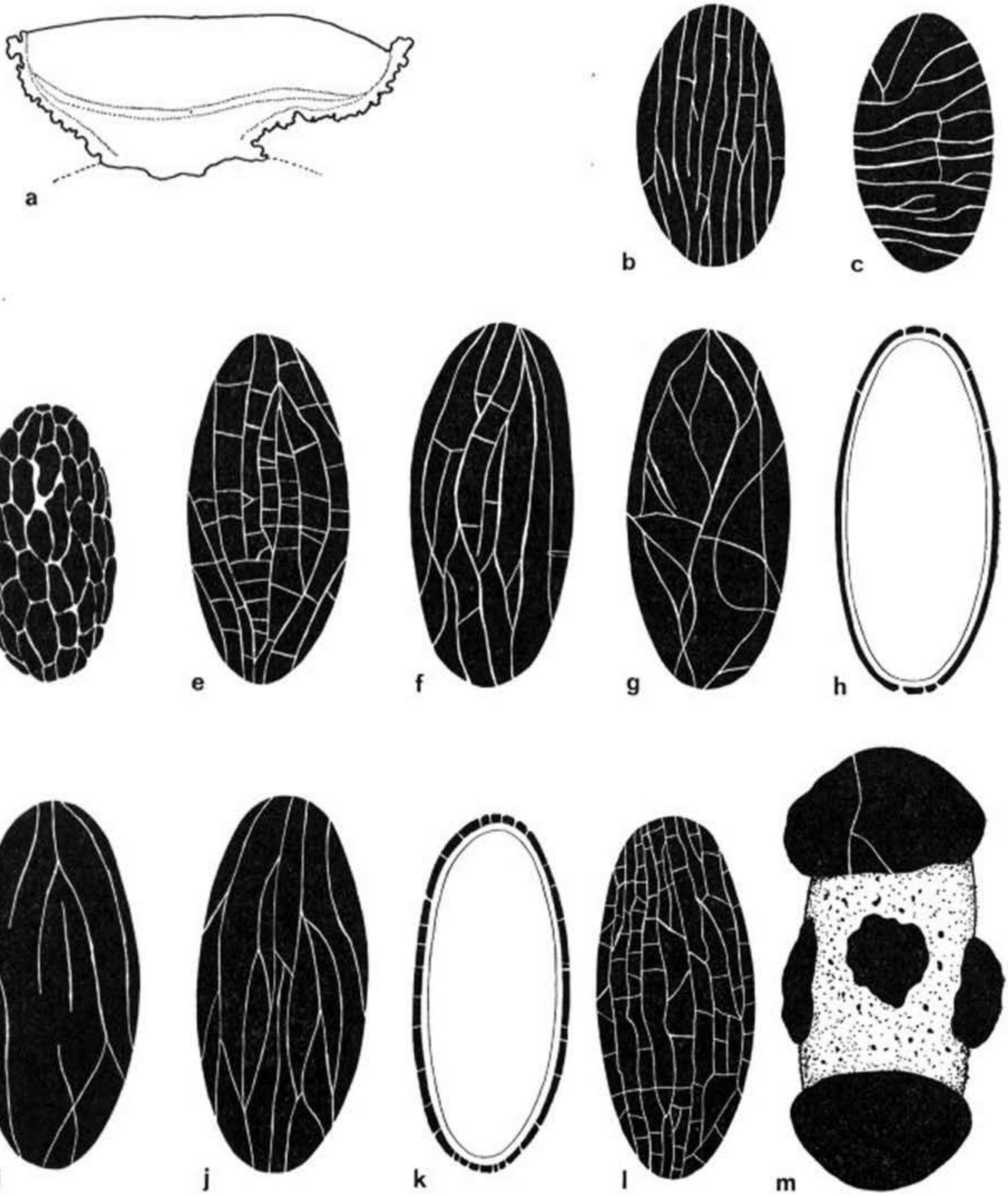


Fig. 24. — *Ascobolus furfuraceus:* a, diagrammatic section of fruit-body × 40; b–g, i, j, l, ascospores × 1600; h, k, id. in optical section; m, very rare, abnormal type of ascospore × 1600. (a, i–m, from *Beeli 730*, BR; b–d, from *Berkeley*, K–A1905; e–h, from lectotype of *A. furfuraceus*.)

Material examined (In brackets the number of specimens examined for each country is cited. With the exception of type specimens, only the names of the collectors are mentioned). —**Iceland** (1): *Feddersen*. **Sweden** (22): *Fries* (*A. parmeloides* UPS-A2007); *Hagelund*; *Henricson*; *Holm*; *Juel*; *Kjellmark*; *Kugelberg*; *Lindblad*; *von Post*; *Romell*; *Starbäck*; *Vleugel*. **Finland** (3):

Karsten; *Tigerstedt*. **Great Britain** (44): *Berkeley*; *Broome*; *Cooke*; *Crossland*; *Currey*; *Dennis*; *J. W. Ellis*; *Greville*; *Hughes*; *Limminghe*; *Massee*; *Phillips*; *Redhead*; *Salmon*. **Netherlands** (18): *van Brummelen*; *Buse*; *Daams*; *Destrée*; *van Luyk*; *Molkenboer*; *Oudemans*; *W. J. Reijnders*; *Rick*. **Belgium** (15): *Beeli 730*, Woluwe-St. Pierre, 11.VIII.1918 (Type of *A. glaber* var. *caprea*) (BR); *Bemmer*; *Coemans*; *Libert*; *Mouton*; *Rousseau*; *Wallays*; *Westendorp*. **France** (67): *Bernard*; *Boudier*; *de Brebisson*; *Bueison*; *Crouan*; *Desmazières*; *Fautrey*; *Gaillard*; *Huijsman*; *Léveillé*; *Louvet*; *Meslin*; *Montagne*; *Perris*; *Quélet*, Hérimoncourt, (*A. fimiputris*) (PC-A2200); *Richon*; *Riel*; *Roberge*; *Roussel*; *Therry*; *Tulasne*. **Monaco** (1): *Renner*. **Portugal** (1): *Torrend*. **Denmark** (9): *E. C. Hansen*; *Lind*; *Müllen*; *Rostrup*. **Germany** (103): *Ade*; *Auerswald*; *Britzelmayr*; *Feurich*; *Fuckel*; *Haller*; *Jaap*; *Jahn*; *Junghuhn*; *Krieger*; *Kunze*; *Lojka*; *Ludwig*; *Persoon*, *s. loc.*, *s. dat.* (lectotype of *A. furfuraceus*, L 910.262.143); *Puis*; *Rehm*; *Staritz*; *Strassen*; *Sydow*; *Wagner*; *Wilms*; *Winter*. **Poland** (25): *van Brummelen*; *Dressler*; *Falck*; *Lasch*; *Lojka*; *Schroeter*. **Czechoslovakia** (46): *Hruby*; *Klika*; *Niessl*; *Petrak*; *Picbauer*; *Svrček*; *Vacek*, *Velenovský*. **Switzerland** (5): *Obritz*; *Regel*; *Volkart*. **Austria** (28): *Beck*; *Britzelmayr*; *Demelius*; *von Keissler*; *Lojka*; *Rechinger*; *Rehm*; *Rick*; *Sauter*; *Strasser*. **Italy** (7): *Bresadola*; *Spegazzini*. **Hungary** (1): *Hollós*. **Romania** (14): *Lojka*. **U.S.S.R.** (7): *Dietrich*; *Girzitska*; *Newodowski*; *Satuna*; *Tranzschel*.

Algeria (2): *Durieu de Maisonneuve*. **Madagascar** (1): *Heim*.

Pakistan (1): *Ahmad*. **India** (1): *Ahmad*.

Australia (3): *Simmonds*.

Canada (36): *Bisby*; *Cain*; *Jackson*; *Macoun*; *A. T. T. Smith*.

Greenland (1): *Ulvelort*.

U.S.A.: Oregon (3): *Kienholz*. California (5): *Coon*; *Copeland*; *Harkness*; *McClatchie*. Idaho (3): *W. B. & V. G. Cooke*. Montana (2): *Cummins*. Wyoming (4): *Cain*. Colorado (3): *Seaver & Bethel*. Nebraska (2): *Moore*; *Saunders & Clements*. Oklahoma (1): *Ray*. Iowa (3): *Holway*; *Martin*; *A. H. Smith et al.* Missouri (2): *Linder*. Ohio (1): *Morgan*. Tennessee (4): *Hesler*. Alabama (2): *Baker*; *Earle*. Maine (1): *Thaxter*. New Hampshire (1): unknown collector. New York (13): *Burnham*; *Cain*; *Clinton*; *Cook*; *Dodge*; *Peck*; *Seaver*; *Warne*. Massachusetts (1): *Sturgis*. Connecticut (1): unknown collector. Pennsylvania (3): *Michener*; *Orton*. District of Columbia (1): *Shear*. North Carolina (1): *Diehl*. South Carolina (14): *Ravenel*. Georgia (2): *Ravenel*. Florida (2): *Sturgis*; *West*. Bermuda (3): *Brown et al.*

Venzuela (2): *Chardon*; *Dennis*. **Chile** (4): *Gay*. **Argentina** (1): *Singer*.

Exsiccati.—Cooke, Fungi brit., ed. 2, 189 (K);Desmazières, Pl. crypt., ed. II ser. 1, 715 (BM); Desmazières, Pl. crypt. ed. I, ser. 1, 1315 (BM, G, K, L, PC); Fuckel, Fungi rhen. 1132 (BM, G, GRO, K, LE, M, W); Fuckel, Fungi rhen. 1134 (*A. glaber*; K, GRO); Herbier Barbey-Boissier 1309 (FH, K, S, UPS); Herbier Barbey-Boissier 1310 (*A. glaber*; K); Karsten, Fungi fenn. 170 (BM, K); Krieger, Fungi sax. 1179 (*A. stercorarius*; BM, BPI, HBG, M, W); Libert, Reliquiae Libertianae, ser. 3, 14 (ined.; BR); Linhart, Fungi hung. 1869 (S); Niessl, Fl. Austr.-Hung. 393 (BM, BRSL, DAOM, E, FH, G, HBG, K, L, LE, M, MEL, PRC, S, W, ZT); Patouillard & Doassans, Champ. fig. des. 72 (M); Petrak, Myc. carp. 204 (*A. stercorarius*; BM, BPI, K, S); Petrak, Fl. Boh. Mor., ser. 2, 255 (*A. stercorarius*; BM, E, FH, LE, S); Petrak, Fl. Boh. Mor., ser. 2, 1995 (*A. glaber*; BM, BPI, E, M, S); Petrak, Myc. gen. 507 (*A. glaber*; BPI); Phillips, Elv. brit. 46 (BPI, K, M, MEL, S); Rabenhorst, Klotssch. Herb. viv. mycol., ed. 2, 522 (BRSL, L, LE, M, PAD); Rabenhorst & Winter, Fungi eur. 3069b (BM, G, K, L, LE, M, S, W, ZT); Rabenhorst & Winter, Fungi eur. 3069a (BM, G, HBG, K, L, LE, M, S, W, ZT); Ravenel, Fungi am. 312 (BM, BPI, E, K, NY, PAD, W); Rehm, Ascom. 1 (BM, E, K, L, M, PAD, S, W); Rehm Ascom. 1b (BM, BRSL, E, HBG, K, M, PAD, S); Roumeguère, Fungi gall. 2178 (G, K, L, NY); Sydow, Myc. germ. 1175 (*A. stercorareus*; BM, BPI, E, K, L, LE, M, PAD, S, W, ZT); Sydow, Myc. march. 362 (BM, HBG, K, S, W); Sydow, Myc. march. 587 (HBG, K, PRC, S, W); Sydow, Myc. march. 887 (BM, K, W); von Thümen, Myc. univ. 2178 (BM, BPI, BRSL, G, K, L, LE, M, MEL,

PAD, S, W, ZT); Therry, Crypt. Lyonn. 6531 (G, PAD); Therry, Crypt. Lyonn. 6697 (PAD); Vize, Micro-fungi brit. 371 (G, K, MEL, PAD).

This is an extremely variable species. Several forms, varieties and even species have been distinguished on the ground of certain more or less conspicuous characters. All these forms, however, are linked by transitions, as could be established through the study of several hundreds of rich collections.

Some of the noticeable forms that have been given names are the following. (A) The typical form, which is coarsely furfuraceous over the whole surface of the receptacle (*A. furfuraceus*, *A. furfuraceus* var. *fuscus* Pers., *Peziza stercoraria* var. *violacea* Bull.).

(B) A form with only the marginal zone of the receptacle coarsely furfuraceous and dentate; the lower regions of the surface smooth (*A. furfuraceus* var. *coronatus* Boud., *A. stercorarius* var. *pusillus* Vel.).

(C) A form with the receptacle entirely smooth and a membranous margin (*A. furfuraceus* var. *nudus* Kickx).

(D) A form with yellowish disk and finely furfuraceous receptacle (*Peziza stercoraria* var. *lutea* Bull., *A. furfuraceus* var. *flavo-virens* Pers.).

(E) A form with greenish or green disk and smooth or finely furfuraceous receptacle (*A. aerugineus* Fr., *A. marginatus* Schum.).

(F) A form with small fruit-bodies (*A. furfuraceus* var. *fallens* Heimerl, *A. minor* Vel.).

The attempts of Olive (1954a) to separate *A. stercorarius* from *A. furfuraceus* on the ground of intersterility cannot be sustained on morphological or structural grounds.

Because of the wide range of variation in this species it may sometimes be rather difficult to delimit it from related ones.

Smooth forms of *A. furfuraceus* draw their limits against *A. roseopurpurascens* by the excipular texture and the absence of pinkish or purplish intercellular pigment. It differs from *A. perplexans* by the structure of the excipulum, the more intense blue staining of the ascus-wall with iodine, and the absence of a substipitate base of the receptacle.

From the related *A. laevisporus* it can be separated by the smaller apothecia and the less dense disposition of the striae of the episporium.

Ascobolus furfuraceus is a heterothallic species (Dowding, 1931; Bistis, 1956a) of which the development was studied by Janczewski (1871), Dangeard (1907), and Gamundí & Ranalli (1963). In experiments designed to find the most favourable conditions for ascospore germination Yu (1954) registrated a strong NaOH-effect.

The origin of the episporial pigment was studied in this species by Chadefaud (1942), Le Gal (1947) and Malençon (1962).

A very common cosmopolitan species.

17. Ascobolus laevisporus Speg.—Fig. 25

Ascobolus laevisporus Speg. *in* An. Mus. nac. B. Aires **6**: 307. 1899. — Holotype: LPS 26117.

Apothecia scattered or in small coherent groups, superficial, sessile, 3–8 mm diameter. Receptacle at first globular, then expanding, and becoming scutellate, externally coarsely white-furfuraceous, greenish; margin acute, more or less denticulate. Disk slightly concave or flat, becoming dirty greenish, dotted with the protruding ends of the ripe asci. Hymenium about 175 μ thick. Hypothecium 20–25 μ thick. Flesh about 270 μ thick, of subglobular cells, 16–40 μ in diameter, accompanied by irregular undulating hyphae 6–10 μ thick. Excipulum 30–45 μ thick, composed of globular cells 10–25 μ in diameter, with round, cylindrical or pear-shaped cells only 7–12 μ wide near the margin and on the outside of the furfuraceous particles. Asci cylindric-clavate, 200–250 × 30 μ, 8-spored; the wall blue in Melzer's reagent. Ascospores ellipsoid, at first hyaline, then pinkish-violet, becoming violet, 22–27.5 × 12–13.5 μ, ornamented with closely spaced, extremely fine subparallel striae which only rarely anastomose and of which usually fifteen to twenty-five are visible on each view of the spore, with lateral mucilaginous substance. Paraphyses slender, hyaline, often branched above, about 3 μ thick, near the tip slightly enlarged up to 3–5 μ, embedded in greenish mucus.

On cow dung.

Etymology.—From Latin, laevis, smooth and spora, a seed: with smooth spores.

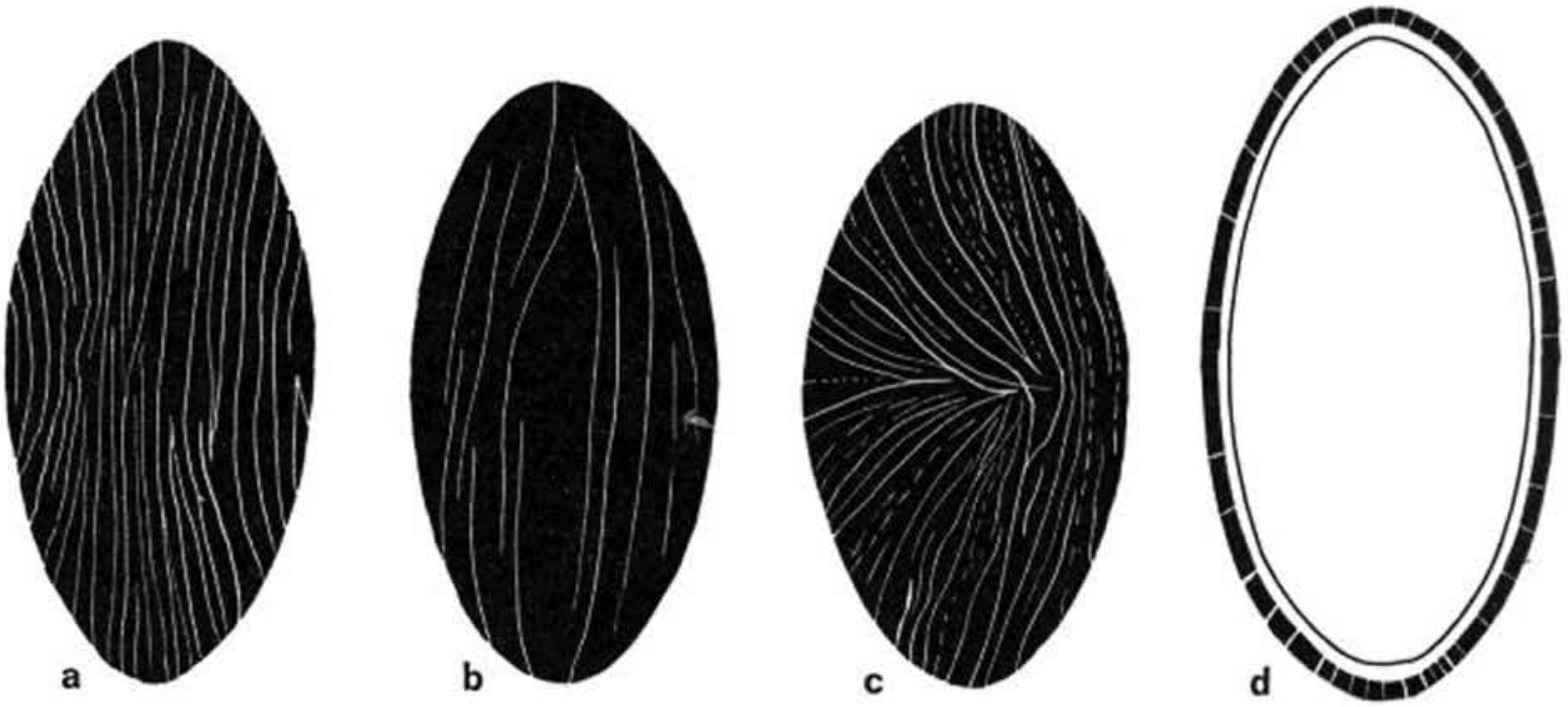


Fig. 25. — *Ascobolus laevisporus:* a–c, ascospores; d, ascospore in optical section. (All × 1600; from holotype.)

Illustration.—van Brummelen *in* Persoonia **2**: 195 *f. 1*. 1962.

Specimens examined (All specimens cited were collected on cow dung).—**U.S.A.**: Alabama: *Peters 800*, Alabama super., VI.1855 (FH).

Brazil: *Rick*, São Leopoldo, Rio Grande do Sul, 1929 (FH-A3169).

Argentina: *Spegazzini*, La Plata, 23.VIII.1888 (holotype of *A. laevisporus*, LPS 26117).

Obviously very close to *A. furfuraceus*. It may be distinguished by the larger apothecia and the closely spaced fine striae of the episporium.

The type specimen was found to be in a rather poor condition.

This species is only known from North and South America.

18. Ascobolus michaudii Boud.—Fig. 26; Pl. 8, figs. D–F

Ascobolus michaudii Boud., Icon. mycol., Liste prélim. champ., unnumbered page. 1904 (nomen nudum); Boud., Hist. Class. Discom. Eur. 71. 1907 (with description); Boud., Icon. mycol., preliminary text, Ser. 6: 22. 1909; Boud., Icon. mycol., Ser. 6. Livr. 27, *pl. 593* (definitive number: 409). 1910; Boud., Icon. mycol., definitive text, 232. 1911. — Holotype: *Michaud*, on horse dung, Alix, Department Rhône, France, *s. dat.* (PC-A2196).

Ascobolus citrinus Schweizer *in* Z. Bot. **15**: 529, *f. 1, 3.* 1923. — Type: not known to be in existence, represented by Schweizer l.c.; type locality, Lustnau near Tübingen, Germany.

Apothecia gregarious or scattered, superficial, substipitate or with a short stalk, 0.7–2.5 mm diameter, 0.8–2.0 mm high. Receptacle at first closed, globular, barrel-shaped or cylindrical, then opening and expanding, finally more or less obconical or with a short stalk, yellow or lemon-yellow, covered with very small whitish grains, mealy or scurfy, rarely almost smooth; the margin dentate or mealy, finally almost smooth. Disk concave or flat, finally slightly convex, yellow or greenish-yellow, dotted with the purplish-black protruding tips of ripe asci. Hymenium about 140 μ thick. Hypothecium 20–25 μ thick, of closely compacted isodiametric cells 4.5–10 μ diameter. Flesh of subglobular cells 7–18(–44) μ diameter, hyaline. Excipulum of varying thickness, of subglobular, ellipsoid or angular cells 19–38(–55) μ diameter (textura globulosa or angularis), lemon-yellow, covered with small groups of globular or ellipsoid cells 10–32 × 10–23 μ. Asci clavate-cylindrical, gradually tapering downwards, rounded above, 180–280 × 22–26 μ, 8-spored; the wall blue in Melzer's reagent. Ascospores uniseriate, finally biseriate, ellipsoid; at first hyaline, then pale or dark violet, finally sometimes brownish; 17–22 × 9.5–12 μ; ornamented with more or less longitudinal or oblique, rather widely spread, rarely anastomosing lines; with unilateral mucilaginous substance. Paraphyses simple or branched, septate, cylindrical or clavate, 2.2–3.5(–7) μ thick, enlarged, narrowed or forked above, at the apex 1.5–12 μ thick, hyaline, embedded in abundant greenish-yellow mucus.

On dung of cow, horse, and rabbit.

Etymology.—After Monsieur Michaud.

Illustrations.—Boudier, Icon. mycol., Ser. 6, livr. 27, *pl. 593* (definitive no.: 409). 1910; Schweizer *in* Z. Bot. **15**: 530 *f. 1*, 532 *f. 3.* 1923 (*A. citrinus*).

Specimens examined.—**Netherlands**: *van Brummelen 706*, on dung of rabbit, Elswout, Overveen, 13.VII. 1959 (L); *van Brummelen 710*, on dung of rabbit, Elswout, Overveen, 14.VIII.1959 (L).

France: *Michaud*, on horse dung, Alix, Department Rhône, *s. dat.* (type of *A. michaudii*, PC-A2196).

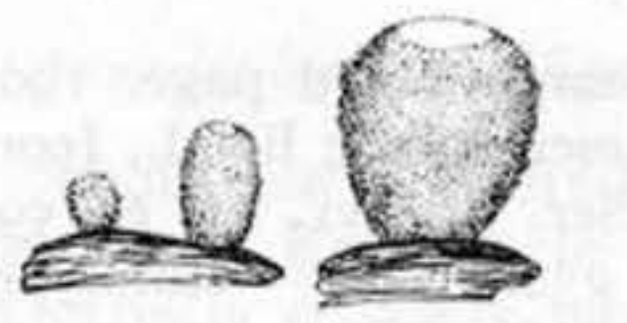
Poland: *Falck 7*, cultures, University of Breslau (= Wrocław), III.1901 (S-A757).

Czechoslovakia: *Velenovský*, on rabbit dung, Mnichovice, IV.1929 (*A. leporinus* Vel., PR 149480); *Velenovský*, on hare dung, Mnichovice, V.1929 (*A. leporinus* Vel., PR 149362).

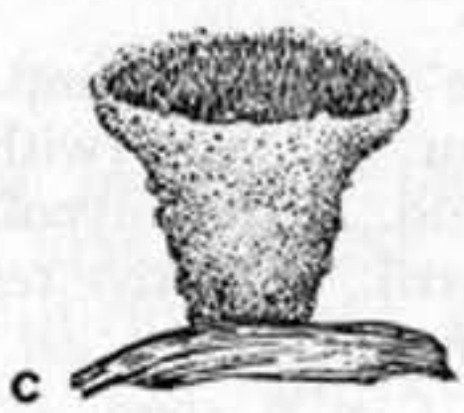
Canada: *Cain*, on cow dung, Glencoe, Middlesex, Ontario, 12.VII.1932 (TRTC 35285).

This species, which is known from Europe and Canada, is characterized by the rather small substipitate or stalked, lemon-yellow apothecia and by the ornamentation of the episporium. It is related to *A. furfuraceus*, *A. cervinus*, and *A. crenulatus*.

Two collections identified by Velenovský as *Ascobolus leporinus* Vel. belong to this species. On the substratum of the type of *A. leporinus* Vel. (PR 150301), however,


a

b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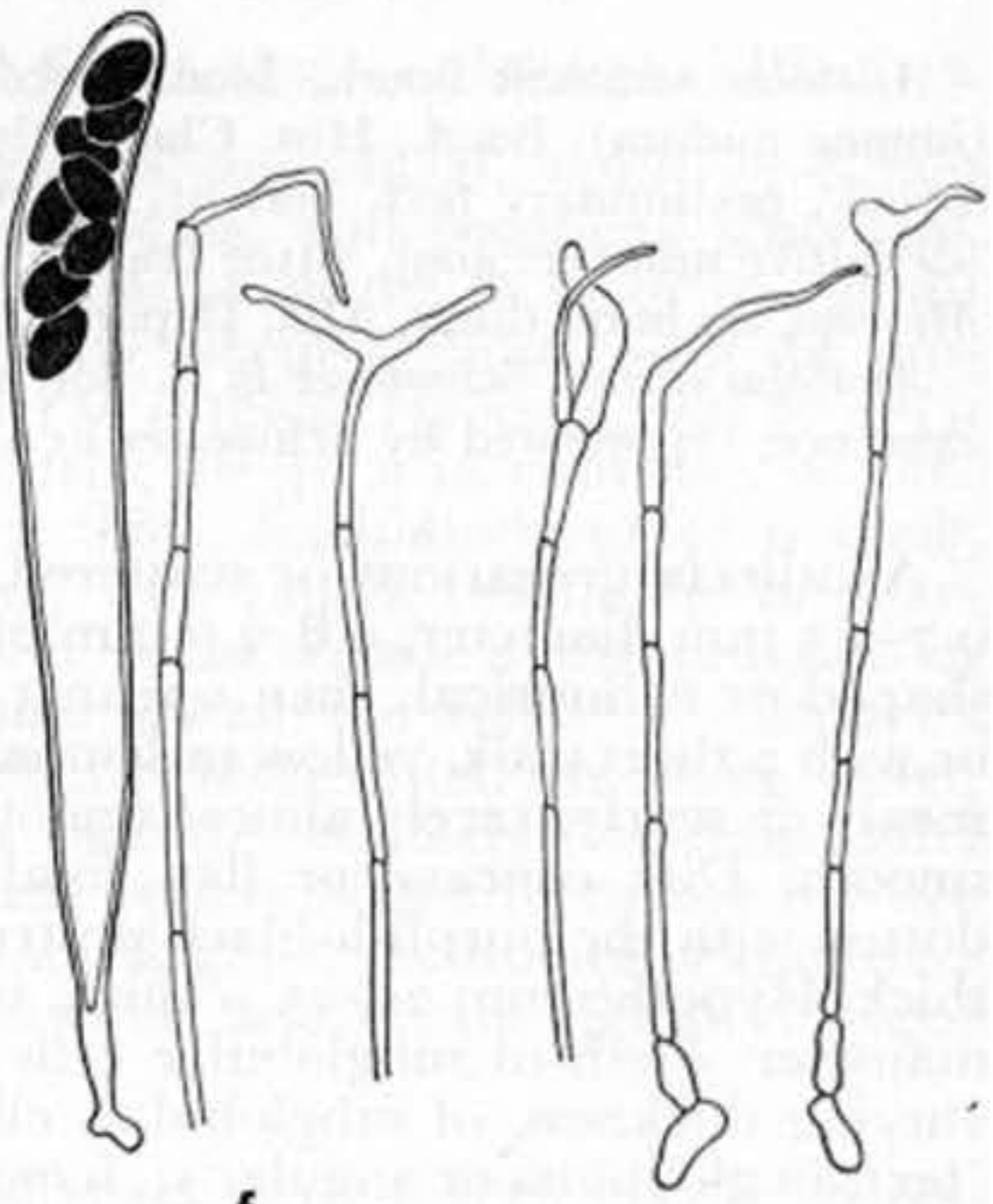
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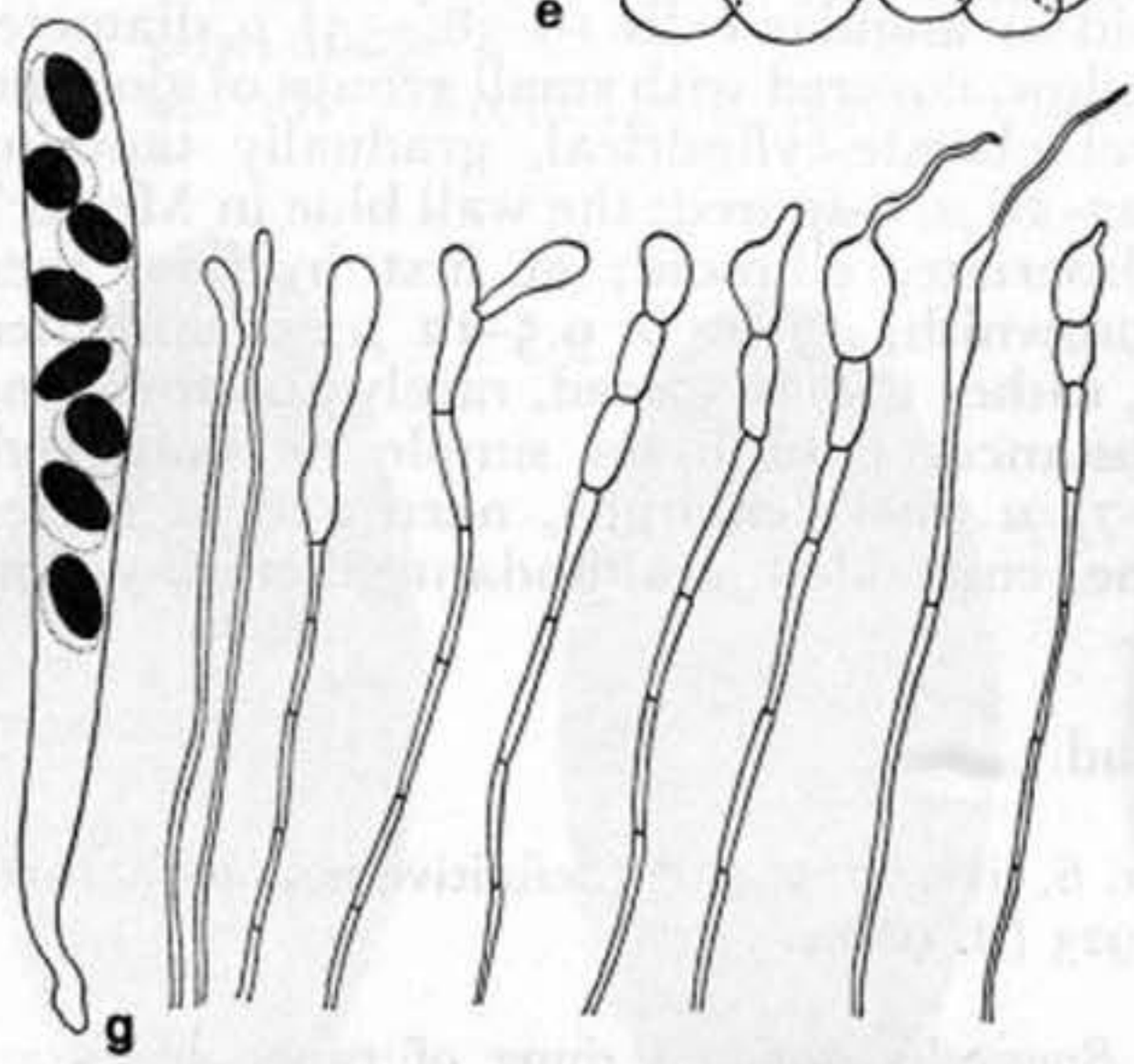
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Fig. 26. — *Ascobolus michaudii:* a–d, habit of fruit-bodies × 15; e, texture of excipulum seen from outside × 275; f, g, asci and paraphyses × 275; h–m, ascospores × 1600. (From *van Brummelen 706* and *710*.)

no apothecia could be found. The short, inadequate, original description by Velenovský (1939: 201) does not agree with *A. michaudii*, so *A. leporinus* Vel. is considered a nomen dubium (cf. p. 224).

Different parts of the fruit-body show a rather complex staining of their hyphal walls and contents with iodine. The tips of paraphyses may show very different shapes. It has often been observed in this species that clavate tips of paraphyses grow out to give rise to filiform or branched tips.

It can easily be cultured.

19. Ascobolus crenulatus P. Karst.—Fig. 27; Pl. 8, figs. A–C

Ascobolus crenulatus P. Karst., Fungi Fenn. exs. No. 763. 1868; *in* Notis. Sällsk. Fauna Fl. fenn. Förh. **11**: 202. 1870. — Type distribution: Fungi Fenn. No. 763.

Ascobolus viridulus Phill. & Plowr. *in* Grevillea **8**: 103. 1880. — Type specimen: destroyed

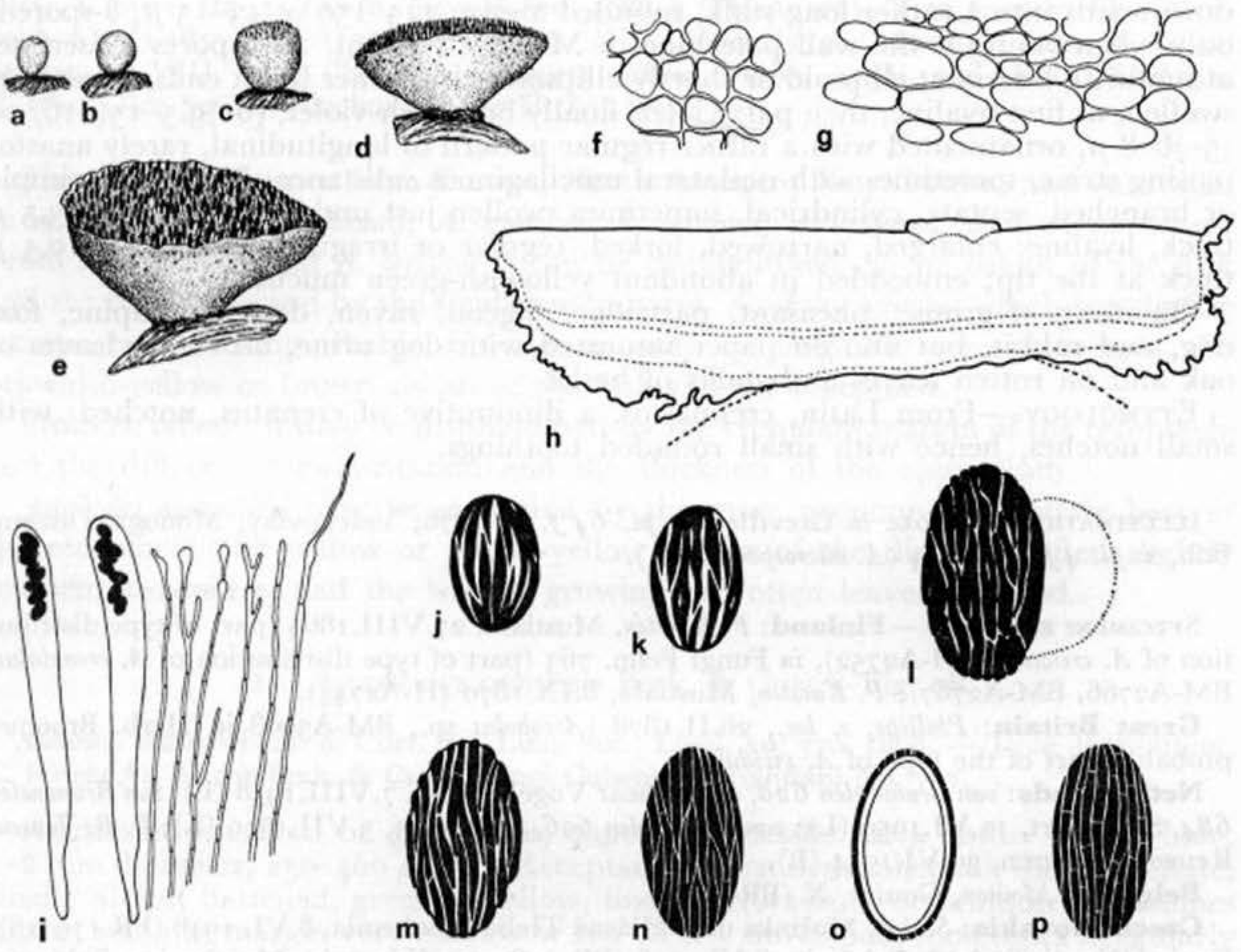

Fig. 27. — *Ascobolus crenulatus:* a–e, habit of fruit-bodies × 12; f, g, texture of excipulum seen from outside, near base (f) and margin (g) of receptacle × 275; h, diagrammatic section of fruit-body × 140; i, asci and paraphyses × 275; j–n, p, ascospores × 1600; o, ascospore in optical section × 1600. (a–l, from *van Brummelen 684*; m–p, from type of *A. crenulatus*, H-A2752.)

by insects. — Type: represented by a drawing by Phillips (BM)); type locality, Shrewsbury, British Isles.

Ascobolus microsporus Vel., Monogr. Discom. Boh. **1**: 365, **2**: *pl. 4 f. 33.* 1934; not *Ascobolus microsporus* Berk. & Broome *in* Ann. Mag. nat. Hist. III **15**: 449. 1865. — Type (selected by Svrček): PR 150307.

Apothecia gregarious, superficial, sessile or rarely substipitate, 0.3–1.8 mm diameter, 0.2–0.9 mm high. Receptacle at first subglobular and closed, then opening and expanding, becoming hemispherical, greenish-yellow or pale olive-green, coarsely or finely furfuraceous or granulated, especially near the margin, rarely almost smooth, with prominent crenulate margin. Disk concave, then flat, greenish-yellow, dotted with the dark purplish tips of ripe asci. Hymenium 115–140 μ thick not always clearly differentiated, of closely compacted isodiametric cells 4.5–7 (–15) μ. Flesh of varying thickness, of isodiametric or oblong cells 4.5–20 × 4.5–14 μ, hyaline. Excipulum 15–30(–65) μ thick, of globular, subangular or oblong rather thick-walled cells 7–30(–40) × 7–20 μ (textura globulosa or angularis); the walls pale yellowish; margin consisting of fragments of excipular layer covered with groups of subglobular cells 20–37 μ diameter. Asci cylindric-clavate, tapering downwards into a rather long stalk, rounded above, 125–150 × 13–15 μ, 8-spored; only when young is the wall pale blue in Melzer's reagent. Ascospores uniseriate, at maturity biseriate; ellipsoid or shortly ellipsoid with rather blunt ends, sometimes swollen, at first hyaline, then pale violet, finally brownish-violet, (8–)9.5–15(–16) × (5–)6–8 μ, ornamented with a rather regular pattern of longitudinal, rarely anastomosing striae, sometimes with unilateral mucilaginous substance. Paraphyses simple or branched, septate, cylindrical, sometimes swollen just under the septae, 2–3.5 μ thick, hyaline; enlarged, narrowed, forked, regular or irregular above, 2.0–10.5 μ thick at the tip; embedded in abundant yellowish-green mucus.

On dung of grouse, pheasant, partridge, pigeon, raven, deer, porcupine, fox, dog, and rabbit, but also on paper saturated with dog urine, on rotten leaves of oak and on rotten leaves and stalks of herbs.

ETYMOLOGY.—From Latin, crenulatus, a diminutive of crenatus, notched: with small notches, hence with small rounded toothings.

ILLUSTRATIONS.—Cooke *in* Grevillea **4**: *pl. 64 f. 6.* 1876; Velenovský, Monogr. Discom. Boh. **2**: *pl. 4 f. 33.* 1934 (*A. microsporus* Vel.).

SPECIMENS EXAMINED.—**Finland**: *P. Karsten*, Mustiala, 27.VIII.1869 (part of type distribution of *A. crenulatus*, H-A2752), *in* Fungi Fenn. 763 (part of type distribution of *A. crenulatus*, BM-A2766, BM-A2767); *P. Karsten*, Mustiala, 8.IX.1870 (H-A2744).

Great Britain: *Phillips, s. loc.*, 26.II.1878 (*Ascobolus* sp., BM-A3008 in Herb. Broome, probably part of the type of *A. viridulus*).

Netherlands: *van Brummelen 628*, dunes near Vogelenzang, 7.VIII.1958 (L); *van Brummelen 684*, Santpoort, 11.VI.1959 (L); *van Brummelen 696*, Santpoort, 3.VII.1959 (L); *P. B. Jansen*, Reuzelse Moeren, 30.VI.1954 (L).

Belgium: *Mouton*, Gomzé, X (BR-A307).

Czechoslovakia: *Svrček*, Mořinka near Hlásná Třebáň, Bohemia, 8.VI. 1946 (PR 179016); *Vacek*, Hlásná, Třebáň, Bohemia, 8.VI.1946 (PR 178992); *Velenovský*, Mnichovice, Bohemia, 29.VIII.1925 (*Ascobolus laevis* Vel., an unpublished name, PR 150254); *Velenovský*, lacus Božkov, Mnichovice, Bohemia, 20.X.1928 (*A. microsporus*, PR 150180); *Velenovský*, Kunice, VI.1931 (lectotype of *A. microsporus* Vel., PR 150307); *Velenovský*, Mnichovice, XI.1933 (*A. microsporus*, PR 150305).

Australia: unknown collector, Apollo Bay, Victoria, 19.V.1936 (Melbourne Univ. dept. Bot.).

New Guinea: *van Brummelen 1990*, Kapul NE (alt. 3000 m.), near Tari, Southern Highands, 1.VIII.1966 (L).

Canada: *Cain*, Fenelon Falls, Ontario, 15.IX.1931 (TRTC 34705); *Cain*, south of Dorset, Haliburton Co., Ontario, 19.IX.1931 (TRTC 34703); *Cain*, Gull Lake Portage, Lake Timagami, Ontario, 27.VI.1932 (TRTC 34697); *Cain*, Little Cross, Lake Timagami, Ontario, 21.VIII.1933 (NY, TRTC 34704); *Cain*, Diamond Lake, Timagami, Ontario, 2.IX.1935 (TRTC 34698); *Cain 6637*, Aurora, Ontario, 2.V.1936 (TRTC); *Cain 6692*, Lake Timagami, Ontario, 11.IX.1936 (TRTC); *Cain 12016*, Bear Island, Lake Timagami, Ontario, 15.VIII.1938 (TRTC); *Cain 6867*, Ste. Catharine, Quebec, 25.VIII.1938 (TRTC); *Cain 6907*, Duchesnay, Quebec, 26.VIII.1938 (TRTC); *Cain 6906 and 6908*, Camp Mercier, Laurentides Park, Quebec, 27.VIII.1938 (TRTC); *Cain*, along Grand River, North of Whiteman's Creek, Brant Co., Ontario, 20.XI.1943 (TRTC 34693); *Cain*, Gomphidius Bay, Lake Timagami, Ontario, 31.VIII.1956 (TRTC 34696); *Cain*, Purbrook, Muskoka, Ontario, 2.IX.1956 (TRTC 33390); *Jackson & Cain*, Timagami Island, Lake Timagami, Ontario, 10.VIII.1931 (TRTC 34709).

U.S.A.: Wisconsin: *G. W. Martin 1251*, Monico, 28.VIII.1932 (NY, TRTC). New Hampshire: *C. H. Martin 701*, 26.IV.1917 (BPI). New York: *Smith & Rogerson*, Brookhaven Nat. Laboratory, Suffolk Co., 21.X.1958 (NY). Massachusets: *Linder*, Canton, XII.1933 (FH). Connecticut: *Thaxter*, New Haven, 1888–9 (FH-A3102). New Jersey; *Ellis*, Newfield, 1.VIII.1875 (NY-A1310). Virginia: *S. L. Meyer 14730*, Mountain Lake Biological Station, 21.VIII. 1942 (TRTC). Georgia: *Shear*, Tifton, 24.IV.1932 (BPI). Florida: *E. West*, Glen Spring, Alachua Co., 12.II.1935 (NY).

This species is known from Europe, North America, New Guinea, and Australia. It is related to *A. michaudii*, *A. minutus*, *A. cervinus*, *A. cubensis*, and *A. costantinii*. From *A. michaudii* and *A. cervinus* it can be distinguished by the colour of the disk and the receptacle and by the smaller ascospores. *Ascobolus minutus* which has similar ascospores is distinguishable by the smooth, immarginate receptacle and the brownish-yellow or brown colour of the disk and the receptacle.

From *A. cubensis* it may be distinguished by the crenulate margin of the receptacle and the different ornamentation and the thickness of the episporium.

Ascobolus costantinii may be separated by the more pronounced stipitate base of the receptacle, the yellow or lemon-yellow colour of the disk, the often slightly fusiform ascospores, and the way of growing on rotten leaves or wood.

20. Ascobolus cubensis Berk. & Curt.—Fig. 28

Ascobolus cubensis Berk. & Curt. *in* J. Linn. Soc., Lond. **10**: 370. 1868. — Type distribution: *C. Wright No. 627 in* Berk. & Curt., Fungi Cubenses Wrightiani No. 707.

Apothecia scattered or gregarious, superficial, sessile on a rather broad base, 1–2 mm diameter, 250–400 μ high. Receptacle at first hemispherical, then scutellate, finally almost flattened, greenish-yellow, finely furfuraceous or pruinose, sometimes almost smooth; margin very narrow or not clearly developed, sometimes irregularly rough in young fruit-bodies. Disk slightly concave or flat, finally sometimes slightly convex, greenish-yellow ('viridiflavus'), dotted with the dark protruding tips of ripe asci. Hymenium 120–140 μ thick. Hypothecium clearly differentiated, 35–50 μ thick, of compacted isodiametric cells 4–14 μ diameter. Flesh 160–200 μ thick, of somewhat irregularly oblong cells 21–35 × 12–16 μ, hyaline. Excipulum 15–30 μ thick, of subglobular or oblong cells 20–37 × 12–30 μ, pale brownish, covered with

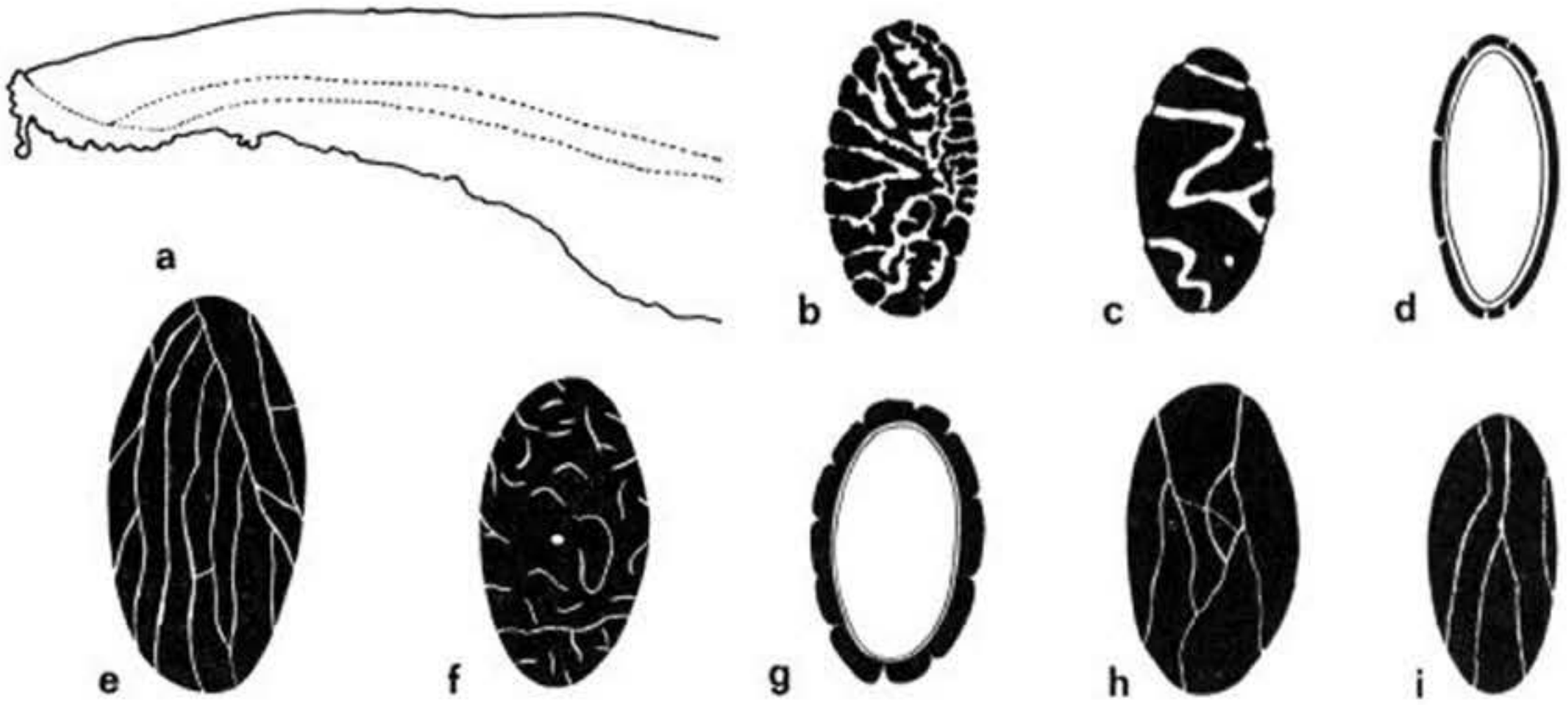

Fig. 28. — *Ascobolus cubensis:* a, diagrammatic section of fruit-body × 65; b, c, e, f, h, i, ascospores × 1600; d, g, id. in optical section. (From Fungi Cubenses Wrightiani 707, K.)

small groups of subglobular cells. Asci cylindric-clavate, gradually tapering downwards into a narrow base, rounded above, 150–180 × 11–13 μ, 8-spored, but often with only a part of the spores developed; the wall not blue in Melzer's reagent. Ascospores uniseriate to biseriate, ellipsoid, at first hyaline, (then probably violet) finally pale purplish-brown; 11.5–14 × 6–7.5 μ in 8-spored asci, sometimes up to 17.5 × 9 μ in 2-spored asci. Episporium with extremely variable ornamentation: with few or many longitudinal, occasionally anastomosing lines, or with repeatedly anastomosing or reticulating lines, or with short curved or irregularly bending lines, or with irregular more or less transversal lines; pigment often in a thick layer up to 1.3 μ thick. Paraphyses simple or branched, septate, filiform, 2.0–2.5 μ thick, thickened, narrowed or curved above, 2.0–7.5 μ thick at the tip, embedded in greenish-yellow mucus.

On hogs' dung.

ETYMOLOGY.—From Cuba.

SPECIMENS EXAMINED—**Cuba**: *Wright 627*, on dung of pig, XII, in Berkeley & Curtis, Fungi Cubenses Wrightiani 707 (type distribution of *A. cubensis*, BM, FH, K, PC).

This is obviously very close to *A. crenulatus* of which it might be an extreme variation. It may be distinguished by the very narrow margin of the receptacle, and by the thickness and the ornamentation of the episporium.

Unfortunately this fungus has never been found a second time.

21. ASCOBOLUS MINUTUS Boud.—Fig. 29; Pl. 8, fig. G

Ascobolus minutus Boud. *in* Bull. Soc. bot. Fr. **34** (Session Cryptog. 1887): XLVIII *pl. 2 f. 1.* 1888; Boud. *in* Bull. Soc. mycol. Fr. **4**: XLVIII *pl. 2 f. 1.* 1888; Boud., Icon. mycol., Ser. 3, livr. 12, *pl. 292* (definitive no.: 411). 1907. Boud., Icon. mycol., definitive text, 233. 1911. — Holotype: Boudier on fox dung, Montmorency, France, II.1881 (*A. parvisporus*, PC-A2197). → *Ascobolus parvisporus* Boud.

Ascobolus parvisporus Boud., Icon. mycol., Liste prélim. champ., unnumbered page, 1904 (nomen nudum); not *Ascobolus parvisporus* Renny *in* Trans. Woolhope Nat. Field Club 1873: 131. 1873. ≡ *Ascobolus minutus* Boud.

Apothecia scattered or gregarious, superficial, sessile on a small base, 0.3–1.2 mm diameter, 0.2–0.4 mm high. Receptacle at first closed and subglobular, then opening and obconical or hemispherical, finally expanding and lenticular or discoid, brownish-yellow to brown, smooth; margin rarely differentiated. Disk flat or slightly convex, brownish-yellow, dotted with the almost black protruding ends of ripe asci. Hymenium about 140 μ thick. Hypothecium not clearly differentiated. Flesh 150–200 μ thick, of isodiametric or oblong cells 5–20 × 5–15 μ, hyaline. Excipulum 15–20 μ thick; of oblong or isodiametric, more or less angular thin-walled cells 7–24 × 5–12 μ (textura angularis, the largest cells near the margin), with intercellular, pale brown pigment, especially between the superficial cells. Asci cylindric-clavate, gradually tapering downwards into a thin stalk, rounded above, 140–170 × 13–14 μ (according to Boudier, 1888: XLVIII), 8-spored; the wall only pale blue in Melzer's reagent. Ascospores uniseriate to biseriate, ellipsoid, at first hyaline, then violet, finally purplish-brown, 12.5–14.5 × (6.5–)7–8.5 μ, ornamented with very regular longitudinal striae that only rarely anastomose. Paraphyses simple or branched, cylindrical, about 2 μ thick, slightly clavate above, up to 7 μ thick at the tip, hyaline, embedded in yellow mucus.

On dung of fox, hare, and rabbit.

ETYMOLOGY.—From Latin, minutus, small.

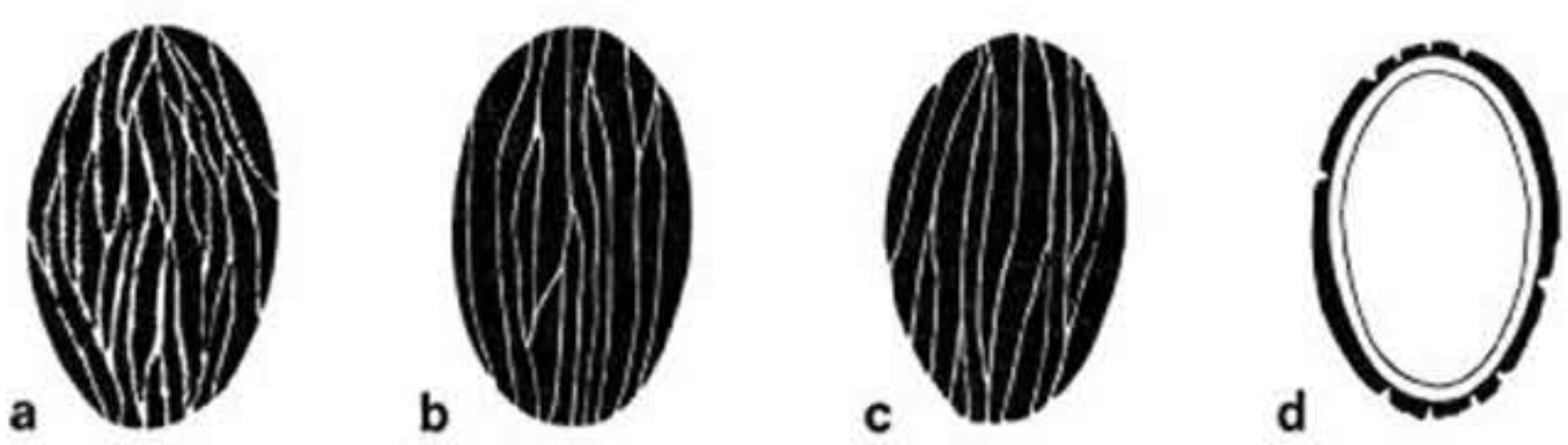

Fig. 29. — *Ascobolus minutus:* a–c, ascospores; d, ascospore in optical section. (All × 1600; from holotype.)

ILLUSTRATIONS.—Boudier *in* Bull. Soc. bot. Fr., Session cryptog. 1887: *pl. 2 f. 1.* 1888; Boudier *in* Bull. Soc. mycol. Fr. **4**: *pl. 2 f. 1.* 1888; Boudier, Icon. mycol., Ser. 3, livr. 12, *pl. 292* (definitive no.: 411). 1907.

SPECIMENS EXAMINED.— **Great Britain**: *Travis*, on rabbit dung, Walton, Liverpool, 15.II.1930 (BM-A3035).

France: *Boudier*, on fox dung, Montmorency, II.1881 ("*A. parvisporus* Boud.", holotype of *A. minutus*, PC-A2197); Crouan, on dog dung, *s. loc.*, 22.II.1867 (CONC-A2409).

Czechoslovakia: *Bubák*, on hare dung, Radotin, near Praha, Bohemia, IX.1899 (S-A668).

U.S.A.: New York: *B. O. Dodge*, on dog dung, Columbia University, New York, 5.X (NY-A1091).

A rare species, related to *A. crenulatus*, from which it may be distinguished by the completely smooth, immarginate receptacle, the brownish-yellow colour, and the slightly larger ascospores.

22. **Ascobolus lineolatus** Brumm., *spec. nov.*—Fig. 30; Pl. 9, figs. A–F

Apothecia sessilia, usque ad 1 mm diam. Receptaculum initio subglobulare, deinde hemisphaericum, denique paullo applanatum, virescens, granulatum, margine interdum crenulato. Excipulum textura globulosa. Asci cylindrico-clavati, 130–150 × 15–18 μ, 8-spori, pariete iodo haud caerulescente. Ascosporae ellipsoideae, primum hyalinae, tum violascentes, 13–14.5 × 7.5–8.5 μ, lineis delicatissimis, parum inter sese distantibus, transversis vel obliquis, subparallelis, iterum et iterum anastomosantibus ornatae. Paraphyses ramosae, cylindricae, 2–2.5 μ crassae. — Ab Ascobolo crenulato imprimis ascosporarum sculptura diversus. Fimum muris ratti incolit. Typus: *van Brummelen 1981* (L).

Apothecia scattered, superficial, sessile, up to 1.0 mm across, 0.4–0.5 mm high. Receptacle at first subglobular and closed, then opening and hemispherical with an obconical base, finally slightly flattened, greenish, covered with small, isolated, white granules, with a narrow, sometimes slightly crenulate margin. Disk concave, then flat, greenish, roughened by the protruding tips of ripe asci. Hymenium about 130 μ thick. Hypothecium 15–23 μ thick, of subglobular cells 4–7 μ diameter. Flesh 140–200 μ thick, of subglobular, angular or oblong cells 7–42 × 6–23 μ, hyaline. Excipulum near the margin 28–35 μ thick, near the base up to 75 μ thick, of subglobular or elongated cells 8–35 × 8–23 μ (textura globulosa), at the base mainly consisting of a layer of closely compacted, intertwined, cylindrical, septate hyphae 3.5–6 μ wide, pale yellowish-brown, covered with small isolated groups of globular cells. Asci cylindric-clavate, tapering downwards, rounded above, 130–150 × 15–18 μ, 8-spored; the wall not blue in Melzer's reagent. Ascospores biseriate; ellipsoid; at first hyaline, then violet; 13–14.5 × 7.5–8.5 μ; ornamented with very delicate, closely spaced, transverse or oblique, subparallel lines that anastomose repeatedly; pigment very thin, about 0.3 μ thick. Paraphyses branched, septate, cylindrical, 2.0–2.5 μ thick, not or scarcely enlarged at the tip, embedded in greenish mucus.

Only known from dung of rat.

Etymology.—From Latin, lineolatus, marked with fine or obscure lines.

Specimens examined.—**Bermuda**: *Brown et al. 1296*, on rat dung (in culture), 29.XI.–14.XII.1912 (NY).

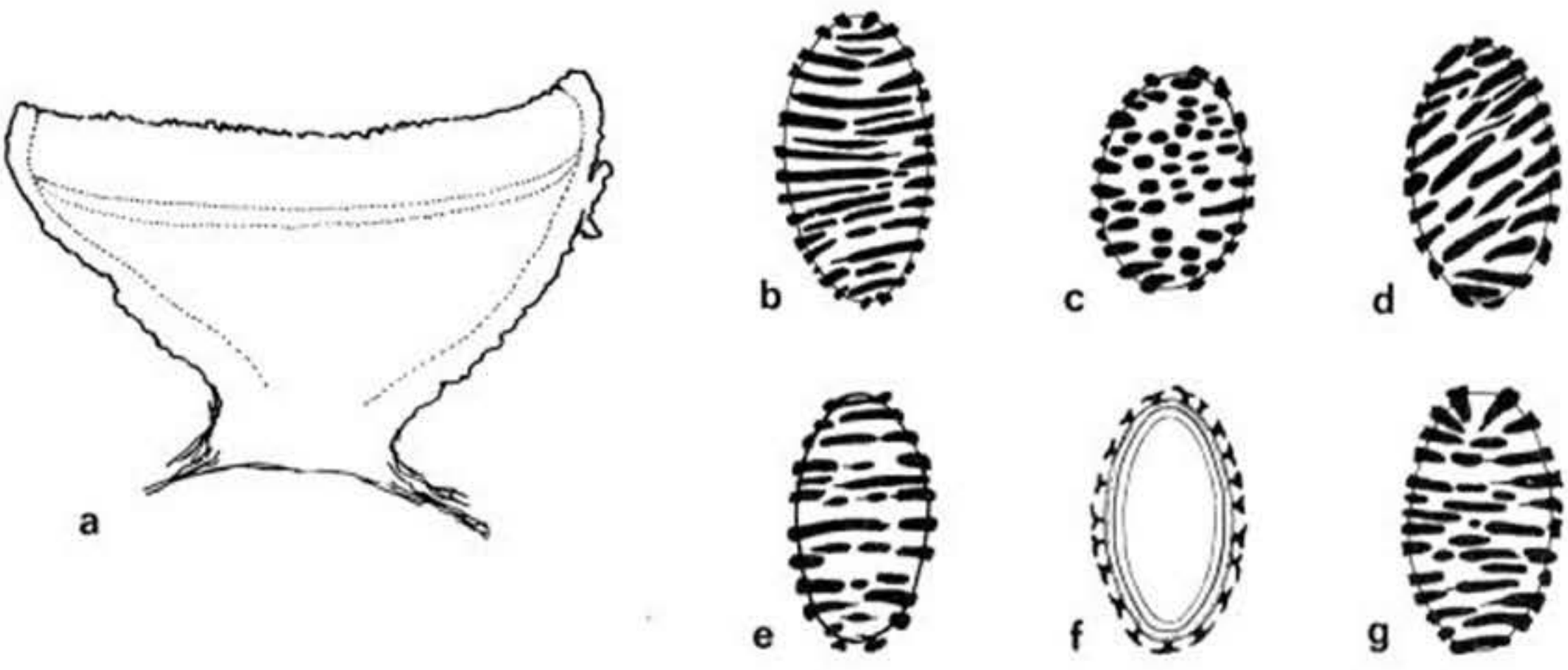

Fig. 30. — *Ascobolus lineolatus:* a, diagrammatic section of fruit-body × 50; b–e, g, ascospores × 1600; f, ascospore in optical section × 1600 (different layers of primary spore wall, staining differently with trypan blue). (a–c, from *Brown et al. 1296*; d–g, from type.

North Borneo: *van Brummelen 1981*, on dung of rat (comm. Dr. Ding Hou), Mesilau Camp (alt. 1500 m). Mt. Kinabalu, 4.VII.1966 (type of *A. lineolatus*, also subcultured on sterilized horse dung, L).

Of this species fine cultures from North Borneo could be studied. It is only known from rat dung of two very remote localities. It is related to *A. crenulatus*, from which it differs in the smaller apothecia and the ornamentation of the episporium.

The episporium of *A. lineolatus* consists of a pattern of transverse or oblique, subparallel crevices that anastomose repeatedly. The crevices, however, are broad and the ribbons of pigment relatively narrow. Therefore the episporium may look like subparallel rows of short ribbons of pigment. These ribbons are T-shaped in transverse section and rest with their narrow side on the primary spore-wall (Fig. 30f).

23. Ascobolus crosslandii Boud.—Fig. 31; Pl. 9, fig. G

Ascobolus crosslandii Boud. *in* Bull. Soc. mycol. Fr. **14**: 126 *pl. 11 f. 2.* 1898 ("crowslandi"). — *Boudiera crosslandii* (Boud.) Mass. *in* Naturalist, Lond. 1901: 179. 1901. — *Sphaeridiobolus crosslandii* (Boud.) Boud., Hist. Class. Discom. Eur. 73. 1907. — Holotype: *Soppitt* (comm. Crossland), on dung of dog, near Salterhebble, near Halifax, England, 24 and 31.X.1897 (PC-A2218).

Apothecia scattered or in small groups, superficial, sessile, 0.5–2.0 mm across, about 0.6 mm high. Receptacle at first subglobular, then hemispherical, finally expanding; yellowish-green, blackish-brown when dry, smooth or finely furfuraceous, with an irregular dentate margin. Disk concave, then flat, yellowish-green, dotted with the black protruding tips of ripe asci. Hymenium up to 200 μ thick. Hypothecium up to about 30 μ thick, of subglobular or oblong cells 4–10 × 3–6 μ. Flesh up to about 400 μ thick, of subglobular or elongated cells 8–20 × 7–16 μ, hyaline. Excipulum near the margin 19–25 μ thick, in the lower part 26–38 μ thick; of subglobular cells (7–)12–24 μ diameter (textura globulosa), hyaline or brownish; covered with small groups of globular cells. Asci clavate, gradually tapering downwards, rounded above, '170–200 × about 25 μ' (according to Soppitt & Crossland 1899, p. 30: 130–170 × 16–20 μ), 8-spored; the wall clearly blue in Melzer's reagent. Ascospores at first uniseriate, finally irregularly biseriate, spherical, at first hyaline, then violet, finally becoming brownish, 11.5–13.4 μ diameter, ornamented with sinuous, subparallel, occasionally anastomosing lines, often together with rows of small pits. Paraphyses simple, septate, cylindrical, 2–4 μ thick, not thickened to strongly swollen at the apex, 2–11 μ thick at the tip, embedded in yellow mucus.

On dung of dog.

Etymology.—After C. Crossland, the British amateur mycologist, who sent the material to Boudier.

Illustrations.—Boudier *in* Bull. Soc. mycol. Fr. **14**: *pl. 11 f. 2.* 1898 ("*A. crowslandi*"); Soppitt & Crossland *in* Naturalist, Lond. 1899: 31 *f. 9–13.* 1899; Dennis, Brit. Cup Fungi *pl. VIII f. E.* 1960 (*Sphaeridiobolus*).

Specimen examined.—**Great Britain**: *Soppitt* (comm. Crossland), on dog dung, near Salterhebble, near Halifax, "XI.1897" (24 and 31.X.1897) [lectotype of *A. crosslandii* ("*A. crowslandi*"), PC-A2218].

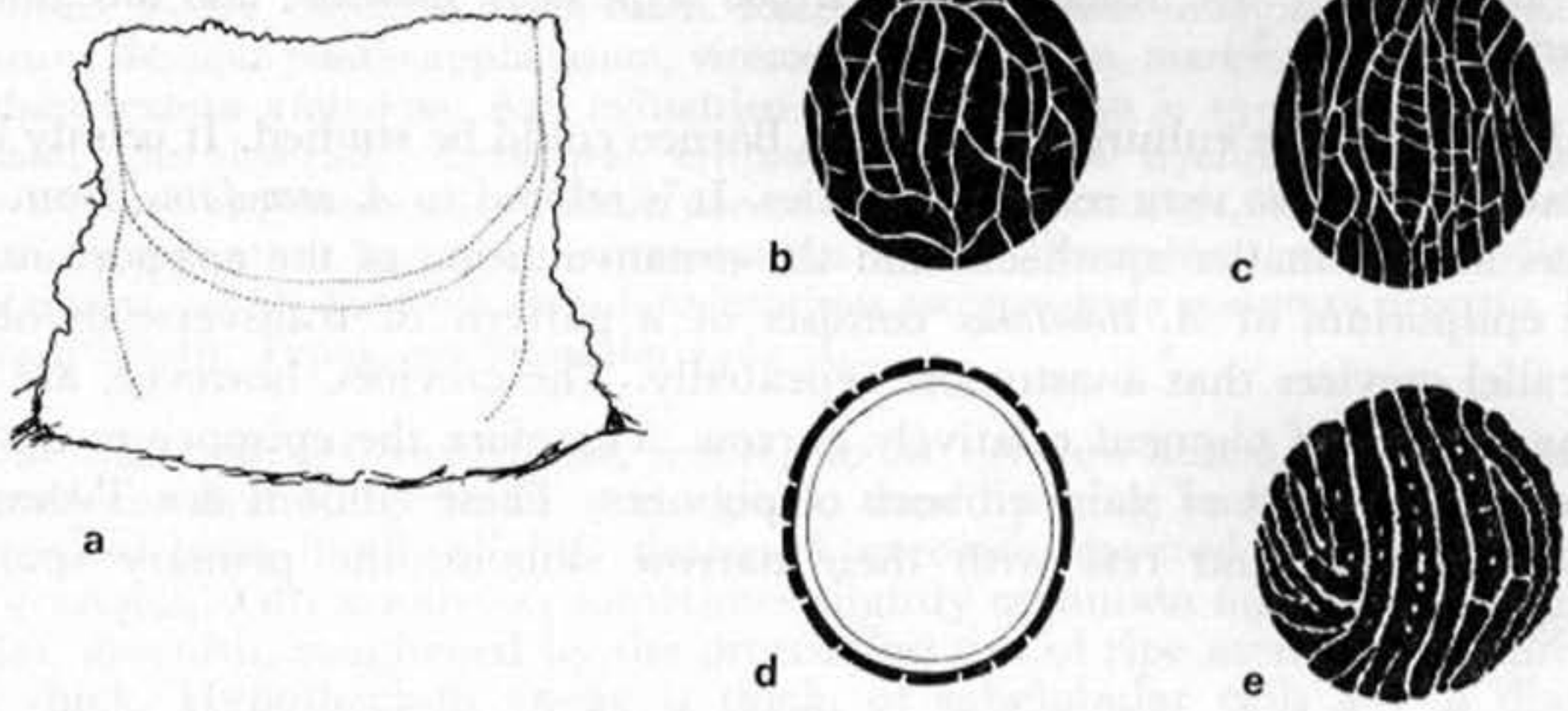

Fig. 31. — *Ascobolus crosslandii:* a, diagrammatic section of fruit-body × 110; b, c, e, ascospores × 1600; d, ascospore in optical section × 1600. (From type PC-A2218.)

When Boudier (1898) described this species he placed it in *Ascobolus* subg. *Sphaeridiobolus* (Boud.) Quél. and not in the genus *Sphaeridiobolus* Boud., erected for *Ascobolus hyperboreus* P. Karst., a species with spherical ascospores. As can be concluded from Boudier's discussion (1898) the possesion of spherical ascospores was considered less important after the study of *A. crosslandii*. This can be explained by the rather remote relationship between *A. hyperboreus* P. Karst. and *A. crosslandii*. Nevertheless, later Boudier (1907) maintained *Sphaeridiobolus* Boud. as a heterogeneous and artificial genus.

Ascobolus crosslandii shows a very close relationship with such species as *A. furfuraceus*, *A. michaudii*, and *A. crenulatus*. From these it only differs in the shape of the ascospores. On the other hand, *Ascoboius hyperboreus* P. Karst. shows characters that warrant it an intermediate position between section *Dasyobolus* and section *Ascobolus*. Therefore *A. brassicae* (syn. *A. hyperboreus* P. Karst.) and the closely related *A. nodulosporus* are retained in section *Sphaeridiobolus* (cf. p. 62).

Since spherosporical mutations were occasionally found in some species of both *Ascobolus* and *Saccobolus* which normally form ellipsoid spores, I do not hesitate to place *A. crosslandii* here.

24. **Ascobolus sacchariferus** Brumm., *spec. nov.*—Fig. 32

Apothecia sessilia, 0.7–1.7 mm diam. Receptaculum initio globulare, denique alte patellatum, album, granulatum, margine angusto. Excipulum textura angulari. Asci cylindrico-clavati, 190–226 × 16–24 μ, 8-spori, parietibus in statu juvenili iodo caerulescentibus. Ascosporae ellipsoideae, 16–20 × 9–10 μ, striis longitudinalibus anastomosantibus ornatae. Paraphyses simplices vel ramosae, cylindricae, 1.5–2.5 μ crassae, apice incrassato vel irregulari. A speciebus alteris sectionis apotheciis puralbidis diversus. Fimum cervinum incolit. Typus: *van Brummelen 661*, Elspeet, Neerlandia (L).

Apothecia scattered, superficial, sessile, 0.7–1.7 mm across, 0.5–0.8 mm high.

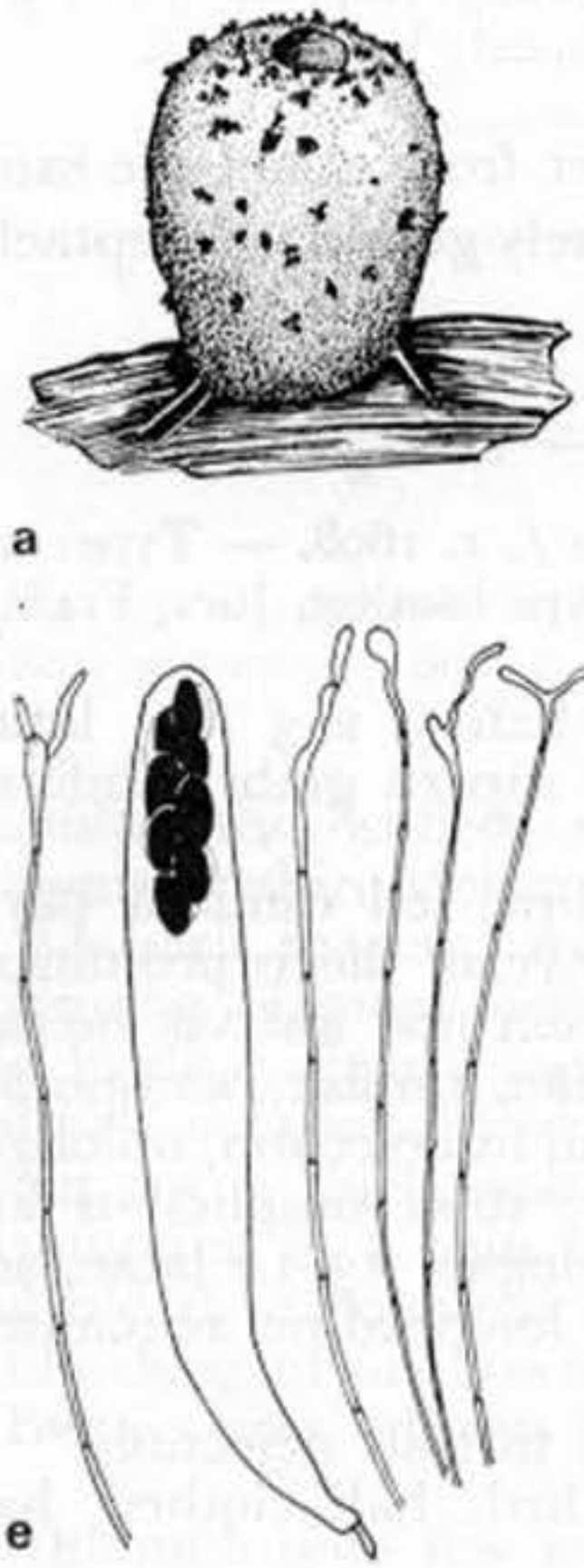

Fig. 32. — *Ascobolus sacchariferus:* a–c, habit of fruit-bodies × 20; d, median section through part of fruit-body × 40; e, ascus and paraphyses × 175; f, detail of excipulum × 275; g, ascospore × 1600. (From *van Brummelen 661.*)

Receptacle at first closed and globular, then opening at the top and hemispherical, finally high saucer-shaped, white, finally darkened by the adhering ascospores, covered regularly with fine, white granules especially at the margin, with a narrow, clearly developed margin. Disk concave then flat, white, dotted with the violet, protruding tips of ripe asci. Hymenium 150–160 μ thick. Hypothecium of isodiametric cells up to 7 μ diameter. Flesh 300–500 μ thick, of subglobular cells 16–25 μ diameter, together with cylindrical hyphae, hyaline. Excipulum about 35 μ thick near the margin, of isodiametric, thick-walled cells 16–32 μ diameter, near the margin often of more oblong cells 13–48 × 7–16 μ (textura angularis), colourless, covered with small groups of globular cells. Asci cylindric-clavate, with a slightly curved stalk, rounded above, 190–226 × 16–24 μ, 8-spored; when young the wall blue in Melzer's reagent. Ascospores at first uniseriate, finally biseriate, ellipsoid, at first hyaline, then violet, 16–20 × 9–10 μ, ornamented with longitudinal, anastomosing striae; with strongly swelling (up to 19 × 15 μ), unilateral, gelatinous cap. Paraphyses simple or branched, septate, cylindrical, 1.5–2.5 μ thick, forked, swollen or irregular above, 2.5–7 μ thick at the tip, hyaline, embedded in somewhat granular, colourless mucus.

Known only from dung of deer.

Etymology.—From Latin, saccharum, sugar and fero, to bear: sugar-bearing.

SPECIMEN EXAMINED.—**Netherlands**: *van Brummelen 661*, on deer dung, Elspeet, 13.IV.1959 (type of *A. sacchariferus*, L); *van Brummelen 1438*, on deer dung, Elspeet, V.1960 (L).

This species, which was collected twice from dung of deer from about the same locality, is sufficiently characterized by the pure white and finely granular receptacle.

25. ASCOBOLUS SEMIVESTITUS Boud.

Ascobolus semivestitus Boud. *in* Bull. Soc. mycol. Fr. **14**: 125 *pl. 11 f. 1*. 1898. — Type: not known to be in existence, represented by Boudier l.c. *pl. 11 f. 1*; type locality, Jura, France.

Boudier's specific description of *A. semivestitus* runs: "Medius, 2–3 mm latus, sessilis, luteo-virens, receptaculis marginatus dimidiâ parte superâ glabrâ, inferne albido-villosâ, hymenio thecis maturis nigro-punctato.

Receptacula sessilia, hemisphaerica, sub-marginata, glabra, sed dimidiâ parte inferâ albo-villosâ, non furfuracea, hymenio plano, dein convexo, thecis prominentibus nigro-punctato. Paraphyses graciles, septatae, ad apicem non aut vix incrassataè, et ut thecae gelatinâ luteâ immersae. Thecae operculatae, amplae, octosporae, 200–250 μ longae, 25–35 latae. Sporae pulchre violaceae, dein fuscescentes, oblongo-ellipticae, magnitudine variantes, longitudinaliter striatae, striis simplicibus aut 2–3 divisis, rarius anastomosantibus, normaliter 25–30 μ longae, 13–14 latae, sed saepè etiam in eâdem thecâ plurimae maximae, 45–50 μ longitudine aequantes, 18–24 latitudine.

In montibus juranis, Maio 1896 ad stercus vaccinum in turfosis dejectum."

ETYMOLOGY.—From Latin, semi, half and vestitus, clothed: half clothed, half covered.

ILLUSTRATION.—Boudier, l.c.

Of this species no material could be studied. Boudier's description and illustrations, however, are sufficiently detailed to ensure future recognition. Undoubtedly, it is related to *A. furfuraceus*, from which it can be distinguished by the villose inferior part of the receptacle and the larger ascospores. No explanation has been found for the occurrence of two different types of ascospores.

26. ASCOBOLUS CERVINUS Berk. & Broome—Fig. 33

Ascobolus cervinus Berk. & Broome *in* J. Linn. Soc. Lond. (Bot.) **15**: 85. 1876. — Holotype: *Thwaites No. 1122* (K), in literature cited by error as "Thwaites 422".

Apothecia gregarious or crowded, superficial, sessile on a broad base, up to 1.5 mm across, up to 0.5 mm high. Receptacle at first closed and globular, then opening at the top and hemispherical, finally expanding and scutellate, olive-green, finely furfuraceous, with a prominent margin. Disk concave to flat, olive-green. Hymenium about 130 μ thick. Hypothecium clearly differentiated, about 30 μ thick, of closely compacted subglobular cells 6–12 μ diameter. Flesh up to 300 μ thick, of isodiametric cells 12–22 μ diameter, hyaline. Excipulum 20–30 μ thick, of irregular or subglobular cells 12–15 μ diameter (the largest cells at the surface), near the base with 3.0–3.5 μ wide hyphae which connect the fruit-body with the substratum; covered with furfuraceous particles consisting of loose groups of sub-

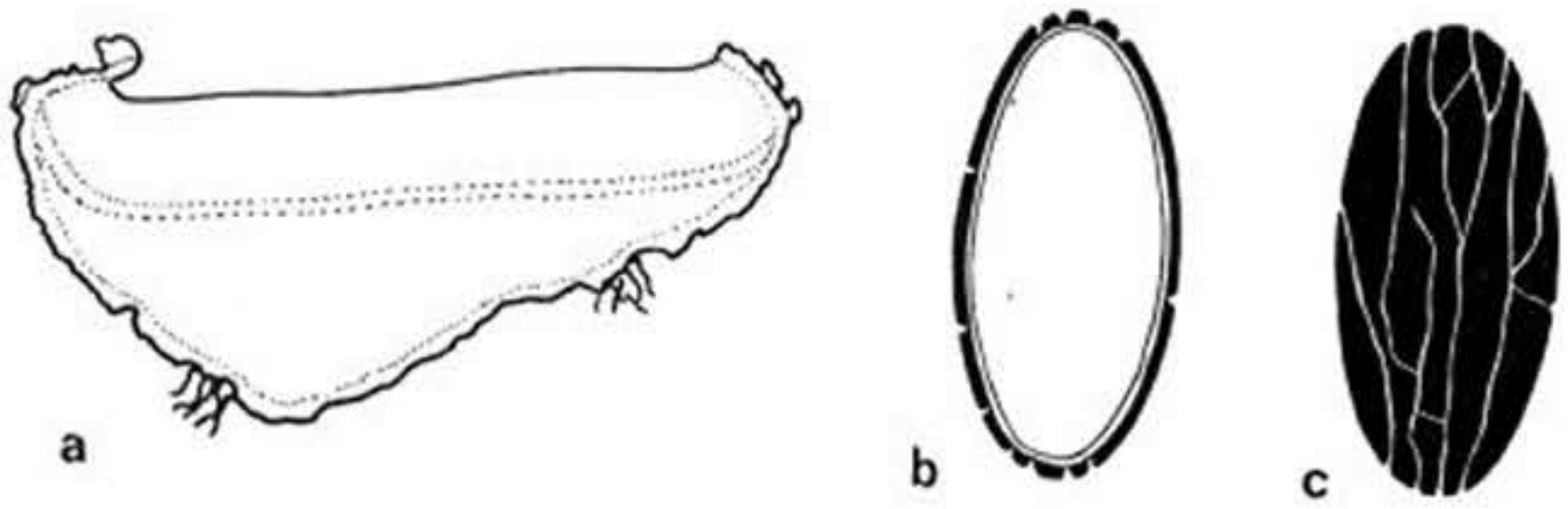

Fig. 33. — *Ascobolus cervinus:* a, diagrammatic section of fruit-body × 40; b, ascospore in optical section × 1600; c, ascospore × 1600. (From holotype.)

globular, thin-walled cells 25–50 μ diameter; contents of excipular cells staining brownish-red in Melzer's reagent. Asci not yet ripened, 8-spored; the wall not blue in Melzer's reagent. Ascospores (not yet fully ripened, only a few spores with a beginning pigment-formation could be found) uniseriate to biseriate, ellipsoid, at first hyaline, then coloured by pigment, 14.5–16 × 8–9 μ, ornamented with longitudinal, occasionally anastomosing striae. Paraphyses branched, septate, filiform, about 2.5 μ thick, scarcely thickened above, often irregularly curved, sometimes terminating in a thin filament or a small knob, 2–4 μ thick at the tip, hyaline, embedded in coloured mucus.

On dung of unknown animal (probably deer).

Etymology.—From Latin, cervinus, related to deer.

Although only few ascospores with a pigmented episporium could be found in the type specimen, a rather complete description could be made.

This species is related with *A. crenulatus* and *A. michaudii*. It differs from these by the rather dark colour of the young fruit-bodies; the size of the ascospores is intermediate.

27. Ascobolus carletonii Boud.—Fig. 34; Pl. 8, fig. H

Ascobolus carletonii Boud. *in* Trans. Brit. mycol. Soc. **4**: 62 *pl. 2 f. 1.* 1913. — Type: *Rea*, on dung of *Tetrao urogalli* (= capercaillie), Scotland, 18.X.1912 (PC-A2265, BM-A2988).

Apothecia superficial, sessile, 0.4–1.0 mm across, 0.3–0.4 mm high. Receptacle at first subglobular and closed, then opening and turbinate, white, smooth in the upper part, coarsely or finely furfuraceous near the base, without a prominent margin. Disk slightly concave, then flat, white, dotted with the dark protruding tips of ripe asci. Hymenium 150–200 μ thick. Hypothecium not continuous, locally up to 40 μ thick, of closely compacted subglobular cells 4–8 μ diameter. Flesh 115–149 μ thick, of subglobular, angular or oblong cells 6–20 × 6–13 μ, hyaline. Excipulum near the margin 20–33 μ thick, near the base up to 60 μ thick, of subglobular or slightly angular cells 7–26 μ diameter (textura angularis to globulosa); the smaller cells near the margin, the larger ones near the base; colourless; near the base with small groups of subglobular cells protruding. Asci clavate, gradually tapering downwards, rounded above, "160–220 × 18–20 μ", 8-spored; the wall deep blue in Melzer's reagent. Ascospores 1–2 seriate, ellipsoid, at first hyaline, then violet, 13–17 × 7.5–8.5 μ, when hypertrophied 14.5–19 × 8.5–10.5 μ, smooth,

but finally often with an irregular net-work of fine lines; with unilateral, transparent, gelatinous cap. Paraphyses simple or branched, with only a few septae, filiform, about 1.5 μ thick, irregularly swollen and often forked above, up to 4 μ thick at the tip, hyaline.

On dung of capercaillie and grouse.

ETYMOLOGY.—After Carleton Rea, a British amateur mycologist.

ILLUSTRATIONS.—Boudier *in* Trans. Brit. mycol. Soc. **4**: *pl. 2 f. 1*. 1913.

SPECIMENS EXAMINED.—**Great Britain**: *Rea*, on capercaillie dung, Dunkeld, Inverness, Scotland, 18.X.1912 (type of *A. carletonii*, BM-A2988, PC-A2265), *Richardson*, on grouse dung, Perthshire, Scotland, 20.XI.1966 (L).

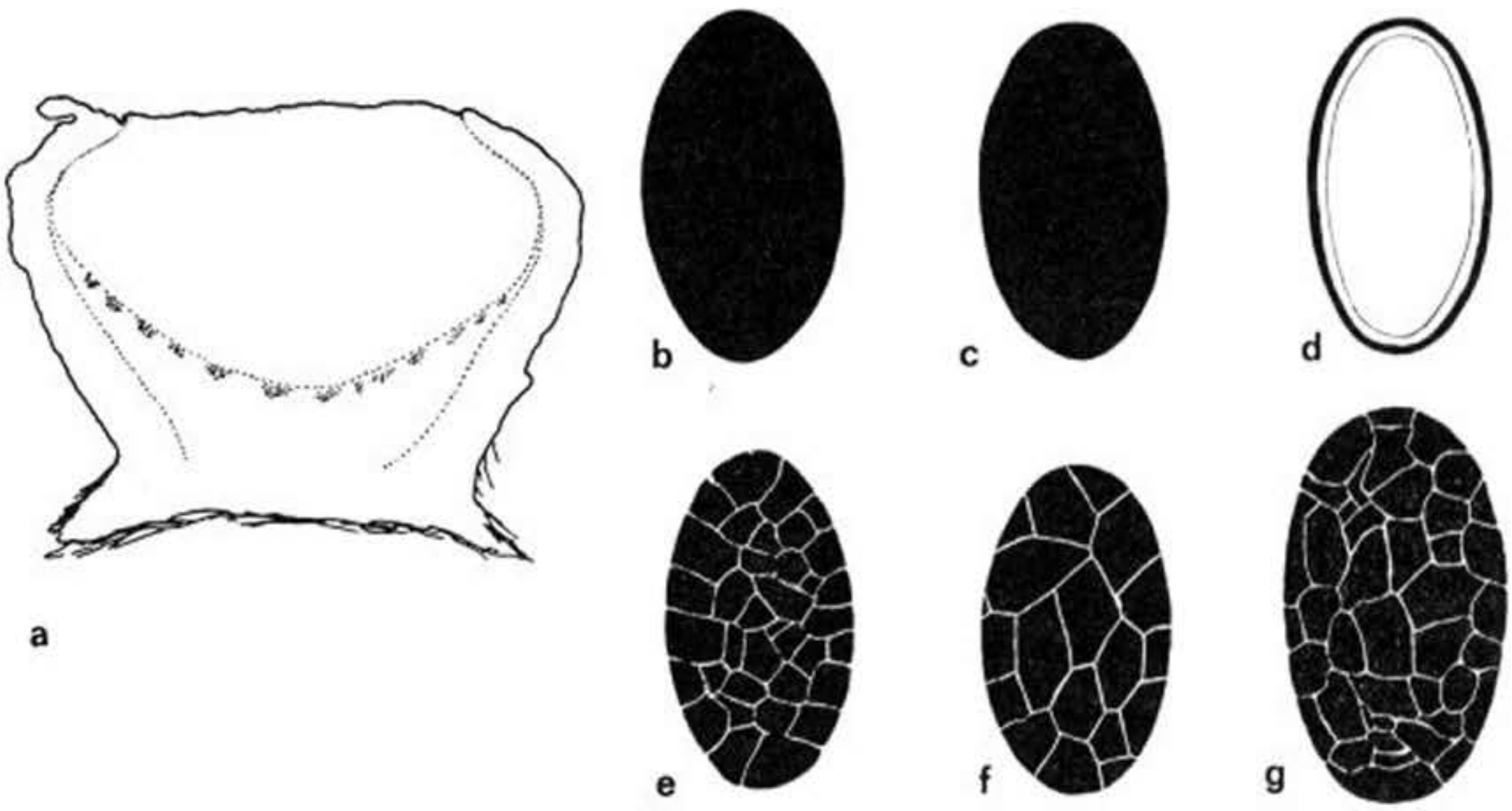

Fig. 34. — *Ascobolus carletonii:* a, diagrammatic section of fruit-body × 160; b, c, e–g, ascospores × 1600; d, id. in optical section. (From type, PC-A2265.)

Together with *A. cainii* this species occupies an isolated position in *Ascobolus* sect. *Ascobolus* because of the smooth episporium, although the development and the structure of the fruit-body point to a relationship with species like *A. furfuraceus*.

Ascobolus candidus Schroet. is perhaps related. Schroeter's species (cf. p. 000) is stated to have smaller ascospores (11–13 × 6–8 μ). The ascospores in *A. cainii* are still smaller (8.5–10 × 5–5.5 μ).

Ascobolus carletonii should not be related to species of *Ascobolus* sect. *Pseudosaccobolus* of which the ascospores may show a similar ornamentation of the episporium. In the latter section the apothecial development is quite different, the asci are of another shape, and the ascospores often tend to form clusters.

28. **Ascobolus cainii** Brumm., *spec. nov.*—Fig. 35; Pl. 9, figs. H, I, Pl. 10, fig. G

Apothecia angustata parva sessilia, 0.4–0.8 mm diam. Receptaculum hemisphaericum, ad extremum applanatum, tenuiter furfuraceum, margine fere integro. Excipulum textura

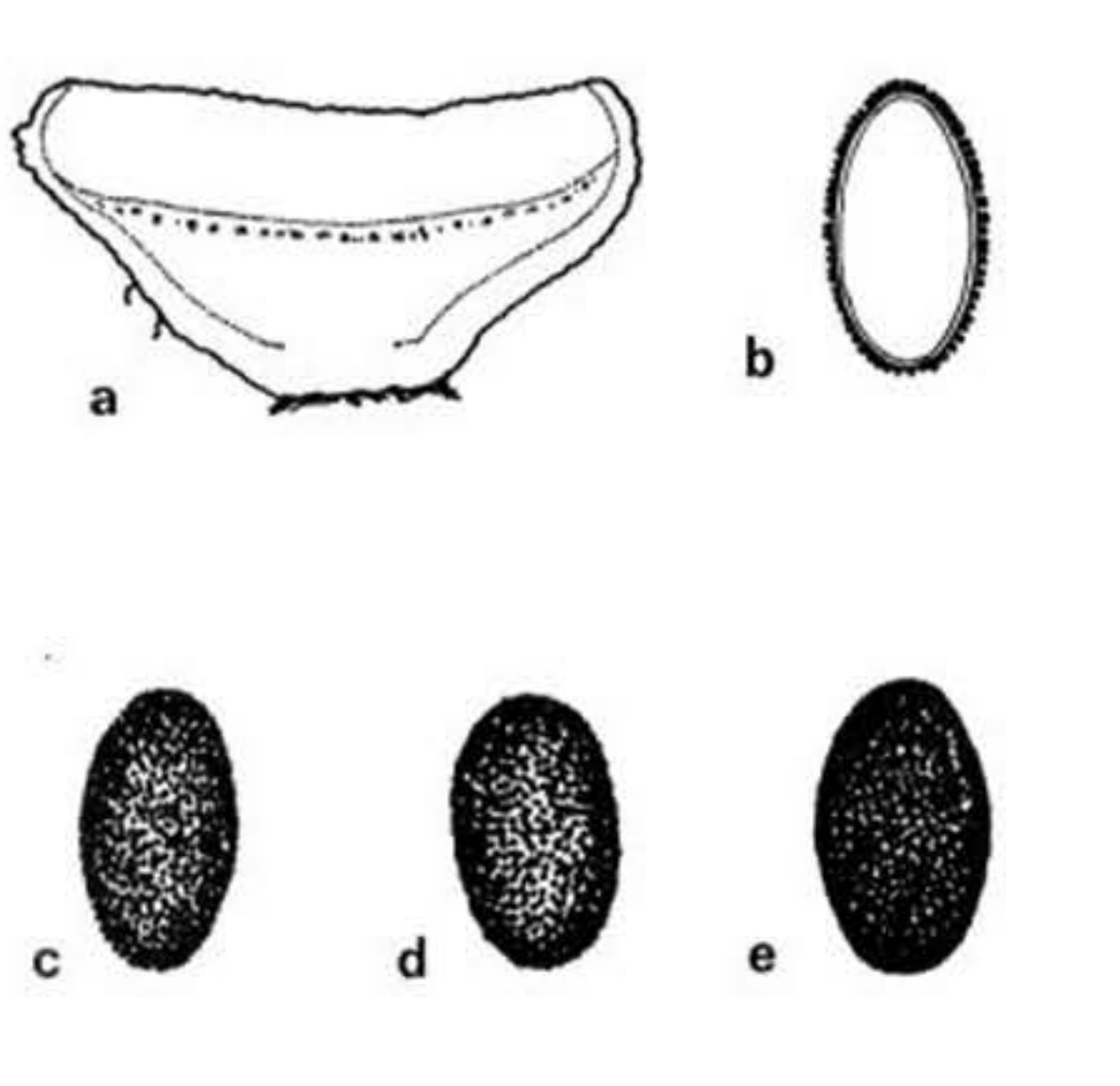

Fig. 35. — *Ascobolus cainii:* a, diagrammatic section of fruit-body × 110; b, ascospore in optical section × 1600; c–e, ascospores × 1600; f, upper parts of paraphyses × 1100; g, flesh (fl.) and excipulum (exc.) in a median section halfway between base and margin × 1100. (From type, TRTC 35284.)

globulosa. Asci cylindrico-clavati, 65–80 × 9–11 μ, 8-spori, pariete iodo bene caerulescente. Ascosporae ellipsoideae, initio hyalinae, denique violascentes, 8.5–10 × 5–5.5 μ, granulis inter sese approximatis tenuissimis ornatae. Paraphyses simplices, 1.6–2.6 μ crassae, apice clavatae. — Ab Ascobolo aglaosporo ascosporis multo minoribus diversus. In fimo cervino invenitur. — Typus: *R. F. Cain*, Paradise Bay, Lake Timagami, Ontario, Canada (TRTC 35284).

Apothecia scattered or gregarious, superficial, sessile on a small base, 0.4–0.8 mm across, 200–250 μ high. Receptacle hemispherical, finally flattened, finely furfuraceous, with an almost smooth margin. Disk concave, then flat, violaceous, roughened by the protruding tips of ripe asci. Hymenium up to about 75 μ thick. Hypothecium not clearly differentiated as a distinct layer, consisting of isolated groups of winding, septate hyphae 2–5 μ wide. Flesh about 70 μ thick, of subglobular or oblong, rather thick-walled cells 5–13 × 4–8 μ, hyaline. Excipulum 19–26 μ thick, near the base up to 60 μ thick, of subglobular and oblong cells 7–20 × 6–13 μ (textura globulosa), near the base often a part with closely compacted, winding, cylindrical, septate, thick-walled hyphae 2.0–2.5 μ thick, hyaline, covered with small groups of subglobular cells. Asci cylindric-clavate, with a short stalk, rounded above, 65–80 × 9–11 μ, 8-spored; the wall clearly blue in Melzer's reagent. Ascospores biseriate, ellipsoid, at first hyaline, then violet, 8.5–10 × 5–5.5 μ, ornamented with a rather thick layer of closely spaced, very fine granules. Paraphyses simple, with only a few septae, clavate, 1.6–2.6 μ thick, gradually enlarged upwards into an oblong-clavate, 4–6 μ thick apex, hyaline.

On dung of deer.

Etymology.—After the Canadian mycologist, Dr. R. F. Cain, who studied many groups of coprophilous Ascomycetes.

Specimen examined.—**Canada**: *Cain*, on deer dung, Paradise Bay, Lake Timagami, Ontario, 26.VIII.1935 (type of *A. cainii*, TRTC 35284).

This species of which only one collection is known was identified by Cain as *A. candidus* Schroet. However, the ascospore dimensions do not agree. Furthermore, the episporium in *A. cainii* is granulate from the beginning and is stated to be smooth in *A. candidus* Schroet.

From *A. carletonii* it differs in the much smaller ascospores and the ornamentation of the episporium.

Species of section *Pseudosaccobolus* can easily be distinguished by the mode of development of the fruit-bodies, the shape of the asci, and a weak tendency of the ascospores to form clusters.

29. Ascobolus lignatilis Alb. & Schw. per Pers.—Fig. 36; Pl. 10, figs. A–D

Ascobolus lignatilis Alb. & Schw., Consp. Fung. nisk. 347 *pl. 6 f. 6.* 1805 (devalidated name). — *Ascobolus lignatilis* Alb. & Schw. *per* Pers., Mycol. eur. **1**: 342. 1822; Fries, Syst. mycol. **2**: 162. 1822. — Type: *Albertini & Schweinitz, s. loc., s. dat.* (L 910.262.142, MEL-A1636).

Peziza psittacina Quél. *in* Mém. Soc. Émulation Montbéliard Ser. II **5**: 395 *pl. 5 f. 9.* 1873 (= Champ. Jura Vosges 390 *pl. 5 f. 9.* 1873). — *Ascobolus psittacinus* (Quél.) Quél., Ench. Fung. 293. 1886. — Type: *Quélet*, in a flower-hothouse, Valentigney, Doubs, France, VI.1872 (UPS-A2005).

Ascobolus marchalii Bomm. & Rouss. *in* Bull. Soc. roy. Bot. Belg. **23**: 143. 1884. — Lectotype: *Marchal*, on cow dung, Bruxelles, Belgium, 1883 (BR-A353).

Apothecia scattered or gregarious, superficial, usually with a very distinct stalk, (2–)5–12 mm diameter, up to 5 mm high. Receptacle at first closed and subglobular or cylindrical, then opening at the top and becoming scutellate or cyathiform, finally flattened, with a distinct furrowed or furfuraceous stipe, which often broadens at the base, dingy yellow to greenish-yellow, furfuraceous; the margin at first often slightly crenulate or fimbriate, prominent, rather thin, finally often slightly curved outward. Disk flat, finally sometimes slightly convex, dingy yellowish-green to yellowish, dotted with the almost black protruding tips of ripe asci. Hymenium 150–190 μ thick. Hypothecium about 30 μ thick, of closely compacted, isodiametric cells 7–11 μ diameter. Flesh of varying thickness, up to more than 4000 μ thick in the central part, of subglobular or rounded cells 7–12 μ diameter, hyaline. Excipulum 24–50(–65) μ thick, of subglobular cells 12–20 μ diameter, hyaline, covered with irregularly formed groups of globular cells. Asci clavate, gradually tapering downwards, rounded above, 160–230 × 16–20 μ, 8-spored; the wall blue in Melzer's reagent. Ascospores biseriate; ellipsoid to fusiform-ellipsoid, with blunt ends, at first hyaline, then violet, finally sometimes purplish-brown, 16–19.5 × 8.5–10 μ, when swollen reaching 22 × 13 μ, ornamented with subparallel, usually longitudinal lines, that only occasionally anastomose, more or less reticulated when swollen. Paraphyses simple or branched, septate, cylindrical, 1.5–2.5 μ thick, clavate or irregularly swollen to 6 μ thick at the tip, embedded in greenish-yellow mucus.

On rotten wood, branches or leaves, on manure heap, on rotten straw and old paper, on humus in a hot-house, on owl-pellets, on dung of cow and man, and on all kinds of substrata which have been dirtied or mixed with dung or urine.

Etymology.—From Latin, lignatilis, pertaining to wood.

Illustrations.—Albertini & Schweinitz, Consp. Fung. nisk. *pl. 6 f. 6.* 1805; Boudier *in* Annls Sci. nat. (Bot.) V **10**: *pl. 5 f. 1.* 1869; Falck *in* Beitr. Biol. Pfl. (ed. Cohn) **8**: *pl. 12*

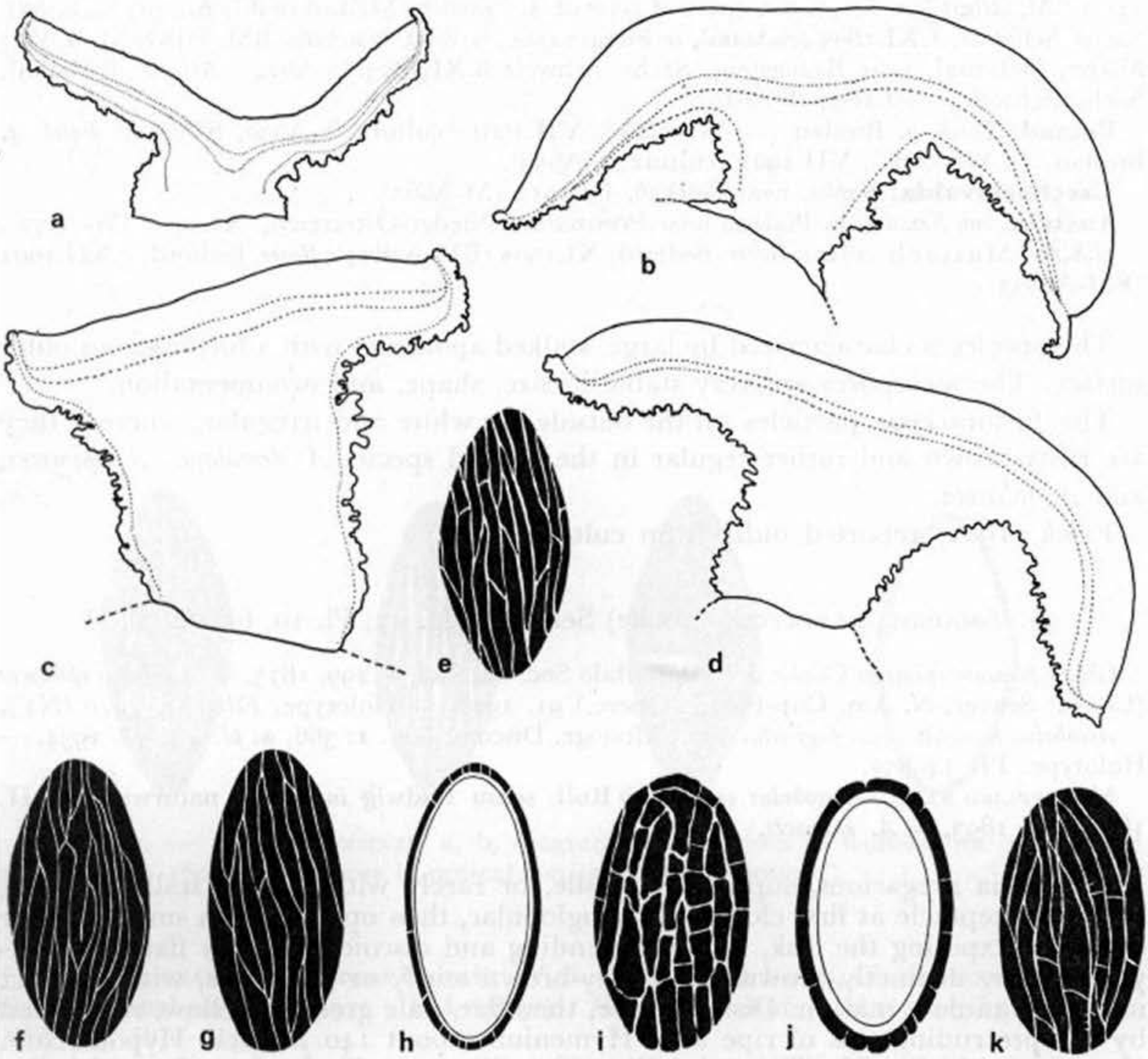

Fig. 36. — *Ascobolus lignatilis:* a, b, diagrammatic sections of fruit-bodies × 40; c, d, idem × 25; e–g, i–k, ascospores × 1600; h, j, id. optical section. (a, b, e–h, from type of *A. lignatilis*;, c, d, i–k, from lectotype of *A. marchallii*.)

fs. 4–6. 1902; Quélet *in* Mém. Soc. Émulation Montbéliard II **5**: *pl. 5 f. 9.* 1873 (*Peziza psittacina*).

Specimens examined.—**Great Britain**: *Bennett*, London, 4.II.1939 (BPI-A1484, FH-A3176).

Netherlands: *Daams 158*, Oud Loosdrecht 30.III.1957 (L); *H. Klein*, Amsterdamse bos, Amsterdam, 4.IV.1957 (L).

Belgium: *Marchal*, Bruxelles, 1883 (lectotype of *A. marchalii*, BR-A353); *Marchal*, Bois de la Cambre, 1885 (*A. marchalii*, BR-A352); *Marchal*, Bois de la Cambre, *s. dat.* (*A. marchalii*, BR-A351).

France: *Quélet*, Valentigney, Doubs, VI.1872 (type of *A. psittacinus*, UPS-A2005); *Romagnesi*, Luzarches, Seine et Oise, 10.VII.1949 (PC-A2331); *Romagnesi*, Coye-la Forêt, Oise, 27.V.1951 (PC-A2332).

Germany: "*Mr. Alberti et Schweinitz*", *s. loc.*, *s. dat.* (part of type of *A. lignatilis*, L 910.262.

141); "*M. Albert*", *s. loc., s. dat.* (part of type of *A. lignatilis*, MEL-A1636); *Krieger*, Bielathal, Sächs. Schweiz, 1.XI.1893 (S-A666), *in* Fungi saxon. 978 (*A. marchalii*, BM, HBG, M, S, W); *Krieger*, Bielathal, near Königstein, Sächs. Schweiz 8.XI.1893 (S-A624): *Krieger*, Bielathal, Sächs. Schweiz, 5.VI.1894 (S-A619).

Poland: *Falck 3*, Breslau (= Wrocław), VII.1901 (culture, S-A638, S-A641); *Falck 4*, Breslau (= Wrocław), VII.1901 (culture, S-A659).

Czechoslovakia: *Kupka*, near Görkaů, IV.1912 (M-A865).

Austria: *von Keissler*, in Pfalzau near Pressbaum, Nieder-Österreich, XI.1913 (W-A272).

U.S.A.: Massachusetts: *Rorer*, Bedford, XI.1901 (BM-A2834); *Rorer*, Bedford, 2.XII.1901 (BM-A2833).

This species is characterized by large, stalked apothecia with a furfuraceous outer surface. The ascospores are very stable in size, shape, and ornamentation.

The furfuraceous particles on the outside are white and irregular, whereas they are rusty-brown and rather regular in the related species *A. denudatus*, *A. epimyces*, and *A. foliicola*.

Falck (1902) reported oidia from cultures.

30. Ascobolus epimyces (Cooke) Seaver—Fig. 37; Pl. 10, figs. E, F, H

Chlorosplenium epimyces Cooke *in* Bull. Buffalo Soc. nat. Sci. **2**: 299. 1875. — *Ascobolus epimyces* (Cooke) Seaver, N. Am. Cup-Fungi (Operc.) 91. 1928. — Holotype: *Ellis No. 1010* (NY).

Ascobolus lignatilis var. *fagisedus* Vel., Monogr. Discom. Boh. **1**: 366, **2**: *pl. 4 f. 38.* 1934. — Holotype: PR 149852.

Missapplied name.—*Ascobolus costantinii* Roll. sensu Ludwig *in* Forstl. naturwiss. Z., II, 1893: 28. 1893. = *A. epimyces*.

Apothecia gregarious, superficial, sessile, or rarely with a short stalk, 1–4 mm across. Receptacle at first closed and subglobular, then opening by a small circular aperture, exposing the disk, finally expanding and discoid to nearly flat, greenish-yellow, very distinctly brownish or rusty-brown scurfy or granulose, with an erect narrow granulose margin. Disk concave, then flat, pale greenish-yellow, roughened by the protruding tips of ripe asci. Hymenium about 140 μ thick. Hypothecium about 20 μ thick, of isodiametric cells 4–8 μ diameter. Flesh of varying thickness, of subglobular or angular cells 8.5–15 μ diameter, hyaline. Excipulum 20–28 μ thick near the margin, up to 40 μ thick in the lower parts of the fruit-body, of subglobular cells 12–26 μ diameter, covered with scaly or granular particles consisting of globular cells with pale brownish walls. Asci cylindric-clavate, tapering downwards, 140–150 × 13–15 μ, 8-spored; the wall not blue in Melzer's reagent. Ascospores biseriate, fusoid or ellipsoid with pointed ends, at first hyaline, then violet, finally purplish-brown, (15.5–)17.5–19.5(–20) × (6.5–)7–9(–10) μ, ornamented with longitudinal anastomosing lines, when swollen also with many, fine, short, transverse lines. Paraphyses simple or branched, septate, cylindrical, 2.0–2.5 μ thick, hyaline, clavate or irregularly swollen up to 4.5 μ thick at the tip, rarely narrowed above, embedded in greenish-yellow mucus.

On rotten wood, on rotten leaves of trees and on old paper.

Etymology.—From Greek, ἐπι upon and μυκης, a mushroom: growing on a fungus, because of the reported growth on some old *Thelephora*.

Illustration.—Velenovský, Monogr. Discom. Boh. **2**: *pl. 4 f. 38.* 1934 (only a single ascospore, *A. fagisedus* Vel.).

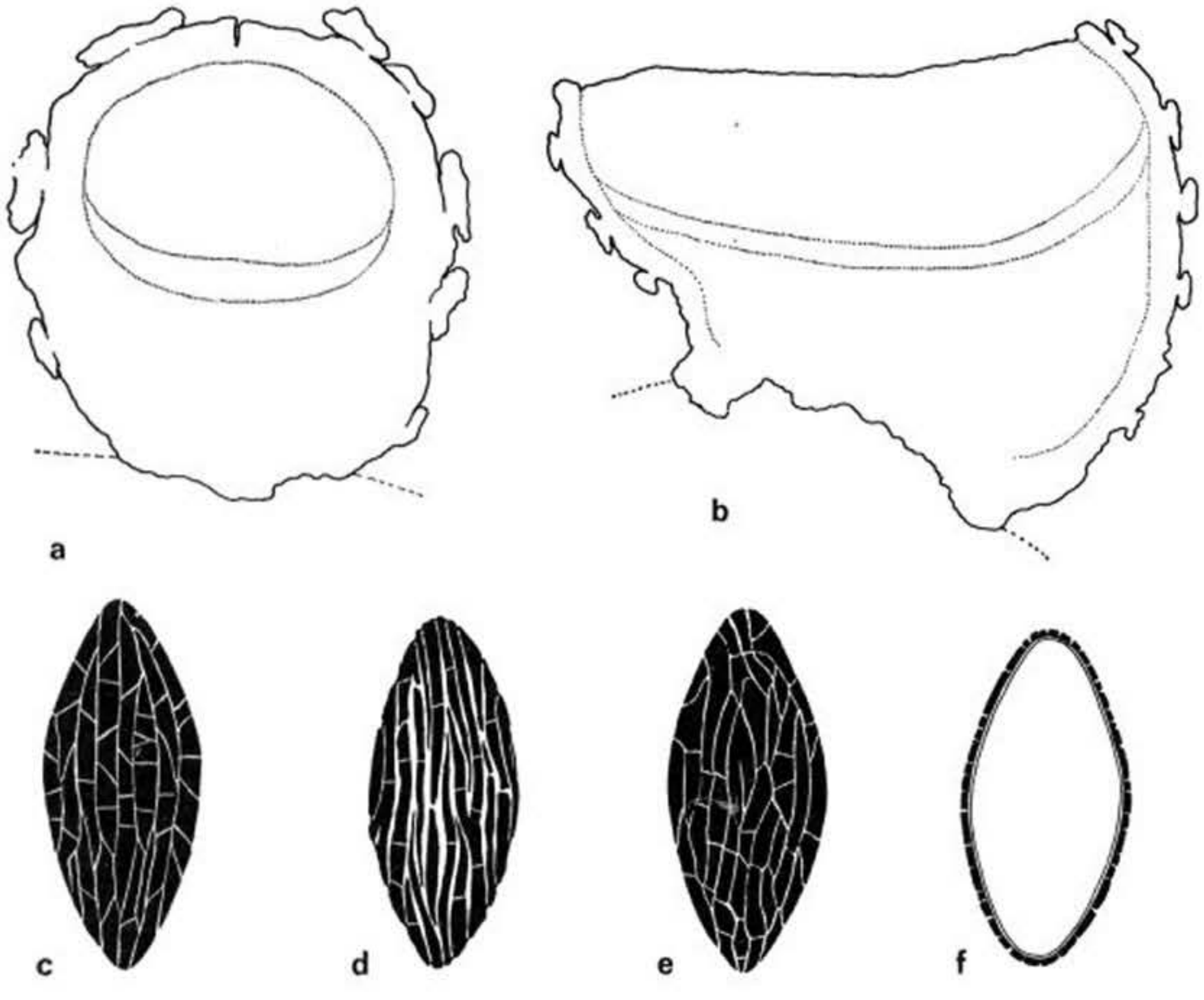

Fig. 37. — *Ascobolus epimyces:* a, b, diagrammatic sections of fruit-bodies × 160; c–e ascospores × 1600; f, ascospore in optical section. (From holotype.)

Specimens examined.—**Great Britain**: *W. B. Grove*, on oak leaves, Clows Wood (probably near Birmingham), 8.X.1921 (BM-A2941); *Hubbard*, culture, Aberystwyth, Cardigan, XII.1935 (BM-A2939).

Germany: *Kummer*, on rotten wood, near Hesellohe, 20.VIII.1854 (*Peziza phaea* n. sp., an unpublished name, BR-A356); *Ludwig*, culture, *s. loc.*, *s. dat.* (*A. costantini* Roll., S-A749); *Ludwig*, culture, near Greiz, 4.XI. (S-A501).

Czechoslovakia: *Velenovský*, on rotten trunc of *Picea*, Mnichovice, 1923 (PR 147915); *Velenovský*, Menčice near Mnichovice, Bohemia, VII.1925 (PR 150316); *Velenovský*, on leaves of *Fagus*, Jevany, VIII. 1925 (holotype of *A. lignatilis* var. *fagisedus*, PR 149852); *Velenovský*, on rotten wood, Mnichovice, Bohemia, 7.VII.1929 (*A. dentatus* Vel., an unpulished name, PR 150267).

U.S.A.: New Jersey: *Ellis 1010*, on rotten wood covered with slime mould, Newfield, *s. dat.* (type of *Chlorosplenium epimyces*, NY-A1279); *Ellis*, Newfield, VII (probably part of the type of *Chlorosplenium epimyces*, K).

This species, which is close to *A. lignatilis* and *A. costantinii*, is characterized by the pointed ends of the ascospores. It is distinguishable from *A. lignatilis* by the smaller apothecia, the brownish furfuraceous particles, and the pointed ends of the ascospores. From *A. costantinii* it may be distinguished by the larger ascospores and the colour of the furfuraceous particles.

Ludwig (1893, 1896) isolated mycelium and oidia of *A. epimyces* from a "Schleimfluss" of a beech, and cultivated the fruit-bodies, which he identified as pertaining to *A. costantinii*.

31. Ascobolus costantinii Roll.—Fig. 38; Pl. 10, fig. I, Pl. 11, fig. A, B

Ascobolus costantinii Roll. *in* Bull. Soc. mycol. Fr. **4**: 56 *pl. 15 f. 1.* 1888. — Type: not known to be in existence, represented by Rolland l.c. — Type locality: near Paris, France.

Ascobolus schweersii Maas G. *in* Fungus **24**: 13 *f. 1.* 1954. — Type: *Maas Geesteranus 9618* (L, PC).

Excluded.—*Ascobolus costantinii* Roll. sensu Ludwig *in* Forstl. naturwiss. Z, II, 1893: 28. 1893 = *Ascobolus epimyces* (Cooke) Seaver.

Apothecia gregarious or closely crowded, superficial, with a short stalk or substipitate, 1.0–2.5 mm diameter, up to 0.7 mm high. Receptacle at first closed and subglobular, soon opening at the top and becoming scutellate, finally more flattened and discoid, often with a narrow base or with a stalk which is enlarged at the base, ochraceous or vivid lemon-yellow, granular, especially toward the margin; margin thin, crenulate. Disc concave, then flat, yellow or lemon-yellow, finally more brownish, dotted with the dark brown protruding tips of ripe asci. Hymenium 115–130 μ thick. Hypothecium 20–29 μ thick, of closely compacted isodiametric or oblong cells 4–16 × 4–8 μ. Flesh of varying thickness, up to 500 μ in the central part of the fruit-body, of subglobular cells 7–20 μ diameter, hyaline. Excipulum 20–40 μ thick, of globular cells 10–21 μ diameter, hyaline, covered with groups of large globular cells, especially near the margin; at the base of the stalk with many colourless, 2–4 μ wide hyphae, which are connected with the substrate. Asci cylindric-clavate, tapering downwards into a short stalk, rounded above, 130–160 × 14–16 μ, 8-spored; the wall not, or scarcely, blue in Melzer's reagent. Ascospores at first obliquely uniseriate, finaly biseriate, ellipsoid or fusiform-ellipsoid, at first hyaline, then violet, 13–15 × 7.5–8.5 μ, ornamented with more or less longitudinal, subparallel lines that only occasionally anastaomose. Paraphyses simple or branched, septate, cylindrical, about 2 μ thick, hyaline, clavate or irregularly swollen to 8 μ thick at the tip, sometimes forked near the tip, embedded in lemon-yellow mucus.

On rotten leaves and branches.

Etymology.—After M. J. Costantin, ex-secretary-general of the French mycological society.

Illustrations.—Maas Geesteranus *in* Fungus **24**: 21 *f. 1.* 1954 (*A. schweersii*); Rolland *in* Bull. Soc. mycol. Fr. **4**: *pl. 15 f. 1.* 1888 (*A. costantinii*).

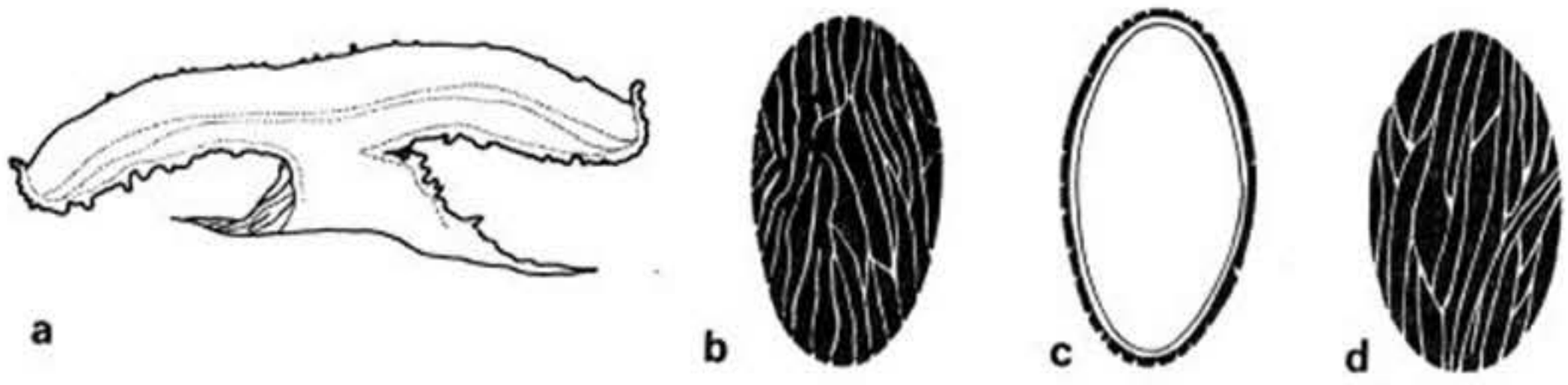

Fig. 38. — *Ascobolus costantinii:* a, diagrammatic section of fruit-body × 40; b, d, ascospores × 1600; c, ascospore in optical section × 1600. (From type of *A. schweersii*, L·)

SPECIMENS EXAMINED.—**Netherlands**: *Maas Geesteranus 9618*, on rotten leaves and twigs, Bierlap, Meiendel, Wassenaar, 7.XII.1953 (type of *A. schweersii*, L, PC).

This species is closely related to *A. crenulatus* of which it might represent an extreme form.

It may be separated from this by the more pronounced stipitate base of the receptacle, the yellow or lemon-yellow colour of the disk, the often slightly fusiform ascospores, and its occurrence only on fallen leaves and branches.

The name *Ascobolus costantinii* had erroneously been applied by Ludwig (1893, 1896) to a fungus isolated from a "Schleimfluss" of a beech. Ludwig's fungus belongs to *A. epimyces*, which can be distinguished from *A. costantinii* by the size of the ascospores and by the usually dark colour of the furfuraceous particles on the excipulum.

32. **Ascobolus singeri** Brumm., *spec. nov.*—Fig. 39; Pl. 11, figs. C, D

Apothecia basi angusta sessilia, 1.0–2.5 mm diam. Receptaculum initio globulare, deinde cupulatum, denique scutellatum, interdum substipitatum, virescenti-luteum, furfuraceum vel verrucosum, marginatum. Excipulum textura globulosa. Asci clavati, c. 130 × 16 μ, 8-spori, pariete iodo haud caerulescente. Ascosporae ellipsoideae, 17.5–19.5 × 8.5–9.5 μ, typo irregulari linearum tenuissimarum, fissurarum brevium foveolarumque minutarum ornatae. Ab Ascobolo foliicola ascosporum sculptura diversus. In foliis caulibusque putrescentibus invenitur. Typus: *R. Singer B 1365*, Rio Yanzia, Prov. Nor Yungas, Depto. La Paz, Bolivia (K).

Apothecia gregarious or scattered, superficial, sessile on a narrow base, 1.0–2.5 mm diameter, 0.6–0.7 mm high. Receptacle at first closed and globular, then opening at the top and becoming cup-shaped, finally flattened and scutellate, sometimes substipitate, greenish-yellow, furfuraceous or warted, with a prominent margin.

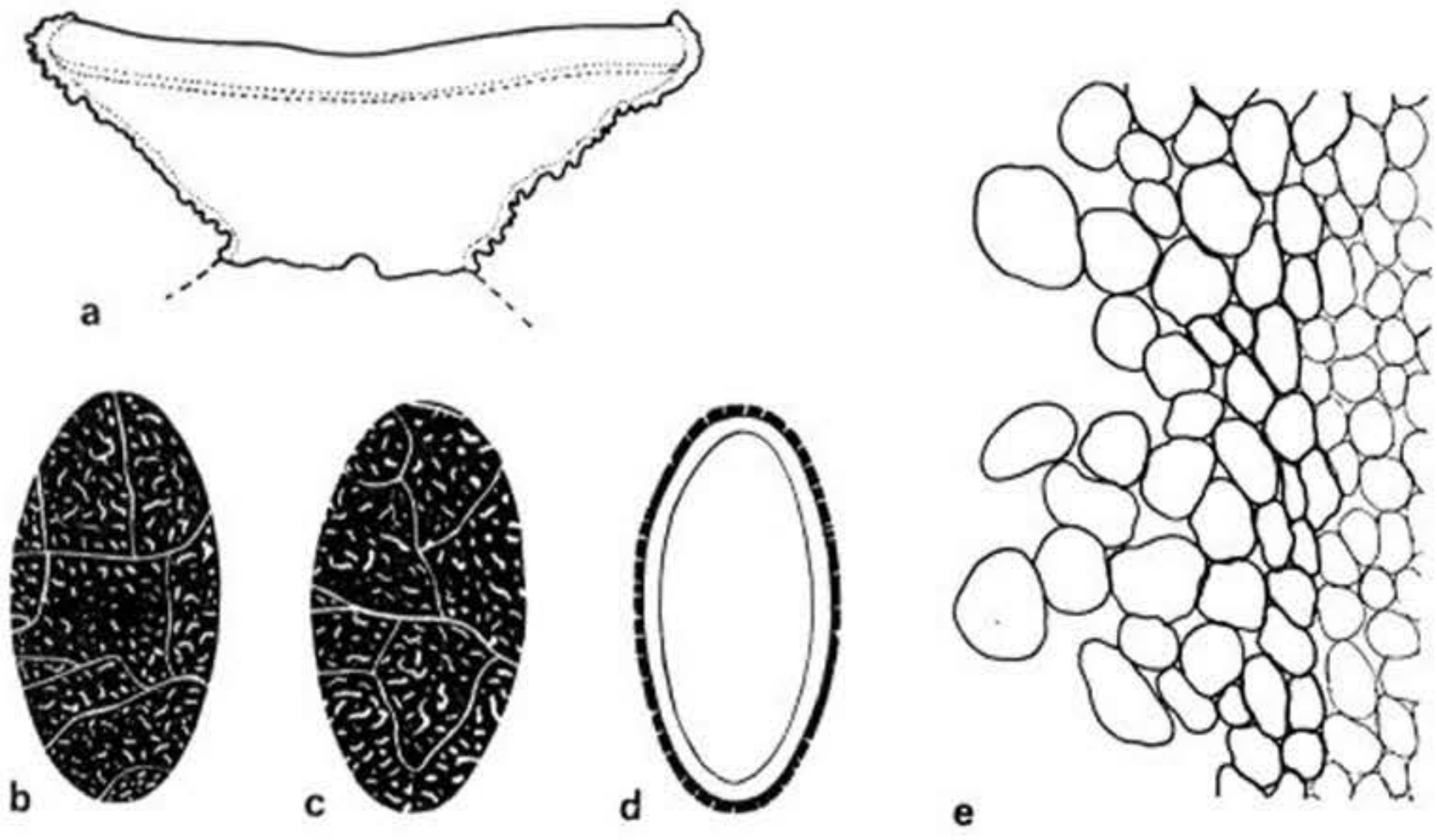

Fig. 39. — *Ascobolus singeri:* a, diagrammatic section of fruit-body × 25; b, c, ascospores × 1600; d, id. in optical section; e, detail of excipulum in median section × 460. (From type.)

Disk concave to flat, greenish-yellow, dotted with the almost black protruding tips of ripe asci. Hymenium 115–130 μ thick. Hypothecium 22–29 μ thick, of closely compacted, subglobular cells 6–10 μ diameter. Flesh up to more than 500 μ thick, of subglobular cells 6–18 μ diameter, hyaline. Excipulum 30–60 μ thick, of subglobular or angular, thick-walled cells 10–25 μ diameter, pale brownish-yellow, covered with more or less regularly disposed groups of globular cells. Asci clavate, about 130 × 16 μ, 8-spored; the wall not blue in Melzer's reagent. Ascospores biseriate, ellipsoid, at first hyaline, then violet, finally purplish-brown; 17.5–19.5 × 8.5–9.5 μ, almost smooth with some irregularly arranged very fine lines together with a pattern of fine, short fissures and small pits. Paraphyses branched, septate, cylindrical, about 2 μ thick, clavate or irregularly swollen to 5 μ thick at the tip, hyaline, embedded in abundant greenish-yellow mucus.

On rotten leaves and stalks of palm, *Urtica*, *Acer*, and *Alnus*.

ETYMOLOGY.—After the mycologist Dr. R. Singer, who collected the type material.

SPECIMENS EXAMINED.—**Germany**: *Krieger*, on rotten stalks of *Urtica dioica*, Festungsberge near Königstein, Sächs. Schweiz, VIII.1886 (LE-A1447).

U.S.A.: New York: *Schaffer & Shoemaker 341*, on leaves of *Acer* and *Alnus* in wet water-soaked area, Ringwood, Ithaca (DAOM).

Bolivia: *Singer B 1365*, on palm, Rio Yanzia, Prov. Nor Yungas, Depto. La Paz, 23.II.1956 (holotype of *A. singeri*, K).

A species close to *A. denudatus* and *A. foliicola*, but distinguishable by the characteristic ornamentation of the episporium. It is known from three widely separated localities.

33. ASCOBOLUS FOLIICOLA Berk. & Broome—Fig. 40

Ascobolus crouanii Boud. *in* Annls Sci. nat. (Bot.) V **10**: 216 *pl. 5 f. 2.* 1869; not *Ascobolus crouanii* Cooke *in* J. Bot. (Lond.) **2**: 151 *f. 3.* 1864; nor *Ascobolus crouanii* Renny *in* J. Bot. (Lond.) **12**: 356 *pl. 154 fs. 6–10.* 1874. — Type: represented by Boud. *in* Annls Sci. nat. (Bot.) V **10**: *pl. 5 f. 2.* 1869; type locality, near Paris, France.

Ascobolus foliicola Berk. & Broome *in* J. Linn. Soc. (Bot.), Lond. **14**: 109. 1873. — Holotype: *Thwaites 14* (K).

Chlorosplenium striisporum Ellis & Dearn. *apud* Ellis & Everh. *in* Proc. Acad. nat. Sci. Phil. 1895: 429. 1895. — *Ascobolus striisporus* (Ellis & Dearn. apud Ellis & Everh.) Seaver, N. Am. Cup-Fungi (Operc.), 90. 1928. — Type: *Dearness 2281* (DAOM, NY).

Ascobolus (*Dasyobolus*) *serbicus* P. Henn. & Ranojević *apud* Ranojević *in* Hedwigia **41**: 103. 1902. — *Dasyobolus serbicus* (P. Henn. & Ranojević apud Ranojević) P. A. Sacc. & D. Sacc. *in* Syll. Fung. **18**: 120. 1906. — Holotype: *Ranojević*, on *Rubus* spec., Topocider near Beograd (= Belgrad), Serbia, Yugoslavia, 20.IX.1897 (S).

Ascobolus boudieri Lort. *in* Bull. Soc. mycol. Fr. **30**: 223. 1914; not *Ascobolus boudieri* Quél., Ench. Fung. 293. 1886. — Holotype: *Lorton 149* (PC).

Apothecia solitary or gregarious, superficial, with a short stalk; 1–5 mm across, 0.5–1 mm high. Receptacle at first closed and subglobular, then opening at the top and becoming cup-shaped, finally expanded and scutellate with a short, subcentral stalk, greenish-yellow, with reddish-brown furfuraceous particles or warts regularly distributed over the surface; with a prominent margin, sometimes curved back against the substratum in old fruit-bodies. Disk concave when young, later becoming flat or slightly undulated, greenish-yellow, then brownish, dotted with the almost

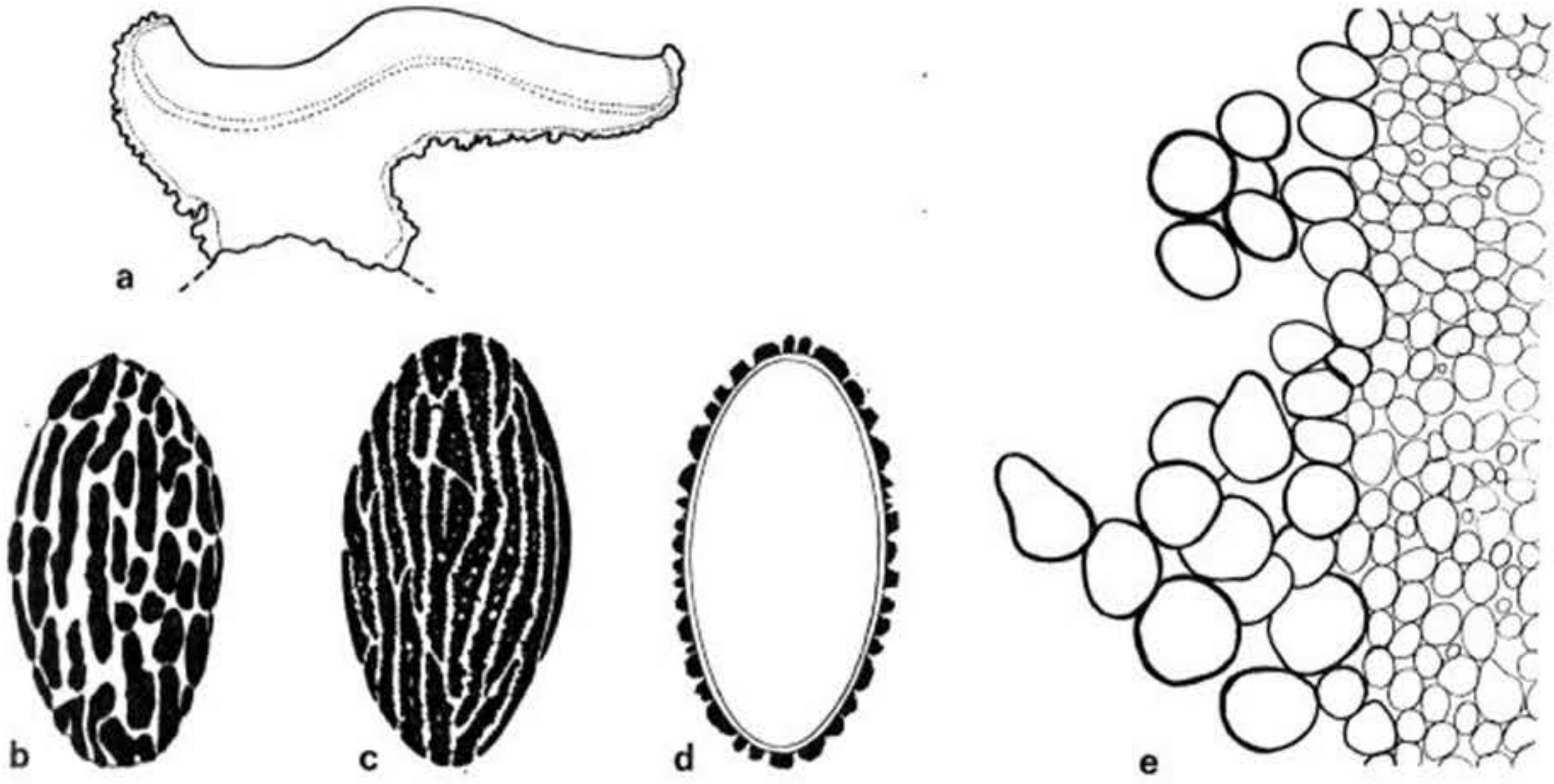

Fig. 40. — *Ascobolus foliicola:* a, diagrammatic section of fruit-body × 25; b, c, ascospores × 1600; d, ascospore in optical section × 1600; e, detail of excipulum in a median section × 460. (From holotype of *A. foliicola*.)

black protruding tips of ripe asci. Hymenium 140–180 μ thick. Hypothecium about 35 μ thick, of closely compacted, subglobular cells 5–10 μ diameter. Flesh of varying thickness, of subglobular cells 4.5–14 μ diameter, hyaline. Excipulum 30–45 μ thick, of globular, thick-walled cells 15–30 μ diameter, brownish, covered with more or less conical groups of globular or pear-shaped cells. Asci cylindric-clavate, tapering downwards, rounded above, 170–200 × 18–20 μ, 8-spored; the wall not, or scarcely, blue in Melzer's reagent. Ascospores biseriate, ellipsoid with rounded or obtuse ends, with strong tendency to swell; at first hyaline, then violet, finally purplish-brown, 15.5–22 × 8–11.5 μ, ornamented with longitudinal anastomosing striae, when swollen often with reticulating striae. Paraphyses branched, septate, cylindrical, about 2 μ thick, clavate or irregularly swollen to 5 μ thick at the tip, hyaline, embedded in greenish-yellow mucus.

On rotten leaves, stalks, wood and bark of plants.

Etymology.—From Latin, folium, a leaf and colo = to inhabit: growing on leaves.

Illustrations.—Boudier *in* Annls Sci. nat. (Bot.) V **10**: *pl. 5 f. 2.* 1869 (*A. crouani*); Lorton *in* Bull. Soc. mycol. Fr. 30: *pl. 12 f. 2.* 1914 (*A. boudieri* Lort.).

Specimens examined.—**Great Britain**: *Buckley*, Burnham, Buches, III.1934 (BM-A2942); *Cooke*, Darenth, Kent, X.1874 (K-1973); *Crossland*, Hebden Bridge, 25.XI.1894 (K); *J. W. Ellis*, Eastham, 20.XII.1913 (K).

Belgium: *Rousseau*, Watermael, VIII.1882. (BR-A308).

France: *Boudier*, Montmorency, I. 1866 (authentic specimen; probably type of *A. crouanii* Boud.; PC-A2213); *Crouan*, Bois de Coatodon, 15.X.1866 (CONC); *Lorton 149*, on bark of rotten Amaranthi, Clessy, IV.1913 (*Ascobolus hemiphanus* Lorton, an unpublished name, holotype of *A. boudieri* Lorton, PC-A2303).

Portugal: *Torrend* (PC-A2214).

Denmark: *Winge*, Bogsvard só, Sjaelland, 17.X.1907 (C).

Germany: *Kirschstein*, Grossbehnitzer See, Westhavelland, 4.VII.1909 (FH).
Czechoslovakia: *Fechtner*, Radotín, Bohemia, IX.1924 (PR 148859); *Velenovský*, Mnichovice, Bohemia, VI.1923 (*A. juglandis* Velenovský, an unpublished name, PR 147789); *Velenovský*, Radotín, Bohemia, VI.1924 (*A. juglandis* var. *corticola* Velenovský, an unpublished name, PR 149700).
Austria: *Niessl*, near Graz, IX.1861 (G-A978, M-A830, M-A831).
Yugoslavia: *Ranojević*, Topocider, near Beograd (= Belgrad), Serbia, 20.IX.1897 (holotype of *Dasyobolus serbicus*, S-A610).
Ceylon: *Thwaites* 12.XI.1867 (K-A1961).
Canada: *Bisby*, University Grounds, University of Manitoba, Winnipeg, 30.VI.1933 (CMI); *Bisby et al.*, Manitoba Agricultural College, Winnipeg, 4.VIII.1927 (NY); *Dearness 2281*, Mc Grady's Bank, London, 20.VII.1895 (parts of type of *Chlorosplenium striisporum*, DAOM, NY).
U.S.A.: Oregon; *Kienholz KD12*, Hood River, 9.V.1943 (BPI). California: *Toole*, Vista Nurseries, 18.IV.1930 (BPI). New York: *Latham 577*, Orient, Long Island, 28.VI. 1922 (*A. lathami* Dearness, an unpublished name, DAOM). Massachusetts: *Rorer*, Bedford, X. 1901 (BPI-A1534). Virginia: *Lefebvre*, Blacksburg, V. 1947 (BPI-A1535).

The growth of this species is restricted to rotten vegetable debris. The fruit-bodies always show a clearly developed stalk and a prominent furfuraceous margin. In the related *A. denudatus* the fruit-bodies are sessile and the margin is smooth. It can be distinguished from *A. singeri* by the ornamentation of the episporium.

34. Ascobolus denudatus Fr.—Fig. 41; Pl. 11, figs. E, F

Ascobolus denudatus Fr., Syst. mycol. **2** (1): 162. 1822; sensu Cooke *in* J. Bot. (Lond.) **2**: 150. 1864; sensu Berk. & Broome *in* Ann. Mag. nat. Hist. III **15**: 448 *pl. 16 f. 24.* 1865; sensu Fuckel, Fungi rhen. No. 1849. 1866; *in* Jb. nassau. Ver. naturk. **23–24**: 287. 1870. — Type: represented by the description of Fries, l.c.; type locality, probably Sweden.
Ascobolus immarginatus Becc. *in* Erb. critt. ital. Ser. I, fasc. 16, No. 775. 1862; De Not. *in* Comm. Soc. critt. ital. **1**: 360. 1864. — Type distribution: Erb. critt. ital. No. 775.
Ascobolus angulisporus Boud. *in* Bull. Soc. bot. Fr. **28**: 92 *pl. 3 f. 2.* 1881. — *Ascobolus furfuraceus* var. *angulisporus* (Boud.) Quél., Ench. Fung. 293. 1886. — Holotype: *Boudier*, on rotten wood, Montmorency, France, June 1879 (PC-A2217).
Ascobolus fimiputris var. *lindaviana* P. Henn. *in* Verh. bot. Ver. Prov. Brandenburg **40**: 150 *pl. 2 f. 2.* 1898. — *Ascobolus stercorarius* var. *lindaviana* (P. Henn.) Boud., Hist. class. Discom. Eur. 72: 1907. — Type: represented by P. Henn. l.c.; type locality, Greenhouse, Botanic Gardens, Berlin, Germany.
Ascobolus perdicinus Vel., Monogr. Discom. Boh. **1**: 365. 1934. — Holotype: PR 150305.
Ascobolus pani Vel., Monogr. Discom. Boh. **1**: 367, **2**: *pl. 4 f. 41.* 1934. — Holotype: PR 149851.
Ascobolus transverse-rimosus Svrček *in* Česká Mykol. **11**: 106, 117 *pl. 2 f. 2.* 1957. — Holotype: *Svřcek*, on rotten wood, Nemyšl near Tábor, Bohemia, Czechoslovakia, 1.IX.1946 (PR-A2723).

Apothecia gregarious or more rarely crowded, superficial, sessile, often on a small base, 2–10 mm diameter, up to 1 mm high. Receptacle at first closed and subglobular, then opening at the top and cup-shaped, finally expanding and scutellate, sometimes undulate, greenish-yellow to yellowish-green, finally more brownish, covered with rusty-brown powder, finally sometimes more or less smooth, especially near the margin; with a prominent, often somewhat crenulate or dentate margin, almost disappearing with age. Disk at first concave, then flat, greenish-

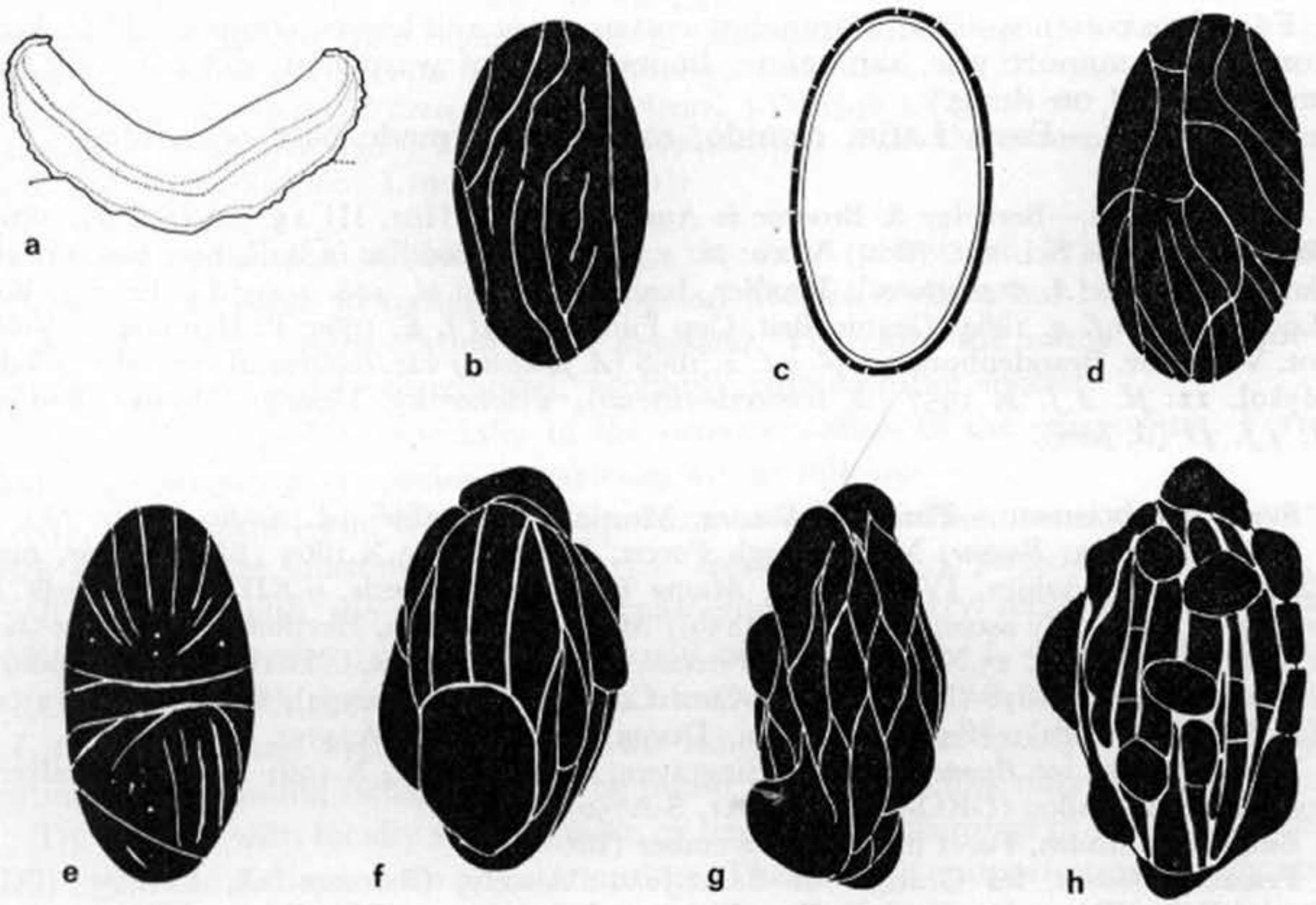

Fig. 41. — *Ascobolus denudatus:* a, diagrammatic section of fruit-body × 25; b, d–h, ascospores × 1600; c, ascospore in optical section × 1600. (a–e, from Erbar. Critt. Ital. 775, S; f, g, from holotype of *A. pani*; h, from type of *A. angulisporus*.)

yellow to yellowish-green, dotted with the violet or brown protruding tips of ripe asci, finally often more brownish or violet by a covering layer of ripe ascospores. Hymenium 140–210 μ thick. Hypothecium 30–43 μ thick, of closely compacted isodiametric cells 6–9(–14) μ diameter. Flesh of varying thickness 180–600 μ thick in the centre, of subglobular or slightly angular cells 22–57 × 20–43 μ, hyaline, often in the upper part with a clearly distinct layer of small, subglobular or somewhat irregularly shaped cells 6–13 μ diameter, together with irregularly swollen hyphae 4–7 μ thick rich in plasm. Excipulum near the margin 20–63 μ thick, in the lower parts sometimes up to 145 μ thick, of subglobular or slightly elongated, thick-walled cells (7–)10–50(–115) μ diameter (the smaller cells near the margin, the largest cells near the base), hyaline or brownish, covered with groups of subglobular, brownish, thick-walled cells; at the extreme base often with up to 200 μ thick conglomerations of hyaline, septate, cylindrical, 4–6 μ wide hyphae, partly penetrating into the substrate. Asci cylindric-clavate, tapering downwards, rounded above, 170–230 × 16–23 μ, 8-spored; only when young is the wall blue in Melzer's reagent. Ascospores biseriate, ellipsoid, with blunt ends, at first hyaline, then violet, finally often purplish-brown, (16–)18–22(–23) × (8.5–)9.5–11.5 μ, when swollen sometimes up to 30 × 16 μ; usually ornamented with longitudinal, subparallel, anastomosing lines, sometimes with the lines all or in part transversely or obliquely arranged; the pigment layer in most cases of uniform thickness, only rarely with thick warts or lumps of pigment; with unilateral mucilaginous cap. Paraphyses simple or branched, septate, cylindrical, 2.5–3.0 μ thick, hyaline, usually not or only slightly enlarged upwards, sometimes forked or more strongly swollen, 3–7(–9) μ thick at the tip, embedded in greenish-yellow mucus.

Found on rotten wood and branches, rotten straw and leaves, composted bracken, humid soil, manure pile, tan refuse, honey comb of wasp nest, old compost, old carpet, rarely on dung.

ETYMOLOGY.—From Latin, denudo, to lay bare: made bare or naked.

ILLUSTRATIONS.—Berkeley & Broome *in* Ann. Mag. nat. Hist. III **15**: *pl. 16 f. 24.* 1865; Boudier *in* Annls Sci. nat. (Bot.) V **10**: *pl. 5 f. 3.* 1869; Boudier *in* Bull. Soc. bot. Fr. **28**: *pl. 3 f. 2.* 1881 (*A. angulisporus*); Boudier, Icon. mycol. **2**: *pl. 408.* 1909; Cooke *in* J. Bot. (Lond.) **2**: 150 *f. 2.* 1864; Dennis, Brit. Cup Fungi *pl. VII f. K.* 1960; P. Hennings *in* Verh. bot. Ver. Prov. Brandenburg **40**: *pl. 2 f. 2.* 1898 (*A. fimiputris* var. *lindaviana*); Svrček *in* Česká Mykol. **11**: *pl. 2 f. 2.* 1957 (*A. transverse-rimosus*); Velenovský, Monogr. Discom. Boh. **2**: *pl. 4 f. 41* (*A. pani*).

SPECIMENS EXAMINED.—**Finland**: *Karsten*, Mustiala, 8.IX.1866 (*A. viridis*, H).

Great Britain: *Broome*, Marlborough Forest, Wiltshire, 15.X.1863 (BM); *Foister*, near Cleghorn, Lamarkshire, IV.1941 (E); *Massee & Crossland*, Leeds, 9.XII.1893 (type of *A. barbatus* in part, only ascospores, NY-A1259); *Moore*, Harpenden, Hertford, 2.VII.1953 (K); *Wilson*, Nottingham, 25.XI.1939 (K); *Perceval*, Stopham, Sussex, XII.1876 (BM); *Phillips*, Norton Camp, XI.1876 (BM); *Phillips*, Card Cock, 1880 (BM-A2999); *Plowright*, Downton, X.1886 (BM-A2881); *Wright*, Braunton, Devon, 22.I.1950 (K-A2475).

Netherlands: *van Brummelen 1398*, Singraven, Denekamp, 14.X.1961 (L); *Rick*, Valkenburg, Limburg, 1899 (GRO-A9, GRO-A1, S-A750).

Belgium: *Mouton*, Forêt de Péry, November (BR-A311).

France: *Bouchet*, les Granges de Saint-Jean-d'Angely, Charente-Inf., VI.1937 (PC); *Bouchet*, Bois d'Essouverts, near Loulay, Charente Inf., XI.1939 (PC); *Boudier*, Montmorency, VIII.1889 (PC-A2206, PC-A2207); *Boudier*, Ham, VIII.1893 (PC-A2208); *Boudier*, Montmorency, VII.1899 (PC-A2205); Boudier (PC-A2186); *Boudier*, Montmorency, June 1879, (type of *A. angulisporus*, PC-A2217); *Grelet*, Cirray, Vienne, 17.V.1916 (PC); *Grelet*, Savigné, Vienne, VI.1916 (PC-A2271); *Louvet*, IV.1899 (PC-A2209).

Portugal: *Torrend*, Mafra, XII.1907 (URM 9011); *Torrend 658* (S-A774); *Torrend*, Lisbon (PC-A2210).

Germany: *von Brefeld*, near Münster, Westfalen, IV.1896 (S-A729); *Britzelmayr*, near Augsburg, IX.1876 (S-A535); *Fuckel*, Grünau near Hattenheim, autumn, *in* Fungi rhen. 1849 (*A. denudatus*, BM, M); *Fuckel*, Altrhein near Hattenheim, Nassau, August (G-A979); *Fuckel*, Oestrich, Nassau, autumn, *in* Herbier Barbey-Boissier 1309 (*A. furfuraceus*, TRTC); *Staritz*, inundated grounds of the river Elbe, Wörlitz, 1890 (S-A761); *P. Sydow*, Tiergarten near Berlin, VII.1885 (S-A759), *in* Myc. march. 786 (BM, HBG, K, PRC, S, W), *in* Rehm, Ascom. 823 (BM, HBG, K, LE, M, PAD, S).

Poland: *Schroeter*, Botanical Garden, Wrocław (= Breslau), III.1888 (BRSL-A1726).

Czechoslovakia: *Bäumler 217*, near Bratislava (= Pressburg), X.1884 (S); *Svrček*, Nemyšl near Tábor, Bohemia, 1.IX.1946 (holotype of *A. transverse-rimosus*, PR-A2723); *Svrček*, Modřany (Libušský potok), Bohemia, 3.V.1947 (PR 179010); *Svrček*, Roblín, Bohemia, 2.X.1949 (PR 179011); *Týn*, road to the water-fall, 26.VI.1923 (PR 178939); *Vacek*, Hrusice near Mnichovice, 2.VIII.1940 (PR 150234); *Vacek*, Ceřnošice, Bohemia, 17.X.1948 (PR 178948); *Velenovský*, Karliché údolí, near Roblín, V.1927 (holotype of *A. pani*, PR 149851); *Velenovský*, Mnichovice, Božkov-lacus, 19.IX.1928 (holotype of *A. perdicinus*, PR 150304); *Velenovský*, Mnichovice, V. 1931 (PR 150128); *Velenovský*, Mnichovice, Koženývich, X.1933 (PR 150302).

Italy: *Beccari*, Orto Botanico, Pisa, II–III.1862, *in* Erbar. Critt. Ital. 775 (type distribution of *A. immarginatus*, BM, G, S); *Bresadola*, Magra, I.1883 (S-A778).

Pakistan: *Ahmad 2262*, Lahore, 29.II.1948 (BPI).

India: *Thind 3037*, Narkanda, Mahasu, 22.VIII.1965. (K).

U.S.A.: California: *Gardner 349*, near pumping station, Golden Gate Park, San

Francisco, III.1915 (BPI). Indiana: *Anderson*, Crawfordsville (NY-A1125). Ohio: *Koshy*, Department of Botany, Ohio State University, Columbus, 21.VI.1948 (NY-A1104); *Koshy*, Department of Botany, Ohio State University, Columbus, 4.VIII.1948 (NY-A1102). Pennsylvania: *Sinden & Reese 1*, State College, 3.IV.1946 (NY). New Jersey: *Seaver*, Palisade, 31.VIII.1916 (NY). District of Columbia: *Shear*, Department of Agriculture Greenhouse, Washington, I.1900 (BPI-A1601).

The type specimen of this species has not been preserved. Fries' description, however, is sufficient to recognize the species. Moreover there has been no controversies about the interpretation of *A. denudatus*. Therefore the name is used for a rather common, widely distributed, probably cosmopolitan species.

It is rather variable, especially in the ornamentation of the episporium. Forms that were described as species or varieties are as follows:—

(A) The typical form, with the episporium of uniform thickness and ornamented with longitudinal anastomosing striae (*A. denudatus* Fr., *A. perdicinus* Vel.).

(B) A form with the episporium ornamented with very narrow longitudinal, oblique or transverse striae, which are only rarely parallel (*A. immarginatus* Becc.).

(C) A form with the episporium with transverse, subparallel, anastomosing striae (*A. transverse-rimosus* Svrček). Since in the same fruit-bodies ascospores with longitudinal anastomosing striae may also be found, this is probably only a mutant-form.

(D) A form with locally semiglobular or irregular thickenings of the episporium, which give the ascospores an angular outline. The rest the episporium is ornamented with longitudinal anastomosing striae (*A. angulisporus* Boud., *A. fimiputris* var. *lindaviana* P. Henn., *A. pani* Vel.).

Ascobolus demangei is distinguishable from *A. denudatus* by the thick episporium and the very closely spaced longitudinal anastomosing striae.

The related *A. foliicola* differs in the stalked apothecia, the furfuraceous margin, and the presence of pyriform cells in the excipular warts. Further studies will be needed to establish their relationship.

35. Ascobolus demangei Pat.—Fig. 42

Ascobolus demangei Pat. *in* Bull. Soc. mycol. Fr. **29**: 222. 1913. — Holotype: *Demange 321* (FH).

Ascobolus nigricans Vel., Nov. mycol. novissimae 153. 1947. — Holotype: PR 150235.

Apothecia gregarious or scattered, superficial, sessile on a broad base, 2–8 mm diameter, about 0.6 mm high. Receptacle at first closed and subglobular, then opening and cup-shaped, finally expanding and scutellate or discoid, yellowish or greenish-yellow, becoming dark brown with age, smooth near the margin, finely furfuraceous at the underside; margin often rather broad, rounded, soon smooth. Disk concave, then flat, greenish, then more brownish, finally almost black, roughened by the protruding asci. Hymenium 170–220 μ thick. Hypothecium 39–50 μ thick, of closely compacted isodiametric or elongated cells 4–12 × 4–8 μ. Flesh 200–260 μ thick, of subglobular, angular or oblong cells 8–34 × 7–25 μ, the larger cells near the outside, hyaline. Excipulum 37–62 μ thick near the margin,

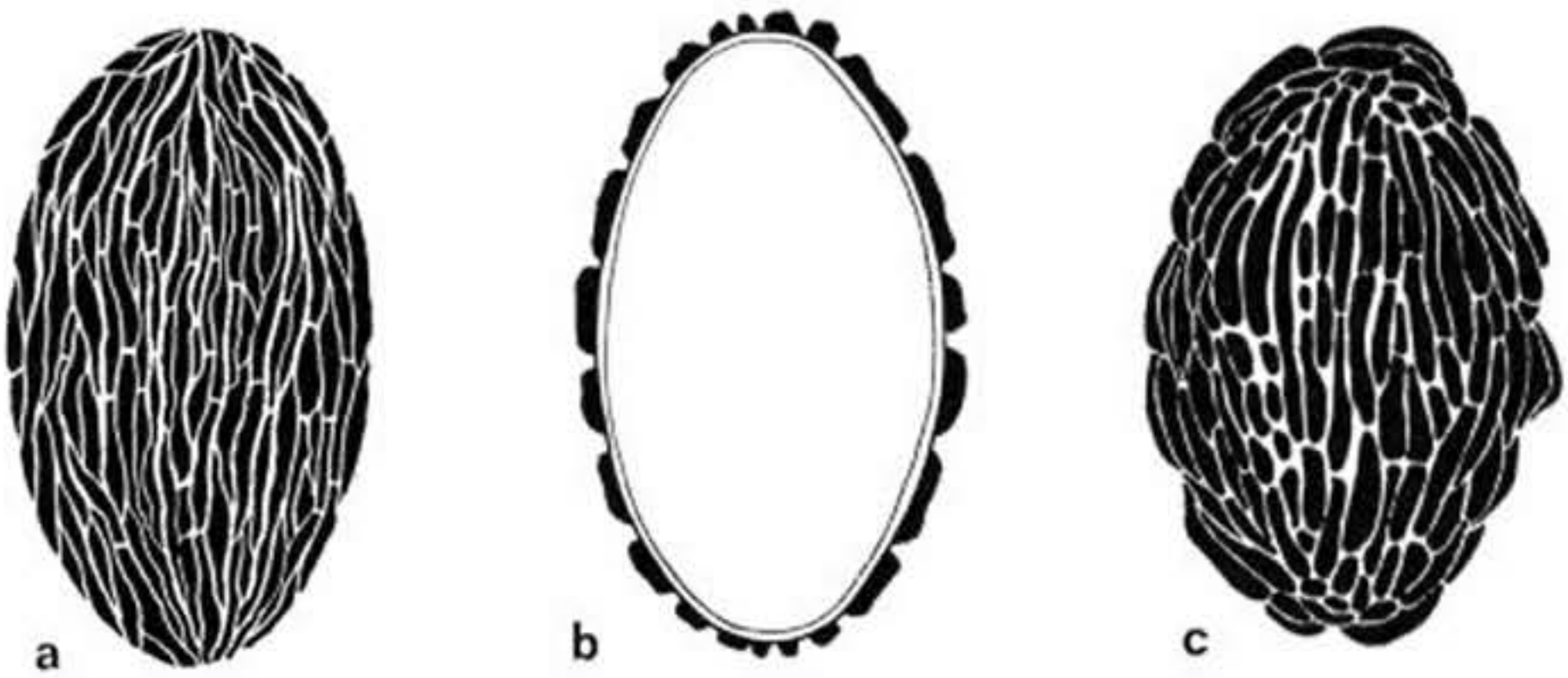

Fig. 42. — *Ascobolus demangei:* a, c, ascospores × 1600; b, ascospore in optical section. (a, b, from holotype; c, from *Velenovský*, PR 150235).

near the base often not clearly distinguishable from the flesh, of subglobular or slightly elongated cells 13–33 × 13–26 μ (textura globulosa), with amorphous, brown, intercellular pigment, at the underside covered with small, irregular groups of subglobular cells. Asci cylindric-clavate, tapering downwards, rounded above, 200–250 × 20–22 μ, 8-spored; the wall not, or scarcely, blue in Melzer's reagent. Ascospores uniseriate, finally more or less biseriate, ellipsoid with rounded or blunt ends, at first hyaline, then dark violet, finally dark purplish-brown to blackish-brown, 21–25 × (10.5–)12–13(–15.5) μ; ornamented with closely spaced, longitudinal, anastomosing lines, fifteen to twenty-five of which are usually visible on each view of the spore; pigment up to 2.2 μ thick. Paraphyses branched, septate, cylindrical, 2.0–2.5 μ thick, slightly enlarged up to 5 μ thick at the tip, hyaline, embedded in yellowish-green mucus, which becomes brownish with age.

On humid soil, often overgrown with algae or mixed with vegetable debris.

Etymology.—After V. Demange, who collected in Tonkin for Patouillard.

Illustrations.—Dissing *in* Dansk bot. Ark. **23**: 118 *f. 1*, 119 *f. 2*. 1963.

Specimens examined.—**Czechoslovakia**: *Velenovský*, Mnichovice, "Bzožek", 4.VIII.1941 (holotype of *A. nigricans*, PR 150235).

Italy: *Saccardo*, Botanical Garden, Padova, autumn 1878, in Myc. ven. 1386 (*A. viridis*, BM, BPI, BRSL, K, W, PAD-A1849).

Viet-Nam: *Demange 321*, La Pho, Tonkin (holotype of *A. demangei*, as *A. viridis* var. *demangei*, FH).

Thailand: *Dissing, 8384*, Rachaburi 26.XI.1961 (C).

This species is sufficiently characterized by the thick episporium ornamented with very closely spaced anastomosing striae. As in *A. denudatus* and *A. geophilus*, the margin of the receptacle soon becomes smooth.

It is only known from four isolated localities.

36. Ascobolus geophilus Seaver—Fig. 43

Ascobolus geophilus Seaver in Mycologia **8**: 96 *pl. 184 fs. 1–2*. 1916. — Holotype: *Seaver*, on damp soil, New York Botanical Garden, New York, U.S.A., 14.VIII.1914 (originally as *A. viridis*, NY).

Apothecia scattered, gregarious or crowded, superficial, sessile on a broad base, 1–5 mm diameter, rarely reaching 10 mm, 0.5–0.8 mm high. Receptacle at first subglobular, then expanding and scutellate or discoid, greenish-yellow, more brownish with age, finely furfuraceous, especially near the base; the margin often smooth and eroded. Disk slightly concave, then flat, greenish-yellow, finally dark brown to almost black, roughened by the protruding tips of ripe asci. Hymenium about 160 μ thick. Hypothecium 28–42 μ thick, of closely compacted, isodiametric cells 5–12 μ diameter. Flesh 250–400 μ thick, of subglobular or oblong cells 9–26 × 7–20 μ, with a zone rich in amorphous, brown, intercellular pigment near the excipulum. Excipulum of varying thickness, up to more than 75 μ thick in the margin, in the lower parts often not sharply differentiated from the flesh, of subglobular or slightly angular cells 9–30 μ diameter, with amorphous, brown, intercellular pigment in the deeper layers near the margin. Asci cylindric-clavate, tapering downwards, rounded above, 160–200 × 17–20 μ (according to Seaver 1916, l.c.: "200–250 × 15–18 μ"), 8-spored; the wall not, or scarcely, blue in Melzer's reagent.

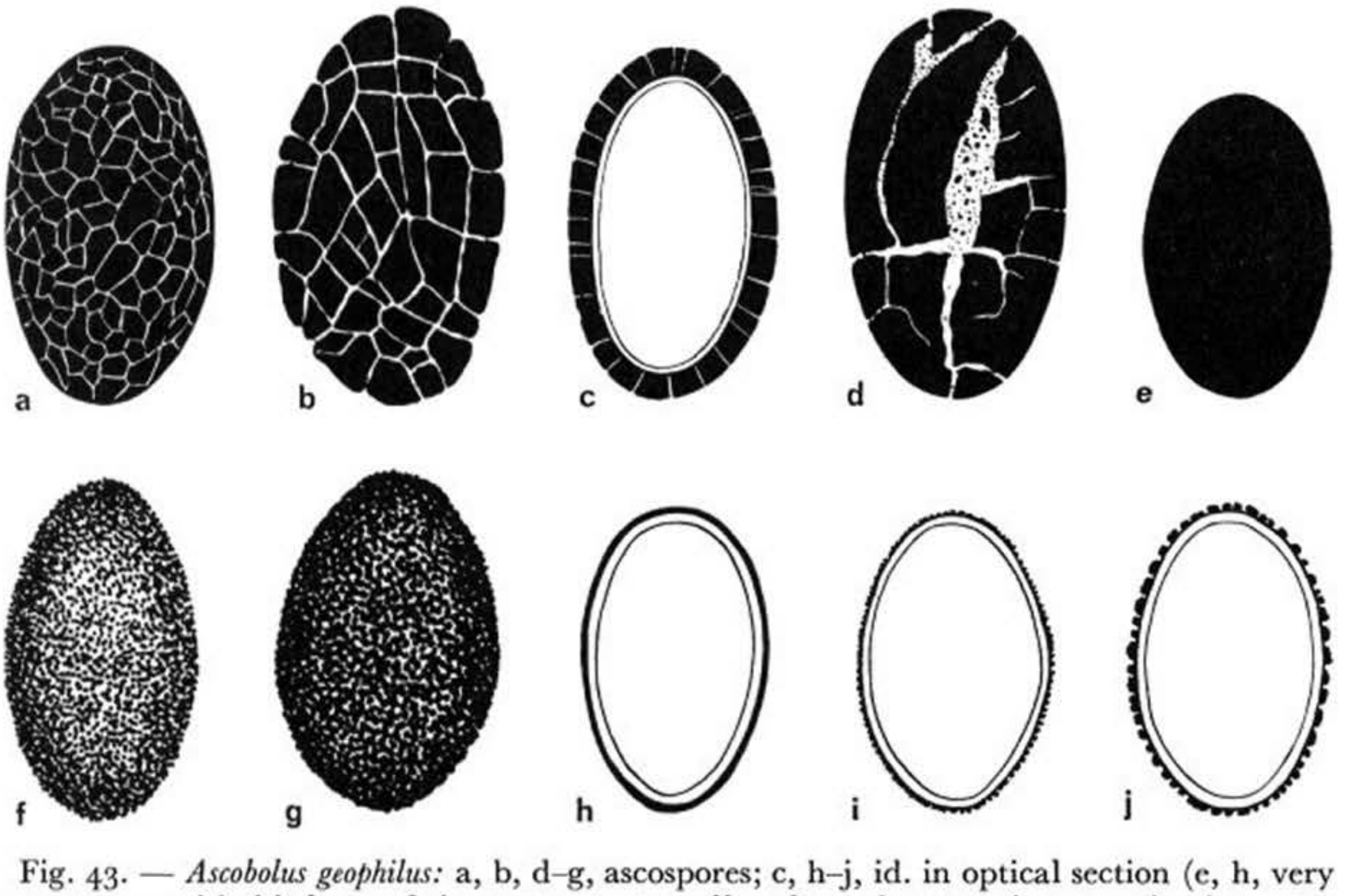

Fig. 43. — *Ascobolus geophilus:* a, b, d–g, ascospores; c, h–j, id. in optical section (e, h, very young spores with thin layer of pigment, not yet swollen; f, g, a, b, successive stages in pigmentation and swelling; b, d, rather extreme types). (All × 1600; a–d, from holotype; e–j, from *Bethel*, NY-A1371.)

Ascospores uniseriate, finally often more or less biseriate, ellipsoid, at first hyaline, then violet, finally dark purplish-brown, (17–)19–22.5(–24) × (9–)9.5–13 μ, often in part swollen; at first smooth or extremely finely granular, then with a pattern of very short, fine fissures in all directions, finally often reticulated or warted, pigment in a rather thick layer, 1.0–1.5(–1.7) μ thick. Paraphyses simple or branched, septate, filiform, 1.5–2.0 μ thick, hyaline, scarcely thickened above, embedded in yellowish mucus which becomes brownish with age.

On humid soil, especially when covered with algae, also on bark of a tree covered with mud.

ETYMOLOGY.—From Greek, γη, the earth and φιλεω, to love: earth-loving, soil-loving.

ILLUSTRATIONS—Seaver *in* Bull. Lab. nat. Hist. State Univ. Iowa **6**: *pl. 30 f. 1.* 1905 (*A. viridis*); Seaver *in* Mycologia **8**: *pl. 184 fs. 1–2.* 1916; Seaver, N. Am. Cup-fungi (Operc.) *pl. 7 f. 2.* 1928.

SPECIMENS EXAMINED.—**Great Britain**: *Soppitt*, Midge hole road, Hebden Bridge, 12.VI. 1898 (K); *Soppitt*, Hebden Bridge, VII.1898 (K-A2484); *Wright*, Braunton, Devon, 18.XI. 1951 (K).

Belgium: *Mouton*, Beaufays (BR-A312); *Mouton*, Wandre, on the bank of the Meuse (BR-A313); *Rousseau*, Boitsfort, VIII.1881 (BR-A334).

France: *Romagnesi*, Coye-la-Forêt, Oise, 22.VI.1952 (PC).

Poland: *Buchs*, near Zülz, VI.1907 (S-A488).

Czechoslovakia: *Svrček*, Praha, Slivenec, Bohemia, 10.VI.1946 (PR 179012); *Vacek*, Slivenec, Bohemia, 10.VI.1946 (PR 178952); *Vacek*, Žarošice, "Gregovňa',, Moravia, 31.VIII. 1946 (PR 178951); *Vacek*, Žarošice, Moravia, 3.VIII.1947 (PR 178949); *Vacek*, Žarošice, Moravia, 5.VIII.1947 (PR 178984); *Vacek*, Žarošice, Moravia, 19.VIII.1947 (PR 178950).

Italy: *Bresadola*, IV.1898 (PC-A2185).

U.S.A.: Oregon: *Kienholz K170*, Mosier Creek, 1.IV.1935 (BPI). Colorado: *Bethel*, Denver (NY-A1371). *Seaver & Shope*, Coal Creek Canon, 23.VIII.1929 (NY). Nebraska: *Clements*, Island of Platte, Gering, 7.VII.1897 (BPI). New York: *Seaver*, New York Botanical Garden, VIII.1912 (NY-A1366); *Seaver*, New York Botanical Garden, 14.VIII.1914 (holotype of *A. geophilus*, NY-A1374). Virginia: *Betts*, University of Virginia, 2.VI. 1938 (NY).

Of this species Seaver (1916) described the episporium as "consisting of verrucose markings and reticulations, the reticulations consisting of light lines which give rise to an irregular net-work". In fact the episporium is at first smooth or extremely finely granular. Later it becomes delicately cracked by short, fine fissures in all directions. Only finally do the thick episporia become reticulated or warted by secondary fissures. As a result this species was only rarely recognized.

The identity of the fungus studied by Le Gal (1947: 249) under this name is doubtful. The illustrated type of ornamentation is not characteristic of this or any of the related species.

Ascobolus geophilus can be distinguished from *A. denudatus* by the ornamentation and the development of the episporium.

Of this species material was studied from North America and Europe. Dr. L. R. Batra collected it in the Mussoorie Hills in India, where it is said to be rather common. Of the Indian material only a description with drawings could be studied.

37. ASCOBOLUS VIRIDIS Curr.—Figs. 4, 44; Pl. 11, fig. G

Ascobolus viridis Curr. *in* Trans. Linn. Soc. Lond. (Bot.) **24**: 154. 1863. — Holotype: *Currey*, on clay ground, Hanham Woods near Bristol, England, 15.X.1861 (K-A1958).

Ascobolus striato-punctatus Boud., Icon. mycol., Ser. 1, livr. 1, preliminary text: 3. 1904:

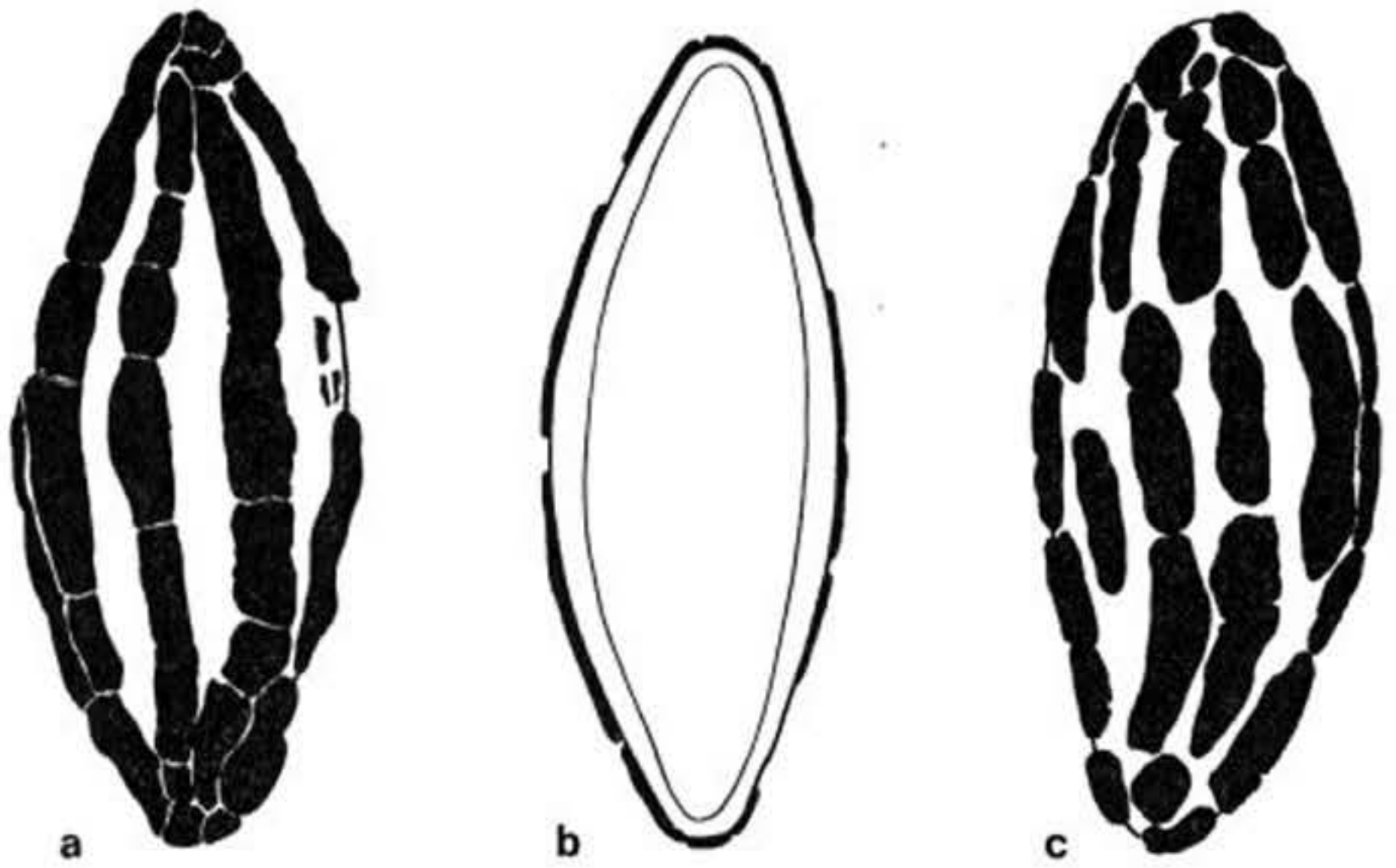

Fig. 44. — *Ascobolus viridis:* a, c, ascospores; b, ascospore in optical section. (All × 1600; from Phillips, Elv. brit. 196, W.)

Boud., Icon. mycol., Ser. livr. 1, 4, pl. 13 (definitive number: 410) 1905; Boud., Hist. Class. Discom. Eur. 72. 1907. — Type: not known to be in existence, represented by Boudier, Icon. mycol., Ser. 1, livr. 4, pl. 13 (definitive number 410); type locality, Forêt de Montmorency, France.

Ascobolus grandis Vel., Monogr. Discom. Boh. **1**: 367, **2**: *pl. 4 f. 40.* 1934. — Type: not known to be in existence, represented by Velenovský, Monogr. Discom. Boh. **2**: *pl. 4 f. 40*; type locality; near Karlštejn, Czechoslovakia.

EXCLUDED.—*Ascobolus viridis* Curr. sensu Boud. *in* Annls Sci. nat. (Bot.) V **10:** 217 *pl. 5 f. 4.* 1869. = *Ascobolus carbonarius* P. Karst.

Ascobolus viridis Curr. sensu P. Karst. *in* Notis. Sällsk. Fauna Flora fenn. Förh. **11**: 202. 1870 = *Ascobolus denudatus* Fr.

Ascobolus viridis Curr. sensu Schroet. *in* Krypt.-Fl. Schles. **3** (2): 56. 1893 = *Ascobolus denudatus* Fr.

Apothecia scattered or gregarious, superficial, sessile, rarely with a stalk, 3–6(–8) mm diameter, 1–2 mm high. Receptacle cup-shaped, then scutellate, yellowish-green, finally more olive-brown, coarsely brownish furfuraceous; margin not very prominent, furfuraceous. Disk slightly concave or flat, of about the same colour as the receptacle, dotted with the almost black protruding tips of ripe asci. Hymenium 230–300 μ thick. Hypothecium about 25 μ thick, of oblong cells 7–12 × 3–4.5 μ. Flesh of varying thickness, of subglobular or elongated cells 16–50 × 9–30 μ; the smaller cells in the upper part, the larger cells near the outside; hyaline, near the base pale brownish. Excipulum 35–65 μ thick; of subglobular, thick-walled cells 16–40 μ diameter, together with thick, irregularly swollen hyphae, brownish, covered with groups of subglobular, thick-walled cells. Asci cylindric-clavate, tapering downwards, rounded above, 240–350 × 23–30 μ, 8-spored; only when young the wall blue in Melzer's reagent. Ascospores finally biseriate, fusiform or ellipsoid with strongly pointed ends, at first hyaline, then violet, (23.5–)28.5–37.5 × (10–)11–14 μ (exceptionally up to 52 × 24 μ), ornamented with long or short longitudinal ridges of pigment; pigment up to 2 μ thick. Paraphyses simple or

branched, septate, cylindrical, 2.5–3.1 μ thick, hyaline, swollen to 7 μ thick at the tip, embedded in yellowish-green or pale greenish mucus.

Only known from humid soil, especially in woods.

ETYMOLOGY.—From Latin, viridis, green.

ILLUSTRATION.—Boudier *in* Bull. Soc. bot. Fr. **24**: *pl. 4 f. 6.* 1877; Boudier, Icon. mycol., Ser. 1, livr. 4, *pl. 13* (definitive number: 410). 1905 (*A. striato-punctatus*); Dennis, Brit. Cup Fungi *pl. VII f. J.* 1960; Phillips, Brit. Discom. *pl.* **9** *f.* **54**. 1887; Seaver, N. Am. Cup-fungi *pl. 7 f. 1.* 1928; Velenovský, Monogr. Discom. Boh. **2**: *pl. 4 f. 40.* 1934 (*A. grandis*).

SPECIMENS EXAMINED.—**Great Britain**: *Broome 393*, Leigh Wood, 4.IX.1848 (BM); *Broome*, Dinmore, Hereford, X.1878 (BM-A2944); *Broome*, Hereford (K-A1956); *Crossland*, Norland, near Halifax 8.X.1898 (K-A2455); *Currey*, Hanham Woods, near Bristol, 15.X.1861 (holotype of *A. viridis*, K-A1958); *Perceval*, Henbury, Bristol, Gloucestershire 21.VI.1878 (BM); *Phillips*, 14.VII.1873 (BM-A2945); *Phillips*, Whitfield and Dinmore, Hereford, V.1875 (BM-A2949); *Phillips*, near Shrewsbury, V.1877 (K.A1959); *Phillips*, Shrewsbury, spring, *in* Elv. brit. 196 (BM, BPI, E, K, M, MEL, W); *Phillips*, Shropshire (PC-A2188).

Belgium: *Mouton*, Gomzé, VI.1898 (BR-A329); *Mouton*, Beaufays, September (BR-A310); *Mouton*, Beaufays, October (BR-A328).

France: *Bouchet*, near Les Ouillères-lez-Nouillers, Charente inférieure, V.1936 (PC-A2309); *Bouchet*, Les Ouillères-lez-Nouillers, Charente inférieure, V.1937 (PC-A2316); *Bouchet*, Forêt de Mervent, Vendée, VIII.1939 (PC-A2308); *Clere*, Ain, VI.1902 (PC-A2189); *Quélet*, Hérimoncourt, Doubs, 10.VII.1878 (UPS); *Quélet*, Jura, 10.VI.1879 (*A. chlorinus* Quél. unpublished name, UPS-A2013); *Quélet*, 1879 (*A. chlorinus* Quél. K-A1960); *Romagnesi*, Coye-la-Forêt, Oise, 18.V.1948 (PC).

Czechoslovakia: *Vacek*, Karlštejn, Bohemia, 28.VI.1942 (PR 178991); *Velenovský*, Mnichovice, Bohemia, IX.1922 (PR 150070); *Velenovský*, Mnichovice, Hubáčkov, Bohemia, 1.VI.1932 (PR 150309).

Austria: *Rick*, near Feldkirch, Vorarlberg, VIII.1897 (S-A790); *Rick*, near Feldkirch, Vorarlberg, IX.1897 (S-A736).

This species, which is known only from Europe, is sufficiently characterized by the long-fusiform ascospores with longitudinal ridges of pigment.

38. ASCOBOLUS ALBINUS Seaver

Ascobolus albinus Seaver *in* Mycologia **8**: 95. 1916. — Type not known to be in existence. — Type locality: Woods, near Yonkers, New York, U.S.A.

"Apothecia gregarious, at first subglobose, expanding and becoming scutellate, reaching a diameter of 4–5 mm, externally pure white, minutely rough; hymenium plane or nearly plane, at first whitish, becoming darkened by the maturing spores; asci cylindric or subcylindric, 8-spored, reaching a length of about 200 μ and a diameter of about 25 μ; spores at first obliquely 1-seriate, becoming 2-seriate or irregularly crowded, ellipsoid, becoming purple then brown, 20–26 × 12 μ, rough; spore roughenings consisting of minute warts; paraphyses very slender, hyaline."

"On damp soil in woods."

ETYMOLOGY.—From Latin, albinus, somewhat white.

DISTRIBUTION.—Known only from the type locality.

This species can easily be distinguished from the related *A. behnitziensis* by the pure white colour of the fruit-body and the finely warted episporium.

39. Ascobolus behnitziensis Kirschst.—Fig. 45; Pl. 11, fig. H

Ascobolus amethystinus Phill. *in* Grevillea **4**: 84. 1875. — *Galactinia amethystina* (Phill.) Wakef. *in* Trans. Brit. mycol. Soc. **6**: 375. 1920 (in part, exclusive of lectotype; seq. excluded species).
Ascobolus behnitziensis Kirschst. *in* Verh. bot. Ver. Brandenburg **48**: 47. 1907. — Type: *Kirchstein*, on loamy soil, Gross-Behnitz, Prov. Brandenburg, Germany, 8.X.1904 (FH, S).

Apothecia gregarious or scattered, superficial, sessile on a broad base, up to 10 mm across, 0.3–0.6 mm high. Receptacle at first closed and subglobular, then opening and cup-shaped with sharp sinuate margin, finally expanding and scutellate or flat, olive-brown or purplish, coarsely furfuraceous. Disk concave, then flat, olive or purplish, darkening with age, roughened by the protruding asci. Hymenium 130–170 μ thick. Hypothecium about 22 μ thick, of closely compacted, isodiametric or oblong cells 6–12 × 4.5–7 μ. Flesh of varying thickness, of isodiametric or slightly elongated cells, 6–20 μ diameter, with a purplish or brownish coloured zone near the excipular layer. Excipulum about 30 μ thick, near the margin sometimes reaching 170 μ, of subglobular or oblong cells 11–28 × 8–28 μ; with brownish or purplish, intercellular, amorphous pigment, covered with irregular groups of large globular cells. Asci cylindric-clavate, tapering downwards, rounded above, 160–200 × 17–23 μ, 8-spored; only when young the wall blue in Melzer's reagent.

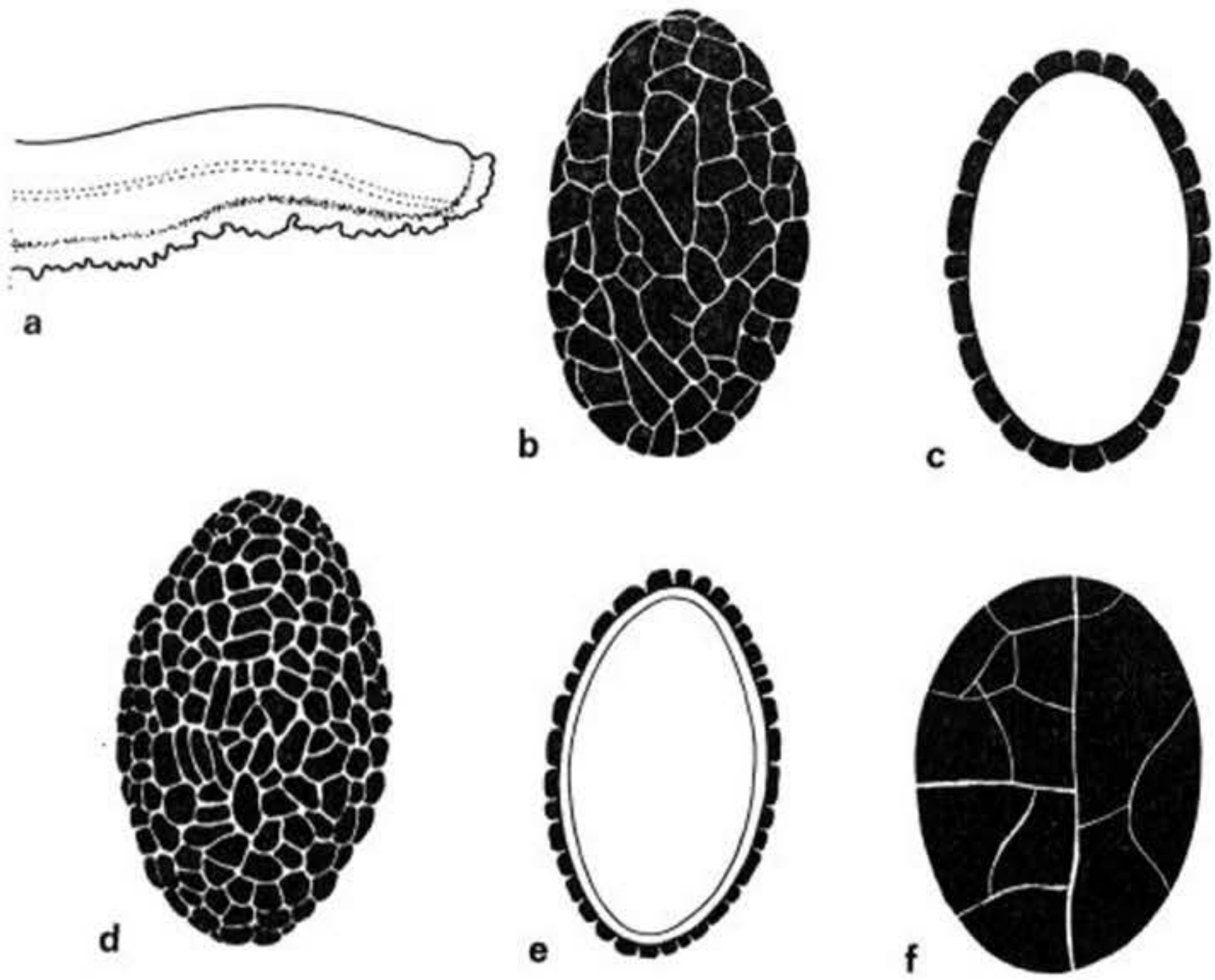

Fig. 45. — *Ascobolus behnitziensis:* a, diagrammatic section of fruit-body × 25; b, d, f, ascospores × 1600 (f, abnormal type from 2-spored ascus); c, e, id. in optical section. (a–c, from *Phillips*, K-A1980; d–f, from type, S-A534.)

Ascospores uniseriate, finally more or less biseriate, ellipsoid; at first hyaline, then pale violet or pale brownish, finally dark violet or dark purplish-brown, 19–22.5 (–23.5) × 11–13.5(–14.5) μ, ornamented with a fine net-work of striae; pigment in a rather thick layer. Paraphyses simple or branched, septate, cylindrical, 2–3 μ

thick, hyaline, slightly enlarged up to 4 μ thick at the tip, embedded in coloured mucilaginous substance.

Only known from humid soil.

ETYMOLOGY.—After Gross-Behnitz in Germany.

SPECIMENS EXAMINED.—**Great Britain**: *Dennis*, Tensmuir, Fife, 10.X.1965, on sand (L-A3286); *Phillips*, *s. loc.*, XI.1875 ("*A. amethysteus*", probably part of the type of *A. amethystinus*, exclusive of lectotype, K-A1980).

Germany: *Kirchstein*, on clay soil, Gross-Behnitz, Prov. Brandenburg, 8.X.1904 (type of *A. behnitziensis*, FH-A3113, S-A534). *Kirschstein*, on loam, Gross-Behnitz, Prov. Brandenburg, 6.X.1905 (B).

Italy: *Bresadola*, on muddy soil, "alte Giare," VI.1896 (S-A784); *Bresadola*, on muddy soil, Trento, s. dat. (S-A482).

When Phillips (1875) described *Ascobolus amethystinus* two species were involved (cf. p. 206): an *Ascobolus* and *Peziza phillipsii* Cooke. Since most elements of the description refer to the *Peziza*, Wakefield (1920) indicated that part of the original collection as lectotype of Phillips species. The excluded *Ascobolus* proved to belong to *A. behnitziensis*.

This species is characterized by the episporium, which shows a net-work of striae from the beginning. It seems to be very rare and is known only from Europe.

40. ASCOBOLUS ARCHERI Berk.—Fig. 46; Pl. 12, figs. A,C

Ascobolus archeri Berk. *in* Hooker f., Botany of the Antarctic Voyage III, **2**: 276. 1860. — Holotype: *Archer*, on charcoal, Tasmania (K-A1997).

Apothecia gregarious, superficial, sessile, up to 4 mm across. Receptacle scutellate, finally slightly undulate, "vinoso-fusca" at maturity, almost smooth, with a rounded, somewhat eroded margin. Disk concave, then flat, brownish at maturity, roughened by the protruding asci. Hymenium up to 230 μ. Hypothecium clearly differentiated, 30–40 μ thick, of isodiametric, rounded cells 6–12 μ diameter. Flesh of subglobular or slightly elongated cells 7–18 μ diameter, hyaline. Excipulum up to 80 μ thick near the margin, of subglobular, rather thick-walled cells 10–26 μ diameter, brownish, irregularly eroded at the outside. Asci cylindric-clavate, tapering downwards, roughened above, up to 250 × 23 μ, 8-spored; only when very young the wall

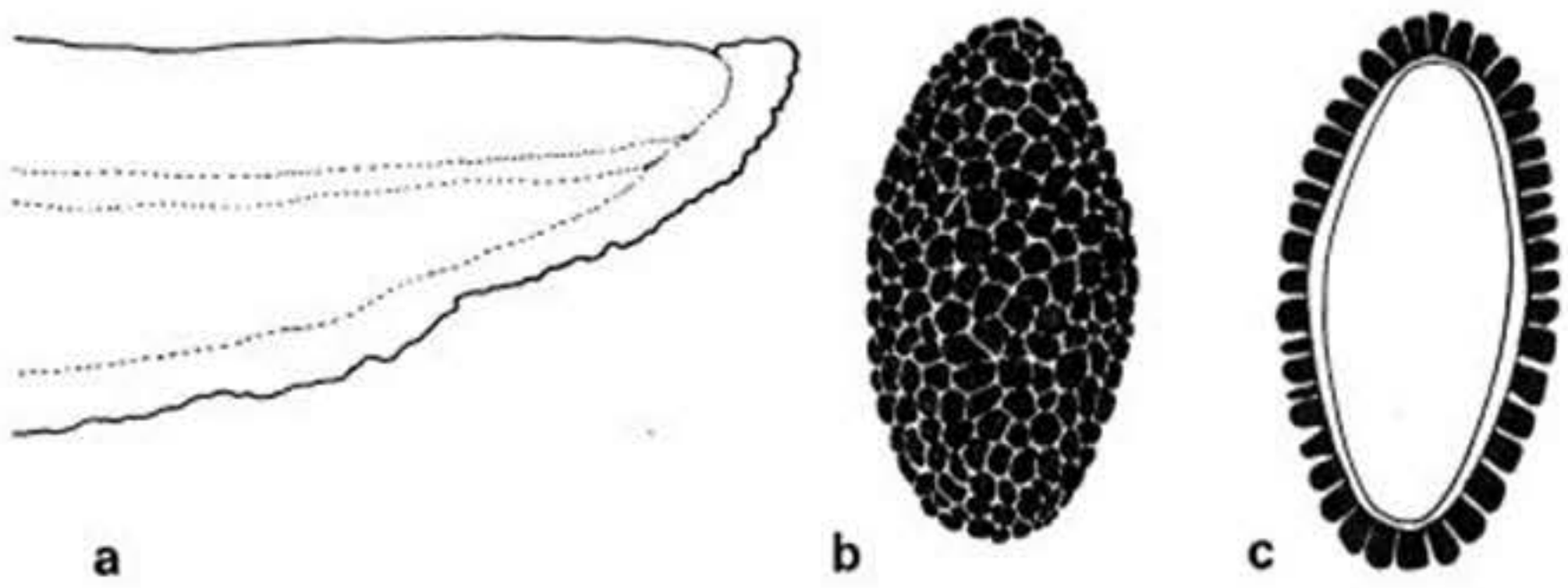

Fig. 46. — *Ascobolus archeri:* a, diagrammatic section of fruit-body × 40; b, ascospore × 1600; c, id. in optical section. (From holotype.)

pale blue in Melzer's reagent. Ascospores uniseriate, finally more or less biseriate, ellipsoid, at first hyaline, then violet, finally purplish-brown, 17.5–22 × 9–11.5 μ (pigment included), often swollen, ornamented with a very regular pattern of round warts 1.0–1.3 μ diameter; pigment in a 1.5–2.5 μ thick layer; without oil drops or granules. Paraphyses branched, septate, cylindrical, about 2 μ thick, not or only very slightly enlarged up to 3 μ at the tip, embedded with the tips in coloured mucus.

On charcoal.

ETYMOLOGY.—After the collector, Mr. Archer.

SPECIMEN EXAMINED.—**Australia**: *Archer*, on charcoal, Tasmania (holotype of *A. archeri*; K-A1997).

Obviously this is close to *A. carbonarius*. It differs mainly in the slightly smaller ascospores and the regularly warted episporium without thickenings at the ends.

41. ASCOBOLUS CARBONARIUS P. Karst.—Fig. 47; Pl. 12, fig. B, D

Ascobolus carbonarius P. Karst. *in* Fungi Fenn. No. 463. 1866; *in* Notis. Sällsk. Fauna Fl. Förh. **11**: 202. 1870. — Type distribution: Fungi fenn. No. 463.

Ascobolus viridis var. *pruinosus* Boud. *in* Annls Sci. nat. (Bot.) V **10**: 218 *pl. 5 f. 5*. 1869. — *Ascobolus atrofuscus* var. *pruinosus* (Boud.) Sacc., Syll. Fung. **8**: 521. 1889. — Type: represented by Boud. l.c. *pl. 5 f. 5*; type locality, near Paris, France.

Ascobolus atrofuscus Phill. & Plowr. *in* Grevillea **2**: 186 *pl. 24 f. 1*. 1874. — Holotype: *Phillips*, the Wrekin, Shropshire, Great Britain, VII, 1873 (K).

[*Ascobolus viridis* Curr. sensu Boud. *in* Annls Sci. nat. (Bot.) V **10**: 217 *pl. 5 f. 4*. 1869. —] *Ascobolus carbonicola* Boud. *in* Bull. Soc. bot. Fr. **24**: 310. 1877. — Type: represented by Boud. *in* Annls Sci. nat. (Bot.) V **10**: *pl. 5 f. 4*. 1869; type locality, near Paris, France.

Ascobolus bohemicus Klika *in* Ann. mycol., Berl. **20**: 291. 1922. — Type (selected by Svrček): PR 129879.

MISAPPLIED NAME.—*Ascobolus viridis* Curr. sensu Boud. *in* Annls Sci. nat. (Bot.) V **10**: 217 *pl. 5 f. 4*. 1869.

EXCLUDED.—*Ascobolus carbonarius* P. Karst. sensu Rehm, Rab. Krypt.-Fl. (Pilze) **3**: 1129. 1896 (with regard to the ascospores).

Apothecia gregarious or crowded, superficial, sessile, 2–5 mm diameter, up to 1 mm high. Receptacle at first subglobular, then scutellate, finally flattened, greenish-yellow, becoming more brownish with age, finally blackish-brown, finely mealy or scaly; margin crenulate, finally almost smooth and blunt. Disk concave, then flat, yellowish-green, more brownish with age, dotted with the black protruding tips of ripe asci, finally almost black. Hymenium 180–250 μ thick. Hypothecium 30–43 μ thick, of closely compacted isodiametric cells 5–10 μ diameter. Flesh of varying thickness, up to 600 μ thick, of subglobular or elongated cells 13–30(–40) × 10–22(–26) μ, hyaline. Excipulum about 60 μ thick, in the margin sometimes up to 170 μ thick, of subglobular, angular and oblong, thick-walled cells 8–22(–35) × 6–17(–23) μ, together with irregularly bending, branched hyphae 2.5–4.0 μ wide, brown, covered with more or less protruding groups of subglobular cells and hyphae. Asci cylindric-clavate, tapering downwards, rounded above, 190–270 × 22–26 μ, 8-spored; only when young the wall pale blue in Melzer's reagent. Ascospores uniseriate, finally more or less biseriate; when immature (without pigment) ellipsoid with pointed ends, when mature (with pigment) ellipsoid with truncate ends;

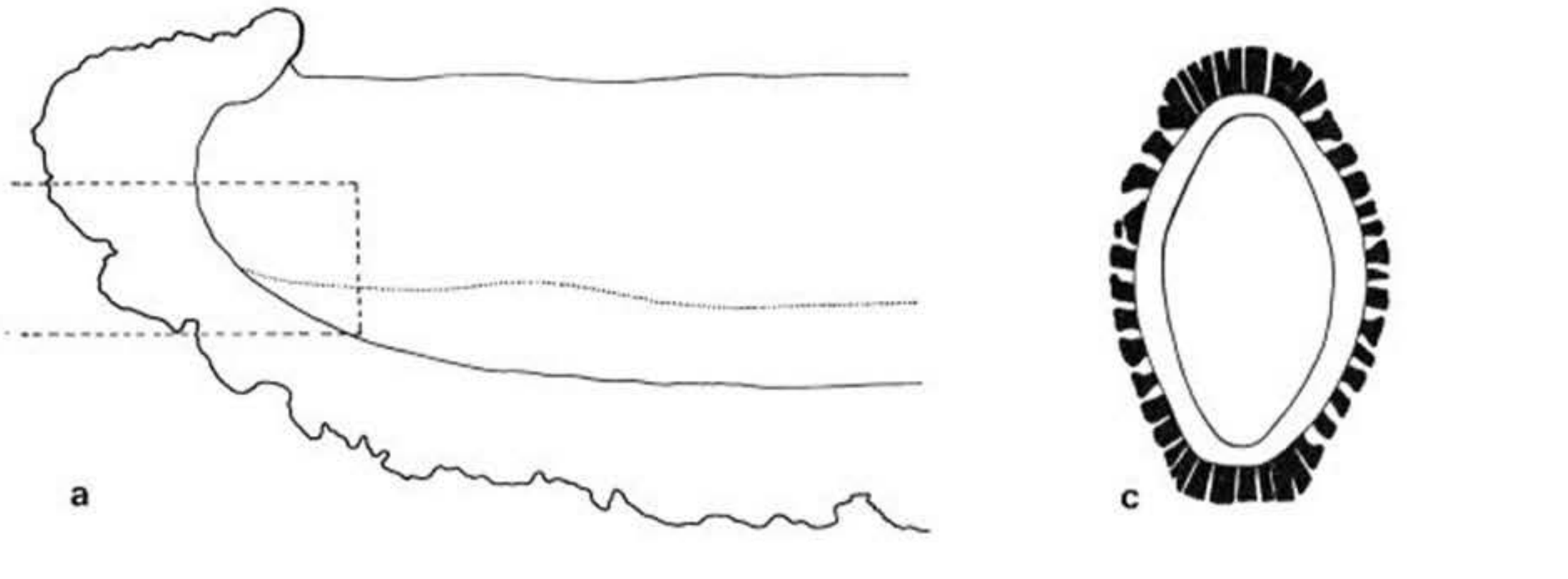

Fig. 47. — *Ascobolus carbonarius:* a, diagrammatic section of fruit-body × 110; b, detail of a median section through fruit-body × 275; c, ascospore in optical section × 1600; d, e, ascospores in optical section × 1600. (a–d, from Fungi fenn. 463, NY; e, from *Daams 297*, L.)

at first hyaline, then dark violet, finally dark purplish-brown, 17.5–25(–27.5) × (11.5–)13–14.5 μ (pigment included), rarely swollen; ornamented with irregular or rounded, isolated warts varying considerably in size; pigment in a very thick layer, at the sides 1.5–2.7 μ thick, at the ends 2.4–3.1 μ thick. Paraphyses occasionally branched, septate, cylindrical, about 2 μ thick, not or scarcely thickened above, up to 3.5 μ thick at the tip, embedded in yellowish-green mucus.

On charcoal, burnt vegetable debris, and burnt soil, rarely on humid soil without remnants of a fire.

ETYMOLOGY.—From Latin, carbonarious, pertaining to charcoal.

ILLUSTRATIONS.—Boudier *in* Annls Sci. nat. (Bot.) V **10**: *pl. 5 fs. 4–5.* 1869 (*A. viridis*); *Dennis*, Brit. Cup Fungi *pl. VII f. I.* 1960; Le Gal *in* Annls Sci. nat. (Bot.) XI **8**: 245 *f. 66*, 247 *f. 67*, *unnumbered plate fs. A–B.* 1947; Phillips & Plowright *in* Grevillea **2**: *pl. 24 f. 1.* 1873 (*A. atrofuscus*); Seaver *in* Bull. nat. Hist. State Univ. Iowa **6**: *pl. 29 f. 1.* 1905; Seaver *in* Mycologia **8**: *pl. 184 fs. 7–8.* 1916; Seaver, N. Am. Cup-fungi (Operc.) *pl. 7 f. 4.* 1928; Velenovský, Monogr. Discom. Boh. **2**: *pl. 4 f. 42.* 1934 (*A. atrofuscus*).

SPECIMENS EXAMINED.—Unless otherwise stated, the samples were collected on charcoal, burnt vegetable debris or burnt soil.

Sweden: *Starbäck*, Knivsta, Uppland, VII.1895 (S-A738, S-A753).
Finland: *Karsten*, Mustiala, VIII.1866 (S-A744); *Karsten*, Mustiala, 25.VIII.1866 (H-A2756); *Karsten*, Mustiala, IX.1866, in Karsten, Fungi Fenn. 463 (type distribution of *A. carbonarius*, BM-A2827, BM-A2828, NY-A1285); *Karsten*, Mustiala, 4.VIII.1871 (S-A767).
Great Britain: *Dennis*, Norbury Park, Wickham, Surrey, 20.VI.1948 (K); *Dennis & Ellis*, Wheatfen, Norfolk, 5.VI.1954 (K); *Eyre*, Abresford, Swarralow, 14.VI.1887 (BM); *Phillips*, the Wrekin, Shropshire, VII.1873 (holotype of *A. atrofuscus*, K); *Phillips*, Excal Hill near Shrewsbury, VII.1873 (BM-A2955, BM-A2959); *Phillips*, Arkollhill, Wellington, Shropshire, VII.1873 (BM); *Phillips*, *s. loc.*, VII.1873 (BM-A2960); *Phillips*, Shrewsbury, 1873 (S-A763); *Phillips*, Shrewsbury, *s. dat.*, *in* Phillips, Elv. brit. 47 (*A. atrofuscus*, BM, BPI, K, M, PAD); *Phillips*, Craven Armes, 6.X.1875 (BM); *Phillips*, road near Sallow Coppice, Upper Millichope, 6.VIII.1888 (BM); *Phillips*, Salop. (= Shropshire), *s. dat.* (*Ascobolus fuscoatra*, unpublished name, BM-A2963); *Phillips*, Shrewsbury, *s. dat.* (BM-A2951, S-A532); Phillips, *s. loc.*, *s. dat.* (BM-A2958); *Plowright*, Ringstead, Norfolk, X.1876 (BM); *Rea*, near Perth, 11.VIII.1910 (BM); *Rea*, Weybridge, 22.XI.1920 (BM); *Rea*, New Parks, Wyreforest, Worcestershire, 30.VII.1925 (BM); *Reid*, Keswick, Cumberland, 4.VI.1956 (K).
Netherlands: *Daams 297*, "Over-Holland", Nieuwersluis, 21.VIII.1957 (L); *Rick*, Valkenburg, Limburg, XII.1899 (S).
Belgium: *Bommer & Rousseau*, Groenendael, VII–IX. 1886, *in* Roumeguère, Fungi gall. 3935 (*A. atrofuscus*, G); *Mouton*, *s. loc.*, *s. dat.* (BR-A306); *Rousseau*, Florenville, IX.1884 (BR); *Rousseau*, Groenendael, VIII.1887 (BR); *Rousseau*, Groenendael, VII.1890 (BR); unknown collector, near Liège, *s. dat.* (S-A601).
France: *Bertrand*, Malzeville, Meurthe, VI. 1914 (PC); *Bouchet*, Bois des Essouverts, near Loulay, Charente-Maritime, V.1942 (PC); *Boudier*, *s. loc.*, VI(?).1882 (S); *Boudier*, Blois, VI.1897 (PC); *Cooke*, Villers Cotterets, *s. dat.* (K-A1968); *Costantin*, Montmorency, Seine-et-Oise, 29.V.1886 (PC); *Grelet*, Savigné, Vienne, 26.V.1916 (PC); *Grelet*, same locality, VI.1916 (PC); *Le Gal*, Parc de St. Cloud, Seine-et-Oise, VI.1942 (PC); *Patouillard*, Bois de Menrois, Jura, VIII.1903 (FH); *Quélet*, Hérimoncourt, *s. dat.* (K-A1969).
Germany: *P. Sydow*, Schlossgarten, Charlottenburg, VIII.1888 (S); *Wagner*, gr.-Winterberg, VII–VIII. 1895, 1897 and 1898, *in* Krieger, Fungi sax. 1982 (*A. atrofuscus*, BM, BPI, HBG ,M, S); *Wagner*, gr.-Winterberg, 17.VI.1897 (HBG).
Poland: *Buchs*, near Schammelwitz, VI.1905 (S); *Buchs*, Neisse-Ufer, near Ottmachau, VIII.1906 (S); *Buchs*, Silberberggrund, VII.1907 (S); *Schroeter*, Kreuzberg, near Striegau, 15.VIII.1888 (BRSL).
Czechoslovakia: *Klika*, Všetaty, VII.1922 (PR 129837); *Klika-Vlach*, Kyselky přivorské, "K. Mikovu", IX.1922 (lectotype of *A. bohemicus*, PR 129879); *Klika*, Lărnov, 20.VII.1924 (PR 129787); *Klika*, D. Štubnia, 26.VII.1924 (PR 129784); *Klika*, Cesta pod Vosvúým, Shědohoŭ, Bohemia, VII.1925 (BPI); *Melzer*, Smolov, Domažlice, 1.VII.1919 (PR 129841); *Petrak*, Mähr.-Weisskirchen (= Hranice), Chorin, VIII.1922 (ZT); *Vacek*, Říčany, Bohemia, VII.1939 (PR 149850); *Vacek*, Krč near Praha, 18.VIII.1946 (PR 178924); *Vacek*, zărošice, Moravia, 18.VIII.1948 (PR 178927); *Vacek*, Karlštejn, Bohemia, *s. dat.* (PR 178925); *Velenovský*, Mnichovice, VIII.1923 (PR 150225); *Velenovský*, Jevany, 3.VIII.1925 (PR 148950); *Velenovský*, Ondrějov, 27.IX.1927 (PR 149848); *Velenovský*, Mnichovice, Menčice, XI.1928 (PR 150315); *Velenovský*, Mnichovice, "Zburany", 3.VI.1929 (PR 150314); *Lany*, VIII.1929 (PR 149847); *Velenovský*, Mnichovice, Hrusice; *Velenovský*, VIII.1930 (PR 150313); *Velenovský*, Senahraby, IX.1931 (PR 149845); *Velenovský*, Mnichovice, Kunice, VII.1932 (PR 150312).
Switzerland: *von Tavel*, Zürichberg, near Zürich, 17.VI.1893 (S, ZT); *Winter*, Zürichberg, near Zürich, V.1877, *in* Winter, Fungi helv. 209 (*A. viridis*, BRSL, HBG, PAD, S).
Austria: *Rick*, near Feldkirch, Vorarlberg, IX.1893 (S); *von Keissler*, near the Kummerbrücke, Gesäuse, Steiermark, VI.1912 (W).
Italy: *Bresadola*, Andalo, 30.VIII.1896 (S).
U.S.S.R.: *Tranzschel*, Bologoje, Nowgorod, 29.VI.1897 (S).

Uganda: *Hansford 1859*, on damp soil, Kampala, VI.1934 (CMI).
Canada: *Bisby et al. 3640*, on damp soil, Manitoba Agr. Coll., Winnipeg, 29.VII.1927 (NY); *Seaver*, Duchesnay, Quebec, 23–25. VIII.1938 (NY).
U.S.A.: Oregon: *Kienholz K 84*, on damp, mossy soil, Hood River, 16.XI.1932 (NY); *Kienholz KD 84*, Tony Mohr ranch, Hood River, 11.V.1943 (BPI). Iowa: *Seaver 63*, Iowa City, X.1904 (BPI); *Seaver 63b*, Iowa City, X.1904 (NY, S). Wisconsin: *Dodge*, Kewaunee County, *s. dat.* (NY-A1295). Michigan: *Fitzpatrick*, Ann Arbor, *s. dat.* (NY-A1296). Indiana: *Cummins*, Lafayette, 27.VI.1930 (NY). Ohio: *Lloyd 0236*, Linwood, V.1902 (NY); Lloyd, *s. loc.*, 1903 (S). Tennessee: *Underwood 11981*, on sand in greenhouse, Knoxville, 16.III.1939 (L). Maine: *Thaxter*, Kittery Point, VII.1897 (FH). New York: *Dodge & Seaver*, Hollis, Long Island, 25.VI.1910 (NY); unknown collector, Hollis, Long Island, 10.VI.1911 (NY-A1264); *Seaver*, N.Y. Bot. Gardens, VI.1910 (NY-A1282, NY-A1291, NY-A1302); *Seaver*, N.Y. Bot. Gardens, 27.V.1912 (NY); *Seaver*, near Yonkers, 19.VII.1912 (NY); *Seaver*, on soil, near Yonkers, VIII.1912 (NY); *Seaver*, New York City, summer 1912 (NY); *Seaver*, Yonkers woods, 26.V.1913 (NY); *Seaver*, New York City, 3.VI.1914 (NY); *Seaver*, New York City, *s. dat.* (NY-A1292); *Whetzel & White 1744*, White Lake, near Syracuse, 13.VI.1935 (FH). Connecticut: *Thaxter*, Cheshire, VI.1890 (FH); *Thaxter*, West Rock, 20.VI.1891 (FH). Pennsylvania: *Dodge*, Bethlehem, 7.VI.1922 (BPI). West Virginia: *Nuttall*, Nuttallburg, V.1893 (*Phaeopeziza Nuttallii*, BPI, NY-A1306, NY-A1308); *Nuttall*, Nuttallburg, VI.1893, *in* Ellis & Everhart, N. Am. fungi Ser. 2, 2908 (*Phaeopeziza Nuttallii* Ell. & Ev., n. sp., type distribution, BM, BPI, NY); *Nuttall*, Fayette Country, *s. dat.* (BPI). Virginia: Shear, Radnor Hts, 23.V.1920 (BPI); *Shear*, Arlington Cemetery, 14.V.1933 (BPI). North Carolina: *Olive*, near Buck Creek Ranch, Jackson County, 16.VIII. 1955 (NY).
Costa Rica: *Martin 8747*, hills above Palmer Norte, Prov. Puntarenas, 8.VIII.1952 (developed in moist chamber, BPI).

This common, cosmopolitan species occurs rather frequently on burnt places, especially when these are on loamy soil. It is characterized by the irregularly warted episporium with polar thickenings.

There is some variation with respect to the coarseness of the furfuraceous particles on the outside of the receptacle. Also the colour of the receptacle may vary. Often this depends on the age of the fruit-body and on environmental conditions during the development.

Chadefaud (1942b) and Le Gal (1947) studied the development of the episporial ornamentation. The pigment is abundantly formed and deposited in the form of thick warts.

The species is heterothallic (Betts, 1926). The germination of the ascospores can be induced by a heat-treatment at temperatures between 65 and 80° C. (Dodge, 1912a; Betts, 1926).

42. Ascobolus subglobosus Seaver.—Fig. 48; Pl. 12, figs. F, G

Ascobolus subglobosus Seaver *in* Mycologia **8**: 96. 1916. — Holotype: *Seaver*, on damp soil among mosses in woods, near Yonkers, New York, U.S.A., 13.VIII.1914 (NY).

Apothecia scattered, gregarious or crowded, superficial, sessile, 2–5 mm diameter, about 0.5 mm high. Receptacle at first closed and subglobular, then opening at the top and cup-shaped, finally expanding and discoid, "greenish-yellow", more

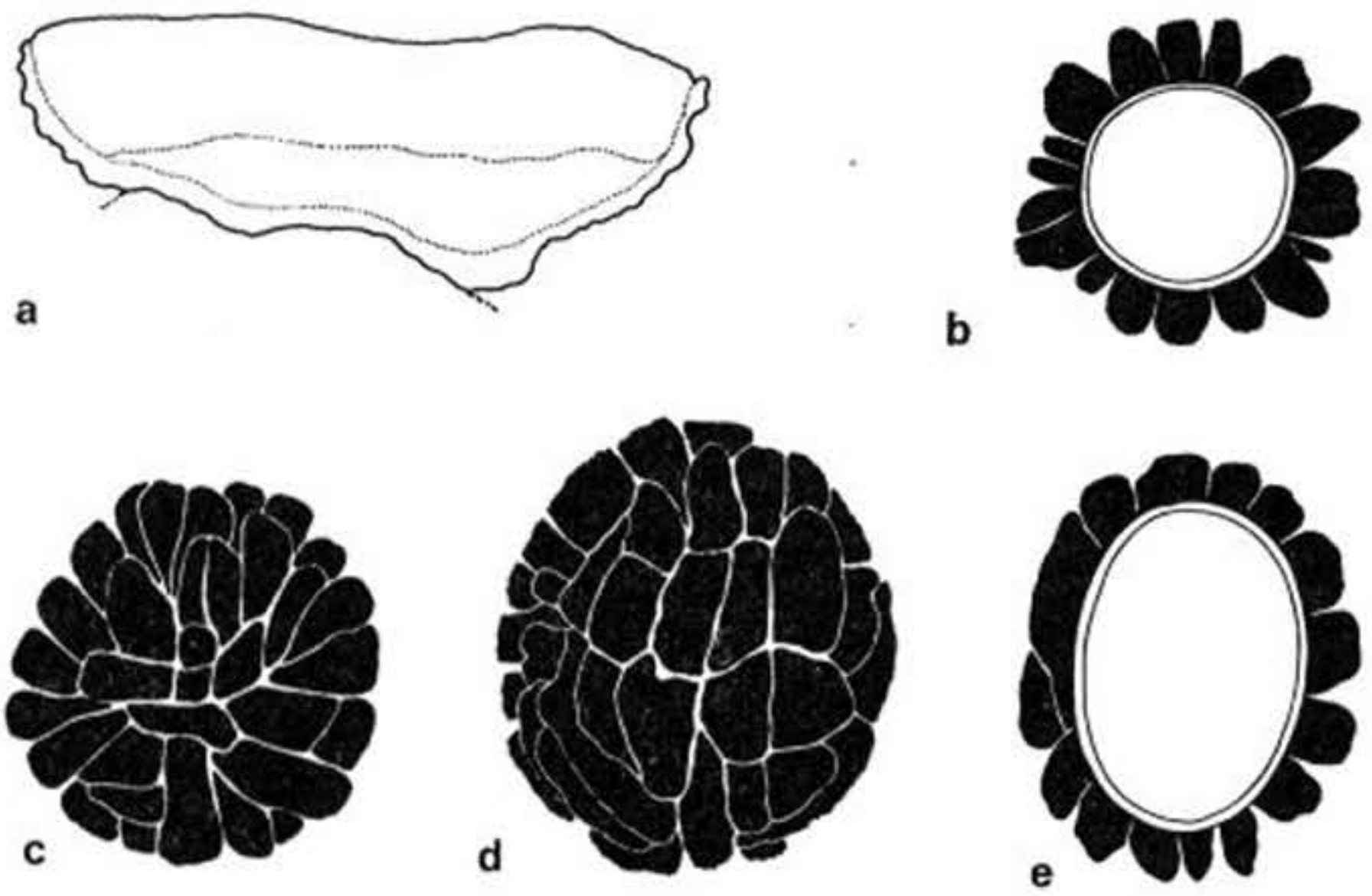

Fig. 48. — *Ascobolus subglobosus:* a, diagrammatic section of fruit-body × 40; c, d, ascospores × 1600; b, e, id. in optical section (b, c, in polar view; d, e, in lateral view). (From holotype.)

brownish with age, finely furfuraceous; margin not very prominent, almost smooth. Disk concave, then flat, finally convex or irregularly convolute, greenish-yellow, dotted with the almost black protruding tips of ripe asci, finally dark brownish-black. Hymenium 200–230 μ thick. Hypothecium not always clearly differentiated, often not continuous, sometimes forming a distinct, 20–27 μ thick layer of isodiametric or slightly elongated cells 5–10 × 5–8 μ. Flesh up to 250 μ thick, of subglobular, angular or oblong 7–16 × 5–16 μ, hyaline. Excipulum near the margin 26–40 μ thick, of subglobular cells 9–13 μ diameter (textura globulosa), in the lower part up to 85 μ thick, of subglobular or elongated cells up to 39 × 26 μ, covered with groups of subglobular cells, with intercellular, amorphous, brown pigment. Asci cylindrical to cylindric-clavate, gradually tapering downwards, rounded above, 215–240 × 20–28 μ, 8-spored; only when young the wall pale blue in Melzer's reagent. Ascospores at first uniseriate, finally more or less biseriate, subglobular to shortly ellipsoid (length-breadth ratio = 1.5–1.43, rarely up to 1.66), at first hyaline, then violet, finally very dark brown, 16–19(–22) × (12–)13–16 (–17) μ (including the pigment), ornamented with more or less longitudinal repeatedly anastomosing or reticulating striae, the pigment areas between them developing into very prominent projections; pigment in a very thick layer, 2.5–3.0 μ thick. Paraphyses simple or branched, septate, cylindrical, 2.5–3.0 μ thick, scarcely or irregularly swollen up to 5 μ thick at the tip, embedded in golden-yellow, mucilaginous substance.

Only known from damp soil.

ETYMOLOGY.—From Latin, sub-, somewhat and globosus, globular: nearly globular.

ILLUSTRATIONS.—Seaver *in* Mycologia **8**: *pl. 184 fs. 5–6.* 1916; Seaver, N. Am. Cup-fungi (Operc.) *pl. 7 f. 3.* 1928.

SPECIMENS EXAMINED.—**Canada**: *Cain*, Indian Docks, Parry Island, Parry Sound, Ontario, 19.VIII.1955 (TRTC).

U.S.A.: New York: *Seaver*, near Yonkers, 13.VIII.1914 (holotype of *A. subglobosus*, NY); *Seaver* near Yonkers, 6.X.1916 (NY); *Seaver & Button*, Bechmond, Staten Island, 12.IX.1914 (NY). Connecticut: *Seaver*, Portland, 20.VII.1916 (NY).

This species, which is only known from North America, is sufficiently characterized by the shortly ellipsoid or subglobular ascospores. The episporium is very thick and consists of very prominent projections.

It is related to *A. denudatus*, especially to the form of this species described under D (p. 139).

43. Ascobolus xylophilus Seaver—Fig. 49; Pl. 12, figs. E, H

Ascobolus xylophilus Seaver *in* Mycologia **3**: 61. 1911. — Isotype: *Bethel & Seaver*, on coniferous wood, Geneva Creek Canyon, Colorado, U.S.A. IX.1910, in Reliquiae Bethelianae No. 760 (BPI, "cotype").

Apothecia gregarious, superficial, sessile, 1–2 mm across, about 0.6 mm high. Receptacle at first subglobular, then expanding and becoming scutellate to discoid, reddish-brown or brownish, darker with age, smooth, without a prominent margin. Disk slightly concave or nearly flat, greenish, becoming darker with age, finally almost black, roughened by the protruding tips of ripe asci. Hymenium up to 230 μ thick. Hypothecium not very compact, sometimes up to 75 μ thick, of subglobular cells 5–11 μ diameter, the contents of which stain intensively with methyl blue.

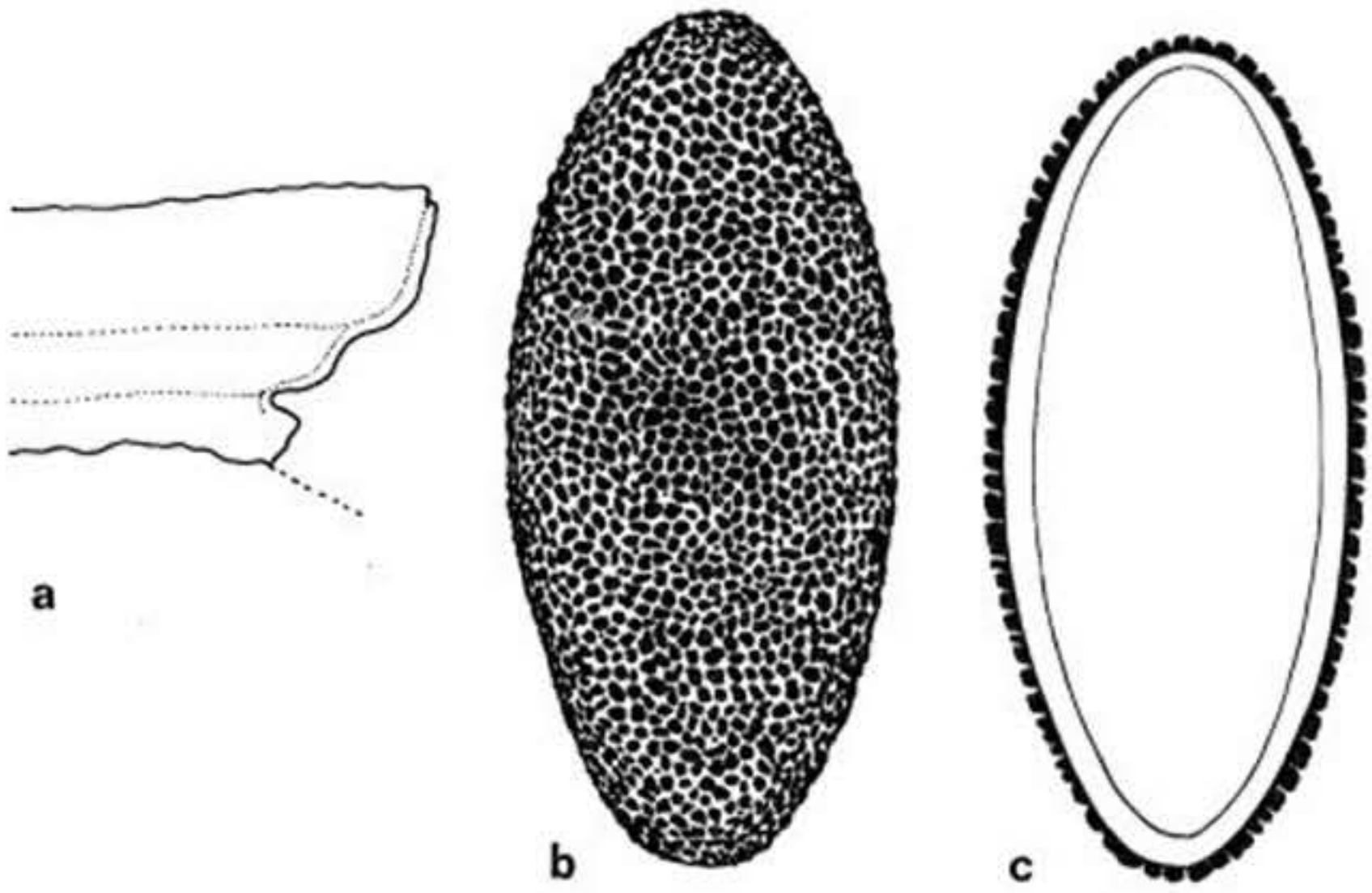

Fig. 49. — *Ascobolus xylophilus:* a, diagrammatic section of fruit-body × 40; b, ascospore × 1600; c, id. in optical section. (From "cotype", BPI.)

Flesh rather thin, of subglobular cells 5–10 μ diameter, together with intertwining, septate hyphae 2–4 μ thick, hyaline. Excipulum rather thin, 13–25 μ thick near the margin, of subparallel intertwining hyphae 2–5 μ wide, together with subglobular or oblong cells 6–20 × 5–14 μ, pale brownish. Asci large, clavate, tapering downwards into a stem-like base, rounded above, 175–235 × 30–35 μ, 8-spored;

the wall deep blue in Melzer's reagent. Ascospores finally biseriate; oblong-ellipsoid, rarely with somewhat narrowed ends, at first hyaline, then beautifully purple, finally brown, 32–37 × 13–16 μ; ornamented with minute warts or finely punctate. Paraphyses simple, septate, filiform, about 2.0 μ thick, not or scarcely enlarged above, hyaline.

Only known from rotten coniferous wood.

ETYMOLOGY.—From Greek, ξυλον, wood and φιλεω, to love: wood-loving.

SPECIMEN EXAMINED.—**U.S.A.**: Colorado: *Bethel & Seaver*, on coniferous wood, Geneva Creek Canyon, IX.1910 (part of the type of *A. xylophilus*, BPI-A1483).

The position of this species in section *Ascobolus* is rather doubtful because the development of the fruit-bodies could not yet be established. The fruit-bodies in the single collection that could be studied were too old to find clues of the type of development.

It is well-characterized by the large ascospores with finely warted or punctate episporium.

IV. **Ascobolus** sect. **Pseudascodesmis** Brumm., *sect. nov.*

Ascomata paragymnohymenialia, iis generis *Ascodesmis* similia, minutissima. Excipulum superficie textura prismatica vel porrecta. Asci sat breves latique, clavati, pariete iodo haud caerulescente. Ascosporae subglobulares vel breviter ellipsoideae. Episporium forma reticuli continui, depressi, pigmentacei. Fimicola. Typus: *Ascobolus reticulatus* Brumm.

Ascomata paragymnohymenial, resembling those of an *Ascodesmis*; superficial, sessile; very small. Receptacle at first subglobular, then lenticular or discoid. Excipulum of textura prismatica or porrecta when seen on the outside. Asci relatively short and broad, with rounded apex; the wall not blue with iodine. Ascospores 8; at first biseriate and spherical, finally multiseriate and usually short-ellipsoid or subglobular. Episporium in the form of a continuous, low net-work of pigment.

Fimicolous.

ETYMOLOGY.—From ψευδης, false, and the generic name *Ascodesmis*.

Of this section only a single species is known. It shows a relationship with both *Ascobolus* sect. *Sphaeridiobolus* and with *Ascodesmis* Tiegh.

The distribution of episporal pigment and the spherical young ascospores suggest relationship with *Ascobolus* sect. *Sphaeridiobolus*. The pattern of episporal ornamentation, the shape of asci and ripe ascospores, and the absence of a blue stain with iodine in the ascus-wall suggest relationship with *Ascodesmis* Tiegh. The developmental type of the fruit-body might represent an intermediate position.

44. **Ascobolus reticulatus** Brumm., *spec. nov.*—Fig. 50; Pl. 13, figs. A–C

Apothecia sessilia, usque ad 0.5 mm diam. Receptaculum initio globulare, deinde lenticulare vel discoideum, lutescens vel lutescenti-brunneum, laeve vel imprimis ad basin dilatatam hyphis sat rigidis obtectum. Excipulum textura prismatica vel porrecta. Asci clavati, 75-90 × 25 μ, 8-spori, pariete iodo haud caerulescente. Ascosporae primum sphaericae, maturitate

generaliter breviter ellipsoideae, 13–19.5 × 13–15.5 μ, reticulo pigmentoso irregulari ornatae. Paraphyses filiformes, c. 3 μ crassae, apice leviter incrassatae. In fimo camelopardali crescens. Typus: *G. H. Wagner*, Zoologischer Garten, Dresden, Germania (S-A478).

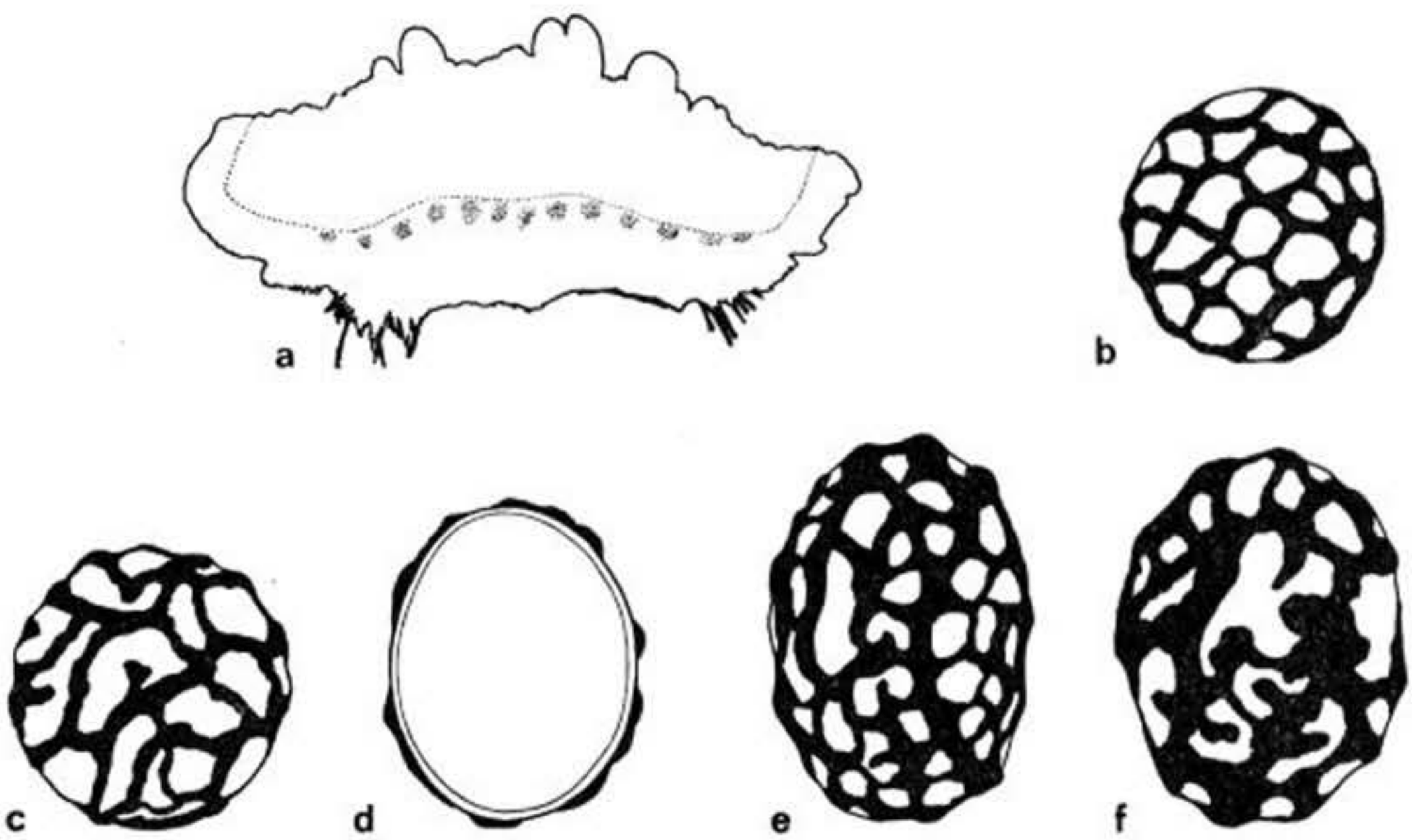

Fig. 50. — *Ascobolus reticulatus:* a, diagrammatic section of fruit-body; b, c, e, f, ascospores × 1600; d, id. in optical section. (From type.)

Apothecia solitary, superficial, sessile, up to 0.5 mm across, about 0.2 mm high. Receptacle at first globular, then lenticular or discoid, yellowish or yellowish-brown, smooth or covered with rather rigid hyphae especially near the broad base. Disk flat or slightly convex, colourless or pale yellowish-brown, roughened by the protruding asci. Hymenium 70–80 μ thick. Hypothecium not clearly differentiated. Flesh about 115 μ thick, of isodiametric, angular cells 6–17 μ diameter, hyaline. Excipulum 16–26 μ thick, of subparallel hyphae with cylindrical or oblong cells 8–27 × 4–7 μ (textura prismatica or porrecta), especially near the base with rather thick-walled hyphae 4–7 μ wide, colourless or somewhat brownish; cell-walls up to 1.0 μ thick. Asci shortly saccate-clavate, with rounded apex, 75–90 × 25 μ, 8-spored; the wall not blued with iodine. Ascospores at first biseriate, finally multiseriate; at first spherical, at maturity usually short-ellipsoid; at first hyaline, then brown; 13–19.5 × 13–15.5 μ; ornamented with an irregular net-work of pigment. Paraphyses, simple or branched, septate, filiform, about 3 μ thick, slightly enlarged up to 5 μ at the tip, hyaline, sometimes with hook-shaped tip.

Known only from dung of giraffe.

ETYMOLOGY.—From Latin, reticulatus, netted like net-work.

SPECIMEN EXAMINED.—**Germany**: *Wagner*, Zoological Garden, Dresden, *s. dat.* (type of *A. reticulatus*, S-A478).

This collection was sent by Wagner to Rehm, who identified it as *Boudiera microscopica* (Crouan) Cooke, which is a synonym of *Ascodesmis microscopica* (Crouan) Seaver. Although *A. reticulatus* resembles this species in several points, it differs

fundamentally from this and other species of *Ascodesmis* Tiegh. in the development of the fruit-body and the origin of the episporial pigment.

Since the type consists of only very few fruit-bodies and no other collections are known, it is to be hoped that this interesting fungus will be collected again.

V. **Ascobolus** sect. **Pseudosaccobolus** Brumm., *sect. nov.*

Ascomata para- vel eugymnohymenialia, iis generis *Saccobolus* simillima, primo hemisphaerica, denique discoidea vel lenticularia. Asci late clavati, pariete iodo intense caerulescente. Ascosporae fusiformi-ellipsoideae, saepe leviter asymmetricae. Episporium primo laeve vel granulatum. Paraphyses intus plus minus luteae. Pyrophila. Typus: *Ascobolus pusillus* Boud.

Ascomata paragymnohymenial or eugymnohymenial, strongly resembling those of a *Saccobolus*; superficial, sessile; small. Receptacle at first hemispherical, then discoid or lenticular. Excipulum of textura globulosa when seen on the surface. Asci broadly clavate, with a broad base and a rounded apex; the wall deep blue with iodine. Ascospores 8; biseriate; fusiform-ellipsoid, often slightly asymmetrical. Episporium at first smooth or granulate, then warted or rarely with a net-work of fine crevices. Paraphyses with yellowish contents.

Pyrophilous.

ETYMOLOGY.—From ψευδης, false, and the generic name *Saccobolus*.

Only a single species is known. It occupies an isolated position within the genus. As noticed by Boudier (1877), *A. pusillus* shows in several characters a noteworthy resemblance to species of *Saccobolus*.

Together with species like *Saccobolus saccoboloides*, with free ascospores, this species possibly forms a transition between *Ascobolus* and *Saccobolus*.

The absence of compact or regularly arranged clusters of ascospores and the way of growth on burnt places of *A. pusillus* justify its disposition in *Ascobolus*.

45. ASCOBOLUS PUSILLUS Boud.—Fig. 51

Ascobolus pusillus Boud. *in* Bull. Soc. bot. Fr. **24**: 310 *pl. 4 f. 7*. 1877; Boud., Icon. mycol., Ser. 1, livr. 4, *pl. 89* (definitive number: 412). Jun. 1905; Boud., Icon. mycol., preliminary text, Ser. 1, livr. 5: 17. Oct. 1905; Boud., Icon. mycol., definitive text, 234. 1911. — Holotype: *Boudier*, on burnt soil, Montmorency, France, 22.XI.1874 (PC-A2193).

Apothecia scattered or in small groups, superficial, sessile on a broad base, 0.4–1.2 mm diameter, about 0.3 mm high. Receptacle hemispherical, then discoid or lenticular, "pale purplish-yellow, darker near the margin", smooth, without a distinct margin. Disk flat, then convex, "purplish-yellow", roughened by the protruding tips of ripe asci. Hymenium 100–170 μ thick. Hypothecium not clearly differentiated as a continuous layer, of isolated groups of isodiametric or elongated cells 4–9 × 4–7 μ. Flesh 100–200 μ thick, of subglobular cells 4–10 μ diameter, together with cylindrical hyphae 2.5–5.0 μ thick, hyaline. Excipulum 20–29 μ thick, of subglobular or oblong, rather thick-walled cells 6–16 × 4–12 μ (textura globulosa or prismatica), with some pale yellowish-brown pigment. Asci broadly clavate, rounded above, 120–150 × 15 μ (according to Boudier, 1911 p. 234: "170–200 × 25–27 μ"), 8-spored; the wall deep blue in Melzer's reagent. Ascospores

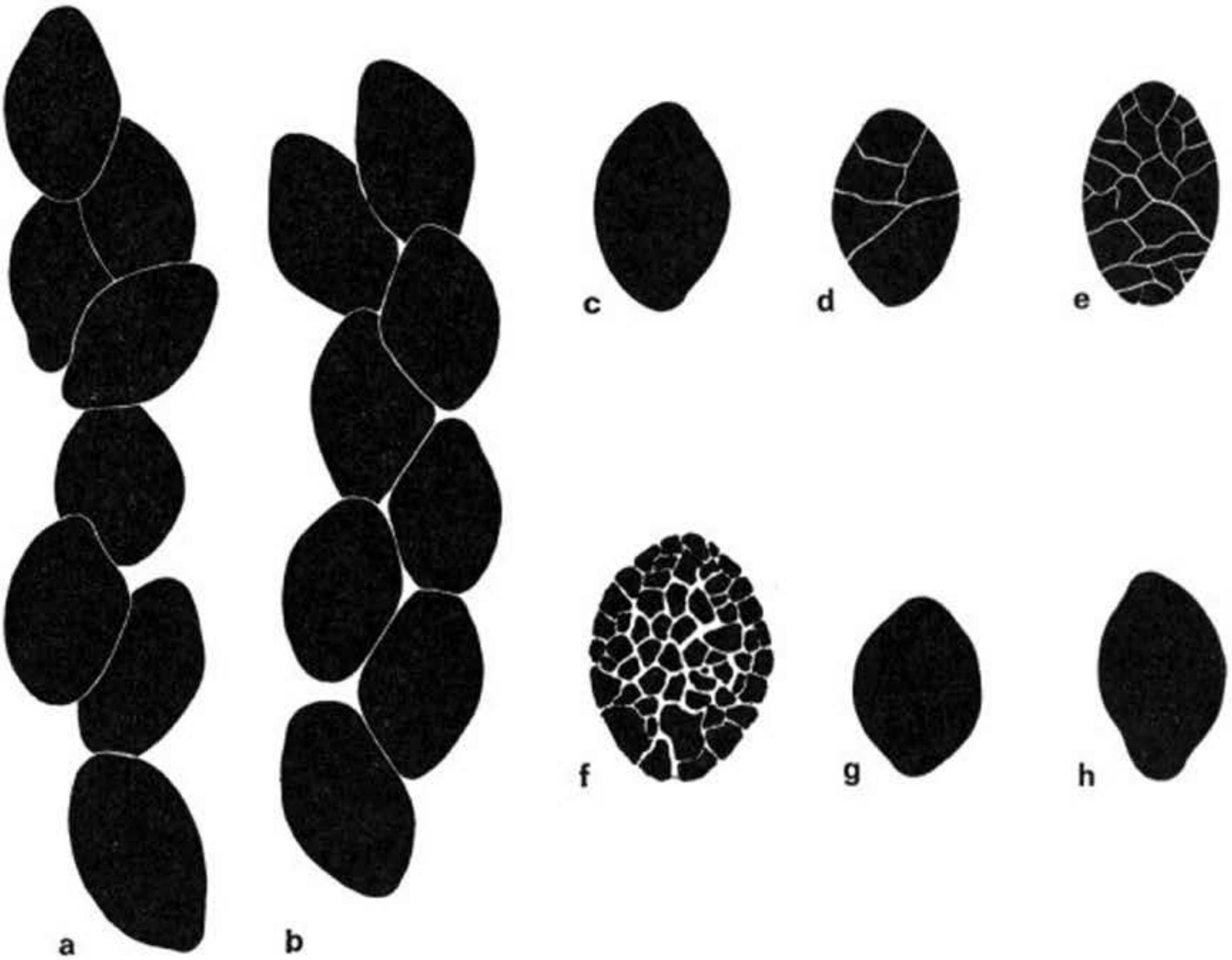

Fig. 51. — *Ascobolus pusillus:* a, b, ascospores of two asci; c–h, ascospores. (All × 1600; a, b, h, from *Quélet*, UPS-A2028; c–g, from holotype.)

biseriate, fusiform-ellipsoid, often with blunt ends, finally swollen, at first hyaline, then violet, finally often brownish, 10–12.5 × 6.5–7.5 μ, when swollen up to 16 × 9 μ; ornamented with granules or warts, more rarely with reticulating striae; pigment in a rather thick layer. Paraphyses simple or branched, septate, clavate, 2.2–2.9 μ thick, gradually enlarged up to 7 μ at the tip, with pale yellowish contents.

On burnt soil.

Etymology.—From Latin, pusillus, petty: very small.

Illustrations.—Boudier *in* Bull. Soc. mycol. Fr. **24**: *pl. 4 f. 7*. 1877; Boudier, Icon. mycol., Ser. 1, livr. 4, *pl. 89* (definitive number: 412). 1905.

Specimens examined.—**France**: *Boudier*, on burnt soil, Montmorency, 22.XI.1874 (holotype of *A. pusillus*, PC-A2193); *Quélet*, on burnt soil, *s. loc.*, X.1878 (UPS-A2028).

U.S.A.: *B. O. Dodge*, *s. loc.*, *s. dat.* (slide, NY-A1251).

This very rare species is clearly distinguishable from all other species of *Ascobolus* thus far known by the development of the fruit-body, the shape of the asci, and the tendency of the ascospores to form irregular, loose clusters.

Ascobolus candidus Schroet. is perhaps related.

VI. **Ascobolus** sect. **Heimerlia** Brumm., *sect. nov.*

Ascomata eugymnohymenialia, parva, pulvinata vel lenticularia. Excipulum vix evolutum. Asci oblongo-clavati, pariete iodo clariter caerulescente. Ascosporae ellipsoideae. Episporium echinulatum vel verrucosum. Fimicola. Typus: *Ascobolus aglaosporus* Heimerl.

Ascomata eugymnohymenial, superficial, sessile, small. Receptacle white, pulvinate or lenticular. Excipulum scarcely developed. Asci oblong-clavate, with short stalk and rounded apex; the wall clearly blue in Melzer's reagent. Ascospores 8; biseriate; ellipsoid. Episporium echinulate or warted.

Fimicolous.

ETYMOLOGY.—After Dr. A. Heimerl, an Austrian botanist, who made a detailed study of the Ascobolaceae near Vienna.

Within the genus *Ascobolus* this section is characterized by the small, white pulvinate, eugymnohymenial ascomata, without a marginal growing zone.

Besides the type *Ascobolus candidus* perhaps also belongs to this section.

KEY TO THE SPECIES OF ASCOBOLUS SECT. HEIMERLIA

1. Ascospores 14.5–17 × 8–10 μ. Episporium echinulate or warted
   46. *Ascobolus aglaosporus*, p. 157
1. Ascospores 11–13 × 6–8 μ. Episporium smooth . . cf. *Ascobolus candidus*, p. 210

46. ASCOBOLUS AGLAOSPORUS Heimerl—Fig. 52; Pl. 13, fig. F

Ascobolus aglaosporus Heimerl *in* Jber. k.k. Ober-Realschule Bezirke Sechshaus Wien **15**: 14 *pl. 1 f. 4.* 1889. — Type: *Heimerl*, on dung of deer, Pressbaum near Vienna, Austria, IV. 1889 (slide, W).

Apothecia scattered, superficial, sessile on a broad base, 0.3–0.9 mm across, 180–250 μ high. Receptacle pulvinate or lenticular, almost white, smooth, without a prominent margin. Disk flat, then convex; almost white, then pale lilac, dotted with the violet protruding tips of ripe asci. Hymenium 100–150 μ thick. Hypothecium not forming a continuous layer, not very compact, locally up to 27 μ thick, of subglobular or elongated cells 4–10 × 4–7 μ. Flesh up to about 90 μ thick, of subglobular cells 5–20 μ diameter, near the base often with a layer up to 50 μ thick of closely compacted small cells 4–13 × 2–6 μ, hyaline. Excipulum scarcely developed. Asci oblong-clavate, with a very short stalk, rounded above, 100–160 × 20–22 μ (according to Heimerl: 146–166 × 26–27 μ), 8-spored; the wall clearly blue in Melzer's reagent. Ascospores biseriate, ellipsoid, at first hyaline, then pale violet, finally pale brown, (13–)14.5–17 × (7.5–)8–10 μ (according to Heimerl: 15–18.5 × 8.5–10 μ), ornamented with small isolated warts or spines, with a mucilaginous envelope round each spore. Paraphyses branched, septate, cylindrical, 1.5–2.0 μ thick, irregularly swollen or clavate above, up to 6 μ thick at the tip, without mucus.

On dung of cow, goat, deer, and American bison.

ETYMOLOGY.—From Greek, ἀγλαος, beautiful and σπορα, a seed: with beautiful spores.

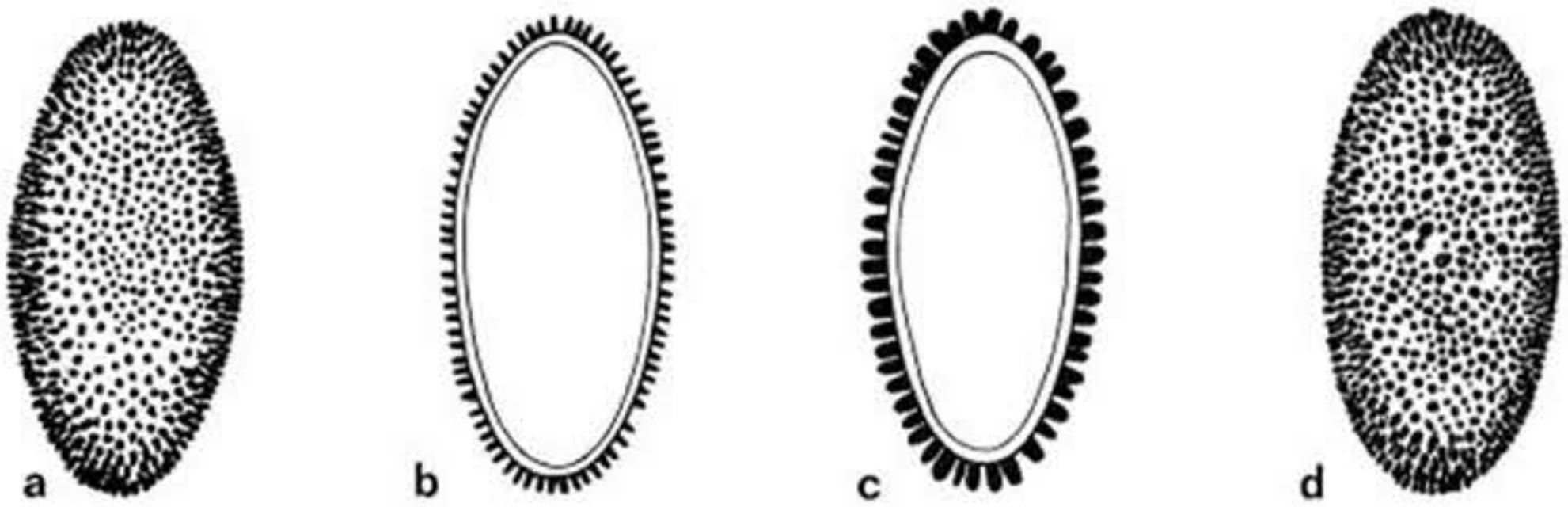

Fig. 52. — *Ascobolus aglaosporus:* a, d, e, g, ascospores; b, c, f, id. in optical section. (All × 1600; a–e, from type; f, g, from *Cain 6683*, TRTC.)

ILLUSTRATION.—Heimerl *in* Jber. k.k. Ober-Realschule Bezirke Sechshaus Wien **15**: *pl. 1 f. 4.* 1889.

SPECIMEN EXAMINED.—**Austria**: *Heimerl*, on dung of deer, Pressbaum, near Vienna, IV. 1889 (slide, type of *A. aglaosporus*, W).

Canada: *Cain*, on cow dung, Glencoe, Middlesex, Ontario, 12.VII.1932 (TRTC 34674); *Cain 6683*, on dung of American bison, High Park, Toronto, Ontario, 2.XI.1936 (TRTC).

U.S.A.: New York: *Cain*, on deer dung, Ringwood near Ithaca, 6.IX.1952 (TRTC 24287); *Seaver*, on goat dung, *s. loc.*, I.1915 (= *A. candidus* Schroet. sensu Seaver, North Am. cup-fungi 86. 1928, NY-A1235).

The type is represented by a rather poor slide, just sufficient to recognize the species with certainty. My knowledge of this species is mainly due to the very fine collections, made by Dr. R. F. Cain, who kindly placed them at my disposal.

This species was identified and described by Seaver (1928: 86) as *A. candidus* Schroet. The ascospores of Schroeter's species, however, are smaller and the episporium is smooth.

VII. **Ascobolus** sect. **Gymnascobolus** Brumm., *sect. nov.*

Ascomata eugymnohymenialia (zona incrementi activa secundaria marginali) satis magna, primo subglobularia, serius cupularia, denique scutellata vel plana. Excipulum distincte evolutum. Asci cylindrico-clavati, pariete iodo clariter caerulescente. Ascosporae ellipsoideae. Episporium laeve, saepe fissura vel fissuris duabus tenuibus praeditum. Fimicola vel rarius xylophila. Typus: *Ascobolus scatigenus* (Berk.) Brumm.

Ascomata eugymnohymenial, with active secondary marginal growing zone;

superficial, sessile; large, 0.8–30 mm diameter. Receptacle at first subglobular but not closed, then cup-shaped, finally scutellate or flat. Excipulum clearly developed. Asci cylindric-clavate, with short stalk and rounded apex; the wall clearly blue with iodine. Ascospores 8; at first uniseriate, finally biseriate; ellipsoid. Episporium at first smooth often with one or two regular fine fissures; finally sometimes with an irregular net-work of secondary fine fissures.

Fimicolous and more rarely xylophilous.

ETYMOLOGY.—From γυμνος, naked, and the generic name *Ascobolus*: an *Ascobolus* with uncovered hymenium.

Apart of the interstitial and intercalary growth, this section has an active marginal or submarginal growing zone.

To the adaxial side branches give rise to paraphyses and to the abaxial side to branches which later differentiate into the elements of flesh and excipulum.

The ascogenous hyphae follow the expanding hymenium by centrifugal growth and form croziers which develop into asci.

This section is clearly characterized by the mode of development and growth of the fruit-bodies and the copiously developed flesh and excipulum. At present only *Ascobolus scatigenus* and *A. castaneus* are allocated a place in this section with confidence.

KEY TO THE SPECIES OF ASCOBOLUS SECT. GYMNASCOBOLUS

1. Episporium smooth. On dung:
   2. Ascospores ellipsoid, length-width ratio about 2.0:
      3. Ascospores 21–26 × 11.5–13 μ. Episporium smooth with a single longitudinal or oblique fine fissure, sometimes with two fissures or finely reticulated . . . . . 47. *Ascobolus scatigenus*, p. 159
      3. Ascospores 15–19.5 × 7.5–9.0 μ. Episporium perfectly smooth 48. *Ascobolus castaneus*, p. 164
   2. Ascospores shortly ellipsoid, with blunt ends; length-width ratio smaller than 1.6; 20–28 × 15–18 μ . . . . . cf. *Ascobolus moellerianus*, p. 229
1. Episporium granular or finely warted. Ascospores 32–37 × 13–16 μ. On wood. cf. *Ascobolus xylophilus*, p. 152

47. **Ascobolus scatigenus** (Berk.) Brumm., *comb. nov.*—Figs. 7, 53; Pl. 13, figs. D. E

Peziza (*Humaria*) *scatigena* Berk. & Curt. *apud* Berk. *in* J. Linn. Soc. (Bot.) **10**: 366. 1869. — *Humaria scatigena* (Berk. & Curt. apud Berk.) Sacc., Syll. Fung. **8**: 147. 1889. — Holotype: *Wright No. 636* in Berk. & Curt., Fungi Cubensis Wrightiana No. 667 (K-A3046).

Ascobolus leiocarpus Berk. & Broome *in* J. Linn. Soc. (Bot.) **14**: 109. 1873. — Holotype: *Thwaites No. 56* (BM).

Ascobolus major Berk. & Curt. *apud* Berk. *in* Grevillea **4**: 6. 1875. — Type: *Curtis No. 3794* (K, FH).

Ascobolus australis Berk. *in* J. Linn. Soc. (Bot.) **18**: 389. 1881. — Type: *Thozet 851* (BM-A2855, MEL-A1625, BM-A2820 drawing).

Ascobolus baileyi Berk. & Broome *in* Trans. Linn. Soc. Lond. II (Bot.) **2**: 69. 1883. — Holotype: *Bailey No. 252*, Brisbane, Queensland, Australia, *s. dat.* (BM).

Phaeopezia orientalis Pat. *in* J. Bot., Paris **4**: 59. 1890 ('*Pheopezia*'). — *Aleurina orientalis* (Pat.) Sacc. & Syd., Syll. Fung. **16**: 739. 1902. — *Ascobolus orientalis* (Pat.) Le Gal, Discom. Madagascar 75. 1953. — Type distribution: [*Delavay*], on cow dung, Tu Phap, Tonkin, Indochina, VII.1887, *in* Balansa, Champ. du Tonkin No. 118 (G).

Ascobolus phillipsii Berk. *apud* Cooke, Australian fungi, 268, *pl. 20, f. 164.* 1892. — Type: [*Thozet*] *No. 851* (Herb. Berkeley), Queensland (BM-A2855).

Ascobolus sarawacensis Cesati *apud* Cooke *in* Grevillea **21**: 74. 1893. — Holotype: *Beccari 226*, on buffalo dung, Sarawak, *s. dat.* (K-A1991).

Ascobolus megalospermus Speg. *in* Anal. Mus. nac. B. Aires **6**: 307. 1899. — Holotype: LPS 28164 (consisting of apothecia of *A. scatigenus* covered with ascospores of *A. immersus*; *A. megalospermus* = nomen confusum).

Ascobolus gollanii P. Henn. *in* Hedwigia **40**: 338. 1901. — Holotype: *Gollan*, on manured soil, Saharanpur-Garden, India, 14.VII.1900 (S-A517).

Ascobolus latus Penz. & Sacc. *in* Malpighia **15**: 218. 1902. — Holotype: *Penzig tub. 917*, on buffalo dung, Tjidahoe near Mt. Salak, Java, Indonesia, 22.I.1897 (PAD).

Ascobolus magnificus Dodge *in* Mycologia **4**: 218. 1912. — Parts of type: *B. O. Dodge*, on horse dung, New York City, New York, U.S.A., IV.1912 (BPI-A1555, FH-A3147, K-A1985, K-A1986, NY-A1317 holotype, NY-A1319 "paratype", PC-A2304, TRTC-A2151, UPS-A2020).

Papulospora magnifica Hotson in Bot. Gaz. **64**: 277 *pl. 22 f. 39, pl. 23 f. 48–69.* 1917 (nomen anamorphosis). — Fide B. O. Dodge (1920: 123).

Ascobolus notatus Batista & Vital *apud* Batista & al. *in* Ann. Soc. Biol. Pernambuco **13**: 61 *fs. 1–3.* 1955 ("notata"). — Type: *Vital No. 1976* (L, TRTC, UPS).

Apothecia solitary or gregarious, superficial, sessile, 0.5–3.0 cm diameter, 1–5 mm high. Receptacle at first subglobular but not closed, then more or less cup-shaped, finally scutellate or flat, white or whitish, becoming brown or greenish-brown, often wrinkled or irregularly curved, finely pruinose or granular; margin white or brownish, smooth or granular, rather thick, involute, sometimes undulate. Disk concave, then flat or undulate, greenish-yellow, brownish or reddish-brown, always darker than the excipulum, roughened by the protruding tips of ripe asci. Hymenium 170–200 μ thick. Hypothecium clearly differentiated, about 25 μ thick, of closely compacted, subglobular cells 6–12 μ diameter. Flesh 350–1000 μ thick or even more, of globular or oblong cells 10–25(–65) × 7–17 μ, accompanied by irregular undulating hyphae 5–9 μ wide, hyaline or brownish. Excipulum 50–60 μ thick, of intertwined hyphae 2–4 μ diameter, hyaline. Asci cylindric-calavate, with a short, narrow stalk, 140–280 × 16–25 μ, 8-spored; the wall blue in Melzer's reagent. Ascospores uniseriate, finally irregularly biseriate, ellipsoid, very rarely slightly asymmetrical; at first hyaline, then pale pinkish-violet, finally violet or purplish-brown; (20–)21.5–25.5(–27.5) × (11–)11.5–13(–14) μ, smooth with a single longitudinal or oblique fine fissure, sometimes with two fissures or finely reticulated; with

Explanation of Figure 53

Fig. 53. — *Ascobolus scatigenus:* a, diagrammatic section of fruit-body × 25; b–e, g–n, p–r, ascospores × 1600 (q, represents a rare, abnormal type of ornamentation); f, o, ascospores in optical section. (a–c, from holotype of *A. leiocarpus*; d–f, from holotype of *A. scatigenus*; g–j, from holotype of *A. gollani*; k–o, from type of *A. orientalis*, G; p–r, from 'paratype' of *A. magnificus*, NY-A1319.)

a


b


c


d


e


f


g


h


i


j


k


l


m


n


o


p


q


r

pigment in a layer of very uniform thickness, 0.5–1.0 μ thick. Paraphyses simple or branched, septate, cylindrical, 2.5–3.5 μ thick, slightly clavate at the 4.5–7 μ thick tip, hyaline or yellowish.

On dung of cow, buffalo, carabao, and horse, also on manured soil, on manure pile, and on rotten wood.

ETYMOLOGY.—From Greek, σκατος, dung, and γιγνομαι, to be born.

ILLUSTRATIONS.—Batista & Vital *in* Ann. Soc. Biol. Pernambuco **13**: 62–65 *fs. 1–3.* 1955 ("*A. notata*"); Cooke, Mycographia *pl. 18 f. 72.* 1875 (*Peziza scatigena*, with immature ascospores); Cooke, Australian Fungi *pl. 20 f. 164.* 1892 (*A. phillipsii*); Dodge *in* Mycologia **4**: *pl. 72 fs. 1–8 and pl. 73.* 1912 (*A. magnificus*); Le Gal, Discom. Madagascar *fs. 28–30.* 1953 (*A. orientalis*, with anomalous ascospores, because of fixation); Penzig & Saccardo, Icon. Fung. javan. *pl. 56 f. 3.* 1904 (*A. latus*); Seaver, N. Am. Cup-fungi (Operc.) *pl. 6.* 1928 (*A. magnificus*).

SPECIMENS EXAMINED.—**Northern Rhodesia**: *Deighton M 1516*, near Njala, I.1938 (CMI).

Madagascar: *Decary*, near Tananarive, 27.II.1921 (PC); *Decary*, on rotten wood, Arubila Lemaitso, 19.IV.1939 (PC); *Decary*, near Tananarive, 10.III.1940 (PC).

Pakistan: *S. Ahmad 2977*, Lahore, 16.IX.1949 (BPI).

India: *S. Ahmad 604*, Ladhar, Sheikhupura, 8.IX.1942 (BPI, NY); *Batra*, Dalhousie, Punjab, 14.VIII.1955 (NY); *Gollan*, Saharanpur-Garden, 14.VII.1900 (holotype of *Ascobolus gollani*, S-A517); unknown collector, Hyderabad, 30.X.1958 (K-A1988).

Ceylon: *Thwaites 56*, Peradeniya (holotype of *Ascobolus leiocarpus*, BM); unknown collector 6536, Peradeniya, VII. 1922 (K-A1946).

China: *Deng 506*, I-hsin, Kiangsu, 1.IX.1933 (BPI); *Deng 1877*, Ling-shui, Hainan, 2.IV.1934 (BPI, TRTC); *Lin*, Foochow, 15.VI.1932 (NY).

Indo-China: *Bou*, "4979 (HN)", Ninh Thai, 28.I.1891 (*Phaeopezia orientalis*, PC); [*Delavay*], Tu Phap, Tonkin, VII.1887, *in* Balansa, Champignons du Tonkin 118 (type distribution of *Ascobolus orientalis*, G).

Philippine Islands: *Rogerson 472*, Wack-wack Country Club, Manila, 16.IX.1945 (NY).

N.W.-Borneo: *Beccari 226*, Sarawak, *s. dat.* (holotype of *Ascobolus sarawacensis*, K-A1991).

Indonesia: *Penzig tub. 917*, Tjidahoe near Mt. Salak, Java, 22.I.1897 (holotype of *Ascobolus latus*, PAD).

Australia: *Thozet 851*, Rockhampton, Queensland (*Ascobolus australis*, drawing after type material of *A. australis* by Phillips, BM-A2820); [*Thozet*] *851* (Herb. Berkeley), Queensland (part of type of *Ascobolus phillipsii*, and part of type of *Ascobolus australis*, BM-A2855); *Thozet 851*, Rockhampton (*Ascobolus thozetii*, part of type of *A. australis*, MEL-A1625); *Bailey 252*, Brisbane (holotype of *Ascobolus baileyi*, BM-A2822); unknown collector 538, Brisbane (BM-A2821).

U.S.A.: California: *Copeland 656*, Los Banos, 10.I. 1913 (S). Louisiana: *Humphrey 5519*, Sow Woods, Slidell, 20.VIII.1909 (NY); *Langlois 47*, Louisiana, IX.1885 (BPI-A1504, BPI-A1518, NY-A1141); *Langlois 3035* (in part), St. Martinsville, 1897 (NY-A1150, NY-A1276); *Neon 1780*, Lafayette, VIII.1932 (FH). Indiana: *Bechtel*, Crawsfordville, 3.VI.1943 (NY). Tennessee: *Hesler 94*, Bluffs, Knoxville, 21.IX.1930 (NY); *Meyer 13362*, University Farm, 24.II.1941 (BPI, FH, L, TRTC). New York: *Dodge*, New York City, IV.1912 (parts of type of *A. magnificus*, BPI-A1555, FH-A3147, K-A1985, K-A1986, NY-A1317 holotype, NY-A1319 "paratype", PC-A2304, TRTC-A2151, UPS-A2020); *Dodge*, New York, Botanical Laboratory, 15.II.1922 (BPI); *Gerard*, Po'keepsie (NY-A1109). Connecticut: *Torrey 1363*, College greenhouse, Mansfield, 14.V.1931 (NY). District of Columbia: *Dodge*, Washington, 11.II.1922 (FH); *Dodge*, Washington, 12.II.1922 (BPI, CMI, K); *Dodge*, Washington, XII.1925 (BPI). North Carolina: *Curtis 482*, Hillsborough, July (BM-A2862, FH-A3178, K-A1994 as *A. curtisii* Berkeley, an unpublished name, UPS-A2004).

South Carolina: *Curtis 3794*, Society Hill, VII.1852 (parts of type of *A. major*, FH, K); *Curtis*, Society Hill (*A. major*, BM-A2824); *Curtis* (*A. major*, UPS-A2021). Florida: *Cain*, Sugarfoot, W. of Gainesville, Alachua Co., 5.IX.1954 (DAOM, TRTC 31216, UPS).

Bermuda: *Seaver & Waterston 135*, Hinson's Island, 5.XII.1938 (K, NY).

Cuba: *Wright 636* (holotype of *Peziza scatigena*, K-A3046); *Wright 667* (K-A3045, K-A3044; Fungi cubensis Wrightiani 667 is a heterogeneous exsiccate and may also contain *Peziza wrightii* as in BM-A3036).

Jamaica: *Dennis J 176*, Hope, 18.XII.1949 (K); *Earle 498*, Hope Gardens, X–XI. 1902 (NY); *Powell 377*, Windsor state, Trelawny, 23.VIII.1956 (K); *Welden 660*, Portland Parish S. E. of Millbank, near Quashies River 12.VIII.1957 (K).

Republica Dominicana: *Chardon 703*, near Sabana la Mar, Prov. Samaná, 4.VII.1937 (NY); *Chardon 1136*, near Jarabacoa, Prov. La Vega, 13.IX.1937 (NY).

Puerto Rico: *Fink 490*, Rio Piedras, 1.XII.1915 (BPI, NY, FH); *Fink 491*, Rio Piedras, 1.XII.1915 (NY); *Fink 879*, Mayaguez, 16.XII.1915 (NY); *Johnston 216*, Rio Piedras, 25.II.1912 (NY); *Kevorkian 1*, Cartagena Lagoon, 5.IX.1936 (FH); *Seaver & Chardon 59*, I–IV.1923 (NY); *Seaver & Chardon 126*, I–IV.1923 (NY); *Stevenson 3894*, Rio Piedro, 15.II. 1916 (NY); *Wille 812*, W. of Humacao, 21.I.1915 (NY); *Wilson 237*, Luguillo Mountains, 14.VII.1902 (NY-A1126, NY-A1268).

Colombia: *Chardon & Nolla 407*, near San Pedro, Valle del Cauca, 4.VI.1929 (NY).

Trinidad: *Baker 1444*, Imperial College of Tropical Agriculture, 31.V.1947 (CMI); *Baker 1479*, St. Augustine, 30.VI.1947 (CMI); *Seaver 3564*, Mora forest, E. of Sangre Grande, 10.IV.1921 (NY).

Brazil: *Puiggari 101*, Apiahy (LPS); *Vital 1976*, Casa Amarela, Pernambuco, Recife, 29.IV.1955 (parts of type of *A. notatus*, L, TRTC, UPS).

Bolivia: *R. E. Fries*, Chaco Tatarenda, 9.IV.1905 (S-A662).

Argentina: *Spegazzini*, Colonia Resistencia, Chaco, I. 1887 (in part, only very young fruit-bodies; type of *A. megalospermus*; LPS 28164).

This is the species with the most conspicuous fruit-bodies of the genus. It is known from the tropical and warm temperate regions of both hemispheres (Fig. 7) and has been published under several names. Berkeley described it no less than six times as a new species. Although much named the species itself is not very variable.

It is sufficiently characterized by the size of the fruit-bodies, the pruinose or granular, white margin, and the smooth episporium with mostly only a single fine fissure.

The ascospores with reticulated episporium are swollen or over-ripe. In poorly dried exsiccata, and especially in material fixed in mixtures containing formalin many secondary fissures occur.

The early development of the fruit-bodies was described by Dodge (1920). It is gymnohymenial.

The number of germinating ascospores can be strongly raised by incubation during 24 hours at 37–40° C. When this treatment is combined with a preliminary treatment with 0.55 % sodium hydroxide during 20 minutes, a frequency of 80–99 % may be reached (Yu, 1954).

Lohwag (1927, 1941) gave a very acceptable explanation for the *Papulospora*-stage described in this fungus by Dodge (1920). According to him, this stage consists of archicarps which are inhibited and stopped further development. The large central cells represent the ascogonium and the sheath is formed by hyphae sprouting

from the cells of the ascogonium. This *Papulospora*-stage is only occasionally found in cultures, and germination of these bodies has never been observed. Inhibited ascogonia were also found in cultures of other species of *Ascobolus*.

The different parts of Berkeley & Curtis' "Fungi Cubensis Wrightiani" No. 667 are not homogeneous. Some parts contain *Peziza wrightii* Berk. & Curt., a species with spherical ascospores. Cooke (1874: 31) already noticed, "*P*(*eziza*) *scatigena*, B., Wright Fungi Cubensis, No. 667, in British Museum, and in my copy, = *P. Wrightii*, B. & C. The true *P. scatigena*, B., is different, having elliptic sporidia."

48. Ascobolus castaneus Teng—Fig. 54 Pl. 13, figs. G, H

Ascobolus castaneus Teng *in* Sinensia **11**: 109. 1940. — Type: *Teng No. 3345* (FH, NY).

Apothecia scattered, gregarious or more rarely crowded, superficial, sessile, 0.8–5 mm across, 0.4–0.6 mm high. Receptacle at first globular, then cup-shaped, finally flattened and scutellate to discoid, "at first Mikado brown, becoming chestnut brown, drying blackish", almost smooth, near the base often somewhat roughened to furfuraceous; with a smooth not very prominent margin, curved outwards with age. Disk concave, then flat, of the same colour as the receptacle, finally very dark brown, roughened by the protruding asci. Hymenium 130–160 μ thick. Hypothecium 28–40 μ thick, of closely compacted isodiametric cells 3–7 μ diameter. Flesh 300–350 μ thick, of subglobular cells 7–21 μ diameter, hyaline. Excipulum 28–55 μ thick, of globular, angular or oblong cells 19–27 × 15–20 μ (textura globulosa especially near the margin, textura angularis near the base), with brown, amorphous, intercellular pigment, together with purplish, intracellular pigment in the outer cell-layer, especially near the base (visible as globular granulae in dried material); covered with small groups of globular cells, especially near the base. Asci cylindric-clavate, 113–160 × 12–18 μ, 8-spored; the wall blue in Melzer's reagent. Ascospores 1–2 seriate, ellipsoid, at first hyaline, "then brown", 15–19.5 × 7.5–9 μ, completely smooth; pigment 0.5–0.7 μ thick. Paraphyses branched, septate, cylindrical, 2.0–2.8 μ thick, not or scarcely thickened above, hyaline, with brownish, amorphous, intercellular pigment, especially between the upper parts.

On dung of Musk-deer.

Etymology.—From Latin, castaneus, chestnut-coloured.

Specimen examined.—**China**: *Teng 3345*, on dung of Musk-deer, Hunba Forest, Kiulunghsien, Sikang, 6.VI.1939 (type of *A. castaneus*, FH, NY).

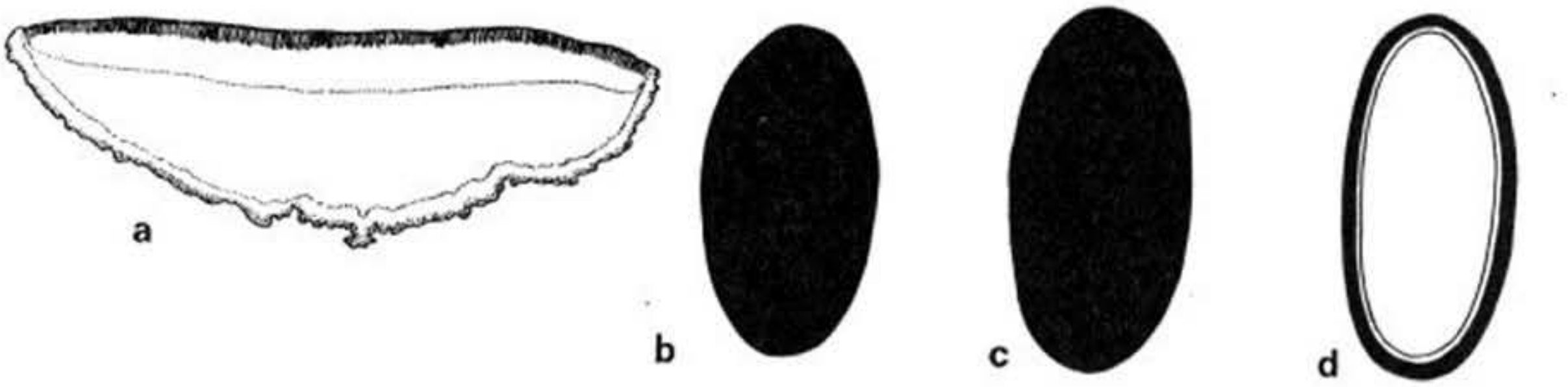

Fig. 54. — *Ascobolus castaneus:* a, diagrammatic section of fruit-body × 110; b, c, ascospores × 1600; d, ascospore in optical section × 1600. (From *Teng 3345*, NY.)

This species is characterized by the chestnut brown colour of the receptacle and disk and by the perfectly smooth episporium without any fissures.

The growth of the fruit-body is as in *A. scatigenus*, by means of a marginal growing-zone. Probably as a result of differences in relative speed of growth and in the structure of the receptacle the fruit-bodies of *A. castaneus* tend to be more discoid or flattened, while in *A. scatigenus* they are cup-shaped with inrolled margin.

SACCOBOLUS Boud.

Saccobolus Boud. *in* Annls Sci. nat. (Bot.) V **10**: 228. 1869. — *Ascobolus* . . . *Saccobolus* (Boud.) Cooke, Handb. Brit. Fung. **2**: 729. 1871 (unreferable rank). — *Ascobolus* subg. *Saccobolus* (Boud.) Quél., Ench. Fung. 294. 1886. — Type: *Saccobolus kervernii* (Crouan) Boud.

[*Saccobolus* sect. *Eu-Saccobolus* Sacc., Syll. Fung. **8**: 524. 1889. — Type: *Saccobolus kervernii* (Crouan) Boud.]

Saccobolus sect. *Eriobolus* Sacc., Syll. Fung. **8**: 527. 1889. — Monotype: *Saccobolus caesariatus* Phillips.

Ornithascus Vel., Monogr. Discom. Boh. **1**: 368. 1934. — Monotype: *Ornithascus corvinus* Vel.

Ascomata paragymnohymenial or eugymnohymenial; superficial, sessile; small 0.1–1.0 mm, rarely up to 2.0 mm diameter. Receptacle at first often subglobular or semiglobular but soon pulvinate or lenticular; surface smooth or sometimes covered with spreading bunches of flexuous hyphae; without a distinct margin. Asci shortly clavate, with clearly truncate apex; at least at maturity the tips strongly protruding above the hymenium; the wall staining blue with iodine. Ascospores firmly united in a cluster or package and ejected together, cemented in a more or less regular pattern (Fig. 2) by the episporial pigment or rarely at first loosely united according to such a pattern and finally free or partly free. Paraphyses slender or rather thick, cylindrical or cylindric-clavate; relatively short; sometimes embedded in colourless mucus; contents colourless or yellow. Sometimes intercellular, amorphous, violet or brown pigment between the tips of paraphyses or in the outer layers of the excipulum.

Fimicolous, more rarely on rotten textiles or on substrata dirtied with dung.

ETYMOLOGY.—From Greek, σακκος, sack, and βαλλω, to throw.

Type: *Saccobolus kervernii* (Crouan) Boud.

Within the Ascoboloideae this genus is characterized by the clustered ascospores, by the relatively short and broad, clavate, truncate asci, and by the relatively short paraphyses.

When Boudier (1869) established *Saccobolus*, the presence of a 'common hyaline sack' around the ascospores was considered one of the major criteria. Although this envelope occurs only in a limited number of species, many authors have maintained it as the most important distinguishing character (e.g. Saccardo, 1884, 1889; Phillips, 1887; Massee, 1895; Rehm, 1896; Boudier, 1907; Le Gal, 1947, 1953a). This common envelope is rather constant in *Saccobolus* sect. *Saccobolus*. In *Saccobolus* sect. *Eriobolus*, however, the gelatinous mass never surrounds the spores; it may be unilateral, subdivided, or absent.

The force by which the ascospores are driven together and united into a package according to a very constant stereometric pattern is still unknown.

The precipitation of the episporial pigment may occur in different phases of the aggregative process, while also the degree to which the ascospores are pressed together differs from species to species. When the precipitation of episporial pigment is finished or almost finished before the spores are firmly united, the spores remain loose (*S. saccoboloides*) or the connection is lost easily (*S. globuliferellus*, *S. geminatus*, *S. infestans*). In *S. geminatus* the ascospores of a pair are more strongly united than

the pairs among themselves. The strongest pressing together of the ascospores is reached in *S. dilutellus* in which the package is subglobular.

Concerning the episporial ornamentation, it is noteworthy that in species of *Saccobolus* the episporia of all spores in a package are always found to be quite similar, while in *Ascobolus* the spores of one and the same ascus sometimes differ greatly in this respect.

The arrangement of the ascospores proved to be a very constant and valuable character to distinguish groups of species. For the sake of convenience the different stereometric patterns according to which the spores may be arranged in *Saccobous* are indicated by numbers of which the corresponding description and figure are found in the chapter on ascospores (p. 40 et seq.).

The species with yellowish or amber fruit-bodies, where the colour is due to yellowish contents of the paraphyses, have their spores arranged according to pattern I. These species are united in *Saccobolus* sect. *Saccobolus*.

The species with white, violet or brownish fruit-bodies, where intercellular pigments may be absent or present, have their spores arranged according to other patterns. They form together *Saccobolus* sect. *Eriobolus*.

In some species of *Saccobolus* the fruit-bodies show a tendency to aggregate and form complexes or even crusts of confluent fruit-bodies. Especially in *S. saccoboloides*, *S. versicolor*, and *S. depauperatus* this is of rather frequent occurrence. In these and other species often more than one ascogonium is found in a single fruit-body. In complex fruit-bodies with a narrow base the peripheral asci may be considerably longer than the central ones.

KEY TO THE SECTIONS OF SACCOBOLUS

1. Receptacle and disk yellow, yellowish or amber. Ascospores ellipsoid or fusiform-ellipsoid with truncate ends; at first arranged according to pattern I, finally sometimes more or less shortened, irregularly arranged or free. Paraphyses, especially in the upper parts, with yellow, lemon-yellow, golden-yellow or orange-yellow contents. Without accumulations of intercellular amorphous pigment in excipulum or hymenium . . . . . I. *Saccobolus* sect. *Saccobolus*, p. 167

1. Receptacle and disk white, pale violet, violet or brown. Ascospores ellipsoid or fusiform-ellipsoid, often with slightly truncate ends, often asymmetrical, ventriculose or somewhat triangular; not arranged according to pattern I. Paraphyses without yellowish or orange contents, mostly colourless. If pigmented, then intercellular and amorphous in excipulum and between the tips of paraphyses II. *Saccobolus* sect. *Eriobolus*, p. 181

I. Saccobolus sect. Saccobolus

For synonymy see under generic name (p. 166).

Receptacle and disk yellow, yellowish or amber. Ascospores 8; ellipsoid or fusiform-ellipsoid with truncate ends; at first arranged in a package according to a symmetrical pattern with 4 rows of 2 ascospores, with their longitudinal axes parallel to the length axis of the package (pattern I, see Fig. 2a, b), finally sometimes more or less shortened or free. Paraphyses especially in the upper parts with yellow, lemon-yellow, golden-yellow or orange-yellow contents. Without accumulation of amorphous intercellular pigment in excipulum or hymenium.

Fimicolous and rarely on rotten textile fabrics.

TYPE: *Saccobolus kervernii* (Crouan) Boud.

This section contains six sharply delimited species, which can be easily recognized by the colour of the fruit-bodies, the shape of the ascospore-packages, the shape and size of the ascospores, and by the ornamentation of the episporium.

KEY TO THE SPECIES OF SACCOBOLUS SECT. SACCOBOLUS

1. Apothecia tending to form crusts. Spore-clusters very loose and ascospores free at maturity. Ascospores 16–19.5 × 7.5–9 μ. Episporium smooth or sometimes finely granular . . . . . 1. *Saccobolus saccoboloides*, p. 168
1. Apothecia not forming crusts. Spore-clusters compact and ascospores firmly cemented:
   2. Ascospores at maturity with length-width ratio 2.0–2.5; ellipsoid or fusiform-ellipsoid, with truncate ends. Episporium up to 0.8 μ thick:
      3. Receptacle and disk vividly yellow or lemon-yellow. Ascospores ventricose with strongly truncate ends; 16–22 × 7.5–9 μ. Episporium with isolated fine warts . . . . . 3. *Saccobolus citrinus*, p. 174
      3. Receptacle and disk golden-yellow or amber. Ascospores not strongly truncate and ventricose. Episporium smooth or finely granular, sometimes with a few irregular crevices:
         4. Ascospores 22–29 × 8.5–14.5 μ . . . . . 2. *Saccobolus glaber*, p. 170
         4. Ascospores less than 18 μ long:
            5. Ascospores 14–17.5 × 7.5–8.5 μ. Spore-clusters at maturity shortened and ascospores arranged according to pattern Ia (Fig. 2c) 4. *Saccobolus truncatus*, p. 176
            5. Ascospores 11.5–13.5 × 5.5–6.5 μ. Spore-clusters not shortened at maturity . . . . . 6. *Saccobolus minimus*, p. 179
   2. Ascospores at maturity with length-width ratio about 1.3–1.5; short-ellipsoid or subglobular; 15–17.5 × 10–12.5 μ. Episporium more than 1.0 μ thick; with a net-work of crevices. Spore-clusters rich in extra-episporial pigment 5. *Saccobolus portoricensis*, p. 178

1. **Saccobolus saccoboloides** (Seaver apud Dodge & Seaver) Brumm., *comb. nov.*— Fig. 55; Pl. 14, fig. A

Ascobolus saccoboloides Seaver *apud* Dodge & Seaver *in* Mycologia **38**: 640. 1946 (basionym). — Holotype: *G. W. Martin J 637* (NY, K).

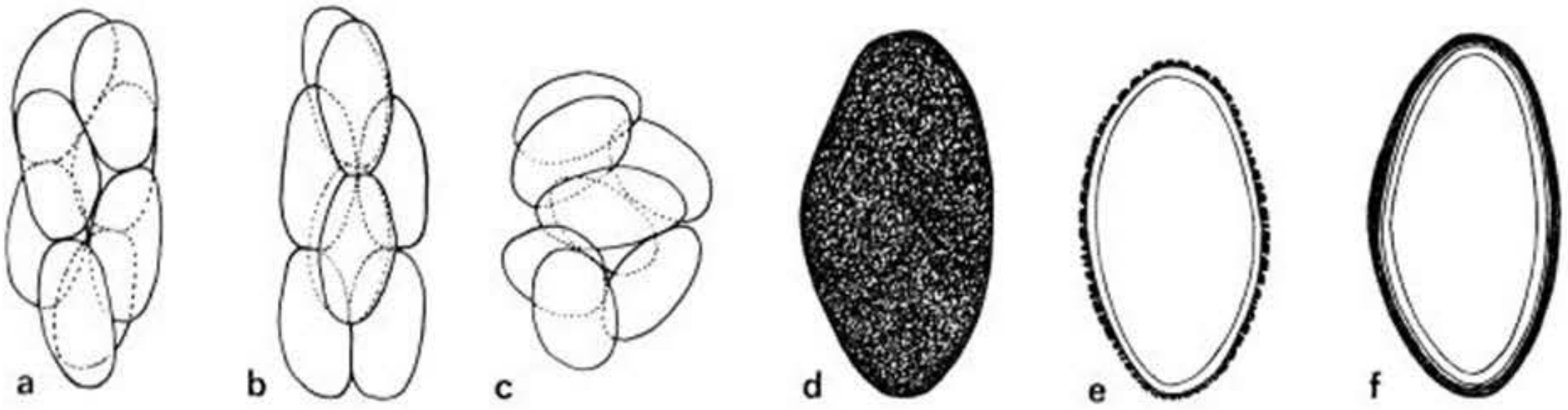

Fig. 55. — *Saccobolus saccoboloides:* a, b, diagram of ascospore arrangement in immature asci × 740; c, diagram of ascospore arrangement at maturity × 800; d, ascospore × 1600; e, f, ascospores in optical section × 1600. (From *G. W. Martin J637*, NY.)

Apothecia scattered or gregarious, often confluent, superficial, sessile, up to 1 mm across. Receptacle lenticular, 'pale yellowish amber', becoming black with maturity, smooth. Disk convex, dull yellow, dotted with the protruding tips of ripe asci. Hymenium about 125 μ thick. Hypothecium and flesh not clearly differentiated. Excipulum rather thin and fugitive, not always distinguishable from the hymenium, of parallel, cylindrical hyphae, some of which may consist of swollen cells and show a globular apex, even up to 16μ thick. Asci broadly clavate, gradually tapering downwards into a slender base, with truncate apex, up to 150 × 20 μ, 8-spored; the wall deep blue in Melzer's reagent. Spore-clusters very loose. Ascospores not cemented together by their pigment, at first free, then clinging together according to pattern I, finally often more or less free, fusoid-ellipsoid; hyaline, then purple, finally brown, 16–19.5 × 7.5–9 μ, smooth or very minutely roughened; pigment in a thin layer 0.4–0.5 μ thick, formed before the spores cling together. Paraphyses filiform, septate, simple, 2.5–3.0 μ thick, not enlarged at the tip, yellowish.

On textile fabrics and on dung of pig.

ETYMOLOGY.—From the generic name *Saccobolus*, and the Greek suffix, -εἰδος, like: like *Saccobolus*.

ILLUSTRATION.—Dodge & Seaver *in* Mycologia **38**: 641 *f. 1.* 1946 (*Ascobolus*).

SPECIMENS EXAMINED.—**Indonesia**: *Boedijn 4906*, on pig dung, Bogor (= Buitenzorg), Java, III.1949 (Herb. Boedijn).

New Guinea: *G. W. Martin J637*, from Japanese fabric (sock), prob. Hollandia, 2.IV.1945 (type of *Ascobolus saccoboloides*, K, NY).

When Seaver (l.c.) described this species he placed it in *Ascobolus* because of the free ascospores and expressed its relationship with *Saccobolus* in the name. The species, however, rightly belongs to *Saccobolus*, where it shows relations to species of section *Saccobolus*.

The occurrence of free ascospores cannot be maintained as the sole conclusive character in separating *Saccobolus* from *Ascobolus*.

In *Ascobolus* sect. *Pseudosaccobolus* species occur in which the ascospores are mutually free but yet show a certain tendency to arrange themselves in very irregular, loose clusters. As a result the ascospores in *Ascobolus pusillus* are often more or less deformed or asymmetrical. Only in a few species the precipitation of the pigment on the primary

walls of the ascospores occurs during a period when the ascospores are not in close contact with each other. In some species the ascospores remain more or less free (*S. saccoboloides*, *S. globuliferellus*). In other species the connections may easily be broken or dissolved in water (*S. geminatus*, *S. infestans*).

The ascospores of *S. saccoboloides* are arranged in an early phase of spore maturation according to pattern I (Fig. 2a, b), which is characteristic of species of *Saccobolus* sect. *Saccobolus*. Only rarely ripe ascospores were found still united in a cluster. The apothecial development, the shape of the asci, and the yellowish contents of paraphyses also support its placing in this section.

2. SACCOBOLUS GLABER (Pers. per Pers.) Lamb.—Figs. 56, 57; Pl. 14, figs. B, C

Ascobolus glaber Pers. *in* Neues Mag. Bot. (ed. Römer) **1**: 115. 1794 (devalidated name); Obs. mycol. **1**: 34 (restricted to var. β and γ) *pl. 4 fs. 3b, 7b–c.* 1796 (devalidated name). — *Ascobolus glaber* Pers. per Pers., Mycol. eur. **1**: 340. 1822; Fries, Syst. mycol. **2** (1): 164. 1822. — *Saccobolus glaber* (Pers. per Pers.) Lamb., Fl. mycol. Belg., Suppl. **1**: 284. 1887. — *Ascobolus stercorarius* var. *glaber* (Pers. per Pers.) Vel., Monogr. Discom. Boh. **1**: 365. 1934. — Lectotype: L 910.262.148.

Ascobolus kervernii Crouan *in* Annls Sci. nat. (Bot.) IV **10**: 193 *pl. 13 B fs. 7–11.* 1858. — *Saccobolus kerverni* (Crouan) Boud. *in* Annls Sci. nat. (Bot.) V **10**: 229. 1869. — Lectotype: *Crouan*, on cow dung, Brest, France, 5.VI.1857 (CONC-A2421).

Saccobolus granulispermus Sopp. & Crossl. *in* Naturalist, Lond. 1899: *30 fs. 14–16.* 1899. — Type: represented by Sopp. & Crossl., l.c. *fs. 14–16*; type locality, Leeds, Great Britain.

EXCLUDED.—*Ascobolus glaber* Pers. per Pers. sensu Cooke *in* J. Bot. (Lond.) **2**: 151 *f. 4.* 1864 = *Ascobolus albidus.*

Ascobolus glaber Pers. sensu Fuckel *in* Fungi rhen. 1134. 1865; *in* Hedwigia **5**: 1. 1866; = *Saccobolus versicolor* (P. Karst.) P. Karst.

Ascobolus glaber Pers. per Pers. sensu Boud. *in* Annls Sci. nat. (Bot.) V **10**: 223 *pl. 7 fs. 13–15.* 1869 = *Ascobolus albidus.*

Ascobolus kerverni Crouan sensu P. Karst. *in* Notis. Sällsk. Fauna Fl. fenn. Förh. **11**: 203. 1870 = *Saccobolus depauperatus.*

Apothecia solitary or gregarious, superficial, sessile, 0.2–1.0 mm diameter. Receptacle at first globular, then pulvinate, golden-yellow or amber-coloured, smooth; margin not differentiated. Disk convex, golden-yellow, dotted with the almost black protruding tips of ripe asci. Hymenium 120–200 μ thick. Hypothecium not clearly differentiated. Flesh thin, of small, isodiametric cells 8–12 μ diameter, hyaline. Excipulum very thin and rather fugitive, in the lower part of subglobular or ellipsoid cells 10–22 × 9–15 μ, the upper part consisting of a palisade of paraphyses-like hyphae. Asci cylindric-clavate, often curved, with a short stalk, flattened above, with a very large operculum, 150–275 × 25–48 μ, 8-spored, the wall deep blue in Melzer's reagent. Spore-clusters elongated, rather compact, 50–68 × 16–25 μ, with thick gelatinous envelope. Ascospores arranged according to pattern I, fusiform-ellipsoid, often slightly asymmetrical or angular by pressure, with blunt ends, at first hyaline, then pinkish-violet, finally violet or purplish-brown, (19–)22–29 × 8.5–14.5(–16) μ, smooth or more rarely finely punctate, often with one or a few irregular cracks taking the form of delicate reticulations; pigment in a thin layer 0.6–0.8 μ thick. Paraphyses simple or branched, septate, irregularly cylindrical, 2.5–4.5 μ thick, enlarged up to 8.8 μ at the tip, with golden-yellow contents especially in the upper part, embedded in a rather fugacious, colourless, mucilaginous substance.

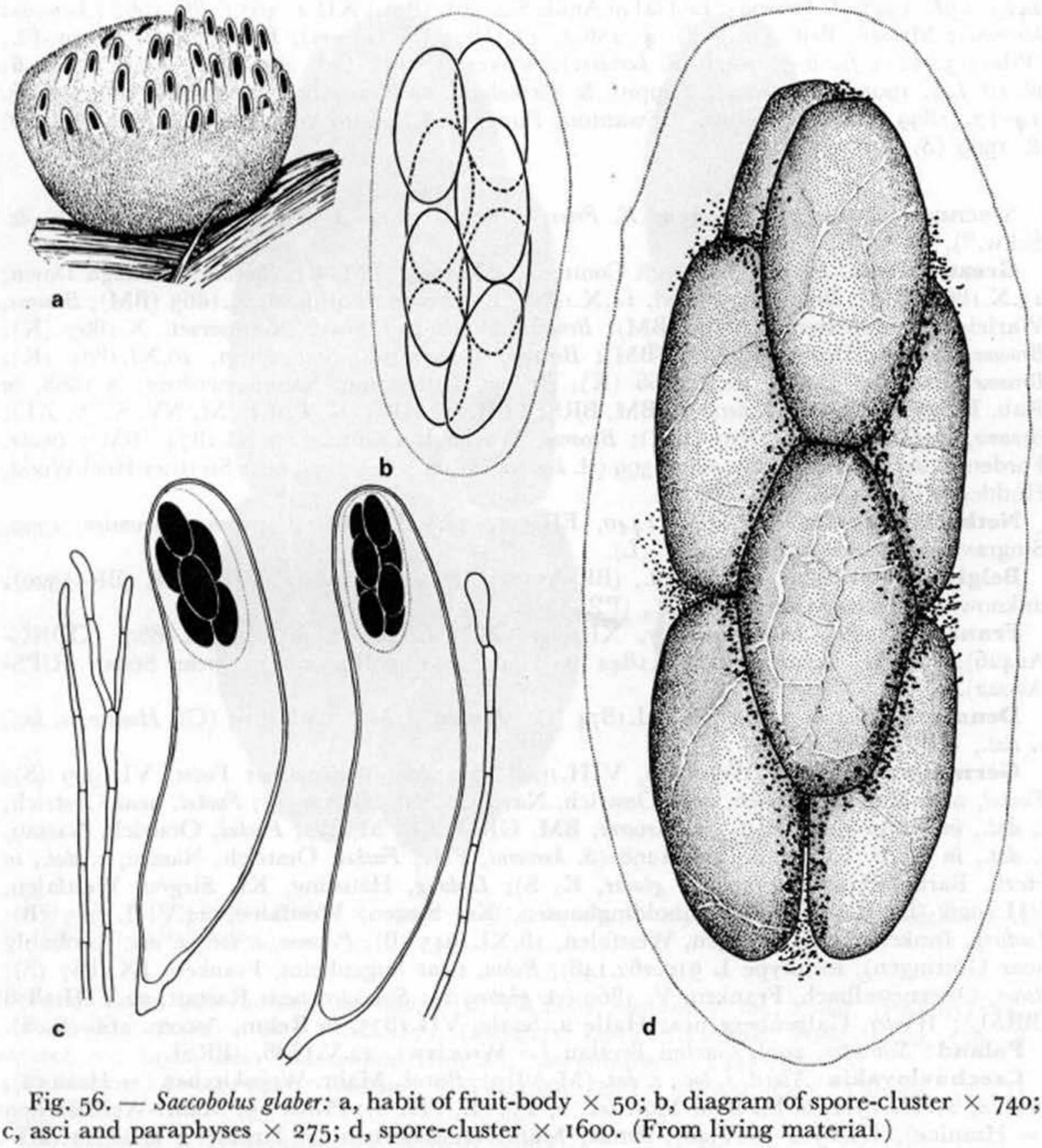

Fig. 56. — *Saccobolus glaber:* a, habit of fruit-body × 50; b, diagram of spore-cluster × 740; c, asci and paraphyses × 275; d, spore-cluster × 1600. (From living material.)

On dung of cow, horse, zebu, sheep, gnu, deer, and on paper under bear-dung.
ETYMOLOGY.—From Latin, glaber, without hairs.

ILLUSTRATIONS.—Berkeley & Broome *in* Ann. Mag. nat. Hist. III **15**: *pl. 17 f. 34.* 1865 (*Ascobolus kerverni*); Boudier *in* Annls Sci. nat. (Bot.) V **10**: *pl. 8 f. 18.* 1869 (*S. kerverni*); Cooke *in* J. Bot. (Lond.) **2**: 153 *f. 8.* 1864 (*Ascobolus kerverni*); Crouan *in* Annls Sci. nat. (Bot.) V **10**: *pl. 13B fs. 7–11.* 1858 (*Ascobolus kerverni*); Dennis, Brit. Cup Fungi *pl. VIII f. D.* 1960 (*S. kerverni*); Gillet, Champ. Fr., Discom. *pl. 85 f. 1.* 1882 (*Ascobolus kerverni*); Hansen *in* Vidensk. Meddr naturh. Foren., Kbh. 1876: *pl. 6 f. 22.* 1876 (*S. kerverni*); Lambotte, Fl. mycol. Belg., Suppl. **1**: *f. 37.* 1887 (*S. kerverni*, very schematic); Le Gal *in* Annls Sci. nat. (Bot.) XI, **8**:

242 *f. 65E.* 1947 (*S. kerverni*); Le Gal *in* Annls Sci. nat. (Bot.) XII **1**: 467 *f. 8B.* 1961 (*Ascobolus kerverni*); Massee, Brit. Fung.-Fl. **4**: 156 *f. 11.* 1895 (*S. kerverni*); Rehm, Rab. Krypt.-Fl., (Pilze) **3**: 1111 *fs. 6–7.* 1896 (*S. kerverni*); Seaver *in* Bull. Lab. nat. Hist. Univ. Iowa **6**: *pl. 18 f. 2.* 1905 (*S. kerverni*); Soppitt & Crossland *in* Naturalist, Yorkshire 1899: 31 *fs. 14–17.* 1899 (*S. granulispermus*); Swanton, Fungi and how to know them (Lond.) *pl. 6 f. 8.* 1909 (*S. kerverni*).

SPECIMENS EXAMINED.—**Sweden**: *E. Fries, s. loc., s. dat.* (*Ascobolus glaber*, "vidi Alb. & Schw."), (S-A756).

Great Britain: *Broome*, Warleigh Common, 5.X.1863 (BM, E); *Broome*, Warleigh Down, 13.X.1863 (BM); *Broome*, Bathford, 14.X.1863 (K); *Broome*, Bathford, X.1863 (BM); *Broome*, Warleigh, Sommerset, X.1863 (BM); *Broome*, Warleigh Down, Sommerset, X.1863 (K); *Broome*, Banner Down, X.1863 (BM); *Broome*, Batheaston, Sommerset, 28.XI.1864 (K); *Broome*, Bathford Down, 22.X.1866 (K); *Broome*, Batheaston, Sommersetshire, X.1868, *in* Rab. Fungi eur. 1313 (*A. kerverni*, BM, BRSL, FH, G, HBG, K, L, LE, M, NY, S, W, ZT); *Broome*, Bathford, 21.X.1870 (BM); *Broome*, Warleigh Common, 7.XI.1874 (BM); *Cooke*, Forden, *s. dat.*, *in* Fungi brit. ed. 2, 399 (*A. kerverni*, E, K); *Crossland*, near Sterther Heel Wood, Huddersfield, 24.IX.1906 (K).

Netherlands: *van Brummelen 1440*, Elspeet, 24.VIII.1961 (L); *van Brummelen 1399*, Singraven, Denekamp, 14.X.1961 (L).

Belgium: *Coemans, s. loc., s. dat.*, (BR-A327); *Mouton*, Beaufays, VII–VIII, (BR-A320); unknown collector, Gomzé, *s. dat.*, (BR-A290).

France: *Boudier*, Montmorency, XI.1891 (PC); *Crouan, s. loc.*, 20.XI.1869, (CONC-A2426); *Roberge*, Lébisey, 31.VII.1842 (G); unknown collector 579, near Sedan (UPS-A2022).

Denmark: *Hansen, s. loc.*, 26.VII.1874 (C); *Hansen, s. loc.*, 7.VI.1875 (C); *Hansen, s. loc., s. dat.*, (HBG-A406).

Germany: *Ade*, near Weismain, VIII.1908 (S); *Ade*, Weismainer Forst, VI.1909 (S); *Fuckel*, near Reicharthausen, near Oestrich, Nassau, *s. dat.* (G-A1059); *Fuckel*, near Oestrich, *s. dat.*, *in* Fungi rhen. 1846 (*A. kerverni*, BM, GRO, LE, M, W); *Fuckel*, Oestrich, Nassau, *s. dat.*, *in* Herb. Barbey-Boissier 1298 (*S. kerverni*, FH); *Fuckel*, Oestrich, Nassau, *s. dat.*, *in* Herb. Barbey-Boissier 1310 (*A. glaber*, K, S); *Ludwig*, Häusling, Kr. Siegen, Westfalen, VII.1926 (B); *Ludwig*, Langenholdinghausen, Kr. Siegen, Westfalen, 24.VIII.1945 (B); *Ludwig*, Innkerhees, Kr. Siegen, Westfalen, 18.XI.1945 (B); *Persoon, s. loc., s. dat.* (probably near Göttingen), lectotype L 910.262.148); *Rehm*, near Sugenheim, Franken, IX.1867 (S); *Rehm*, Obernesselbach, Franken, V. 1869 (*A. glaber*, S); *Schroeter*, near Rastatt, 22.VIII.1878 (BRSL); *Winter*, Galgenberg near Halle a. Saale, VII.1873, *in* Rehm, Ascom. 166 (B, S).

Poland: *Schroeter*, zool. Garten Breslau (= Wrocław), 22.V.1886, (BRSL).

Czechoslovakia: *Niessl, s. loc., s. dat.* (M-A815); *Petrak*, Mähr.-Weisskirchen (= Hranice), Welka, 21.IX.1912, *in* Fl. Boh. Mor. scr. 2, 233 (E, FH, S); *Petrak 19*, Mähr.-Weisskirchen (= Hranice), IX.1912 (S-A540); *Petrak*, Mähr.-Weisskirchen (= Hranice), IX.1927 (ZT-A73); *Svrček*, Březany, Bohemia, 15.VI.1946 (PR); *Svrček*, Hoštice near Nemyšl Bohemia, 20.VIII.1946 (PR); *Vacek*, Březany, Bohemia, 15.VI.1946 (PR); *Vacek*, Karlštejn, Bohemia, 13.VII.1947 (PR).

Austria: *Britzelmayr*, Peischelkopf, W. Tyrol, VII.1878 (S); *Heimerl*, Pressbaum near Wien, III.1889, *in* Rehm, Ascom. 964 (*S. kerverni*, slide, HBG, M, S); *Heimerl, s. loc.*, 1889, (S-A571); *Rehm*, near Kühtei, Oetz, Tyrol, VIII.1872, *in* Ascom. 165 (*S. violascens*, M, NY); *Rehm*, near Praxmar and Sellrain, Tyrol, VII.1872 (S); *Rick*, near Feldkirch, Vorarlberg, IX. 1897 (S).

Italy: *Bizzozzero*, Hortus botanicus, Padua, VIII.1886 (PAD); *Bresadola, s. loc.*, V. 1886, (S-A568); *Bresadola*, Gocciadoro, VI.1896 (S); *Cesati*, Vercilli, *s. dat.*, *in* Rabenhorst, Klotzsch. Herb. viv. mycol. ed. 2, 1430 (*A. glaber*, L, UPS); *Cavara*, S. Giuseppe near Papia, *s. dat.*,

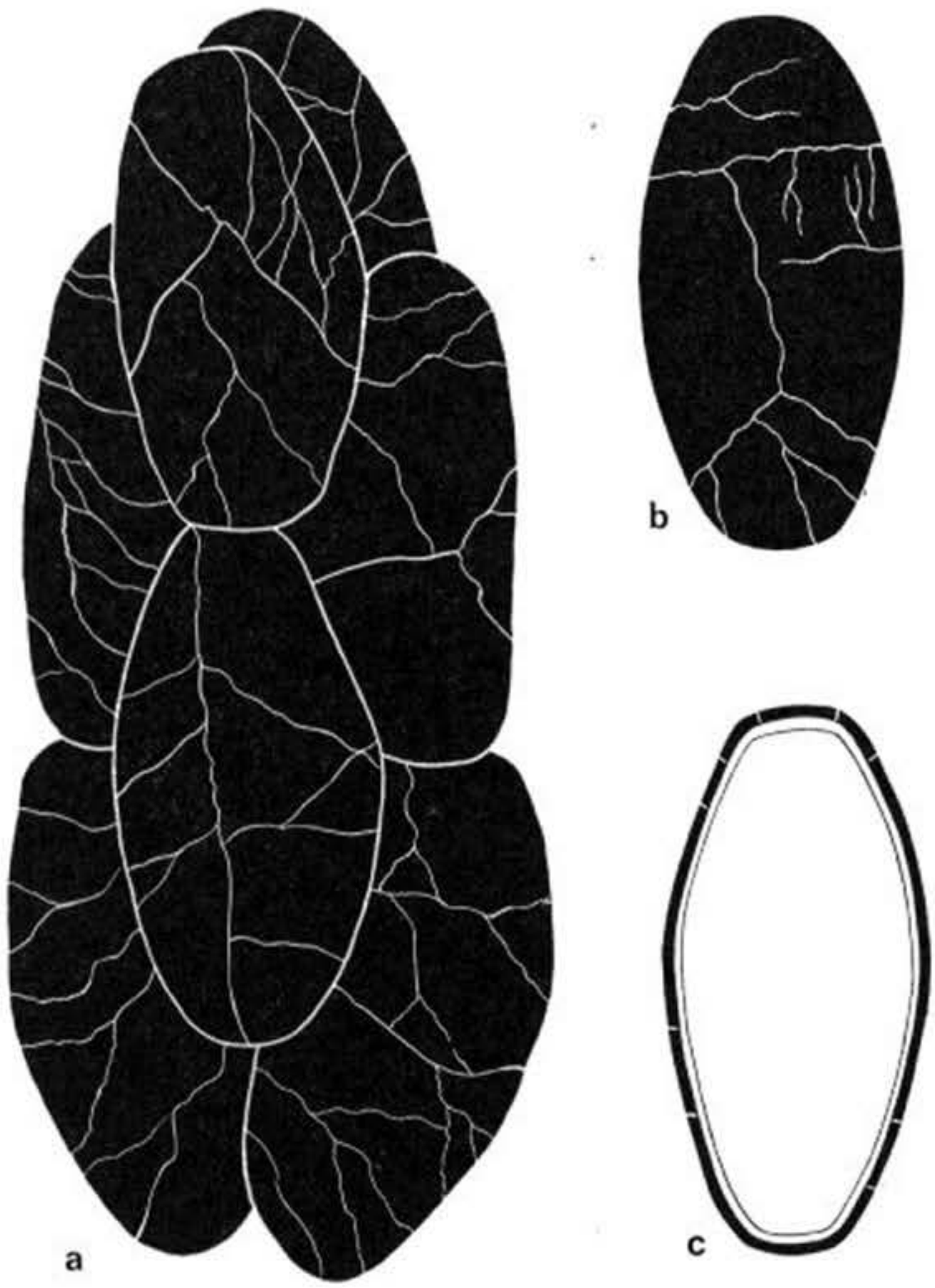

Fig. 57. — *Saccobolus glaber:* a, spore-cluster; b, ascospore; c, id. in optical section. (All × 1600; from lectotype.)

in Fungi Long. 226 (*Sordaria anserina*, BPI, TRTC); *Saccardo*, *s. loc.*, *s. dat.* (PAD-A1745).

Romania: *Lojka*, *s. loc.*, 17.VI.1871, (S-A494); *Lojka in* Linhart, Fungi hung. 139 (*A. kerverni*, S); *Lojka*, near Malornoiz, Hunyad, Siebenbürgen, VIII.1872 (S).

Pakistan: *Ahmad 2926*, Ladhar, 31.VII.1949 (BPI); *Ahmad* 2943, Lahore, 31.VII. 1949 (BPI).

India: *Salan 6*, Hyderabad, 12.IX.1958 (CMI).

Indonesia: *Boedijn 4904*, Bogor (= Buitenzorg), Java, V.1949 (Herb. Boedijn); *Boedijn 4939*, Bogor (= Buitenzorg), Java, VI.1949 (Herb. Boedijn).

Tahiti: *Olive 4*, Tautira, 27.VI.1956 (TRTC); *Olive 7*, Tautira, 27.VI.1956 (TRTC 35275, TRTC 33723).

Canada: *Cain 12000*, Ste. Catharine, Quebec, 25.VIII.1938 (TRTC); *Groves*, N.W.-Ottawa, Ontario, III.1931 (TRTC).

U.S.A.: Colorado: *Bethel & Seaver*, Geneva Creek Canyon, 3–12.IX.1910 (BPI, NY). Iowa: *Seaver 59*, Mt. Pleasant, summer 1905 (BPI); *Seaver 59c*, Big Creek, Mt. Pleasant, 17.VIII.1905 (NY, S). Tennessee: *Meyer*, Knoxville, 2.X.1942 (TRTC). New Jersey: *Seaver*, near New York, 17.VII.1912 (NY). North Carolina: *Diehl*, Grandfather Mt., 5.VIII.1927 (BPI). Florida: *West*, Magnesia Spring, Alachua Co., 18.VI.1939 (NY).

Bermuda: *Brown et al. 1220*, XI–XII. 1912 (NY); *Brown et al. 1532*, XI–XII.1912 (NY); *Brown et al. 1547*, XI–XII. 1912 (NY).

Cuba: *Britton & Wilson 405*, near Matanzas, 1903 (NY).

Jamaica: *Dennis J177*, Hope, 18.XII.1949 (K); *Earle 498*, Hope Gardens, X–XI. 1902 (NY).

Republica Dominicana: *Chardon 1140*, trail from Tarabacoa to Constanza, Prov. La Vega, 13.IX.1937 (NY).

Puerto Rico: *Chardon 1510*, Quebradillas, 5.I.1922 (NY); *Fancetti*, 29.VII.1914 (NY); *Fancetti* (NY-A1183); *Fink 1240* Mayaguez, 23.XII.1915 (B, BPI, FH, NY); *Fink*, Mayaguez, XII.1915 (ZT-A72); *Seaver & Chardon 60*, I–IV.1923 (NY); *Seaver & Chardon 78*, I–IV.1923 (NY); *Seaver & Chardon 125*, I–IV.1923 (NY); *Seaver & Chardon 684*, I–IV.1923 (NY); *Wille 812*, near Humacao, 21.I.1915 (NY); *Wilson 237*, Luguillo Mountains, 14.VII. 1902 (NY).

Guatemala: *Kellerman 4602*, Livingston, Dept. Izabal, 20.I.1905 (NY).

Venezuela: *Whetzel*, beyond Ortez Entrance to Llanos Edo Guarico, 7.IV.1939 (TRTC).

Trinidad: *Seaver 3097*, Manzanilla, 9.III.1921 (NY); *Seaver 3102*, Manzanilla, 9.III.1921 (NY); *Seaver 3416*, near Queen's Park Hotel, 1.IV.1921 (NY).

Brazil: *Müller*, Virosa, Minas Gerais, 20.V.1934 (TRTC).

When Persoon (Tentamen, 1794) described *Ascobolus glaber* he could have in mind only this species. In his "Observationes Mycologicae" (1796) he distinguished four varieties of which var. β and var. γ belong to this species. Under var. α young fruit-bodies of this species or *Ascobolus albidus* may have been described. As already noticed by Persoon (1796: 34) var. δ is probably another species.

This point of view was also held by Coemans (1862: 14) and Boudier (1869: 230). Boudier remarked: "Persoon a certainement vu cette espèce [= *Saccobolus kervernii* (Cr.) Boud.], c'est même elle qu'il décrit dans son *Tentamen disp. Fung.* et qu'il semble avoir figurée dans ses *Observationes*, t. I, tab. IV, fig. 7, si l'on peut s'en rapporter à ses détails anatomiques."

The collection in Herbarium Persoon is labelled in Persoon's handwriting: "*Ascobolus glaber* Syn. fung." This collection which fully agrees with the original description is here indicated as type.

The name *Ascobolus glaber* Pers. was freely misapplied after Crouan (1858) had described the same species under the name *Ascobolus kervernii* Crouan.

Saccobolus glaber is clearly recognizable by the golden-yellow or amber colour of the fruit-bodies and the size of the ascospores. Normally the ascospores are completely smooth. At full maturity the episporium may show some irregular secondary fissures. After drying or swelling of the ascospores the episporium may even become reticulated by these fissures.

This is a cosmopolitan species.

3. Saccobolus citrinus Boud. & Torrend—Fig. 58

Saccobolus citrinus Boud. & Torrend *in* Bull. Soc. mycol. Fr. **27**: 131 *pl. 6 f. 1.* 1911. — Type specimen: very poor (PC-A2231); type locality, Lisboa, Portugal.

Apothecia solitary or gregarious, superficial, sessile, up to 0.3 mm diameter.

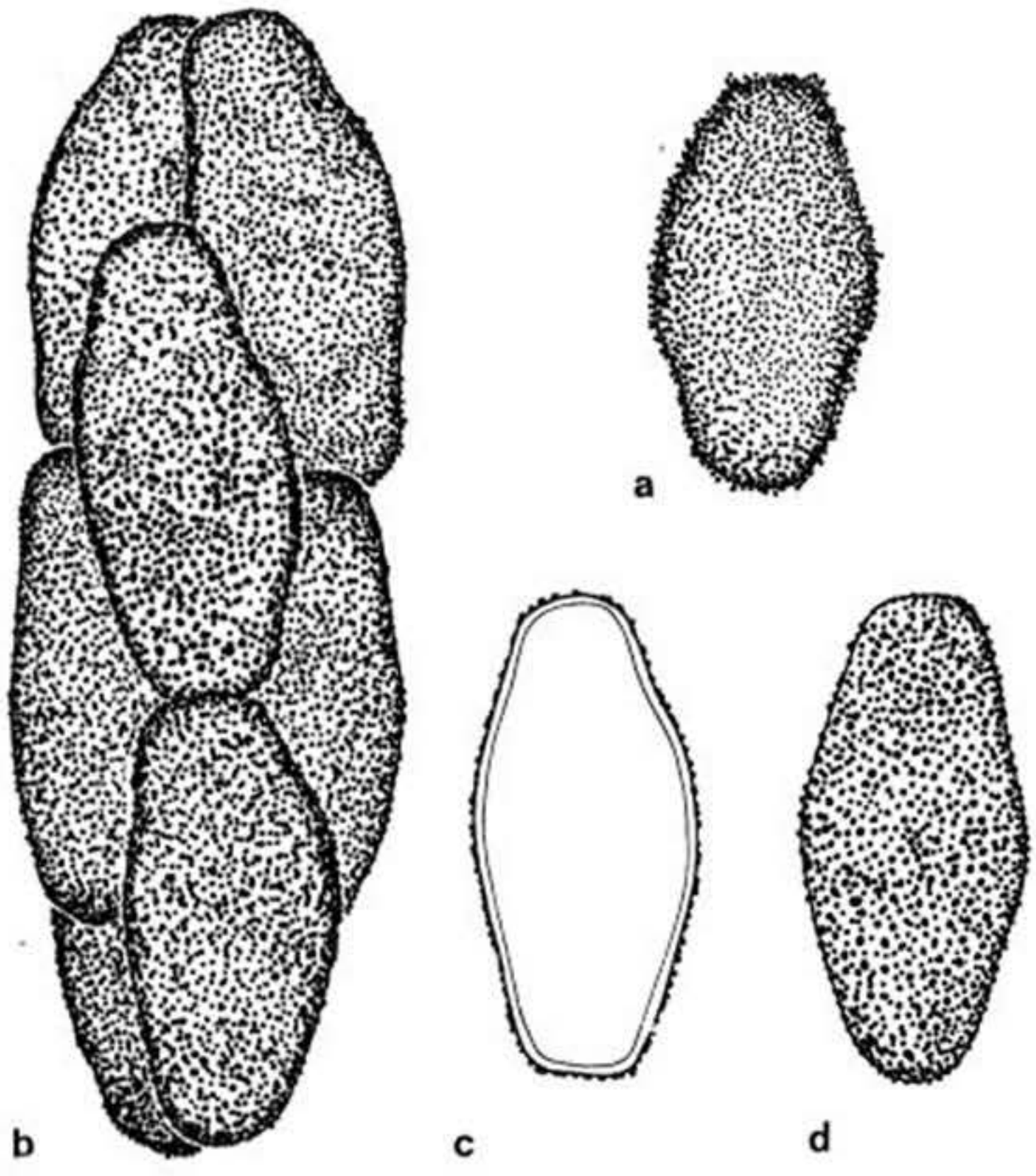

Fig. 58, — *Saccobolus citrinus:* a, d, ascospores; b, spore-cluster; c, ascospore in optical section. (All × 1600; a, from type; b–d, from *Meslin*, PC-A2325.)

Receptacle pulvinate or lenticular, ochraceous yellow, smooth; margin not differentiated. Disk convex, ochraceous yellow or lemon-yellow ("citrin vif" according to Le Gal 1942: 54), dotted with the almost black protruding tips of ripe asci. Hymenium up to 120 μ thick. Hypothecium not clearly differentiated. Flesh very thin. Excipulum consisting of a palisade of hyphae resembling paraphyses, thin, pale yellowish. Asci broadly clavate, gradually tapering downwards, with truncate apex, "130–150 × 30–35 μ" (Boudier & Torrend l.c.), 8-spored; the wall blue in Melzer's reagent. Spore-clusters elongated, 43–51 × 14–17 μ, not shortened with ripening. Ascospores arranged according to pattern I, ellipsoid-fusiform with blunt ends, often slightly asymmetrical or ventricose; at first hyaline, then pinkish, finally brownish-purple, 16–22(–23) × 7.5–9(–9.5) μ, ornamented with very fine isolated round warts. Paraphyses simple or branched, septate, cylindrical, 2.0–2.5 μ, thick, slightly enlarged up to 4 μ at the tip, with yellowish contents, especially in the upper parts.

On different kinds of dung. Known from dung of cow, horse, sheep, goat, and an unidentified bird.

ETYMOLOGY.—From Latin, citrinus, lemon-yellow.

ILLUSTRATIONS.—Boudier & Torrend *in* Bull. Soc. mycol. Fr. **27**: *pl. 6 f. 1.* 1911. (spore shape and coloured substance among paraphyses not typical); Le Gal *in* Bull. Soc. mycol. Fr. **57**: 54 *f. 2.* 1942 (ascospores). Le Gal *in* Annls Sci. nat. (Bot.) XI **8**: 241 *f. 64 B.* 1947 (ascospore).

SPECIMENS EXAMINED.—**Great Britain**: *Broome*, Warleigh, X.1863 (UPS-A2003); *Broome*,

Batheaston, X.1864, *in* Rabenhorst, Fungi eur. 780 (*Ascobolus depauperatus*, W); Crossland, Halifax, VII.1898 (*S. distinguendus* Boudier, an unpublished name, PC-A2232).

France: *Crouan*, *s. loc.*, 15.X.1868 (CONC-A2425); *Meslin*, Potigny, Calvados, *s. dat.* (see Le Gal, Bull. Soc. mycol. Fr. **57**: 54. 1941; PC-A2325).

Portugal: *Torrend*, Lisboa, II (holotype of *S. citrinus*, PC-A2231).

Czechoslovakia: *Petrak*, Mähr.-Weisskirchen (= Hranice), Welka, 21.IX.1912, *in* Fl. Boh. Mor., Pilze 233 (*Ascobolus kerverni*, LE).

Italy: *Cavara*, Hortus botanicus, Ticino, *s. dat.*, *in* Fungi Long. 164 (*S. neglectus*, BM, BPI, L, NY, PAD, S, W).

Canada: *Cain*, Lake Boshkuny, Haliburton Co., Ontario, 14.IX.1931 (TRTC 34740); *Cain*, Cedar Springs, Kent Co., Ontario, 13.VIII.1932 (TRTC 34738).

Brazil: *Theobald*, São Leopoldo, Rio Grande do Sul, 11.III.1936 (TRTC 34739).

This species is characterized by the normally lemon-yellow colour of the fruit-bodies, the size of the ascospores with clearly truncate ends, and the episporium with isolated, round warts. It seems to have a very wide distribution.

The type was studied and compared with richer material by Le Gal (1942).

4. Saccobolus truncatus Vel.—Fig. 59; Pl. 14, fig. D

Saccobolus nov. spec. E. C. Hansen *in* Vidensk. Meddr naturh. Foren., Kbh 1876: 87 *pl. 6 f. 23*. 1876.

Saccobolus truncatus Vel., Monogr. Discom. Boh. **1**: 370, **2**: *pl. 5 f. 25*. 1934. — Holotype: PR 152994.

Apothecia solitary or gregarious, superficial or in small cavities, sessile, 0.1–0.3 mm diameter, about 0.1 mm high. Receptacle semiglobular or lenticular, pale yellow, smooth; margin not differentiated. Disk convex, pale yellow, dotted with the

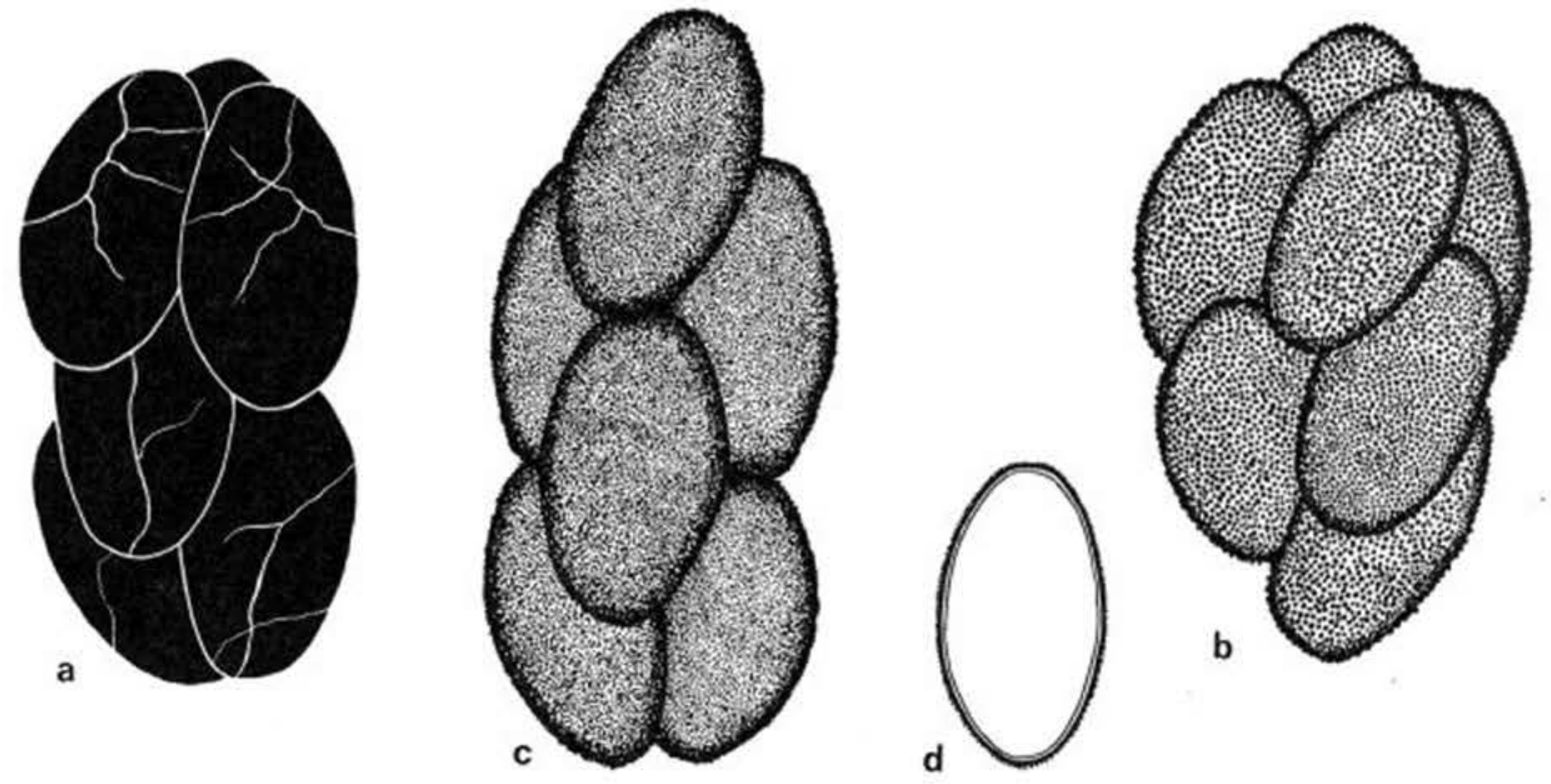

Fig. 59. — *Saccobolus truncatus:* a–c, spore-clusters; d, ascospore in optical section. (All × 1600; from holotype.)

purplish-black tips of ripe asci. Hymenium 50–80 μ thick. Hypothecium thin, of closely compacted isodiametric cells 4.5–8 μ diameter. Flesh not clearly differentiated. Excipulum consisting of a palisade of hyphae with subglobular cells 7–10 × 6–8 μ (textura globulosa), hyaline. Asci clavate, gradually tapering downwards into a rather thick base, with truncate apex, 74–97 × 16–23 μ, 8-spored; the wall deep blue in Melzer's reagent. Spore-clusters elongated to very compact, (20–)29–42(–48) × (14–)16–19(–22) μ; the longitudinal axis becoming increasingly shorter with ripening; surrounded by a thick gelatinous envelope. Ascospores at first arranged according to pattern I, gradually changing into pattern Ia, ellipsoid, sometimes fusiform-ellipsoid, with blunt ends, at first hyaline, then violet, finally often violet-brown, 14–17.5 × 7.5–8.5 μ, smooth or very finely punctate, sometimes with an occasional fissure in the episporium; pigment in a thin layer about 0.3 μ thick. Paraphyses slightly clavate, branched or simple, septate, 1.5–3.0 μ thick, the upper part enlarged up to 4.5 μ, with yellow pigment in the enlarged parts.

On dung of cow, horse, sheep, rabbit, raven, and partridge.

ETYMOLOGY.—From Latin, truncatus, shortened, ending abruptly as if cut off at the tip.

ILLUSTRATIONS.—Hansen *in* Vidensk. Meddr naturh. Foren., Kbh. 1876: *pl. 6 f. 23*. 1876 (*Saccobolus* nov. spec.); Velenovský, Monogr. Discom. Boh. **2**: *pl. 5 f. 25*. 1934.

SPECIMENS EXAMINED.—**Denmark**: *E. C. Hansen, s. loc.*, 29.VI.1874 (= *Saccobolus* nov. spec. E. C. Hansen *in* Vidensk. Meddr naturh. For. 1876: 87 *pl. 6 f. 23*. 1876; C-A58).

Netherlands: van *Brummelen 59.18*, Zoological Garden, Amsterdam, 24.VII.1959 (L).

Germany: *Winter*, Galgenberg, near Halle a.d. Saale, VII.1873, *in* Rehm, Ascom. 166 (*S. kerverni*, E).

Czechoslovakia: *Velenovský*, Mnichovice, Bohemia, VI.1931 (PR 152997); *Velenovský*, on raven dung, Kunice, Mnichovice, Bohemia, VII.1931 (holotype of *S. truncatus*, PR 152994).

Austria: *Demelius 1180*, Schöngrabern, near Unterwaltersdorf, Wiener Neustadt, Nieder-Oesterreich, 24.IX.1917 (W).

Thailand: *van Brummelen 1779*, Pha Nok Khao, S. of Loey, prov. Udawn, 14.XI.1963 (from culture; L).

Canada: *Bisby*, M.A.C., Winnipeg, Manitoba, 2.IX.1935 (TRTC 34716); *Cain*, Singhampton, Grey Co., Ontario, 5.VII.1930 (TRTC 34735); *Cain*, North Bay, Ontario, 3.IX.1931 (TRTC 34733); *Cain*, Singhampton, Grey Co., Ontario, 11.II.1932 (NY-A1202); *Cain*, Ilderton, Middlesex Co., Ontario, 12.VII.1932 (TRTC 34737).

U.S.A.: New York: *Cain*, McLean, near Ithaca, 5.IX.1952 (TRTC 34750). Virginia: *S. L. Meyer 14745*, Mountain Lake Biological Station, 8.VIII.1942 (TRTC).

Peru: *G. W. Martin 6280*, Talara, 5.IX.1945 (NY-A1229).

This is related to *S. citrinus* and *S. minimus*. It is sufficiently characterized by the pale yellow colour, the shape and size of the ascospores, and the finely punctate or smooth episporium.

With maturity the ascospore packages in this species are somewhat shortened, and the arrangement of the ascospores, which is at first very regular, becomes rather irregular at full maturity. In *S. portoricensis* the ascospores are pressed together still more tightly.

This widely distributed species is easily overlooked by its hidden and often solitary manner of growth.

5. Saccobolus portoricensis Seaver—Fig. 60; Pl. 14, figs. E–G

Saccobolus portoricensis Seaver, North Am. Cup-fungi 94. 1928. — Holotype: *Seaver*, on dung sent from Puerto Rico, autumn 1915 (NY).

Apothecia gregarious or scattered, superficial, sessile, up to 1 mm diameter. Receptacle at first perfectly globose, then short-cylindrical to obconical, finally

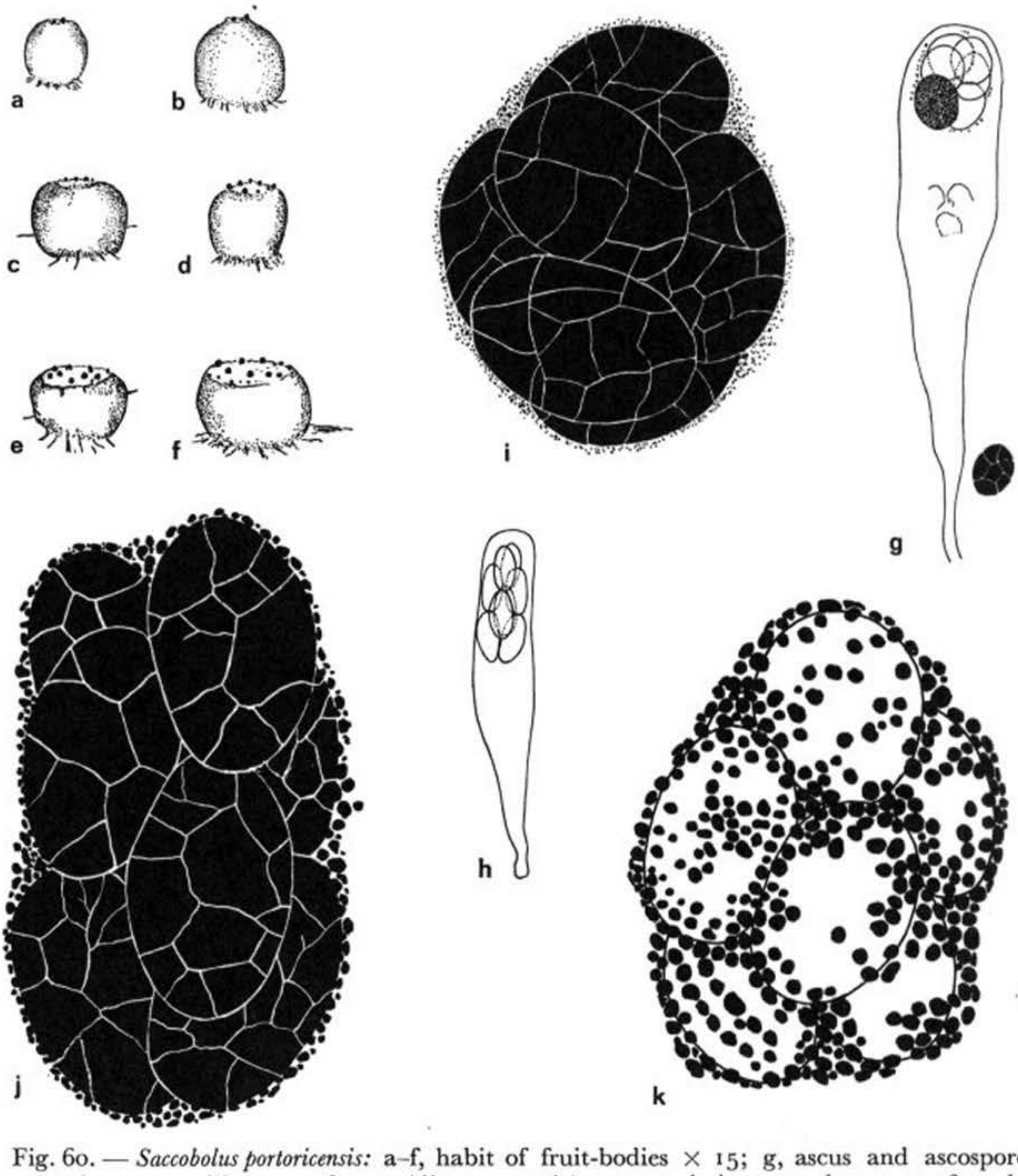

Fig. 60. — *Saccobolus portoricensis:* a–f, habit of fruit-bodies × 15; g, ascus and ascospore × 310; h, ascus with spore-cluster (diagrammatic) × 275; i, j, spore-cluster × 1600; k, spore-cluster with only the extra episporial pigment indicated × 1600. (From holotype; a–g, after drawings by Seaver, NY.)

discoid, pale-amber, smooth; margin not differentiated. Disk flat, then convex, at first similar in colour to the outside of the apothecium, dotted over with the protruding asci, finally almost entirely black. Hymenium about 200 μ thick. Hypothecium not clearly differentiated. Flesh 80–200 μ thick, of rather loosely united roundish or angular cells, hyaline. Excipulum in the lower part not differentiated from the flesh; in the upper part of parallel, paraphysoid hyphae, not clearly distinguishable from paraphyses. Asci clavate, tapering downwards into a rather long, slender base, with truncate apex, 170–200 × 35–40 μ, 8-spored. Spore-clusters at first elongated, finally subglobular, closely compacted and opaque or nearly so, surrounded by many purple granules, 34–44 × 22–30 μ. Ascospores arranged according to pattern I, then pressed together in an irregular, subglobular cluster; at first fusiform-ellipsoid, finally subglobular; at first hyaline, then purple, finally pale-brown; mature spores, 15–17.5 × 10–12.5 μ, shorter and broader than the almost mature ones, 19–21 × 9–10 μ; ornamentation consisting of very delicate reticulations; pigment in a 1.0–1.2 μ thick layer and in granules up to 1 μ diameter surrounding the spore-clusters. Paraphyses slender, simple, septate, about 3 μ thick, not or scarcely enlarged above, filled with orange granules.

On dung of unidentified animal.

ETYMOLOGY.—From Porto Rico (= Puerto Rico).

SPECIMENS EXAMINED.—**Puerto Rico**: *Seaver*, on dung from Puerto Rico, autumn 1915 (holotype of *S. portoricensis*, NY-A1185).

This species, which is only known from the type collection, is sufficiently characterized by the short-ellipsoid to subglobular ascospores and the thick episporium with a net-work of crevices.

The ascospores are at first regularly arranged in an elongated cluster according to pattern I. Soon, however, the cluster is shortened and becomes almost globular at maturity. The shape of the ascospores also changes during this process from ellipsoid to short-ellipsoid or subglobular.

Apart from a rather thick episporium, granules of extra-episporial pigment are also formed in the asci and surround the spore-clusters.

6. SACCOBOLUS MINIMUS Vel.—Fig. 61; Pl. 14, figs. H, I, Pl. 15, figs. A, B

Saccobolus minimus Vel., Monogr. Discom. Boh. **1**: 370 **2**: *pl. 5 f. 26.* 1934. — Holotype: PR 150081.

Apothecia solitary or gregarious, superficial, sessile, 0.1–0.2 μ diameter. Receptacle at first globular, then pulvinate, transparent amber-coloured to ochraceous yellow ("melina, vitreo-pellucida" according to Velenovský, 1934: 370), smooth; margin not differentiated. Disk convex, amber-coloured to golden-yellow, dotted with the almost black protruding tips of ripe asci. Hymenium 50–60 μ thick. Hypothecium not clearly differentiated. Flesh thin, of subglobular cells 5–12 μ diameter. Excipulum very thin, and rather fugitive, in the lower part of small subglobular cells, in the upper part consisting of a palisade of paraphyse-like hyphae. Asci cylindric-clavate, gradually tapering downwards into a rather thick base, with truncate apex, 50–60 × 14–16 μ, 8-spored, the wall blue in Melzer's reagent. Spore-clusters compact, ellipsoid to elongated, 29–33 × 12–15 μ, surrounded by a common hyaline, mucilaginous envelope. Ascospores arranged according to pattern I, ellipsoid to fusiform-

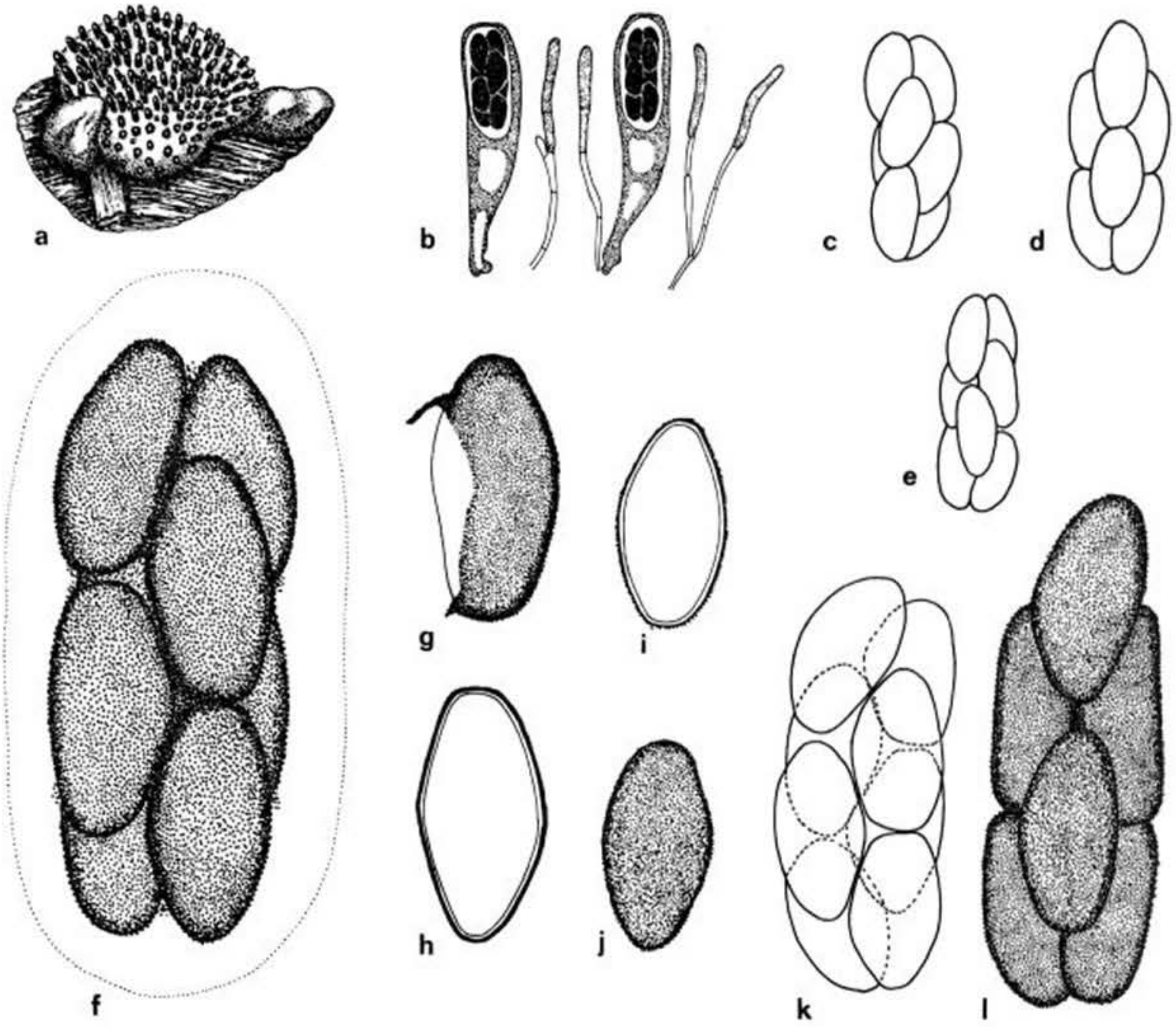

Fig. 61. — *Saccobolus minimus:* a, habit of fruit-body × 125; b, asci and paraphyses × 275; c–e, diagrams of spore-clusters × 800; f, l, spore-clusters × 1600; g, j, isolated ascospores × 1600; h, i, ascospores in optical section × 1600; k, diagram of spore-cluster × 1600. (c–e, i–l, from holotype.)

ellipsoid, often somewhat asymmetrical, at first hyaline, then pinkish-violet, finally violet or purplish-brown, (10–)11.5–13.5(–14.5) × 5.5–6.5(–7.5) μ, extremely fine punctate, or smooth with often some irregular cracks; pigment in a thin layer up to 0.7 μ thick. Paraphyses simple or rarely branched, septate, filiform, 2.0–2.5 μ thick, especially in the upper part with yellow contents not or scarcely thickened above (up to 4 μ).

On dung of cow, goat, sheep, deer, burro, and muskrat.

ETYMOLOGY.—From Latin, minimus, very small, smallest.

ILLUSTRATION.—Velenovský, Monogr. Discom. Boh. **2**: *pl. 5 f. 26.* 1934.

SPECIMENS EXAMINED.—**France**: *Meslin*, Potigny, Calvados, *s. dat.* (PC-A2325).
Germany: *Krieger*, near Königstein; IX.1903 (S-A509).
Czechoslovakia: *Velenovský*, Mnichovice, X.1928 (holotype of *S. minimus*, PR 150081).

Austria: *Demelius 762*, Voslau, Nieder-Oesterreich, X.1912 (W 1808).
Poland: *Schroeter*, near Breslau (= Wrocław), VII.1880 (BRSL-A1652).
Thailand: *van Brummelen 1789*, Khao Dai Kuad, prov. Surat, 26.XI.1963 (L); *van Brummelen 1783*, Doi Chieng Dao, prov. Payap, 22.XI.1963 (L); *van Brummelen 1781*, Pha Nok Khao, S. of Loey, prov. Udawn, 21.XI.1963 (L).
Hawaii: *van Brummelen 1465*, Mt. Kaala, Oahu, 3.V.1962 (L); *van Brummelen 1468*, Mt. Kaala, Oahu, 9.V.1962 (L); *van Brummelen 1462*, Mt. Kaala, Oahu, 10.V.1962 (L).
Canada: *Cain*, Storeleigh, Muskoka, Ontario, 18.VIII.1932 (TRTC 34717); *Cain*, Pickerel L.P., Lake Timagami, Ontario, 10.VIII.1933 (TRTC 34724); *Cain*, Lake Timagami, Ontario, 27.II.1934 (NY); *Cain 6968*, Pine River, Lac St. Joseph, Quebec, 25.VIII.1938 (TRTC); *Cain 6978*, Pine River, Lac St. Joseph, Quebec, 26.VIII.1938 (TRTC); *Cain 6930*, Camp Mercier, Laurentides Nat. Park, Quebec, 27.VIII.1938 (TRTC).
U.S.A.: Maine: *Thaxter*, Kittery Point, IX.1891 (FH-A3077).
Ecuador: *G. W. Martin 6277*, Salinas, 3.IX.1945 (NY); *G. W. Martin 6281*, Islet Baltra, Galápagos, 6.IX.1945 (NY).

Because of the small fruit-bodies, this fungus has been collected only rarely. Probably it will prove to have a world-wide distribution.

It is easily recognizable by its small ascospores. *Saccobolus depauperatus* has ascospores of about the same size, but the fruit-bodies are white or pale violet instead of amber or ochraceous yellow. Furthermore the arrangement of the ascospores is different. Yet these two species show a certain degree of relationship. In *S. depauperatus* an ascospore-cluster can occasionally be found in which the spores are arranged according to pattern I. Sometimes the contents of paraphyses are faintly coloured.

II. Saccobolus sect. Eriobolus Sacc.

Saccobolus sect. *Eriobolus* Sacc., Syll. Fung. **8**: 527. 1889. — Monotype: *Saccobolus caesariatus* Renny apud Phillips.

Receptacle and disk white, pale violet, violet or brown. Ascospores 8 or sometimes 4; ellipsoid or fusiform-ellipsoid, very rarely subglobular or globular, often the ends slightly truncate, often asymmetrical, ventriculose or somewhat triangular; arranged differently from pattern I or Ia (Fig. 2a–c). Paraphyses mostly colourless, without yellowish or orange contents. Sometimes with violet or brownish, amorphous, intercellular pigment in the outer layers of the excipulum and between the tips of paraphyses.

Fimicolous, more rarely on textiles, rotten vegetable debris, board and plaster walls.

Etymology.—From Greek, ἔριον, wool and βαλλω, to throw.

In this section twelve species can be distinguished, among which is *Saccobolus versicolor*, an extremely variable species. Formerly, different variations of this species had been given different specific names. However, studies on the variation of the different characters in many cultures and rich collections have shown that they are mere variations bridged by very gradual transitions.

The ascospores of the species in this section are arranged according to various patterns. Pattern II and III (Fig. 2f–h) occur in at least seven species. Two special

patterns (Va and Vb, Fig. 2d, e) are found in *S. quadrisporus*, which has 4-spored asci.

In *S. globuliferellus* and *S. dilutellus* the spore-cluster is shortly ellipsoid or subglobular. In my opinion, the patterns found in the packages of these species are only extremely contracted variations of pattern II or III (Fig. 2i, j).

A quite different arrangement is found in the spore-clusters of *S. geminatus* and *S. infestans*. Here the longitudinal axes of the ascospores is perpendicular to the longitudinal axis of the package (pattern VI). These two very rare species might deserve a separate section. At the moment, however, our knowledge of the development of their ascospores is insufficient to determine their relationship with other species of *Saccobolus* sect. *Eriobolus*.

KEY TO THE SPECIES OF SACCOBOLUS SECT. ERIOBOLUS

1. Ascus with 4 spores; ellipsoid or slightly triangular; 16.5–19.5 × 9.5–10.5 μ
   12. *Saccobolus quadrisporus*, p. 196
1. Ascus with 8 spores:
   2. Ascospores at first arranged according to pattern II or III. Spore-clusters finally sometimes becoming shortened or somewhat irregular but never loose or subglobular:
      3. Episporium smooth or finely granular, sometimes with small pits or with an incomplete net-work of fine fissures. Ascospores not shortened at maturity:
         4. Receptacle outside with bunches of hyphae to form tapering squamules. Excipulum of textura angularis . . . . 9. *Saccobolus caesariatus*, p. 191
         4. Receptacle completely smooth. Excipulum of textura globulosa or intricata:
            5. Apothecia 0.1–0.3 mm diameter. Excipulum of textura globulosa, rarely with intercellular, amorphous pigment. Central asci 60–95 × 15–20 μ. Ascospores 10–14.5 × 5–7.5 μ. Episporium smooth or finely granular . . . . . 7. *Saccobolus depauperatus*, p. 183
            5. Apothecia 0.2–2.0 mm diameter. Excipulum predominantly of textura intricata, mostly with intercellular, amorphous pigment in excipulum and between the tips of paraphyses. Central asci 100–145 × 22–37 μ. Ascospores 13–21.5 × 6.5–9.5 μ. Episporium smooth, sometimes with small pits, with an incomplete net-work of fissures or finely granular . . . . . 8. *Saccobolus versicolor*, p. 186
      3. Episporium coarsely or finely warted or with a coarse net-work of fissures; sometimes very thick. Ascospores sometimes shortened at maturity:
         6. Episporium very coarsely warted or reticulated, 1–3 μ thick. Ascospores 17.5–23 × 8.5–10 μ . . . . . 10. *Saccobolus beckii*, p. 193
         6. Episporium not so roughened and thick. Ascospores smaller:
            7. Apothecia lenticular or pulvinate. Spore-clusters at maturity of the ascospores shortened, by which the arrangement becomes more or

less irregular (pattern IIIa, Fig. 2i). Episporium coarsely or finely warted:

8. Apothecia 0.3–0.8 mm diameter. Ascospores ellipsoid or fusiform-ellipsoid; 13.5–18 × 7.5–9.5 μ; firmly united in the clusters. With intercellular, amorphous, brown pigment in excipulum and between the tips of paraphyses . . 11. *Saccobolus obscurus*, p. 194

8. Apothecia 0.1–0.3 mm diameter. Ascospores broadly ellipsoid or fusiform-ellipsoid; 10.5–14 × 7–9 μ; rather loosely united in the clusters. Without intercellular pigment in excipulum and hymenium . . . . . 13. *Saccobolus thaxteri*, p. 197

7. Apothecia cylindrical or subglobular. Spore-clusters at maturity not shortened, always arranged according to pattern II. Episporium coarsely warted. Ascospores 14–16 × 8–9 μ. With intercellular, amorphous pigment in excipulum and between the tips of paraphyses. 14. *Saccobolus verrucisporus*, p. 198

2. Ascospores not arranged according to pattern II or III; at maturity according to pattern IV or VI, or rather loosely in a shortly ellipsoid or subglobular cluster:

9. Spore-cluster at maturity subglobular or shortly ellipsoid. Ascospores 11.5–14.5 × 6–7.5 μ:

10. Ascospores loosely united in the cluster, mostly at all sides covered with fine warts . . . . . 15. *Saccobolus globuliferellus*, p. 200

10. Ascospores closely compacted in a subglobular cluster; only the exposed surfaces covered with fine and coarse warts 16. *Saccobolus dilutellus*, p. 201

9. Ascospores arranged in a package according to pattern VI (axes of ascospores at right angles with axis of package, Fig. 2k–p):

11. Ascospores firmly united in pairs (Fig. 2q); 10.5–13 × 5–6.5 μ. The pairs rather loosely united in a cylindrical pile. Episporium finely warted . . . . . 17. *Saccobolus geminatus*, p. 202

11. Ascospores arranged according to package VI, not firmly united in pairs; 9–11 × 5–6.5 μ. Episporium granular 18. *Saccobolus infestans*, p. 204

7. Saccobolus depauperatus (Berk. & Broome) E. C. Hansen—Fig. 62

Ascobolus depauparatus Berk. & Broome *in* Ann. Mag. nat. Hist. III **15**: 448 *pl. 14 f. 6.* 1865; Broome *in* Rab., Fungi eur. No. 780. 1865. — *Saccobolus depauperatus* (Berk. & Broome) E. C. Hansen *in* Vid. Meddr dansk naturh. Foren. 1876: 87. 1876. — Lectotype: *Broome (No. 319)*, Hanham, 31.X.1864 (K, BM, E).

Saccobolus neglectus Boud. *in* Annls Sci. nat. (Bot.) V **10**: 231 *pl. 9 f. 20.* 1869. — *Ascobolus neglectus* (Boud.) Phill. & Plowr. *in* Grevillea **10**: 69. 1881; Gillet, Discom. 141. 1883. — *Ascobolus violascens* var. *neglectus* (Boud.) Quél., Ench. Fung. 294. 1886. — Type: represented by Boudier l.c.: *pl. 9 f. 20*; type locality, Montmorency, France.

Saccobolus depauperatus forma *denigratus* Rehm, Ascomyceten exs. No. 1271. 1899 (nomen nudum); Rehm *in* Hedwigia **38**: (243). 1899 (with diagnosis). — Type distribution: *von Lagerheim* in Rehm, Ascom. 1271.

Saccobolus aparaphysatus Speg. *in* An. Mus. nac. Hist. nat. B. Aires **6**: 308. 1899. — Holotype: LPS 26139.

Apothecia scattered or gregarious, superficial, sessile, 0.10–0.20(–0.25) mm diameter, 0.10–0.30 mm high. Receptacle at first subglobular, then more expanded and becoming pulvinate or turbinate-hemispherical, often with a narrow base, white, then pale violet, smooth; margin not differentiated. Disk convex, white, then pale vinous to violet, dotted with the dark purplish protruding tips of ripe asci. Hymenium 70–90(–100) μ thick. Hypothecium thin, of closely compacted isodiametric cells 3–6 μ diameter. Flesh not differentiated or very thin, of globular cells 6–14 μ diameter. Excipulum very thin, consisting of subglobular cells 6–12 μ diameter (textura globulosa), hyaline or with pale purplish, intercellular, amorphous pigment. Asci broadly clavate, gradually tapering downwards into a rather thick base, with abruptly truncate apex, 60–95 × (12–)15–20 μ (the longer ones near the margin of the disk), 8-spored, the wall deep blue in Melzer's reagent. Spore-clusters compact, elongated, 28–37 × 10–13 μ. Ascospores arranged according to pattern II or III, very rarely in a part of the asci according to pattern I, ellipsoid or fusiform-ellipsoid, sometimes somewhat asymmetrical, with blunt ends, at first hyaline, then pinkish-violet, finally dark violet or purplish-brown, 10–14.5 × 5–7.5 μ, smooth or extremely fine granular; pigment in a thin or a thick layer (0.5–1.1 μ thick). Paraphyses sometimes rather scarce, simple, septate, filiform, 1.5–3.2 μ thick, colourless or faintly coloured, slightly enlarged up to 4.5(–6) μ at the tip, often slightly curved above, without mucus.

On dung of horse, cow, sheep, deer, porcupine, elk, chamois, elephant, rabbit, and hare, also on the mud plaster of a wall.

Etymology.—From Latin, de-, prefix signifying down, away, off and paupero, to impoverish: poorly developed.

Illustrations.—Berkeley & Broome *in* Ann. Mag. nat. Hist. III **15**: *pl. 14 f. 6.* 1865 (*Ascobolus*); Boudier *in* Annls Sci. nat. (Bot.) V **10**: *pl. 9 f. 20.* 1869 (*S. neglectus*); van Brummelen *in* Persoonia **2**: 197 *f. 3.* 1962 (*S. aparaphysatus*, ascospores); Hansen *in* Vid. Meddr. dansk. naturh. Foren. 1876: *pl. 6 fs. 14–21.* 1876; Heimerl *in* Jber. k.k. Ober-Realschule Bezirke Sechshaus Wien **15**: *pl. 1 f. 6.* 1889.

Specimens examined.—**Sweden**: *Lagerheim*, Nacka near Stockholm, *in* Rehm, Ascom. 1271 (type distribution of *S. depauperatus* forma *denigratus*, B, BM, HBG, LE, M, S, W).

Finland: *Karsten*, Wasa, 20.VIII.1867 (H).

Great Britain: *Broome*, Hanham, 24.X.1864 (*Ascobolus depauperatus*, BM-A3012); *Broome*, Bathford-Down, 28.X.1864 (*Ascobolus vinosus*, K-A1914); *Broome*, Hanham, 31.X.1864 (lectotype of *Ascobolus depauperatus*, BM-A3010, BM-A3013, E-A136, K-A2448); *Broome*, Batheaston, Somerset, 28.XI.1864 (*Ascobolus depauperatus*, K-A2450); *Broome*, 7.XII.1864 (*Ascobolus depauperatus*, K-A2451); *Cooke*, Forden, *in* Fungi brit. ed. II, 399 (*Ascobolus kerverni*, PAD); *Crossland*, Stokesley, Cleveland, 8.VIII.1899 (K); *Dennis*, West Sandwick, Islet Yell, Shetland Islands, 5.IX.1952 (K); unknown collector, Kew, 1.IX.1916 (K-A2496).

Netherlands: *van Brummelen 625*, Leiden, 6.VIII.1958 (L); *van Brummelen 642*, Leiden, 20.VIII.1958 (L).

France: *de Croculs*, near Toulon, V. 1927 (PC); *Crouan*, *s. loc.*, 10.X.1868 (CONC-A2436).

Denmark: *E. Müller*, Vintre höller, Seeland, 13.IX.1952 (ZT); *E. C. Hansen*, 15.VIII.1874 (C-A60).

Germany: *Ludwig*, Langenholdinghausen, Kr. Siegen, Prov. Westfalen, 23.VIII.1945

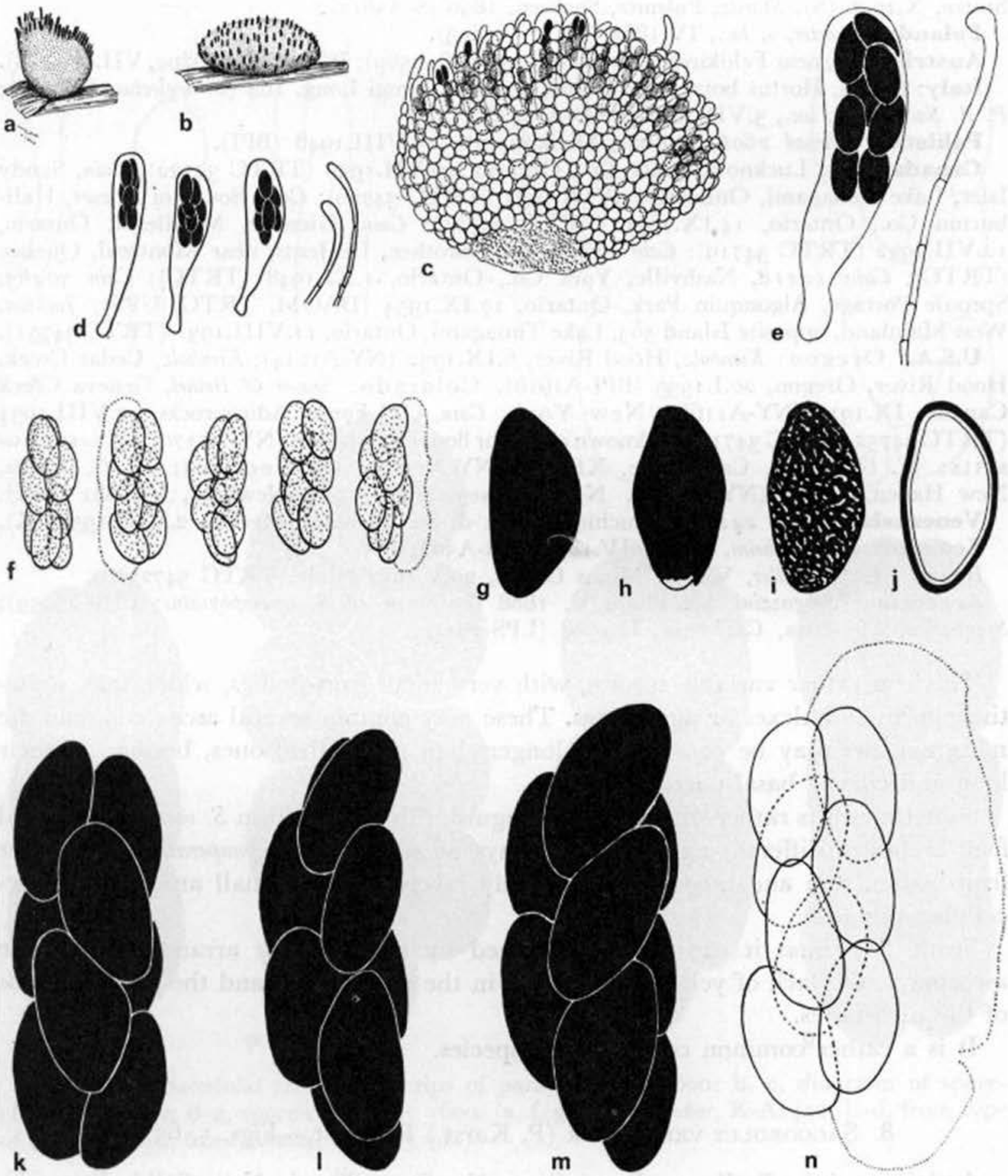

Fig. 62. — *Saccobolus depauperatus:* a, b, habit of fruit-bodies × 50; c, fruit-body in transmitted light × 175; d, asci and paraphyses × 275; e, ascus and paraphysis × 600; f, diagrams of spore-clusters × 600; g–i, isolated ascospores × 1600; j, ascospore in optical section × 1600; k–m, spore-clusters × 1600 (the spores of m relatively long); n, diagram of spore-cluster with mucilaginous substance × 1600. (a–f, n, from *van Brummelen 625*; k, l, from type of *S. aparaphysatus*; g–j, m, from type of *S. depauperatus*, K-A2448.)

(BPI); *Rehm*, Grufwald, near Windesheim, Franken, X.1873 (S); *Rehm*, Eibsee, near Zug-Spitze, X.1906 (S); *Staritz*, Pulsnitz, Sachsen, 1890 (S-A581a).

Poland: *Schroeter*, *s. loc.*, IV.1884 (BRSL-A1653).

Austria: *Rick*, near Feldkirch, Vorarlberg, 1898 (S-A569); *Wagner*, Rax-Alpe, VII.1894 (S).

Italy: *Cavara*, Hortus botanicus, Ticino, *s. dat. in* Fungi Long. 164 (*S. neglectus*, BM, W); *P. A. Saccardo*, *s. loc.*, 5.VII.1877 (PAD-A1744).

Pakistan: *Ahmad 2606*, Ladhar, Sheikhupura, 13.VIII.1948 (BPI).

Canada: *Cain*, Lucknow, Bruce Co., Ontario, 10.VII.1930 (TRTC 34722); *Cain*, Sandy Islet, Lake Timagami, Ontario, 21.VIII.1931 (TRTC 34720); *Cain*, South of Dorset, Haliburton Co., Ontario, 14,IX.1931 (TRTC 34721); *Cain*, Glencoe, Middlesex, Ontario, 12.VII.1932 (TRTC 34719); *Cain 12369*, Ste Dorothee, Ile Jesus, near Montreal, Quebec (TRTC); *Cain 12218*, Nashville, York Co., Ontario, 1.XI.1948 (TRTC); *Cain 30485*, Sproule Portage, Algonquin Park, Ontario, 17.IX.1954 (DAOM, TRTC, UPS); *Jackson*, West Mainland, opposite Island 563, Lake Timagami, Ontario, 11.VIII.1931 (TRTC 34751).

U.S.A.: Oregon: *Kienholz*, Hood River, 6.IX.1932 (NY-A1214); *Kienholz*, Cedar Creek, Hood River, Oregon, 20.I.1939 (BPI-A1618). Colorado: *Seaver & Bethel*, Geneva Creek Canyon, IX.1910 (NY-A1166). New York: *Cain*, Old Forge, Adironrocks, 22.VIII.1934 (TRTC 34752, TRTC 34719); unknown collector 809, Long Island (NY-A1170). Massachusetts: *W. G. Sturgis*, Cainbridge, XI.1890 (NY-A1219). Connecticut: *W. G. Sturgis*, New Haven, I.1893 (NY-A1221). New Jersey: *Ellis 3518*, Newfield, VI.1881 (BPI).

Venezuela: *Dennis 2413*, Mucuchíes, Sierra di St. Domingo Merida, 2.VIII.1958 (K).

Ecuador: *de Lagerheim*, Quito, IV.1892 (FH-A3081).

Brazil: *A. S. Müller*, Virosa, Minas Gerais, 20.V.1934 (slide, TRTC 34723).

Argentina: *Spegazzini*, La Plata, V. 1888 (holotype of *S. aparaphysatus*; LPS 26139); *Spegazzini*, Mendoza, Cacheuta, II.1908 (LPS-26140).

This is a rather variable species, with very small fruit-bodies, which may sometimes form complexes or aggregates. These may contain several ascogonia, and the marginal asci may be considerably longer than the central ones, because of their long and curved basal part.

Sometimes it is rather difficult to distinguish this species from *S. versicolor*. Several fruit-bodies of different ages should always be studied. *S. depauperatus* has smaller fruit-bodies, asci and ascospores, and only rarely forms a small amount of intercellular pigment.

From *S. minutus* it can be distinguished by the different arrangement of the ascospores, the lack of yellowish contents in the paraphyses, and the truncate ends of the ascospores.

It is a rather common cosmopolitan species.

8. Saccobolus versicolor (P. Karst.) P. Karst.—Figs. 5, 63, 64

Ascobolus versicolor P. Karst., Fungi Fenn. No. 659. 1867; *in* Notis. Sällsk. Fauna Fl. fenn. Förh. **11**: 203. 1870. — *Saccobolus versicolor* (P. Karst.) P. Karst. *in* Acta Soc. Fauna Fl. Fenn. II **6**: 123. 1885; Saccardo, Syll. Fung. **8**: 525. 1889. — Type distribution: *P. Karsten in* Fungi Fenn. exs. 659.

Saccobolus violascens Boud. *in* Annls Sci. nat. (Bot.) V **10**: 230 *pl. 8 f. 19*. 1869. — *Ascobolus violascens* (Boud.) Gill., Champ. Fr., Discom. 141. 1883. — Type: represented by Boud. l.c. *pl. 8 f. 19*; type locality, Montmorency, France.

Saccobolus boudieri Oud. *in* Hedwigia **21**: 166. 1882; *in* Versl. Med. Kon. Akad. Wet.,

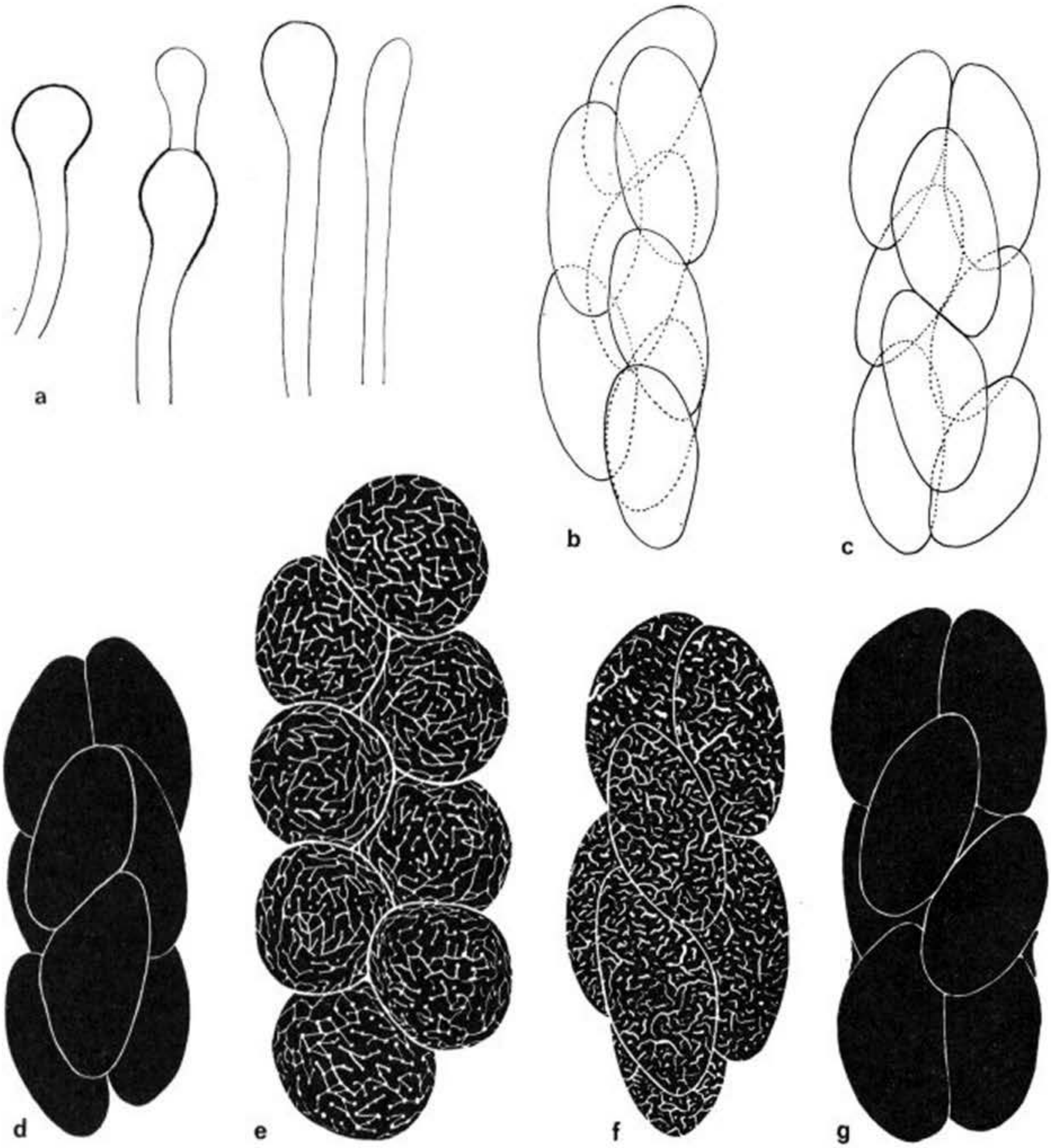

Fig. 63. — *Saccobolus versicolor:* a, tips of paraphyses × 1600; b, c, diagrams of spore-clusters × 1600; d–g, spore-clusters × 1600. (a, f, g, from *Boudier*, K-A2452; b–d, from type of *S. versicolor*; e, from *Léveillé*, PC-A2315b.)

Amsterdam, Afd. Natuurk. II **18**: 283. 1883; *in* Ned. kruidk. Arch. II **4**: 263. 1886. — *Saccobolus violascens* var. *boudieri* (Oud.) Vel., Monogr. Discom. Boh. 370. 1934. — Type: not known to be in existence; type locality, Netherlands.

Saccobolus pseudo-violascens Heimerl *in* Jber. k.k. Ober-Realschule Bezirke Sechshaus Wien **15**: 17. 1889. — Type: represented by Heimerl l.c. *f.* 7; type locality, Geissberg, Austria.

Saccobolus neglectus var. *fallax* Heimerl *in* Jber. k.k. Ober-Realschule Bezirke Sechshaus Wien **15**: 17. 1889. — Type: not known to be in existence; type locality, Pressbaum, Austria.

Saccobolus murinus Vel., Monogr. Discom. Boh. 371. 1934. — Holotype: *Velenovský*, on dung of mouse, Mnichovice, Myšlín, Czechoslovakia, XI.1927 (PR 152921).

Apothecia scattered or gregarious, superficial, sessile, (0.1–)0.2–1.0(–2.0) mm across. Receptacle at first globular, then hemispherical, and finally often pulvinate or lenticular, pale violet, becoming darker with age, smooth; margin not differentiated. Disk convex or plano-convex, pale violet, dotted with the dark violet or almost black protruding tips of ripe asci. Hymenium 55–120 μ thick. Hypothecium very thin and often not clearly differentiated, of closely compacted isodiametric cells 4–7 μ diameter. Flesh very thin, of isodiametric or elongated cells 5–16 × 4–7 μ, hyaline. Excipulum 7–13 μ thick, often poorly developed, of closely intertwined hyphae 2.5–4 μ wide, with enlarged apical cells up to 7 μ thick, with amorphous, violaceous, intercellular pigment. Asci broadly clavate, (80–)100–145 × 22–37 μ, 8-spored; the wall deep blue in Melzer's reagent. Spore-clusters rather compact, elongated, often somewhat curved, 40–62 × 14–19(–23) μ. Ascospores arranged according to pattern II or III, ellipsoid-fusiform or more rarely fusiform-ellipsoid, very rarely subglobular or globular, often asymmetrical, subtrigonal or ventricose, with blunt ends, at first hyaline, then pinkish-violet, finally violet, purplish-brown or purplish-grey, 13–21.5(–23.5) × 6.5–9.5(–10) μ, smooth, finely warted or with small pits and short more or less reticulating fissures; with common or individual, lateral, mucilaginous substance. Paraphyses branched, septate, filiform, 2–3 μ thick; not, slightly, or strongly enlarged above, up to 7.5 μ at the tip; hyaline, often with amorphous, violet, intercellular pigment between the upper parts.

On dung of cow, caribou, horse, goat, sheep, deer, hare, rabbit, lemming, muskrat, and mouse, also on rotten stems of cabbage and on pasteboard.

ETYMOLOGY.—From Latin, versicolor, of changeable colour.

ILLUSTRATIONS.—Boudier *in* Annls Sci. nat. (Bot.) V **10**: *pl. 8 f. 19.* 1869 (*S. violascens*); Dangeard *in* Botaniste **10**: *pls. 71, 72 and 90, f. 2.* 1907 (*S. violascens*); Gillet, Champ. Fr., Discom. *pl. 85 f.* 2. 1882 (*Ascobolus violascens*); Heimerl *in* Jber. k.k. Ober-Realschule Bezirke Sechshaus Wien **15**: *pl. 1 f. 7.* 1889 (*S. pseudo-violascens*); Lindau *in* Engler & Prantl, Natürl. PflFam. I **1**: 192 *f. 154 B–C.* 1897 (*S. violascens*); Oudemans *in* Ned. kruidk. Arch. II **1**: *pl. 16 f. 6.* 1873 (*S. violascens*); Phillips, Brit. Discom. *pl. 9 f. 55.* 1887 (*S. violaceus*); Rehm, *in* Rab. Krypt.-Fl., (Pilze) **3**: 1111 *fs. 1–5.* 1896 (*S. violascens*); Velenovský, Monogr. Discom. Boh. **2**: *pl. 5 f. 24.* 1934 (*S. violascens*).

SPECIMENS EXAMINED.—**Norway**: *Juel*, Kongsvold, 25.VIII.1888 (S).

Sweden: *Kugelberg*, Aspvik, Värmdö, Uppland, X.1891 (S); *Starbäck*, Knivsta, Uppland, VIII.1895 (S).

Finland:—*P. Karsten*, on dung of lemming, near Kola, 27.VII.1861 (H-A2746); *P. Karsten*, Mustiala, VI. 1866, *in* Fungi Fenn. 659 (type-distribution of *Ascobolus versicolor*, BM); *P. Karsten*, VI.1866 (S-A586); *P. Karsten*, Mustiala, 29.IX.1868 (H-A2755).

Great Britain: *Boyd*, West Kilbride, Ayrshire, II.1893 (BM); *Broome*, Chapman's Pool, Swanep, Dorset, X.1857 (BM-A2904); *Broome*, Bathford Hill, I.1860 (BM-A2905); *Broome*, Bathford Down, Somerset, IX.1863 (BM-A2896); *Broome*, Banner Down, 10.X.1863 (BM-A2897); *Broome*, Bathford, Somerset, 14.X.1863 (K); *Broome*, near Batheaston, Bath, X.1863, *in* Rabenhorst, Fungi eur. 644 (*Sphaeria stercoris*, S); *Broome*, Batheaston, X.1864, *in* Rabenhorst, Fungi eur. 780 (*Ascobolus depauperatus*, BM, FH, G, K, LE, M, PRC, S, W, ZT); *Broome*, 18.X.1864 (K-A1864); *Broome*, Bathford, 1.XII.1864 (BM-A3016); *Broome*, Batheaston, 5.XII.1864 (BM-A3014); *Broome*, Batheaston, X.1868 (E); *Cooke* (K-A2509); *Crossland*, Cadeby near Doncaster, IX.1901 (K); *Phillips* (BM-A3021); *Plowright*, Norfolk, III. 1874 (K); *Plowright*, Nar Bank, King's Lynn, Norfolk, 1874 (BM-A2998); *Plowright*, Somerset, IV.1876

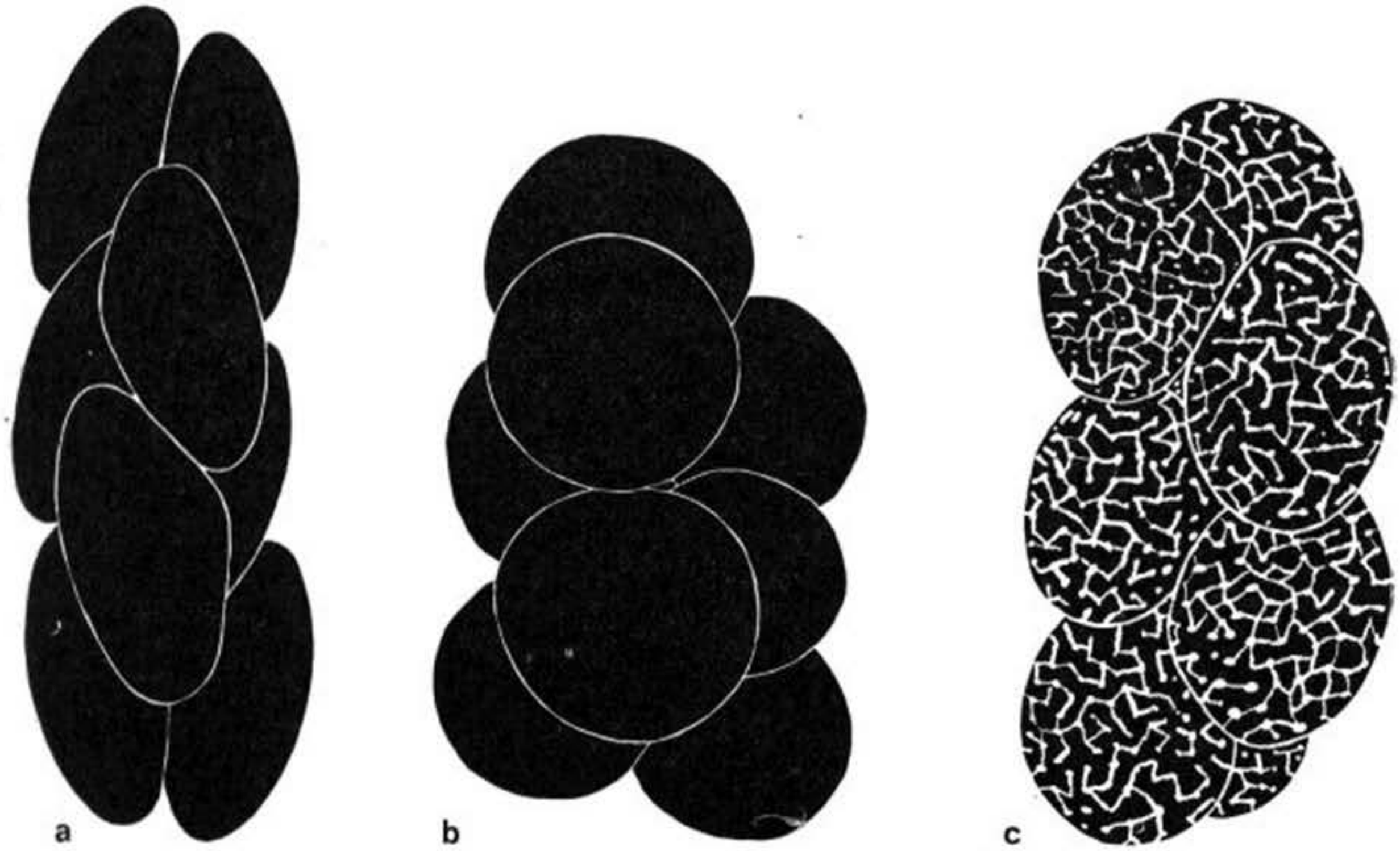

Fig. 64. — *Saccobolus versicolor*, spore-clusters × 1600. (a, from type of *S. murinus*, PR 152921; b, c, from Rabenhorst, Fung, eur. 644, S.)

(BM-A3018); *Plowright*, *in* Phillips, Elv. brit. 48 (*S. violascens*, BM, BPI, K, M, MEL, PAD); *Salmon*, Walton, Reigate, XI.1900 (K, NY).

Netherlands: *van Brummelen 1357*, De Peel near Helenaveen, 23.IX.1961 (L); *van Brummelen 1342*, Castricum, 27.IX.1961 (L); *Maas Geesteranus 10859*, Geversduin, Castricum, 23.X.1955 (L); *Maas Geesteranus 13509*, Castricum, 9.IV.1961 (L); *Maas Geesteranus 13526*, Stakenberg, Nunspeet, 17.IX.1961 (L); *Oudemans*, Bloemendaal, 21.V.1872 (GRO, L).

Belgium: *Bommer & Rousseau*, Dunes d'Ostende, VII.1882 (BR); *Bommer & Rousseau*, Boitsfort (BR-A292); *Marchal*, Forêt à Boitsfort, X.1883 (PAD); *Marchal*, Bigginnendijk, 1884 (BR); *Mouton*, Beaufays (BR-A289); *Mouton*, Beaufays, VIII. (BR-A291); *Mouton*, Beaufays (BR-A295); *Mouton*, Gomzé, autumn (BR-A300); *Rousseau*, Ostende, V. 1885 (BR); *Rousseau*, Coxyde, XI.1907 (BR); *Rousseau*, La Panne, XII.1910 (BR); *Rousseau*, Sapinière à la Panne, 1.I.1912 (BR).

France: *Boudier*, Montmorency, 1878 (*S. violascens*, authentic material from type locality, K-A2452); *Boudier* (*S. violascens*, authentic material, BM-A2870); *Crouan*, 24.VII. (*Ascobolus bruneus* de Guernisac, unpublished name, CONC-A2378); *Fautrey*, Montagne de Bard, VI, *in* Herb. crypt. Côte-d'Or 2382 (*S. violascens*, PC); *Grelet*, Savigné, Vienne, XII.1924 (PC-A2318); *Léveillé*, Bois de Boulogne, 1850 (PC-A2315b); *Léveillé*, Bois de Boulogne, spring (G-A1040); unknown collector (herb. Patouillard), Angers, III.1900 (FH-A3080).

Denmark: *Hansen*, V.1874 (C-A56); *Hansen* (G-A1061, HBG-A411).

Germany: *Auerswald*, near Leipzig, 29.III.1866 (*Ascobolus leporinus* Auersw., unpublished name, LE-A1445, LE-A1446); *Buchs*, Wartha, 31.VII.1919 (B); *Fleischhak*, Arnstadt, Thüringen (B, BRSL-A1715); *Fuckel*, Nassau, winter (G-A1008); *Fuckel* (G-A1002, G-A1003); *Fuckel*, Oestrich, autumn, *in* Fungi rhen. 1134 (*Ascobolus glaber*, LE, M), *in* Herb. Barbey-Boissier 1310 (*A. glaber*, BPI, FH, S, TRTC, UPS, W); *Fuckel*, Oestrich, Nassau, *in* Herb. Barbey-Boissier 1311 (*Ascobolus immersus*, W); *Jaap 860*, Triglitz, Prignitz, 5.X.1910 (S); *Kirschstein*, Sellin, Rügen, 29.VII.1909 (B); *Kirschstein*, Oberfürsterei Chorin, 24.X.1915 (B);

Kirschstein, between Potsdam and Templin a.d. Havel, 12.XII.1915 (B); *Kirschstein*, Rodelberg, Nieder-Schönhausen, 12.XI.1938 (B, FH); *Kirschstein*, Schönholzer Heide, Berlin-Pankow, 4.XI.1939 and 5.XI.1940 (B); *Kirschstein*, Rathenow (B-A1377); *Kirschstein*, Stadtforst, Rathenow (B-A1378); *Krieger*, near Königstein, V. 1882 (S-A562); *Krieger*, near Königstein, VII–VIII.1881, 23.V.1882 (*S. depauperatus*), *in* Fungi sax. 842 (BM, BPI, BRSL, M, S, W), *in* Rehm, Ascom. 661 (BM, E, FH, G, HBG, M, NY, PAD, S), *in* Roumeguère, Fungi sel. 4740 (G), *in* von Thümen, Myc. univ. 2213 (B, BM, BPI, G, L, LE, M, MEL, PAD, W, ZT); *Ludwig*, Breitscheiderwald, Dillkreis, Hessen-Nassau, V.1944 (B); *Ludwig*, near Langenholdinghausen, Siegen, Westfalen, 23.VIII.1945 (B-A1391, B-A1397); *Magnus*, Havelufer near Schildhorn, 2.XII.1876 (HBG); *Rehm*, Obernesselbach, Franken, 1870 (S-A580); *Rehm*, Obernesselbach, Franken, IV.1871 (S-A537); *Rehm*, München, IX.1902 (S-A670). *Schroeter*, near Oelze, 16.X.1881 (BRSL); *Staritz*, near Pulsnitz, Sachsen, 1884 (S); *Winter*, Harth, near Leipzig, V. 1874 (S-A591).

Poland: *Schroeter*, 22.V.1876 (BRSL-A1655); *Schroeter*, Karlowitz near Breslau (=Wrocław), V.1882 (BRSL); *Schroeter*, Ochojetz near Rybnik, X.1882 (BRSL); *Schroeter*, near Wiersbel, 9.VII.1884 (BRSL).

Czechoslovakia: *Lojka*, Lingléz, near Eperjes (= Prešov), 5.X.1869 (S); *Niessl*, Schweibwald, 28.IV.1870 (M); *Niessl*, near Strutz, Moravia, VI.1876 (M); *Niessl*, Schweibwald, VIII. 1876 (M); *Niessl*, near Ratschitz, Moravia, VIII.1886 (M); *Niessl*, Brünn (= Brno) (PAD-A1751); *Niessl*, Brünn (= Brno), autumn (PAD-A1754); *Niessl*, near Popuwek, Moravia (M-A805); *Petrak*, Mähr.-Weisskirchen, near Hrabuvka, 24.II.1912 (S), *in* Fl. Boh. Mor. ser. 2, 232 (*S. depauperatus*, BM, BPI, E, FH, LE, S); *Petrak*, Mähr.-Weisskirchen: Welka, 21.IX.1912, *in* Fl. Boh. Mor. ser. 2, 233 (*S. kerverni*, BM); *Petrak*, Sternberg, Moravia, VIII.1930 (BM, ZT); *Svrček*, Zbraslav, 15.VI.1946 (*S. kerverni* f. *minima* Svrček, unpublished name, PR-A2679a); *Svrček*, Jilovište, Bohemia, 18.V.1947 (PR 179019); *Velenovský*, Mnichovice, VIII.1923 (PR 150061); *Velenovský*, Stráničice, XII.1926 (PR 148812); *Velenovský*, Mnichovice, Myślín, XI.1927 (holotype of *S. murinus*, PR 152921); *Velenovský*, Mnichovice, Hubáčhov, 25.VI.1929 (*S. atrofuscus* Vel., unpublished name, PR).

Switzerland: *Volkart*, Fürstenalp, 26.VI.1903 (ZT).

Austria: *Britzelmayr*, Peischl-Kopf, W. Tyrol, VII.1878 (S); *Rehm*, near Kühtei, Oetz, Tyrol, VIII.1872, *in* Ascom. 165 (*S. violascens*, BM, E, L, M, PAD, S, W).

Italy: *Bizzozzero*, VIII.1884 (PAD-A1757).

Romania: *Lojka*, near Malornoiz, Siebenbürgen, VIII.1872 (S).

U.S.S.R.: *Tranzschel*, Varsonia near Zobki, 20.X.1898 (LE); *Tranzschel*, Zobki near Varsonia, II.1899 (LE).

Hawaii: *van Brummelen 1458, 1470, 1471, 1473*, Puuhokomo, Mauna Kea, 3–10.V. 1962 (L).

Canada: *Cain*, S.E.-Aurora, Ontario, 19.X.1930 (TRTC); *Cain*, Long Point, Lake Eric, Ontario, 17.VII.1932 (TRTC); *Cain*, Sky Lake, Bruce, Ontario, 22.VII.1932 (TRTC); *Cain*, Melissa, Muskoka, Ontario, 2.VIII.1932 (TRTC); *Cain 6674*, High Park, Toronto, Ontario, 2.XI.1936 (TRTC); *Cain 6681*, High Park, Toronto, Ontario, 2.XI.1936 (TRTC); *Clark*, Prain Lake, Thelon Game Preserve, N.W.T., summer 1936 (TRTC).

U.S.A.: Oregon: *Kienholz*, Winan's pasture, Dee, 21.II.1939 (BPI, NY). California: *Harkness 1962* (BM, K); *Martin 655*, 14.II.1917 (culture, BPI). Idaho: *Bigelow*, Payette Lake, 2.VII.1954 (G); *W. B. & V. G. Cooke 19530*, near Stites, Idaho Co., 19.IV.1947 (BPI, FH, NY). Colorado: *F. E. & E. S. Clements 301*, Castle Canyon, 19.VII.1906 (E). Texas: *Ravenel 1869*, Houston (BPI). *Maine*: *Thaxter*, Kittery Point (FH-A3076). New York: *Kauffman*, Ithaca, 24.V.1902 (BPI); *Kauffman 898*, Coy Glen, Cayuga Lake Basin, 27.IV.1904 (TRTC). Connecticut: *Thaxter*, Greens Farms (FH-A3096). New Jersey: *Ellis 3510*, Newfield, VI.1881 (BPI).

This is without doubt the most variable species of the genus *Saccobolus*. The fruit-

bodies may be rather large with a well developed excipulum which is rich in violet pigment or else they may be minute without a clearly developed excipulum and without intercellular pigment. Sometimes the paraphyses show pear-shaped tips surrounded by violet pigment; this was thought to be characteristic of *S. violascens* Boud. (Boudier, 1869: 231). In other fruit-bodies of the same culture or collection the paraphyses are without thickened tips. Rarely the paraphyses are almost absent.

This variation in the shape and structure of the fruit-bodies finds its origin in the wide scale of possibilities during the initial development of the fruit-bodies. This fully agrees with Dangeard's observations (1907: 327): "Nous n'avons jamais rencontré dans aucune espèce d'Ascomycète une aussi grande irrégularité dans la manière d'être des filaments recouvrants; il n'existe souvent qu'un peloton irrégulier sans véritable parois; sur ce peloton proéminent les premières thèques peu nombreuses; on ne voit pas encore le système des paraphyses; des hyphes passent d'un peloton à l'autre, reliant les divers périthèces entre eux; la dimension de ces périthèces est elle-même des plus variables."

Normally the ascomata are eugymnohymenial or paragymnohymenial (c.f. p. 00). Only rarely also cleistohymenial ascomata were observed that opened in the prohymenial phase.

Apart of the variation due to differences in the development, there is a considerable variation in pigmentation of the fruit-bodies, the size of the ascospores, and the ornamentation of the episporium.

Experiments with cultures proved that more and darker intercellular pigment is formed in fruit-bodies exposed to high intensities of light than in unexposed fruit-bodies. Irrespective of this, more pigment also seems to be formed when growing on dung of cow and rabbit than when growing on other substrata.

I found it impossible to distinguish more or less constant forms within the species.

Only in this species of *Saccobolus* spherosporical mutations were accidentally found (Figs. 63e, 64b).

The related species *S. caesariatus*, *S. beckii*, and *S. quadrisporus* might prove to be extreme forms or mutant-forms of it.

Saccobolus versicolor is the most common species of *Saccobolus* and has a world-wide distribution.

9. Saccobolus caesariatus Renny apud Phill.—Fig. 65

Saccobolus caesariatus Renny *apud* Phill., Brit. Discom. 297. 1887. — Type: represented by a drawing after Renny (BM) "*Saccobolus caesariatus* Renny after Renny, Sussex 1875"; type locality, Sussex, England.

Apothecia solitary, superficial, sessile, 150–200 μ diameter, 200–300 μ high. Receptacle ovoid-cylindrical or hemispherical, white in all parts; surface covered with white, flexuous bunches of septate hyphae to form tapering squamules; margin not differentiated. Disk flat or convex, colourless, roughened by the protruding asci. Flesh none or very thin. Excipulum thin, of elongated or angular cells (textura

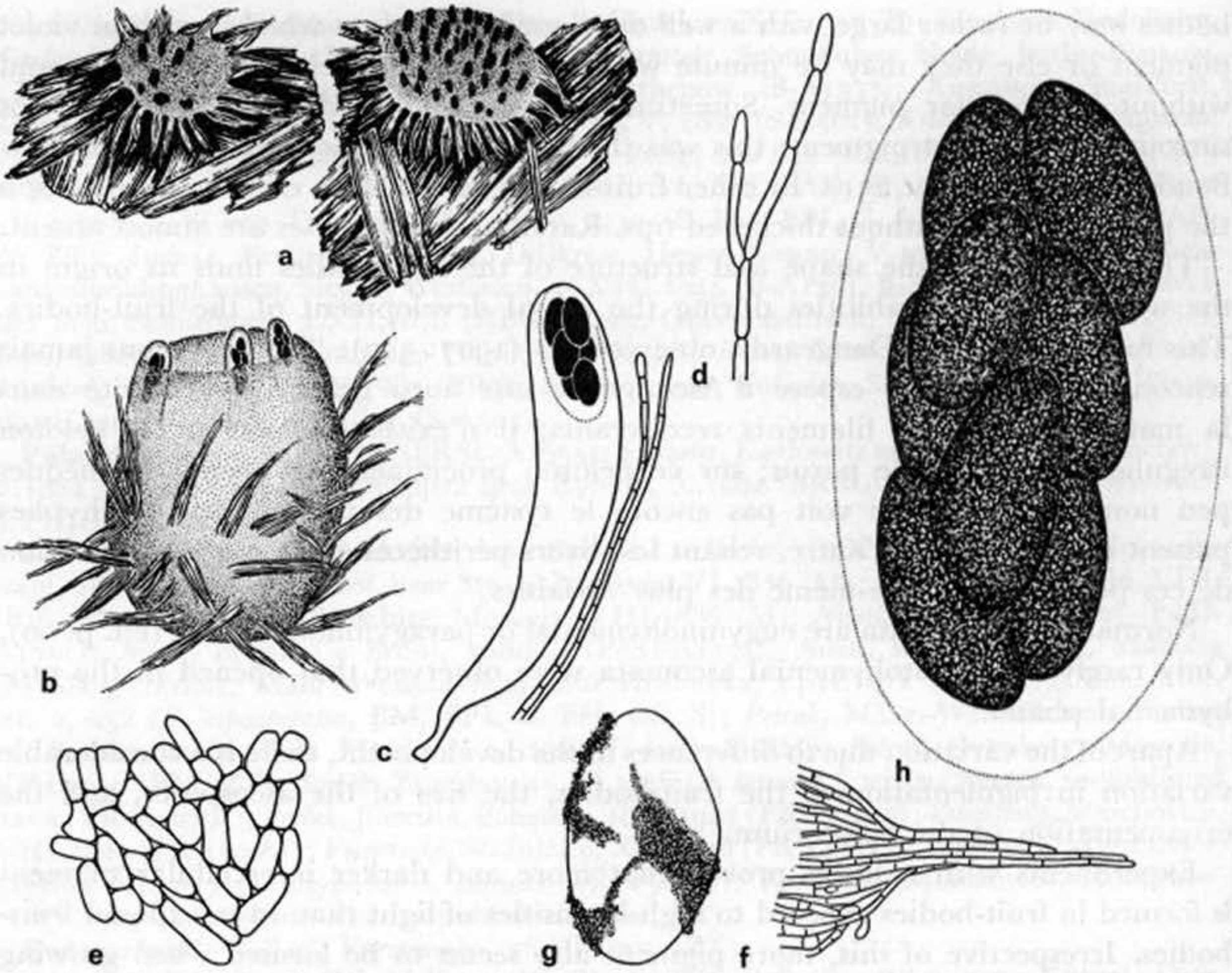

Fig. 65. — *Saccobolus caesariatus:* a, habit of fruit-bodies × 50; b, fruit-body in transmitted light × 80; c, d, ascus and paraphyses × 275; e, texture of excipulum seen from outside × 600; f, bundle of hyphae from the outside of the receptacle × 275; g, isolated ascospore × 1600; h, spore-cluster × 1600. (a, b, d, f, g, from *van Brummelen* 12.II.1958; c, e, h, from *van Brummelen* 18.VIII.1959.)

angularis), colourless. Asci clavate, gradually tapering downwards into a rather thin base, 175–193 × 30–33 μ, 8-spored, the wall blue in Melzer's reagent. Spore-clusters compact, elongated, 38–43 × 15–17 μ, with thick gelatinous envelope. Ascospores arranged according to pattern II, fusiform-ellipsoid, at first hyaline, then pale violet, finally violaceous-brown; 16–17.5 × 7–8.5(–9.5) μ, smooth or finely punctate. Paraphyses not or scarcely branched, multi-septate, cylindrical, 2.0–3.5 μ thick, not enlarged upwards, colourless.

On dung of sheep and rabbit.

Etymology.—From Latin, caesariatus, covered with hairs.

Specimens examined.—**Netherlands**: *van Brummelen*, on rabbit dung, Duin en Kruidberg, Santpoort, 12.II.1958 (drawing, L); *van Brummelen*, on sheep dung, Elspeet, 18.VII.1959 (slide, L).

Austria: *Beck 511*, on dung, Nieder-Oesterreich, *s. dat.* (PRC-A1473).

Obviously very close to *S. versicolor*, from which it can be distinguished by the

squamulated outer surface of the receptacle. The squamules consist of cohering septate hyphae. Until now, it has been found growing solitary and only a few collections could be studied.

The type is represented by a very fine drawing in the British Museum; it leaves no doubt about its identity.

10. Saccobolus beckii Heimerl—Fig. 66

Saccobolus beckii Heimerl *in* Jber. k.k. Ober-Realschule Bezirke Sechshaus Wien **15**: 18 *pl. 1 f. 8.* 1889. — Type distribution: Rehm, Ascom. 965.

Apothecia solitary or gregarious, superficial, sessile, 0.1–0.7 mm diameter. Receptacle at first semiglobular, then more or less pulvinate, almost colourless, smooth; margin not differentiated. Disk convex, hyaline, at maturity dotted with the black protruding tips of ripe asci. Hymenium 130–150 μ thick. Hypothecium not clearly differentiated. Flesh very thin. Excipulum thin, of intertwined, cylindrical hyphae 2.0–3.5 μ wide (between textura intricata and epidermoidea), colourless,

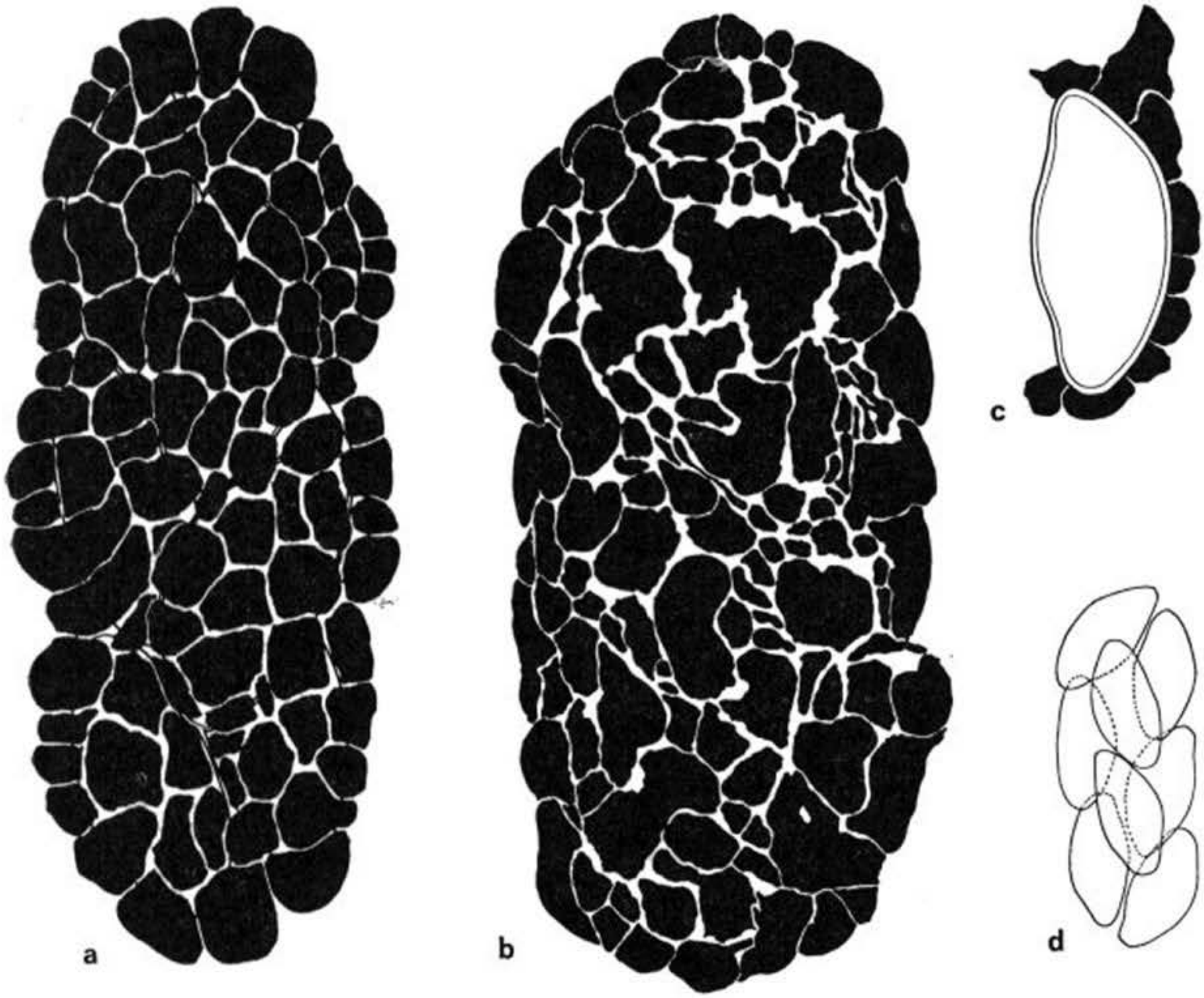

Fig. 66. — *Saccobolus beckii:* a, b, spore-clusters × 1600; c, ascospore in optical section × 1600; d, diagram of spore-cluster × 740. (From type.)

or with some pale violaceous or brownish-violaceous, intercellular pigment. Asci broadly clavate, tapering downwards into a rather thick base, with truncate apex, 130–180 × 40–47 μ, 8-spored; the wall blue in Melzer's reagent. Spore-clusters rather compact, elongate, 42–60 × 18–24 μ, "with unilateral gelatinous substance 8–9 μ thick" (Heimerl 1889: 18). Ascospores arranged according to pattern II, ellipsoid-fusiform, often slightly ventricose, at first hyaline, finally black, 17.5–23 × 8.5–10(–12) μ (15–17 × 8–9.5 μ without episporium), with very coarse warts or thick lumps of pigment 1–3 μ thick. Paraphyses simple or branched, septate, cylindrical, 2–3 μ thick, hyaline, scarcely thickened above.

With certainty only known from dung of deer and cow.

ETYMOLOGY.—After Günther Beck, Knight of Managetta.

ILLUSTRATION.—Heimerl *in* Jber. k.k. Ober-Realschule Bezirke Sechshaus Wien **15**: *pl. 1. f. 8.* 1889.

SPECIMENS EXAMINED.—**Great Britain**: *Dennis*, on cow dung, west of Torbest, Isle of Canna, Invernessshire, 28.VIII.1962 (L).

Germany: *Ade*, near Mainroth, Bezirk Lichtenfels, 28.II.1912 (S-A484).

Austria: Heimerl, on deer dung, Pressbaum near Vienna, XII.1888–III.1889 (slides, from cultures in collection Heimerl, W, and in Rehm, Ascom. 965, BM, S, W; type distribution of *S. beckii*).

Bermuda: *B. & J. Dodge*, VIII.1911 (NY-A1165, NY-A1227).

The slides of this species prepared by Heimerl in his own collection and in Rehm's "Ascomyceten" No. 965 are in a very poor condition. Only a few of them could be restored by remounting them in polyvinyl lacto-phenol. These were just sufficient to establish the identity of the species.

Although Heimerl made slides of his culture from December 1888 till March 1889, I see for the moment no reason to choose one of these very poor slides as lectotype.

Saccobolus beckii can be distinguished from *S. versicolor* and *S. obscurus* by the very thick and coarsely warted episporium.

Collections were studied from four isolated localities. On one occasion a single ascospore-cluster was found adhering to a fruit-body of another species from Brazil.

11. SACCOBOLUS OBSCURUS (Cooke) Phill.—Fig. 67; Pl. 15, fig. F

Ascobolus obscurus Cooke *in* Grevillea **4**: 112 *pl. 64 f. 7.* 1876. — *Saccobolus obscurus* (Cooke) Phill., Brit. Discom. 295. 1887. — Type: *Cooke*, on old sacking, Forden, Montgomeryshire, England (BM, K, PC).

Apothecia gregarious or closely crowded, superficial, sessile, up to 0.8 mm across. Receptacle at first lenticular, then often more pulvinate, becoming dark brown with age, smooth; margin not differentiated. Disk convex, pale brown, dotted with the almost black protruding tips of ripe asci. Hymenium about 85 μ thick. Hypothecium not clearly differentiated. Flesh of intermingled hyphae, some of which stain intensively in cotton blue. Excipulum clearly differentiated by the presence of an intercellular brownish pigment, of somewhat intertwined hyphae. Asci clavate with truncate apex, 'circ. 100 × 26 μ' (Heimerl 1889: 19), 8-spored; the wall deep blue in Melzer's reagent. Spore-clusters compact, (23–)26–43 × 13–19 μ,

longitudinally compressed with ripening. Ascospores at first arranged according to pattern II, gradually changing into pattern IIIa, ellipsoid or fusiform-ellipsoid, at first hyaline, then violet, finally often purplish-brown, 13.5–18 × 7.5–9.5 μ, ornamented with fine or coarse warts (0.3–2.0 μ diameter); pigment in a rather thick layer. Paraphyses simple, with few septae, filiform, about 2 μ thick, sometimes enlarged up to 4 μ at the tip, hyaline or yellowish-brown due to the presence of intercellular pigment in the upper part.

Especially on linen, old sacking, and rotten fabric, more rarely on dung of donkey, goat, and rabbit.

ETYMOLOGY.—From Latin, obscurus, of a dark colour.

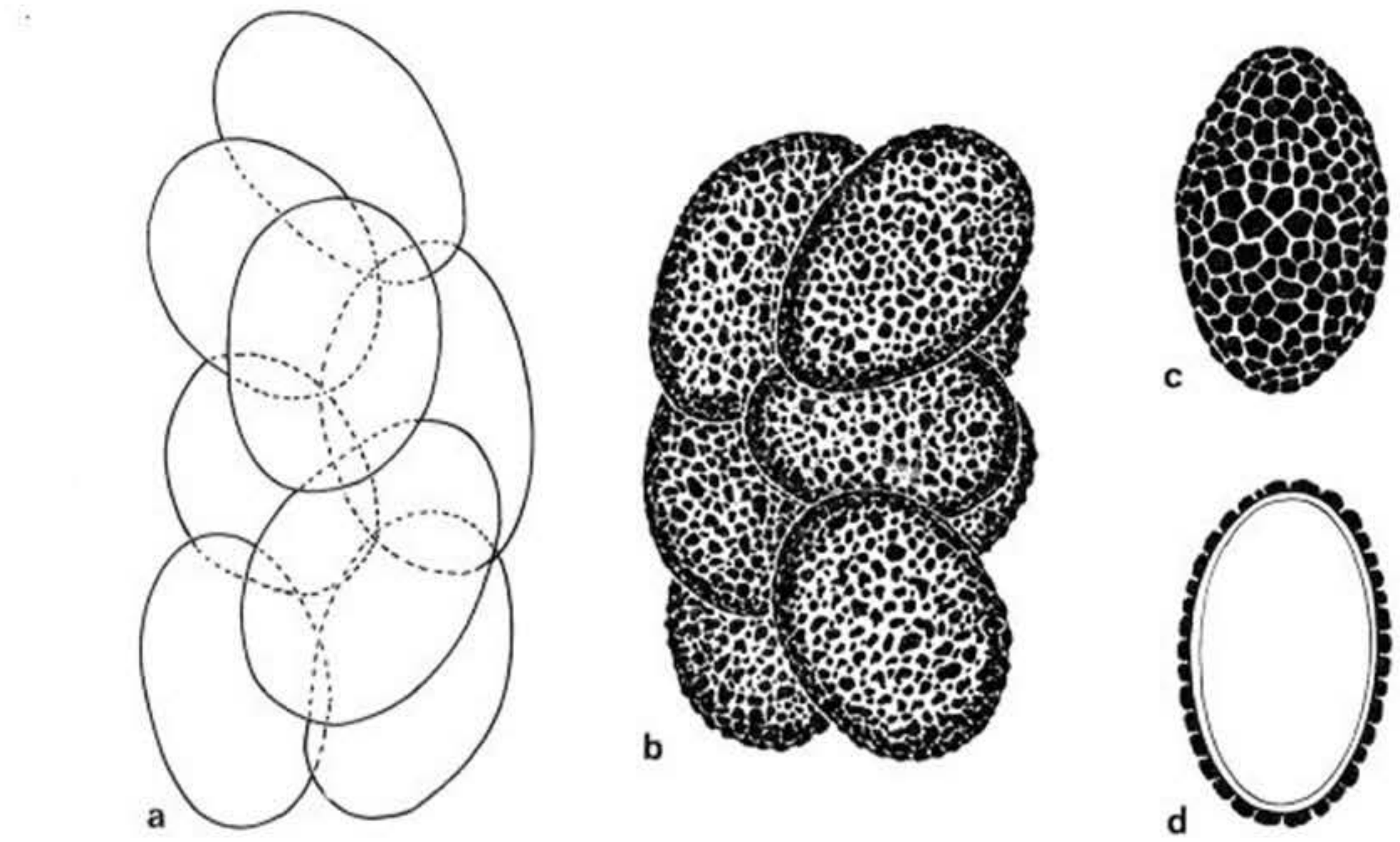

Fig. 67. — *Saccobolus obscurus:* a, diagram of spore-cluster; b, spore-cluster; c, ascospore; d, id. in optical section. (All × 1600; from type, PC-A2234.)

ILLUSTRATIONS.—Cooke *in* Grevillea **4**: *pl. 64 f. 7.* 1876 (*Ascobolus*); Dennis, Brit. Cup Fungi *pl. VIII f. B.* 1960; Heimerl *in* Jber. k.k. Ober-Realschule Bezirke Sechshaus Wien **15**: *pl. 1 f. 5.* 1889; Le Gal *in* Annls Sci. nat. (Bot.) XI **8**: 242 *f. 65A.* 1947 (ascospore).

SPECIMENS EXAMINED.—**Great Britain**: *Cooke*, on old sacking, Forden, *s. dat.* (type of *Ascobolus obscurus*, BM-A3009, K-A3047, PC-A2234); *Hughes*, on old sacking, Bookham Common, Surrey, 22.VI.1947 (CMI, K).

France: *Boudier*, on old rotten fabric, IX.1899 (PC-A2236); *Boudier*, on rotten fabric, Montmorency, X.1899 (PC-A2237, PC-A2238); *Boudier*, on fabric contaminated with dung, Montmorency, XI.1899 (PC-A2235).

Germany: *Kirschstein*, on rotten linen, Rathenow, Stadtforst, near Berlin, 9.XII.1904 (B); *Krieger*, on old piece of linen, near Nossen, 25.VII.1886 (S); *Winter*, on rabbit dung, Harth, near Leipzig, V.1874 (PAD).

Liberia: *Straub*, laboratory culture on dung of donkey, *s. loc.*, *s. dat.* (FH-A3066).

Venezuela: *Blakeslee*, laboratory culture on goat dung, Caracas, XII.1903 (FH-A3065).

This species occurs on dirtied and rotten textile fabric, but also on droppings of animals.

From *S. versicolor* and *S. beckii* it can be distinguished by the brown, intercellular pigment, the shape of ascospores and spore-clusters, and the ornamentation of the episporium. From *S. thaxteri* it differs in the size of the fruit-bodies, the size and shape of the ascospores, the compactness of the spore-clusters, and the presence of intercellular pigment.

This widely distributed species has been collected only rarely.

12. Saccobolus quadrisporus Mass. & Salm.—Fig. 68; Pl. 15, fig. C

Saccobolus quadrisporus Mass. & Salm. *in* Ann. Bot. **15**: 329 *pl. 18 fs. 48–51*. 1901. — Holotype: *Massee & Salmon*, on goose dung, Kew Gardens, England, X.1901 (*S. tetrasporus*, NY).

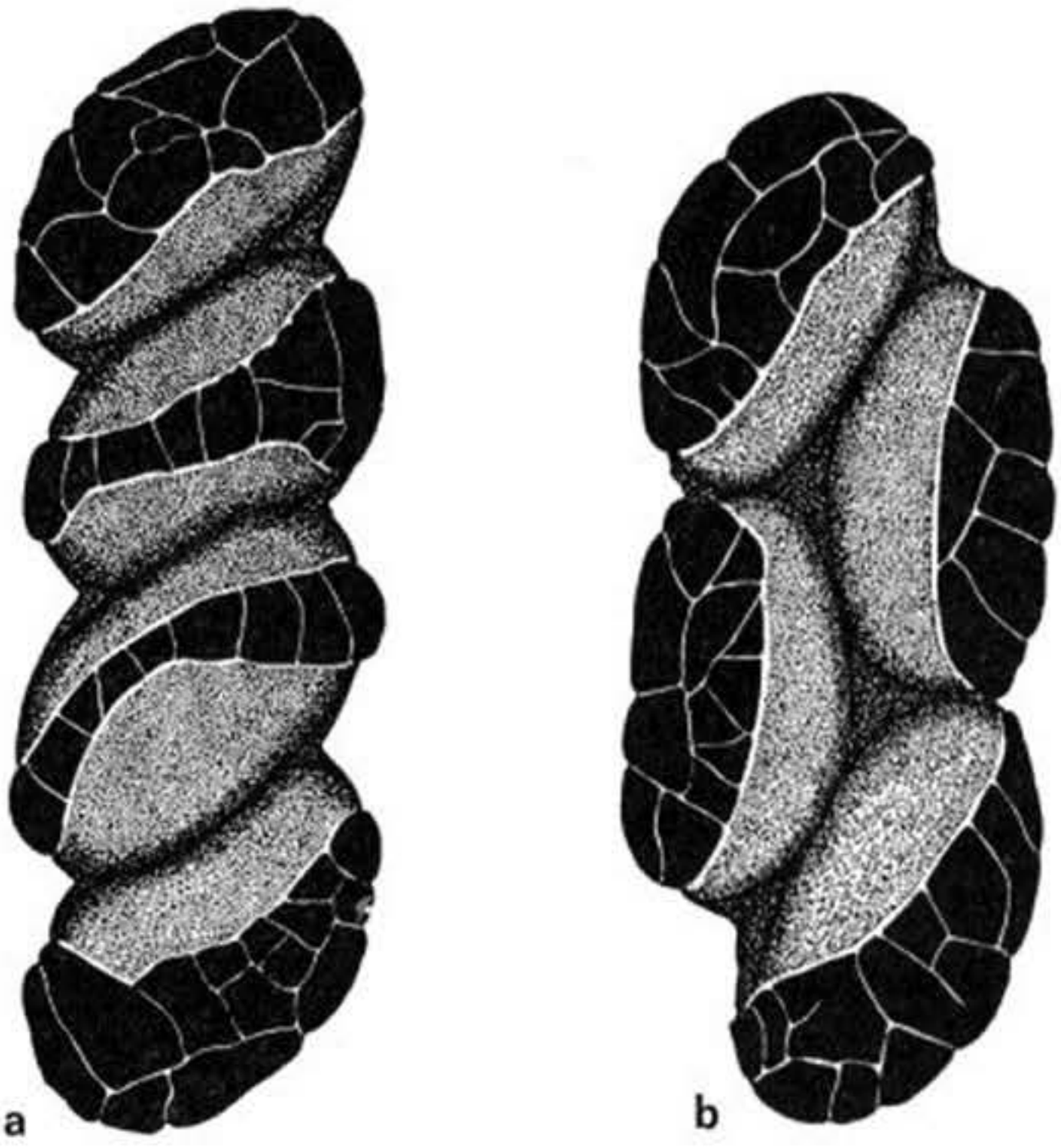

Fig. 68. — *Saccobolus quadrisporus*, spore-clusters × 1600 (from type).

Apothecia superficial, sessile, 0.5–0.7 mm diameter. Receptacle more or less pulvinate, at first clear watery violet, gradually becoming darker with age, smooth; margin not differentiated. Disk at first convex, then flat, clear watery violet, becoming blackish-violet or black, at maturity dotted with the dark apices of the protruding asci. Asci clavate, tapering downwards into a rather thick base, with truncate apex, 95–110 × 18–20 μ, 4-spored, the wall staining blue with iodine. Spore-clusters ellipsoid or elongated, 42–48 × 16–17 μ if ascospores in two rows, 46–51 × 14–16 μ if ascospores in a single row, surrounded by a common mucilaginous covering. Ascospores arranged in two parallel rows or side by side in a single row, ellipsoid, often somewhat trigonous, at first hyaline, then blackish-violet, 16.5–19.5 × 9.5–10.5 μ; with a thick cap or girdle of irregularly reticulated or warted pigment up to 1.6 μ thick, which is surrounded by a narrow zone of greater translucency,

in the other parts smooth to finely punctate and with only a thin layer of pigment. Paraphyses simple or branched, septate, filiform, clavate at the apex.

Known only from goose dung.

ETYMOLOGY.—From Latin, quattuor, four and spora, a seed: with four seeds (spores).

ILLUSTRATION.—Massee & Salmon *in* Ann. Bot. **15**: *pl. 18 fs. 48–51.* 1901.

SPECIMEN EXAMINED.—**Great Britain**: *Massee & Salmon*, on goose dung, Kew Gardens, X.1900 (*S. tetrasporus* Mass. & Salm., an unpublished name, holotype of *S. quadrisporus*, NY-A1174).

This very characteristic species is the only known representative of *Saccobolus* with a reduced number of ascospores. It was collected once from goose dung in Kew Gardens. The possibility of finding the same fungus again on the same kind of substratum from this locality should not be set aside at once.

The arrangement of the four ascospores in an ascus may be realized in the same fruit-body in two different ways. The most frequent is the arrangement in two adjacent rows of two ascospores (Fig. 68b), more rarely is the arrangement in a single row with the ascospores more or less obliquely disposed (Fig. 68a).

13. **Saccobolus thaxteri** Brumm., *spec. nov.*—Fig. 69; Pl. 15, figs. D, E

Apothecia sessilia, 0.1–0.3 mm diam. Receptaculum initio globulare, deinde semiglobulare, denique pulvinare, albidum vel pallidissime violaceum, laeve. Asci crasse clavati, apice truncati, 68–86 × 19–23 μ, pariete iodo pallide caerulescente. Sporarum fasciculi sat laxi usque valde compacti, subellipsoidei usque subglobulares, 23–33 × 12–20 μ, saepe maturitate breviores et latiores. Ascosporae secundum typum II, vel saepius irregulariter dispositae, late ellipsoideae usque late fusiformi-ellipsoideae, 10.5–14 × 7–9 μ, hinc inde verrucis ornatae. Paraphyses sat profunde ramosae, irregulariter filiformes, 2.5–6.0 mm crassae, raro apice incrassatae. In fimo caprino vel sciurino crescit.—Typus: *R. Thaxter*, sine loco, America septentrionalis (FH-A3061).

Apothecia solitary or more often gregarious, superficial, sessile, 0.1–0.3 mm diameter, 0.1–0.2 mm high. Receptacle at first globular, then semiglobular, soon pulvinate, whitish or very pale violet, smooth; margin not differentiated. Disk flat, then convex, whitish, dotted with the dark protruding tips of ripe asci. Hymenium about 70 μ thick. Hypothecium not clearly differentiated. Flesh very thin, of hyphae with subglobularly or elliptically swollen cells 4–9 × 4–7 μ. Excipulum very fugacious, only present in very young fruit-bodies only 4–5 μ thick, consisting of somewhat intermingled hyphae, almost colourless. Asci broadly clavate, tapering downwards into a rather thick base, with slightly truncate apex, 68–86 × 19–23 μ; the wall pale blue in Melzer's reagent. Spore-clusters rather loose to very compact, subellipsoid to subglobular, 23–33 × 12–20 μ, often becoming shorter and broader with ripening. Ascospores arranged according to pattern II or more often irregularly disposed, broadly ellipsoid or broadly fusiform-ellipsoid, at first hyaline, then pinkish-violet, finally dark purple, 10.5–14 × 7–9 μ, ornamented with isolated warts. Paraphyses rather strongly branched, septate, irregularly filiform, often with swollen cells, 2.5–6.0 μ thick, colourless, scarcely thickened above, rarely with globularly swollen terminal cells 6–13 μ diameter.

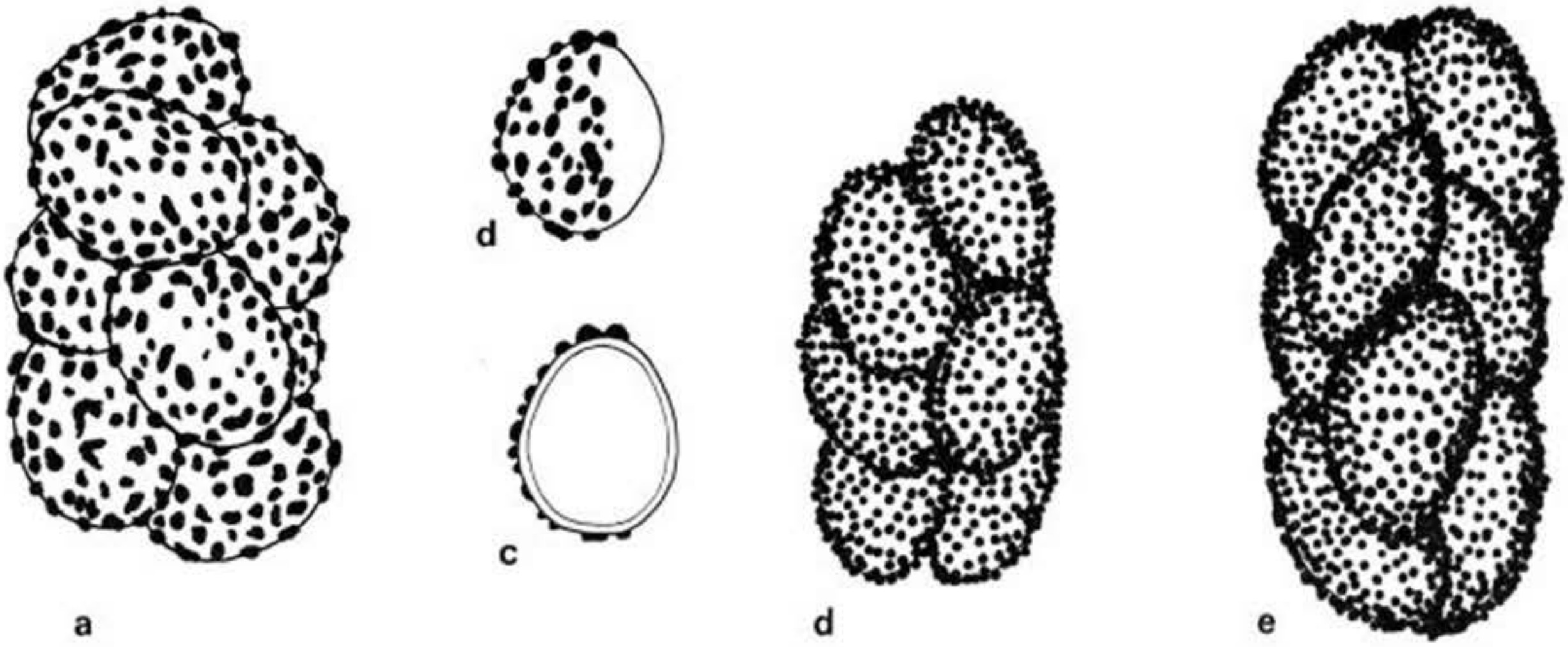

Fig. 69. — *Saccobolus thaxteri:* a, d, e, spore-clusters; d, ascospore; c, id. in optical section (All × 1600; a–c, from type; d, e, from *van Brummelen 1791*.)

Known from dung of goat and squirrel.

ETYMOLOGY.—After Dr. Roland Thaxter, the great American mycologist.

SPECIMENS EXAMINED.—**Thailand:** *van Brummelen 1791*, on dung of Burmese goat, Pha Nok Khao, 800 m, 2.XII.1963 (culture, L).

Philippine Islands: *W. H. Weston*, on goat dung, Los Baños, XI.1918 (FH-A3062).

U.S.A.: *Thaxter*, in moist chamber on filterpaper on which squirrel dung was scattered, *s. loc.*, *s. dat.* (type of *S. thaxteri*, FH-A3061).

This species is related to *S. verrucisporus*, from which it can be distinguished by the shape of the fruit-bodies, the smaller asci and ascospores, and the more irregular arrangement of the broadly ellipsoid ascospores. The ascospores are rather loosely united in a cluster of which the shape gradually changes from ellipsoid to almost subglobular during maturation.

In the type specimen the size of the ascospores is rather uniform, 10.5–12 × 7–8 μ, while in specimens from Los Baños the size is more variable, 10.5–14 × 8.5–9 μ. In the latter collection of which I do not doubt that it belongs to the same species, some spore-clusters were found with more abundant episporial pigment. In it rather large and thick warts were formed.

14. **Saccobolus verrucisporus** Brumm., *spec. nov.*—Fig. 70; Pl. 16, fig. H

Apothecia sessilia, 130–200 μ diam. Receptaculum cylindricum vel subglobulare, interdum basi minute constrictum, albidum et violascenti-suffusum, hyphis hyalinis obtectum. Asci crasse clavati, apice truncati, 90–110 × 26–29 μ, 8-spori, pariete iodo saturate caeruleo. Sporum fasciculi compacti, elongati, 33–39 × 14–16 μ. Ascosporae secundum typum II dispositae, fusiformi-ellipsoideae, 14.0–16.2 × 8.0–9.1 μ, sparse verrucis crassis instructae. Paraphyses tenues, ramosae, 2.3–3.4 μ crassae. In fimo caprae invenitur.—Typus: *van Brummelen 1287*, Ifar prope Hollandia, Novo-Guinea septentrionalis (L).

Apothecia solitary or in small groups, superficial, sessile, 130–200 μ diameter,

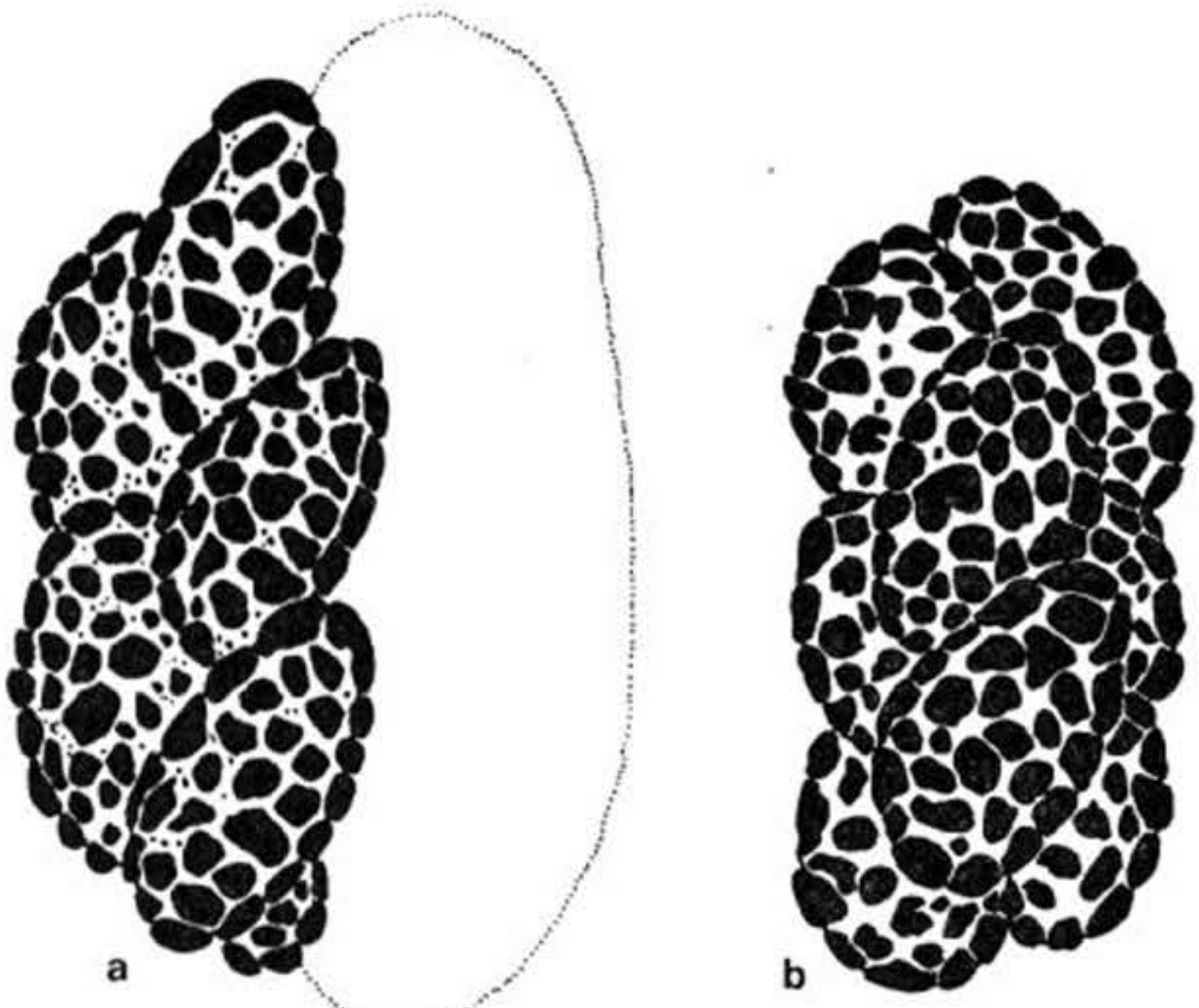

Fig. 70. — *Saccobolus verrucisporus*, spore-clusters × 1600 (from *van Brummelen 1287*).

150–200 μ high. Receptacle cylindrical or subglobular, sometimes on a small base and more or less obconical, whitish with a shade of violet; surface covered with short or long hyphae which are connected with the substratum; margin not clearly differentiated. Disk flat or convex, at first white, then pale violet, dotted with the far protruding tips of ripe asci. Hymenium 100–115 μ thick. Hypothecium very thin, of closely compacted cells 4.5–9 μ diameter, colourless. Flesh not clearly differentiated. Excipulum of one or a very few layers of intermingled hyphae 3–4.5 μ wide, which consist of more or less swollen cells 4.5–9 μ long; with pale violet, intercellular pigment. Asci broadly clavate with truncate apex, 90–110 × 26–29 μ, 8-spored; the wall deep blue in Melzer's reagent. Spore-clusters compact, elongated, 33–39 × 14–16 μ, with unilateral mucilaginous substance 7–10 μ thick. Ascospores arranged according to pattern II, fusiform-ellipsoid, at first hyaline, then dark violet, 14–16 × 8–9 μ, ornamented with coarse, isolated warts. Paraphyses slender, branched, 2.3–3.4 μ thick, not enlarged upwards, colourless, with pale violet, intercellular pigment.

Known only from dung of roe-deer.

Etymology.—From Latin, verruca, a wart and spora, a seed: with warted spores.

Specimens examined.—**New Guinea**: *van Brummelen 1287*, on dung of roe (sent by Dr. H. O. Sleumer), Ifar, near Hollandia, 26.VI.1961 (type of *S. verrucisporus*, L); *van Brummelen 1442*, on dung of roe, Ifar, near Hollandia, 5.VIII.1961 (L); *van Brummelen 1439*, on dung of roe-deer, Ifar, near Hollandia, 11.IX.1961 (L).

This species was collected three times from cultures of different samples of dung of roe-deer from Ifar.

The cylindrical to subglobular shape of the ripe fruit-bodies is very characteristic of this species.

From the related *Saccobolus thaxteri* it can be distinguished also by the larger asci and ascospores, the more regular arrangement of the ascospores in elongated spore-clusters, and the coarse warts of the thick episporium. The ornamentation of the episporium may resemble that of *S. obscurus* and *S. beckii*. From *S. obscurus* it can be distinguished by the minute, cylindrical, whitish fruit-bodies and the more regular arrangement of the ripe ascospores (pattern II).

In *S. beckii* the episporial pigment is still thicker and the ascospores are distinctly larger than in *S. verrucisporus*. The shape of the ascospores also differs in these species.

15. Saccobolus globuliferellus Seaver—Figs. 6, 71; Pl. 16, figs. C, D

Saccobolus globuliferellus Seaver, North. Am. Cup-fungi (Operc.) 95. 1928. — Holotype: Seaver, on horse dung, New York City, U.S.A., autumn 1914 (NY-A1207, NY-A1205).

Apothecia scattered, superficial, sessile, up to 0.4 mm across. Receptacle semi-globular or lenticular, white, smooth; margin not differentiated. Disk convex, white, dotted with the almost black protruding tips of ripe asci. Hymenium up to 65 μ thick. Hypothecium and flesh very thin or not clearly differentiated. Excipulum fugitive or not differentiated. Asci broadly-clavate, tapering downwards into a stem-like base, the apex somewhat flattened, up to 60 × 23–25 μ, 8-spored, the wall blue in Melzer's reagent. Spore-clusters at first rather loose, then more compact, short-ellipsoid or subglobular, 17–25(–39) × 15–19 μ. Ascospores at first loosely disposed in the ascus, then loosely united and arranged according to pattern IIIa or IV, finally in most cases becoming compressed, ellipsoid, at first hyaline, then "assuming a faded-blue colour", finally smoky-blackish or dark brown, 11.5–13.5(–14.5) × 6–7 μ, ornamented with small, isolated warts. Paraphyses simple, septate, cylindrical, about 3 μ thick, not or scarcely thickened above (according to Seaver l.c.: "rather strongly enlarged above, where they reach a diameter of 7–8 μ"), hyaline.

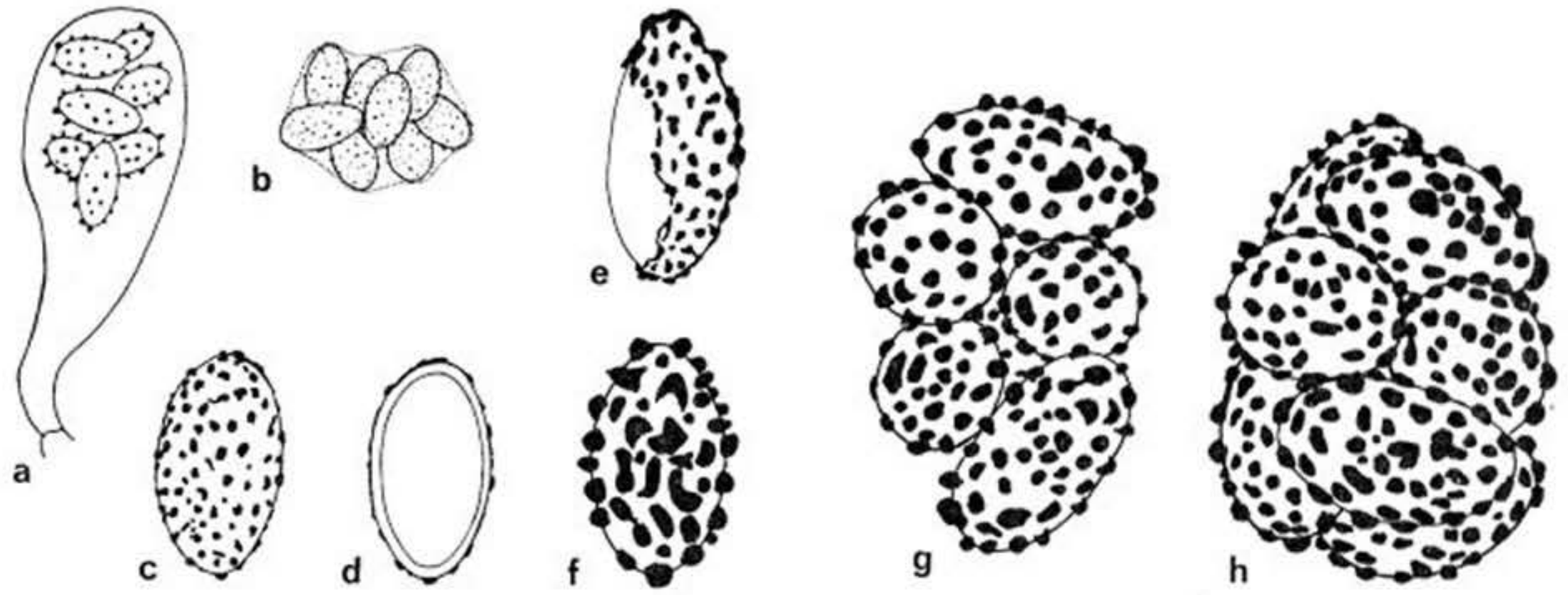

Fig. 71. — *Saccobolus globuliferellus:* a, ascus with ripe ascospores × 575 (after drawing by Seaver); b, spore-cluster × 600 (from slide studied by Seaver); b, spore-cluster × 600 (from slide studied by Seaver); c, e, f, isolated ascospores × 1600; d, ascospore in optical section × 1600; g, h, spore-clusters × 1600. (a–d, from holotype; e–h, from *Cain*, NY-A1206.)

On dung of horse and rodents (especially rabbit and wild guinea pig).

ETYMOLOGY.—From Latin, globulus, a globule and fero, to bear: bearing a globule + -ellus, a suffix signifying the dimunitive of globulifer.

SPECIMENS EXAMINED.—**Canada**: *Cain 6770*, Don valley, Toronto, Ontario, 27.IV.1930 (TRTC); *Cain*, Wroxeter, Huron, Ontario, 19.VII.1932 (TRTC 34727); *Cain*, Sheguiandah, Ontario, 1.VIII.1933 (TRTC 34726); *Cain*, Fraserburg, Muskoka, Ontario, 24.VIII.1932 (TRTC 34731); *Cain*, Sheguiandah Manitoulin, Ontario, 27.I.1934 (NY-A1206); *Cain 6598*, East of Hatchley, Brant Co., Ontario, 11.VIII.1935 (TRTC).

U.S.A.: New York: *Seaver*, New York City, autumn 1914, (holotype of *S. globuliferellus*, NY-A1207, with slide NY-A1205). Connecticut: *Thaxter*, New Haven, *s. dat.* (FH-A3060).

Argentina: *Thaxter*, laboratory culture, Llavellol, 1906 (FH-A3063).

This is strikingly close to *S. dilutellus*, from which it differs consistently in the arrangement and the ornamentation of the ascospores.

In *S. dilutellus* the ascospores are closely pressed together into a subglobular cluster and the pigment is condensed in the form of small and thick warts on the exposed surfaces of the ascospores.

In *S. globuliferellus* the ascospores are only loosely united and small isolated warts are found over almost their whole surface.

As far as can be concluded from the restricted number of collections studied of both species, they are vicarious species, of which *S. globuliferellus* occurs in North and South America and *S. dilutellus* is found in Europe (Fig. 6).

16. SACCOBOLUS DILUTELLUS (Fuck.) Sacc.—Figs. 6, 72; Pl. 16, fig. B

Ascobolus dilutellus Fuck. *in* Hedwigia **5**: 4 *pl. 1 f. 7*. 1866; *in* Jb. nassau. Ver. Naturk. **23–24**: 287. 1870. — *Saccobolus dilutellus* (Fuck.) Sacc., Syll. Fung. **8**: 526. 1889. — Holotype: *Fuckel*, on dog dung, Oestricher Wald, Nassau, Germany, spring (G-A1057).

Saccobolus globulifer Boud. *in* Annls Sci. nat. (Bot.) V **10**: 232 *pl. 9 f. 21*. 1869. — *Ascobolus globulifer* (Boud.) Gill., Champ. Fr., Discom. 142. 1883. — Type: represented by Boudier l.c., *pl. 9 f. 21*; type locality, Ecouen near Paris, France.

Ornithascus corvinus Vel., Monogr. Discom. Boh. **1**: 369, **2**: *pl. 3 f. 3*. (pro parte). 1934. — Holotype: PR 147869.

Apothecia scattered or in small groups, superficial, sessile, up to 0.5 mm across. Receptacle at first semiglobular, then lenticular, white, smooth; margin not differentiated. Disk convex or flat, at first white, then often pale violet, dotted with the almost black protruding ends of ripe asci. Hymenium up to 80 μ thick. Hypothecium and flesh very thin or not clearly differentiated. Excipulum fugitive or not differentiated. Asci broadly clavate, short-stalked, with rather abruptly truncate apex, "70–93 × 20.5–29 μ" (Heimerl 1889: 18), 8-spored; the wall blue in Melzer's reagent. Spore-clusters extremely compact, subglobular, 19–26 × 18–20 μ. Ascospores arranged according to pattern IV, ellipsoid, sometimes asymmetrical or even slightly trigonal, at first hyaline, then pinkish-violet, finally greyish- or brownish-violet, 11.5–14.5 × 6.5–7.5 μ, only the exposed surface of the spores is covered with pigment; ornamented with small and coarse warts, the former equally distributed over the pigmented area, the latter especially at the outline of it. Paraphyses simple, septate, cylindric-clavate, 1.5–2.0 μ thick, enlarged above, 2.5–4.5 μ thick at the tip, hyaline.

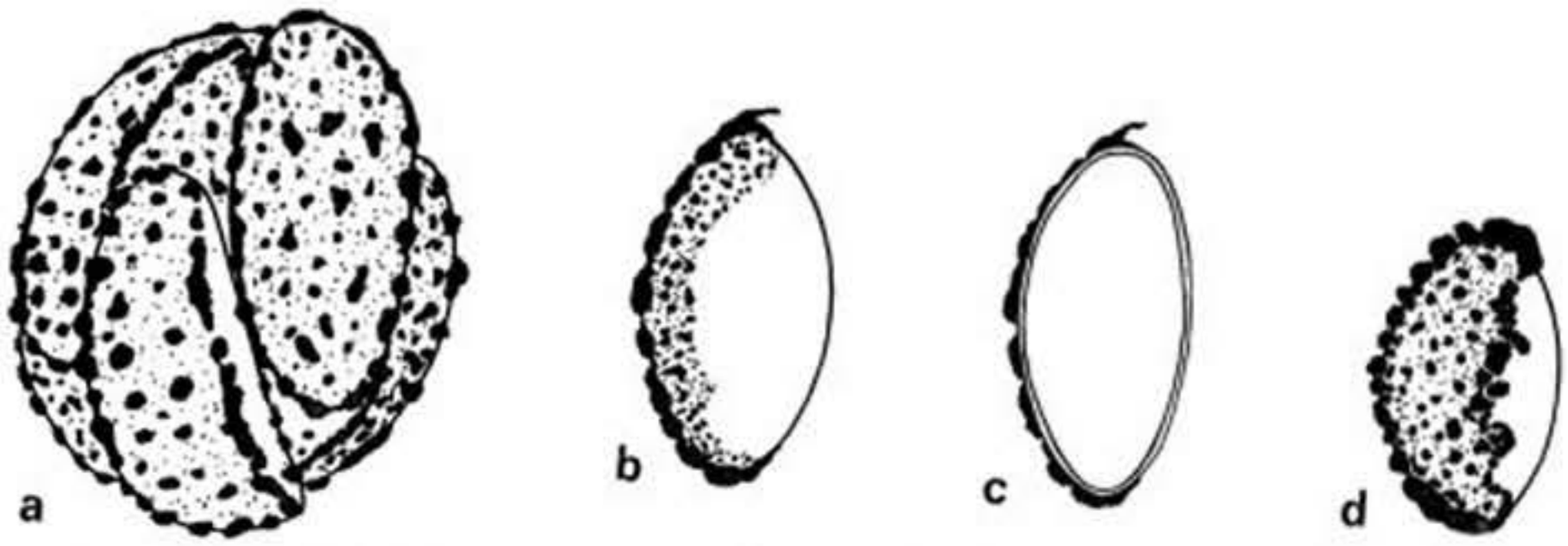

Fig. 72. — *Saccobolus dilutellus:* a, spore-cluster; b, d, ascospores; c, ascospore in optical section. (All × 1600; from holotype.)

On dung of dog, fox, rabbit, mouse, raven, pheasant, and finch.

ETYMOLOGY.—From Latin, dilutus, thinned and -ellus, a suffix signifying the dimunitive: of a rather pale tint.

ILLUSTRATIONS.—Boudier *in* Annls Sci. nat. (Bot.) V **10**: *pl. 9 f. 21.* 1869 (*S. globulifer*); Fuckel *in* Hedwigia **5**: *pl. 1 f. 7.* 1866 (*Ascobolus dilutellus*); Rehm, Rab. Krypt.-Fl. (Pilze) **3**: 1111 *fs. 1–4.* 1896 (*S. globulifer*); Svrček *in* Česká Mykol. **17**: *pl. 51, middle.* 1963; Velenovský, Monogr. Discom. Boh. **2**: *pl. 5 f. 23.* 1934 (*S. globulifer*); Velenovský, Monogr. Discom. Boh. **2**: *pl. 3 f. 3., top left.* 1934 (*Ornithascus corvinus*).

SPECIMENS EXAMINED.—**Germany**: *Fuckel*, on dog dung, Oestricher Wald, Nassau, spring (holotype of *Ascobolus dilutellus*, G-A1057); *Vogel*, Tamsel, 12.III.1935 (TRTC 34725); *Winter*, Harth near Leipzig, III.1874 (M-A809); *Winter*, Leipzig, IV.1874 (S-A607).
Czechoslovakia: *Velenovský*, W. Anna, Stránčice, XII.1926 (PR 149800); *Velenovský*, Hůra near Tehov, Mnichovice, V.1928 (*Ascobolus corvinus* Vel., holotype of *Ornithascus corvinus* Vel., PR 147869); *Velenovský*, Mnichovice, IX.1933 (PR 152992); *Velenovský*, Mnichovice, X.1933 (PR 15300); *Velenovský*, Mnichovice, 20.III.1934 (PR 152999); *Velenovský*, Mnichovice, IV. 1934 (PR 152923); *Velenovský*, Mnichovice, V.1934 (PR 152996).

Although the ascospores in this species are very closely compacted in a subglobular cluster, they may be rather easily separated from each other during the preparation of microscopical slides from fresh material.

This species is very close to *S. globuliferellus* from which it can be distinguished by the more compact spore-clusters and the ornamentation of the ascospores.

Saccobolus globuliferellus and *S. dilutellus* may be considered vicarious species of which the former occurs in North and South America and the latter in Europe (Fig. 6). Both species are closely related with typical representatives of *Saccobolus* sect. *Eriobolus*, such as *S. depauperatus* and *S. versicolor.*

During the maturation of the ascospores in species of both sections of *Saccobolus* a tendency can be observed for the ascospore-clusters to shorten and become more pressed together. *Saccobolus globuliferellus* and *S. dilutellus* may represent the extremes of such a tendency.

17. **Saccobolus geminatus** Thaxter ex Brumm., *spec. nov.*—Fig. 73; Pl. 16, fig. A

Apothecia sessilia, 0.2–0.3 mm diam. Receptaculum initio semiglobulare, denique pulvinare,

albidum, laeve. Asci clavati, apice truncati, 65–75 × 14.6–16.0 μ, 8-spori, pariete iodo caerulescente. Sporum fasciculi sat laxi, faciliter per pares soluti, cylindrici, 27–37 × 12–13 μ. Ascosporae geminae, paribus 4 in fasciculum cylindricum congregatis, inaequilateralifusiformes, 10.7–13.1 × 5.2–6.5 μ, hinc inde verrucis ornatae. Paraphyses filiformes, 1.7–2.6 μ crassae. In fimo Didelphidis virginianae invenitur. Typus: *R. Thaxter*, Sandy River, North Carolina, America septentrionalis (FH-A3069).

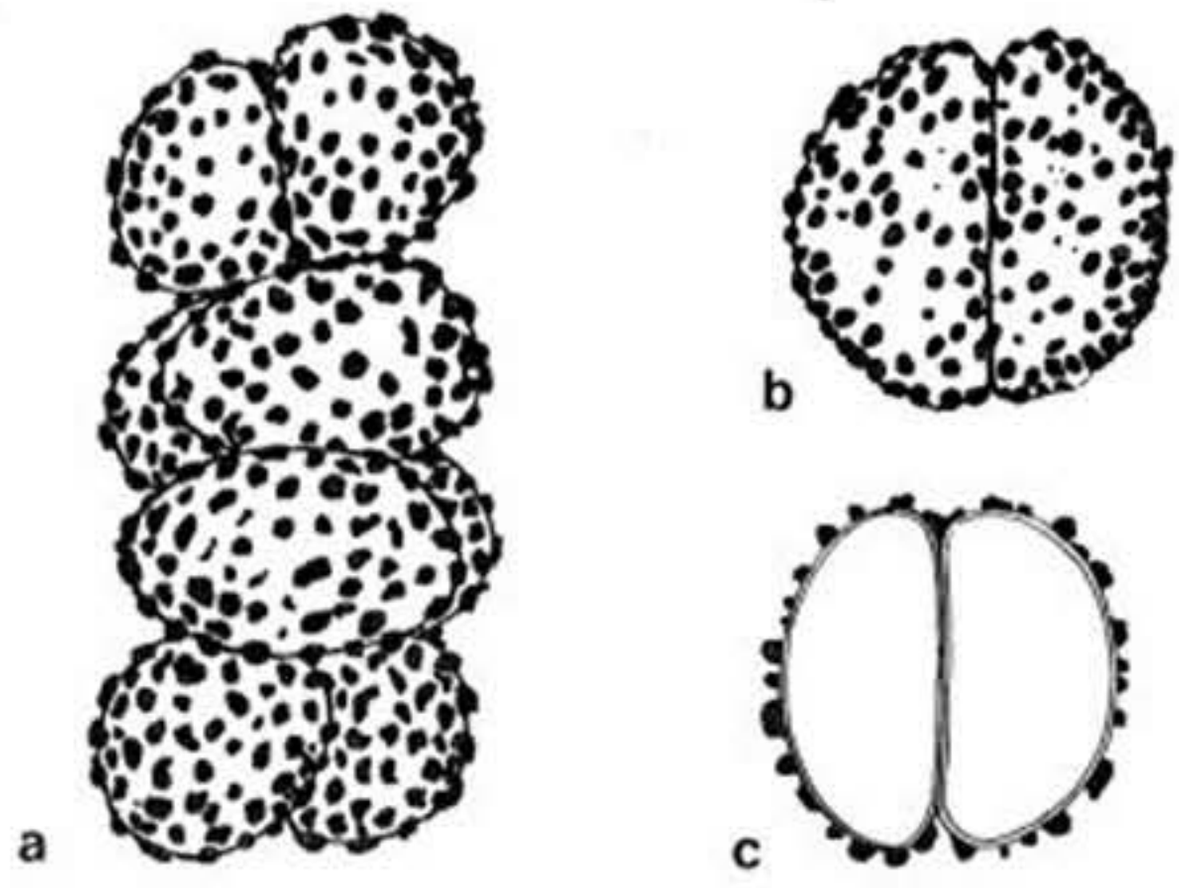

Fig. 73. — *Saccobolus geminatus:* a, spore-cluster; b, pair of ascospores; c, id. in optical section. (All × 1600; from type.)

Apothecia solitary or gregarious, superficial, sessile, 0.2–0.3 mm diameter, up to 0.2 mm high. Receptacle at first semiglobular, then pulvinate, white, smooth; margin not differentiated. Disk at first flat, then convex, white, becoming somewhat violet, dotted with the dark protruding tips of ripe asci. Hymenium about 70 μ thick. Hypothecium very thin, of hyphae with ellipsoid or elongated, cells 6.5–10.5 × 4–6.5 μ, colourless. Excipulum very thin, rather fugitive, in the lower part consisting of hyphae with subglobularly or elliptically swollen cells 4.0–10.5 × 4.0–7.5 μ, in the upper part consisting of a palisade of paraphyse-like hyphae (2.6–4.5 μ wide) with slightly swollen cells, colourless. Asci clavate, gradually tapering downwards into a rather thick base, with truncate apex, 65–75 × 14.5–16.0 μ, 8-spored; the wall blue in Melzer's reagent. Spore-clusters rather loose and easily breaking up into pairs, cylindrical, 27–37 × 12–13 μ. Ascospores firmly united in pairs; four pairs loosely united in a cylindrical cluster, unequal-sided fusiform; at first hyaline, then pinkish-violet, finally violet or purplish-brown, 10.5–13 × 5–6.5 μ, ornamented with isolated warts. Paraphyses simple, septate, filiform, 1.7–2.6 μ thick, slightly enlarged up to 3.9 μ at the tip, colourless.

Only known from opossum dung.

Etymology.—From Latin, geminatus, doubled, in pairs, binate.

Specimen examined.—**U.S.A.**: North Carolina: *Thaxter*, laboratory culture on opossum dung, Sandy River, II.1904 (type of *S. geminatus*, "*S. geminatus*" in Herb. Thaxter, FH-A3069).

In this species the pairs of ascospores are more firmly united than the pairs among themselves. Loose pairs of ascospores can often be found.

Although the arrangement of the ascospores is quite different from that in most of the other species of *Saccobolus* sect. *Eriobolus*, it is placed in this section because of the colourless paraphyses and an apparent relationship with *S. dilutellus* in characters of the ascospores.

18. **Saccobolus infestans** (Batista & Pontual) Brumm., *comb. nov.*—Fig. 74; Pl. 16, figs. F, G

Ascobolus infestans Batista & Pontual *in* Bol. Agr., Pernambuco **15**: 31 *f. 6.* 1948 (basionym). — Part of type: "No. 204 Cx. Peq." (Herb. Batista – A3277).

Apothecia scattered or gregarious, superficial, sessile, 80–160(–360) μ diameter. Receptacle pulvinate, white, smooth; margin not differentiated. Disk convex, white, becoming violet as ascospores mature, dotted with the dark protruding tips of ripe asci. Hymenium about 60 μ thick. Hypothecium and flesh not clearly differentiated.

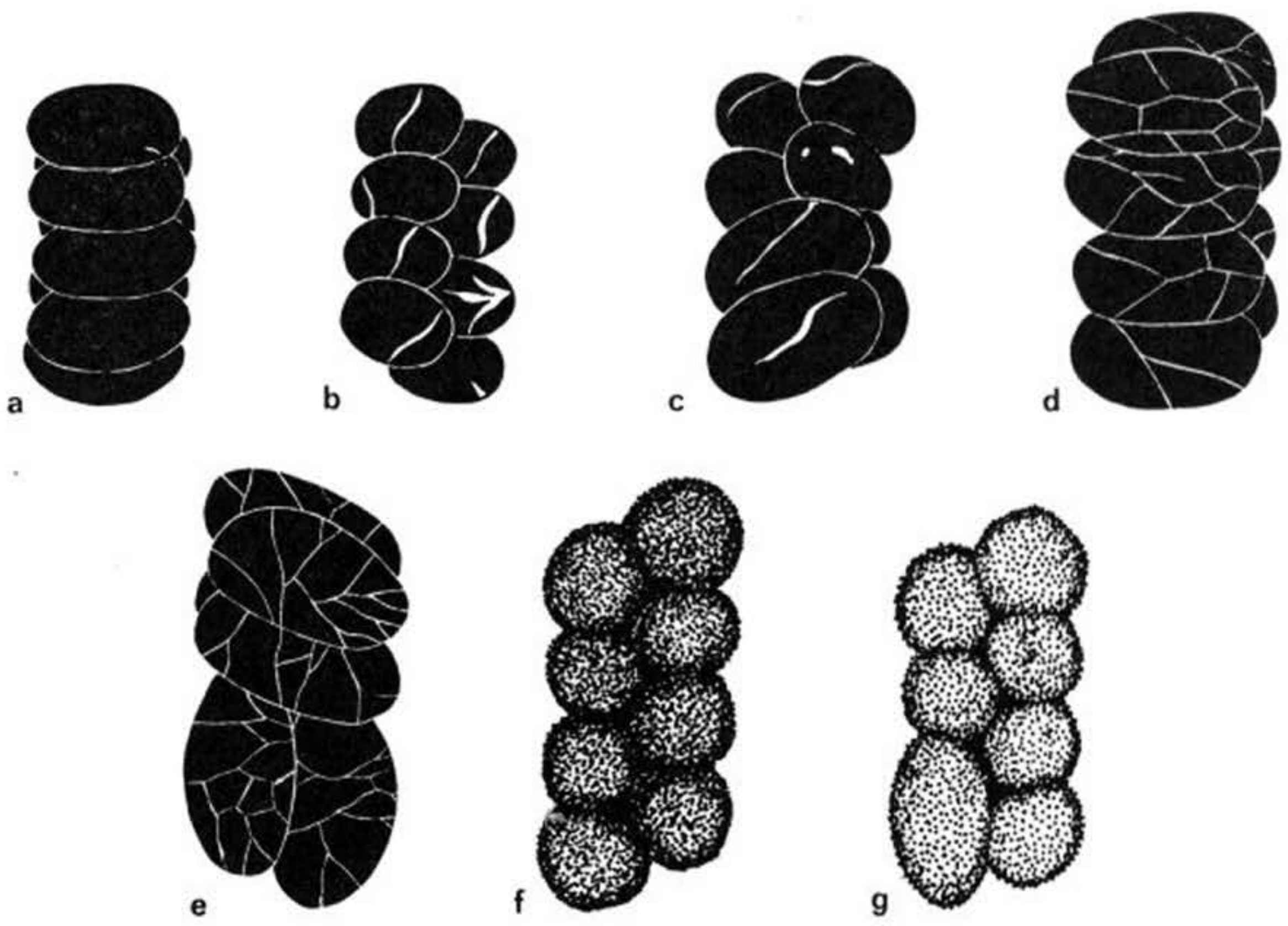

Fig. 74. — *Saccobolus infestans*, spore-clusters × 1600 (a–c, from type; d–g, from *Whetzel & Müller*, TRTC 35272).

Excipulum consisting of few small isodiametric cells up to 6 μ diameter, at the base of apothecium only. Asci clavate, with a rather thick base, flattened above, 60–100 × 12–19 μ, 8-spored; the wall blue in Melzer's reagent. Spore-clusters rather compact, elongated, 21–28 × 10–14 μ. Ascospores arranged transversely in two rows or in a similar very regular pattern (pattern VI, Fig. 21), ellipsoid, with broadly rounded ends, at first hyaline, then violet, finally brown, 9–11 × 5–6.5 μ, slightly roughened with small dots; the outer part of the coloured layer of the ascospores dissolves gradually in water and allows spores to separate, while the inner part remains smooth and olive in colour. Paraphyses simple or branched, septate, filiform 1.5–2.5 μ thick, only slightly larger up to 3 μ above, with olive coloured contents.

Known from dung of horse and donkey.

ETYMOLOGY.—From Latin, infestans, infesting, attacking.

ILLUSTRATIONS.—Batista & Pontual *in* Bol. Agr., Pernambuco **15**: *31 f. 6.* 1948.

SPECIMENS EXAMINED.—**Tahiti**: *L. S. Olive*, on horse dung, Paea District, 24.IV.1956 (TRTC 35274); *L. S. Olive*, on horse dung, Tautira, 27.VI.1956 (TRTC 35273).
Panama: *S. L. Meyer 17892*, on horse dung, Salud, 6.IV.1945 (NY).
Venezuela: *Whetzel & Müller*, on donkey dung, Los Choros, near Caracas, 29.I.1942 (TRTC 35272).
Brazil: *Batista & Pontual*, on horse dung, *s. loc.*, *s. dat.* ("No. 204 Cx. Peq.", part of type of *Ascobolus infestans*, Herb. Batista – A3277).

This species is known from Tahiti and tropical America. It is characterized by the special arrangement of the ascospores (Fig. 2k–p).

It occupies a rather isolated position in *Saccobolus* sect. *Eriobolus* because of the aberrant type of ascospore arrangement and the coloured contents of paraphyses. It is tentatively placed in this section, together with *S. geminatus* in which the ascospores are also transversely arranged in the spore-cluster.

This species could not be recognized from the insufficient original description, apart from this it had been unexpectedly placed in *Ascobolus*. My knowledge of this species in the fresh condition is mainly due to Drs. R. F. Cain and L. S. Olive, who kindly placed at my disposal their material and their description after fresh material.

CHAPTER XII

INSUFFICIENTLY KNOWN AND EXCLUDED SPECIES

The following species have been referred, at some time or other, to the genera placed here under the Ascoboloideae. Many are excluded from this subfamily because they do not answer to the accepted character of that group. The remaining species are insufficiently known on account of the lack of sufficient descriptions which are not supported by adaequate material. Among these insufficiently known species some might still be re-instated when good material is collected: of these species the descriptions are cited below.

albicans. — *Ascobolus albicans* Fuck. *in* Hedwigia **1**: 3 *pl. 1 f. 2.* 1866; Fungi rhen. No. 1855. 1866. — *Peziza (Sarcoscypha) albicans* (Fuck.) Cooke, Mycographia 135 *pl. 60 f. 234.* 1877. — *Neottiella albicans* (Fuck.) Sacc., Syll. Fung. **8**: 191. 1889. — *Lasiobolus albicans* (Fuck.) Sacc., Syll. Fung. **8**: 538. 1889. — *Lachnea albicans* (Fuck.) Rehm, Rab. Krypt.-Fl., Pilze **3**: 1068. 1895. — Type distribution: Fuckel, Fungi rhen. No. 1855.

Boudier (1907: 64) listed this as a species of *Neottiella* (Cooke) Sacc. emend. Boud.

amethysteus. — *Ascophanus amethysteus* Quél. *in* Bull. Soc. bot. Fr. **25**: 291. 1878. — *Ascobolus amethysteus* (Quél.) Gill., Champ. Fr., Discom. 143. 1883; Quél., Ench. Fung. 297. 1886. — Type locality: Jura, France.

The transfer of this species to *Ascobolus* by Gillet (l.c.) and Quélet (l.c.) is certainly due to their very broad conception of the genus. According to its description it belongs to *Ascophanus* Boud.

amethystinus. — *Ascobolus amethystinus* Phill. *in* Grevillea **4**: 84. 1875. — *Galactinia amethystina* (Phill.) Wakef. *in* Trans. Brit. mycol. Soc. **6**: 375. 1920. — Lectotype (selected by Wakefield, l.c.): the fungus described by Cooke (1876a: 48) under the name *Peziza phillipsii* Cooke.

When Phillips (1875) described *Ascobolus amethystinus* two species were involved: a species of *Ascobolus* and a species described from the same collection by Cooke (1876a) as *Peziza phillipsii* Cooke.

Cooke (1876a: 48) did not exclude *Ascobolus amethystinus* from *Ascobolus*. But Wakefield (l.c.) considered the fungus described by Cooke identical with *Ascobolus amethystinus*, and excluded it from *Ascobolus*.

The *Ascobolus* element belongs to *A. behnitziensis* Kirschst. According to Wakefield *A. amethystinus* must be called *Galactinia amethystina* (Phill.) Wakef. The position of this species in *Galactinia* (Cooke) Boud. is problematic, since no part of the ascus-wall stains blue with iodine.

The description by Cooke agrees with my observation of the type. In his ascospore measurements the ornamentation is included. Normally this ornamentation is colourless, but it may be stained by the hymenial pigment (Massee & Crossland, 1906; Wakefield, l.c.).

applanatus. — [*Peziza applanata* (Hedw.) per Fr. sensu Gonn. & Rab., Mycol. eur. *pl. 6 f. 5*. 1869 (without text and lacking authors' citation). —] *Phaeopezia applanata* Sacc., Syll. Fung. **8**: 472. 1889 [exclusive of type, viz. *Peziza applanata* (Hedw.) per Fr., see p. 92; "(Rab. et Gonn.)"]; not *Phaeopezia applanata* (Hedw. per Fr.) Sacc. *in* Bot. Cbl. **18**: 218. 1884 ["(Rabenh. et Gonn.)"; basionym, *Peziza applanata* (Hedw.) per Fr. which was not yet explicitely excluded]. — *Aleurina applanata* (Sacc.) Sacc. & Syd. *in* Syll. Fung. **16**: 739. 1902. — *Ascobolus applanatus* (Sacc.) Rehm, Rab. Krypt.-Fl., Pilze **3**: 1131. 1896. — *Aleuria applanata* (Sacc.) Boud., Hist. Class. Discom. Eur. 46. 1907. — Type: represented by Gonn. & Rab., Mycol. eur. *pl. 6 f. 5*; type locality: presumably Germany.

This species with hyaline, ellipsoid ascospores and brown paraphyses is based on the figure by Gonnermann and Rabenhorst (l.c.) the accompanying text of which has never been published. Saccardo (1889: 472) conceived it as a new species of his genus *Phaeopezia*. It is, however, very unlikely that Gonnermann & Rabenhorst would have overlooked the name *Peziza applanata* (Hedw.) per Fr. for a strikingly similar species. In my opinion Gonnermann & Rabenhorst intended to illustrate Hedwig's species.

Boudier (1907: 46, 48) transferred Saccardo's species to *Aleuria* (Fr.) Boud., while he referred Hedwig's species to the synonymy of *Galactinia castanea* Quél. According to current conception both species belong to *Galactinia* (Cooke) Boud. emend. Le Gal, where their position is still rather doubtful.

argenteus Curr. — *Ascobolus argenteus* Curr. *in* Trans. Linn. Soc. (Bot.) **24**: 496. 1864; not *Ascobolus argenteus* Renny *in* Trans. Woolhope Nat. Field Club 1871: 46. 1871. — *Ascophanus argenteus* (Curr.) Boud. *in* Annls Sci. nat. (Bot.) V **10**: 245. — Type locality: Eltham, British Isles.

A species of *Ascophanus* Boud.

argenteus Renny. — *Ascobolus argenteus* Renny *in* Trans. Woolhope Nat. Field Club 1871: 46. 1871; not *Ascobolus argenteus* Curr. *in* Trans. Linn. Soc. (Bot.) **24**: 496.

1864. — *Rhyparobius argenteus* (Renny) Berk. & Broome *in* Ann. Mag. nat. Hist. IV **11**: 347 *pl. 9 f. 11*. Mai 1873. — *Ascozonus argenteus* (Renny) Boud., Hist. Class. Discom. Eur. 79. 1907. — Type locality: Hereford, British Isles.

This typical representative of *Ascozonus* (Renny) E. C. Hansen was reduced to the synonymy of *Ascobolus* (*Ascozonus*) *cunicularius* (Boud.) Renny by Renny (1874: 356).

asininus. — *Ascobolus asininus* Cooke & Mass. *apud* Cooke *in* Grevillea **21**: 72. 1893. — Type specimen: not known to be in existence. — Type locality: Kew, England.

This fungus is only known from the original description and has never been found again. The description is insufficient to place the species definitely in the genus *Ascobolus*.

The original description (Cooke, l.c.) runs: —

"Scattered or gregarious, hemispherical or sub-depressed, watery, fleshy, at first umbilicate, then open, with a thick margin, indistinctly rugulose, pale olive green or amber, or a combination of both. Asci broadly clavate, octosporous, sporidia elliptical, at first colourless, at length reddish brown, epispore thick, finally minutely cracked into subhexagonal minute areolae, paraphyses very long, filiform, flexuous, much longer than the asci. On asses' dung. Kew."

"Cups 1–2 mm diam., asci 160–170 × 45–50 μ, sporidia 40–45 × 21–23 μ."

atrovirens. — *Peziza atrovirens* Pers., Syn. meth. Fung. **2**: 635. 1801 (devalidated name). — *Ascobolus atrovirens* (Pers.) Nees, Syst. Pilze Schwämme 269. 1816 (devalidated name). — *Peziza atrovirens* Pers. *per* Pers., Mycol. eur. **1**: 306. 1822; Fries, Syst. mycol. **2** (1): 141. 1822. — *Calloria atrovirens* (Pers. per Pers.) Fr., Summa Veg. Scand. **2**: 359. 1849. — *Ombrophila atrovirens* (Pers. per Pers.) P. Karst. *in* Bidr. Känn. Finl. Nat. Folk. **19**: 92. 1871. — *Mollisia atrovirens* (Pers. per Pers.) Gill., Champ. France, Discom. 126. 1882. — *Coryne atrovirens* (Pers. per Pers.) Sacc., Syll. Fung. **8**: 641. 1889. — *Tympanis atrovirens* (Pers. per Pers.) Rehm, Ascom. exs. Fasc. 13, No. 618. 1882; Rehm *in* Hedwigia **21**: 70. 1882. — *Corynella atrovirens* (Pers. per Pers.) Boud., Hist. Class. Discom. Eur. 99. 1907. — *Chlorosplenium atrovirens* (Pers. per Pers.) Seaver, N. Am. Cup-fungi (Inoperc.) 106. 1951.

This species belongs to the genus *Corynella* Boud. It is one of the two species mentioned in the original description of the genus (Boudier, 1885: 114) and it is now considered type of the name *Corynella*.

aurora. — *Peziza aurora* Crouan, Fl. Finist. 53. 1867. — *Ascophanus aurora* (Couan) Boud. *in* Annls Sci. nat. (Bot.) V. **10**: 248, *pl. 11 f. 36*. 1869. — *Ascobolus aurora* (Crouan) Cooke *in* Grevillea **1**: 132. 1873. — *Ascobolus testaceus* var. *aurora* (Crouan)

Quél., Ench. Fung. 297. 1886. ("auroreus"). — Type: *Crouan*, on very old cow dung, *s. loc.*, 15.X.1866 (CONC-A2447).

A representative of *Ascophanus* Boud.

barbatus. — *Ascobolus barbatus* Mass. & Crossl. *apud* Mass. *in* Grevillea **22**: 97. 1894. — Type: *H. Wagner*, on tan refuse, Leeds, British Isles, 6.XII.1893 (NY-A1259); 1.XII.1893 (K-A2489); 9.XII.1893 (K-A1982).

Ascobolus barbatus is a nomen confusum, and as such should be rejected. The parts of the type cited above originally belonged together, although different dates were given. They consist of immature fruit-bodies of a species of *Scutellinia* (Cooke) Lamb. covered with ascospores from neighbouring old apothecia of *Ascobolus denudatus*. Massee & Crossland described this heterogeneous combination as a single species.

Denison (1959: 630) also studied type material and came to the same conclusion.

brunneus. — *Rhyparobius brunneus* Boud. *in* Annls Sci. nat. (Bot.) V **10**: 237 *pl. 9 f. 23*. 1869. — *Ascobolus brunneus* (Boud.) Cooke *in* Grevillea **5**: 153. 1876; not *Ascobolus brunneus* Cooke, Handb. Brit. fungi 728. 1871. — Type locality: Montmorency near Paris, France.

This fungus with 32 ascospores per ascus belongs to *Rhyparobius* Boud.

brunneus. — *Ascobolus brunneus* Cooke *in* Fung. brit. exs. No. 286. 1867 (nomen nudum); Cooke *in* Hedwigia **6**: 154. 1867 (nomen nudum); Cooke, Handb. Brit. fung. 728. 1871 (with description); not *Ascobolus brunneus* (Boud.) Cooke *in* Grevillea **5**: 153. 1876. — *Dasyobolus brunneus* (Cooke) Sacc., Syll. Fung. **11**: 421. 1895. — Type distribution: Cooke, Fungi brit. exs. No. 286.

This name has been a source of confusion since its publication. It was often interpreted as a species of *Dasyobolus* or of *Ascobolus*, related to *Ascobolus amoenus*.

The writer examined different parts of the type distribution and found *Ascobolus brunneus* Cooke to be nothing else but *Lasiobolus pilosus* (Fr.) Sacc. of which the contents of the ascospores do become pale brownish with age (Pl. 16, fig. E). Cooke's name thus appears to be a later synonym.

burcardius. — [*Burcardia globosa, cortice reticulato* Schmidel, Icon. Pl. 261 *pl. 69 fs. 1–13*. 1797 ("*Burkardia*" under plate; devalidated name). —] *Peziza burcardia* Pers., Syn. Fung. 632. 1801 (first binomium, devalidated name). — *Ascobolus burcardius* (Pers.) Martius, Fl. crypt. Erlang. 471. 1817 ("burcardia", devalidated

name). — *Peziza* (*Burcardia*) *burcardia* Pers. *per* Pers., Mycol. eur. **1**: 319. 1822. — Type: represented by Schmidel l.c., *pl. 69*.

As *Burcardia globosa* is the type of the generic name *Bulgaria* Fr., the correct name for this species is *Bulgaria globosa* (Schmidel) ex Fr. See also under 'inquinans'.

candidus. — *Ascobolus candidus* Schroet. *in* Krypt.-Fl. Schles. **3** (2): 55. 1893. — Type specimen: not known to be in existence. — Type locality: Oswitz, Wrocław, Poland.

This species is unknown to the writer. *Ascobolus candidus* Schroet. sensu Seaver (1928: 86) is *Ascobolus aglaosporus* Heimerl which has larger ascospores and a different spore-sculpturing.

Ascobolus candidus undoubtedly belongs to the genus *Ascobolus* and is likely to be found again.

Schroeter's description runs: —

"Fruchtkörper zerstreut, sitzend, flach gewölbt, 0.5–1 mm breit, schneeweiss, glatt. Scheibe unberandet, zuletzt von den vortretenden Schläuchen schwarz punktiert. Schläuche keulenförmig, am Scheitel abgerundet, nach unten stark zusammengezogen, bis 120 μ lang, 22 μ breit, 8 sporig. Sporen 2 reihig, im oberen Drittel des Schlauches ruhend, ellipsoidisch, 11–13 μ lang, 6–8 μ breit; Membran lange Zeit farblos, zuletzt hell-violett, glatt. Paraphysen fadenförmig, 2–3 μ breit."

"Auf Hasenmist. November, Dezember. — Breslau: Oswitz."

caninus. — *Ascobolus caninus* Auersw. *in* Hedwigia **7**: 52. 1868; not *Ascobolus caninus* Fuckel in Hedwigia **5**: 3. 1866. — *Rhyparobius caninus* (Auersw.) Sacc., Syll. Fung. **8**: 539. 1889. — *Rhyparobius crustaceus* var. *caninus* (Auersw.) Boud., Hist. Class. Discom. Eur. 78. 1907. — Type locality: Rosenthal, Leipzig, Germany.

A species of *Rhyparobius* with 24–32 ascospores.

carneus. — *Ascobolus carneus* Pers., Syn. Fung. **1**: 676. 1801 (devalidated name). — *Ascobolus carneus* Pers. *per* Pers., Mycol. eur. **1**: 341. 1822; Fries, Syst. mycol. **2**: 165. 1822. — *Ascophanus carneus* (Pers. per Pers.) Boud. *in* Annls Sci. nat. (Bot.) V **10**: 250. 1869. — *Peziza carnea* (Pers. per Pers.) P. Karst. in Notis. Sällsk. F. Fl. fenn. Förh. **10**: 120. 1869. — *Pyronema carneum* (Pers. per Pers.) Schroet. *in* Krypt.-Fl. Schl. **3** (2): 34. 1893. — Type locality: Germany.

One of the most common species of *Ascophanus*. *Ascophanus carneus* was chosen as lectotype of the generic name *Ascophanus* Boud. by Clements & Shear (1931: 330) and Korf (1958). As this agrees with Boudier's conception (1885) and with Heimerl's introduction (1889: 20) of *Ascophanus* sect. *Eu-Ascophanus*, this typification is followed here. The choice of *A. cinereus* (Crouan) Boud. by Saccardo (1884: 219) as represent-

ative species and the indication according to the first species rule of *A. subfuscus* (Crouan) Boud., by Seaver (1927: 87) were not adopted thus far.[11]

carneus forma **conglobatus.** — *Ascobolus carneus* forma *conglobatus* Rehm in Ascom. No. 425. 1878 (nomen nudum). — Type distribution: Rehm, Ascom. No. 425.

One of the many variations of *Ascophanus carneus*. The name is not cited in later work by Rehm.

carneus var. **cuniculi.** — *Ascophanus carneus* var. *cuniculi* Boud. *in* Annls Sci. nat. (Bot.) V **10**: 250 *pl. 12 f. 39*. 1869. — *Ascobolus carneus* var. *cuniculi* (Boud.) Pim *in* Grevillea **9**: 57. 1880. — Type locality: France.

One of the many variations of *Ascophanus carneus*.

cenangioides. — *Ascobolus cenangioides* Ces. *in* Atti Accad. Sci. fis. mat. Napoli **8** (3): 11. 1879. — Type: not known to be in existence. — Type locality: Sarawak, Borneo.

Judging from the description this species does neither belong to the Ascobolaceae, nor to the other families of the operculate Discomycetes. The description is insufficient to place the species.

cesatii. — *Ascobolus cesatii* Carest. *in* Rab., Fungi europ. exs. No. 976a. 1866. — *Pezizula cesatii* (Carest.) P. Karst. *in* Bidr. Känn. Finl. Nat. Folk. **19**: 83. 1871. — *Rhyparobius cesatii* (Carest.) P. Karst. *in* Acta Soc. Fauna Fl. fenn. II **6**: 122. 1885. — *Ascophanus cesatii* (Carest.) Sacc., Syll. Fung. **8**: 533. 1889. — Type distribution: Rabenhorst, Fungi europ. exs. No. 976a.

This name is a synonym of *Ascophanus microsporus* (Berk. & Broome) E. C. Hansen.

ciliatus. — *Ascobolus ciliatus* J. C. Schmidt *in* Mykol. Hefte **1**: 90. 1817 (devalidated name). — *Ascobolus ciliatus* J. C. Schmidt *per* Pers., Mycol. europ. **1**: 340. 1822; Fries, Syst. mycol. **2**: 164. 1822. — *Ascobolus papillatus* var. *ciliatus* (J. C. Schmidt per Pers.) Kickx, Fl. crypt. Flandres **1**: 476. 1867. — *Ascophanus ciliatus* (J. C.

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[11] However, very recently Kimbrough & Korf (1967: 19) supported Seaver's typification, which according to them makes *Ascophanus* Boud. a synonym of *Thelebolus* Tode per Fr. For *A. carneus* and its close allies they introduced the generic name *Iodophanus* Korf apud Kimbr. & Korf.

Schmidt per Pers.) Boud. *in* Annls Sci. nat. (Bot.) V **10**: 253. 1869. — *Ascobolus equinus* subsp. *ciliatus* (J. C. Schmidt per Pers.) P. Karst. *in* Not. Sällsk. Fauna Flora fenn. Förh. **10**: 209. 1870. — *Peziza equina* var. *ciliata* (J. C. Schmidt per Pers.) P. Karst. *in* Bidr. Känn. Finl. Nat. Folk. **19**: 73. 1871. — *Ascophanus pilosus* var. *ciliatus* (J. C. Schmidt per Pers.) Phill., Discom. 312. 1887. — *Lasiobolus equinus* subsp. *ciliatus* (J. C. Schmidt per Pers.) Sacc., Syll. Fung. **8**: 537. 1889. — *Lasiobolus ciliatus* (J. C. Schmidt per Pers.) Boud., Hist. Class. Discom. Europ. 78. 1907. — Type locality: near Schandau, Germany.

This species of *Lasiobolus* is characterized by a disk with a swollen margin, which is covered with a white powder and cilia of the same colour. Rehm (1895: 1096) reduced *Ascobolus ciliatus* together with many other names to the synonymy of *Lasiobolus equinus*. In his remarks to this species he doubts whether *Ascophanus ciliatus* sensu Boudier (1869: 253) belongs to it. From Boudier's description, however, it is clear that his species is the same as Schmidt's. As I have not yet come across this species, I hesitate to place it into the synonymy of *Lasiobolus pilosus*.

ciliatus var. **citrinus.** — *Ascobolus ciliatus* var. *citrinus* Crouan, Fl. Finist. 55. 1867. — *Streptotheca citrina* (Crouan) Le Gal *in* Annls Sci. nat. (Bot.) XII **1**: 451. 1960. — Type: *Crouan*, on dog dung, *s. loc.*, autumn (*A. citrinus* Crouan, CONC-A2424, lectotype; CONC-A2412, probably also part of type).

After studying both specimens and a small authentic drawing in colour, on the ground of observations, deviating at some points from those of Le Gal (1961: 450–451), my conclusion is that Crouan's variety differs in nothing from typical *Lasiobolus pilosus* but the lemon-yellow colour.

cinerellus. — *Ascobolus cinerellus* P. Karst., Fungi Fenn. exs. No. 760. 1868; P. Karst. *in* Not. Sällsk. Fauna Fl. fenn. Förh. **11**: 206. 1870. — *Peziza cinerella* (P. Karst.) P. Karst. *in* Bidr. Känn. Finl. Nat. Folk **19**: 51. 1871. — *Ascophanus cinerellus* (P. Karst.) Speg. *in* Ann. Soc. cient. argent. **10**: 24. 1880. — Type distribution: P. Karsten, Fungi Fenn. exs. No. 760.

A species of the genus *Ascophanus* Boud. (fide Spegazzini, l.c.; Karsten, 1885: 121; Saccardo, 1889: 532; Heimerl, 1889: 25; Rehm, 1895: 1085; Boudier, 1907: 77).

cinereus. — *Ascobolus cinereus* Crouan *in* Annls Sci. nat. (Bot.) IV **10**: 194 *pl. 13D fs. 17–20.* 1858. — *Ascophanus cinereus* (Crouan) Boud. *in* Annls Sci. nat. (Bot.) V **10**: 249. 1869. — *Peziza cinerea* (Crouan) P. Karst. *in* Bidr. Känn. Finl. Nat. Folk **19**: 59. 1871. — *Thecotheus cinereus* (Crouan) Chenant. *in* Bull. Soc. mycol. Fr. **34**: 39. 1918. — *Thecotheus setisperma* Le Gal *in* Bull. Soc. mycol. Fr. **78**: 411. 1963 (superfluous name change). — Type: *Crouan*, on old cow dung, near Brest, Finistère, France, *s. dat.* (CONC-A2395, Cotype PC-A2336).

Boudier (1869: 250) placed this species with some doubt in the genus *Ascophanus*. Chenantais (1918: 39) considered *Ascobolus cinereus* to be closely related to *Ascophanus holmskjoldii* and, on account of their ascospores, transferred both of them to the genus *Thecotheus* Boud. Le Gal (1961: 443; 1963b: 405) who studied the type, argued that it should be kept in the latter genus.

Thecotheus setisperma Le Gal is a superfluous name, since there is a type specimen and even a cotype. Moreover, if *Ascophanus holmskjoldii* E. C. Hansen is to be considered a synonym of Crouan's species (Le Gal 1963: 406), then Hansen's name should have priority. See also under 'holmskjoldii.'

coccineus. — *Ascobolus coccineus* Crouan *in* Annls Sci. nat. (Bot.) IV **7**: 174 *pl. 4D fs. 15–19*. 1857. — *Leucoloma coccinea* (Crouan) Fuck., Fungi rhen. No. 1854. 1866; Fuck. *in* Jb. nassau. Ver. Naturk. **23–24**: 318. 1870. — *Peziza corallina* Cooke *in* Grevillea **3**: 73. 1874 (name change); not *Peziza coccinea* Jacq., Fl. austr. *pl. 169*. 1774. — *Humaria coccinea* (Crouan) Quél., Ench. Fung. 289. 1886. — *Humarina coccinea* (Crouan) Seaver, N. Am. Cup-fungi (Operc.) 137. 1928. — Type: *Crouan*, on soil among small mosses, under Chateau de Brest, and in the neighbourhood of Morlaix, Finistère, France, spring, autumn (CONC-A2389); *Crouan*, on soil among small mosses, near Brest, Finistère, France, *s. dat.* (PC-A2337, probably part of type).

This species is related to *Octospora tetraspora* (Fuck.) Korf and *Octospora fusispora* [12] and should likewise be placed in the genus *Octospora* Hedw. per S.F. Gray emend. Korf among the species with fusiform ascospores as **Octospora coccinea** (Crouan) Brumm., *comb. nov.*

coemansii. — *Ascophanus coemansii* Boud. *in* Annls Sci. nat. (Bot.) V **10**: 244 *pl. 10 f. 30*. 1869. — *Ascobolus coemansii* (Boud.) Quél., Ench. Fung. 296. 1886. — Type locality: near Paris, France.

A species of *Ascophanus* of the group of *Ascophanus microsporus* (Berk. & Broome) E. C. Hansen.

conglomeratus. — *Ascobolus conglomeratus* Schwein. *in* Trans. Am. phil. Soc. II **4**: 178. 1832. — *Angelina conglomerata* (Schwein.) Fr. *in* Nova Acta Soc. Sci. upsal. III **1**: 121. 1851. — Type locality: Carolina, U.S.A.

This is the type of the name *Angelina* Fr. According to Duby (1862: 51–52) *Ascobolus conglomeratus* falls into the synonymy of *Angelina rufescens* (Schwein.) Duby, a species of Hysteriaceae.

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[12] **Octospora fusispora** (Berk.) Brumm., *comb. nov.* — basionym: *Peziza fusispora* Berk. in J. Bot., Lond. **5**: 5. 1846.

consociatus. — *Ascobolus consociatus* Berk. & Broome *in* Ann. Mag. nat. Hist. Ser. IV **15**: 39 *pl. 2 f. 7.* 1875. — *Ascophanus consociatus* (Berk. & Broome) Phill., Brit. Discom. 312. 1887. — Type locality: Langridge, British Isles.

According to Phillips (1887: 312) and Boudier (1907: 77) this is a species of *Ascophanus* Boud.

cookei. — *Ascobolus cookei* Crouan, Fl. Finistère 56. 1867. — *Rhyparobius cookei* (Crouan) Boud. *in* Annls Sci. nat. (Bot.) V **10**: 238. 1869. — Type: *Crouan*, on album graecum, *s. loc.*, 7.IV.1860 (in pencil also: III. 1862) (CONC-A2391).

One of the many synonyms of *Rhyparobius crustaceus* (Fuck.) Rehm. In the type collection asci with 32, 48 and 64 ascospores were found. In the same package Le Gal (1961: 449) also found fruit-bodies with at least 150–180 ascospores in an ascus.

coronatus. — *Ascobolus coronatus* Schum., Enum. Pl. Saell. **2**: 437. 1803 (devalidated name). — *Phacidium coronatum* (Schum.) Fr., Obs. mycol. **1**: 167. 1815 (devalidated name). — *Phacidium coronatum* (Schum.) *per* Fr., Syst. mycol. **2** (2): 577. 1823. — *Coccomyces coronatus* (Schum. per Fr.) De Not. *in* Erb. critt. ital., Ser. I, fasc. **5**, No. 236. 1859. — Type locality: Bagsvaerd, Sjaelland, Denmark.

This species belongs to *Coccomyces* De Not. of the Phacidiales.

corvinus var. **avium.** — *Ornithascus corvinus* var. *avium* Vel., Monogr. Discom. Boh. **1**: 369. 1934. — Type: not known to be in existence. — Type locality: near Božkov, Bohemia, Czechoslovakia.

Velenovský's description of this variety is too short and too incomplete to reduce it with certainty to the synonymy of *Saccobolus dilutellus*. Considered a nomen dubium.

crec'hqueraultii. — *Ascobolus crec'hqueraultii* Crouan *in* Annls Sci. nat. (Bot.) IV **10**: 194 *pl. 130 fs. 12–16.* 1858. — *Mollisia crec'hqueraultii* (Crouan) Gill., Champ. Fr., Discom. 118. 1882. — *Humaria crec'hqueraultii* (Crouan) Quél., Ench. Fung. 288. 1886. — *Barlaea crec'hqueraultii* (Crouan) Sacc., Syll. Fung. **8**: 113. 1889. — *Lamprospora crec'hqueraultii* (Crouan) Boud., Icon. mycol., Ser. I, livr. 2, Liste préliminaire, unnumbered page. 1904. — *Barlaeina crec'hqueraultii* (Crouan) Sacc. & Trav. *in* Syll. Fung. **19**: 138. 1910. — Type: *Crouan*, on soil on the banks of brooks, *s. loc.*, IX and X. 1858 (lectotype, PC-A2340); *Crouan*, on soil on the banks of brooks, in the neighbourhood of Morlaix and Brest, Finistère, France, September (CONC-A2371, exhausted).

A well-known species of *Lamprospora* De Not. with beautifully ornamented ascospores.

crouanii. — *Ascobolus crouanii* Cooke *in* J. Bot., Lond. **2**: 151 *f. 3. 1* May 1864; not *A. crouanii* Boud. *in* Annls Sci. nat. (Bot.) V **10**: 216 *pl. 5 f. 2.* 1869; nor *A. crouanii* Renny *in* J. Bot., Lond. **12**: 356 *pl. 154 fs. 6–10.* 1874. — *Peziza crouanii* (Cooke) Cooke *in* Grevillea **3**: 185. 1875; Cooke, Mycographia 13 *pl. 5 f. 17.* 1875. — *Aleuria crouanii* (Cooke) Gill., Champ. Fr., Discom. 50. 1879. — *Crouania crouanii* (Cooke) Lamb., Fl. mycol. Belg., Suppl. **I**: 319. 1887. — *Lamprospora crouanii* (Cooke) Seaver *in* Mycologia **6**: 8. 1914; ≡ *Ascobolus miniatus* Crouan.

crouanii. — *Ascobolus crouanii* Renny *in* Trans. Woolhope Nat. Field Club 1872–3: 130 *pl. 154 fs. 6–10.* 1873; Renny *in* J. Bot., Lond. **12**: 356 *pl. 154 fs. 6–10.* 1874; not *A. crouanii* Cooke *in* J. Bot., Lond. **2**: 151 *f. 3.* 1864; nor *A. crouanii* Boud. *in* Annls Sci. nat. (Bot.) V **10**: 216 *pl. 5 f. 2.* 1869. — *Rhyparobius crouanii* (Renny) Sacc., Syll. Fung. **8**: 543. 1889. — *Ascozonus crouanii* (Renny) Schroet. *in* Bot. Jb. (ed. Just) **2**: 283. 1876 (incidental mention); Boud., Hist. Class. Discom. Eur. 79. 1907. — *Streptotheca crouanii* (Renny) Seaver, N. Am. Cup-fungi (Operc.) 142. 1928. — Type locality: Hereford, British Isles.

A species of *Ascozonus* (Renny) Boud.

crustaceus. — *Ascobolus crustaceus* Fuck., Fungi rhen. No. 1858. 1866; *in* Hedwigia **5**: 4. 1866. — *Pezizula crustacea* (Fuck.) P. Karst. *in* Bidr. Känn. Finl. Nat. Folk **19**: 81. 1871. — *Rhyparobius crustaceus* (Fuck.) Rehm, Ascom. exs. No. 52b. 1872. — Type distribution: Fuckel, Fungi rhen. No. 1858.

A species of *Rhyparobius* Boud.

cunicularius. — *Peziza cunicularia* Boud. *in* Annls Sci. nat. (Bot.) V **10**: 258. 1869. — *Ascobolus cunicularius* (Boud.) Renny *in* Trans. Woolhope Nat. Field Club 1872–3: 130. 1873; Renny *in* J. Bot., Lond. **12**: 255. 1874; Cooke *in* Grevillea **3**: 185. 1875. — *Ascozonus cunicularius* (Boud.) Schroet. *in* Bot. Jb. (ed. Just) **2**: 283. 1876 (incidental mention); E. C. Hansen *in* Vidensk. Medd. naturh. Foren. Kbh. 1876: 91. 1877. — Type locality: Montmorency, France.

A species of *Ascozonus* (Renny) Boud. and very probably a synonym of *Ascozonus leveillei* (Crouan) Brumm.

daldinianus. — *Ascobolus daldinianus* De Not. *in* Comm. Soc. critt. ital. **5**: 360. 1864. — Type: not known to be in existence. — Type locality: Locarnese, Italy.

From the original description it is not even certain that De Notaris' species belongs to *Ascobolus*. As already suggested by Boudier (1869: 234) it might be a species of *Saccobolus* related to *S. versicolor* or *S. depauperatus*. A nomen dubium.

difformis. — *Ascobolus testaceus* var. *difformis* P. Karst., Syn. Pez. Ascob. 43. 1861. — *Ascobolus difformis* (P. Karst.) P. Karst., Fungi Fenn. exs. No. 325. 1866; Nyl. *in* Notis. Sällsk. Fauna Fl. fenn. Förh. **10**: 85. 1868; P. Karst. *in* Notis. Sällsk. Fauna Fl. fenn. Förh. **11**: 207. 1870. — *Ascophanus difformis* (P. Karst.) Boud. *in* Annls Sci. nat. (Bot.) V **10**: 252. 1869. — *Ascophanus carneus* var. *difformis* (P. Karst.) Rehm, Rab. Krypt.-Fl. (ed. 2), Pilze **3**: 1095. 1895. — Type locality: Finland.

This fungus belongs to *Ascophanus* Boud. and is closely related to *Ascophanus carneus* (Pers. per Pers.) Boud.

diversisporus. — *Ascobolus diversisporus* Fuck. *in* Jb. nassau. Ver. Naturk. **23–24**: 289. 1870. — *Humaria diversispora* (Fuck.) Speg. *in* Michelia **1**: 236. 1878. — *Lasiobolus diversisporus* (Fuck.) Sacc., Syll. Fung. **8**: 538. 1889. — Type locality: Frankensteiner Kopf, Germany.

According to the description this species belongs to *Lasiobolus* Sacc. Seaver (1928: 155) placed it into the synonymy of *Lasiobolus equinus* (O. F. Müller per Pers.) P. Karst. [= *L. pilosus* (Fr.) Sacc.].

dubius. — *Rhyparobius dubius* Boud. *in* Annls Sci. nat. (Bot.) V **10**: 240 *pl. 10 f. 26.* 1869. — *Ascobolus dubius* (Boud.) Quél., Ench. Fung. 296. 1886. — Type locality: Montmorency, France.

A member of *Rhyparobius* Boud.

dubius. — *Saccobolus dubius* Vei., Monogr. Discom. Boh. 414. 1934. — Type specimen: non-existent. — Type locality: near Mnichovice, Bohemia, Czechoslovakia.

Because of the very insufficient description *Saccobolus dubius* is to be regarded as a nomen dubium.

equinus. — *Helvella equina* O. F. Müller *in* Fl. dan. **5**, Fasc. 13: 8 *pl. 779 f. 3.* 1778 ("*Elvela*", devalidated name). — *Peziza equina* (O. F. Müller) Retz., Fl. Scand. Prodr. (ed. 2): 325. 1795 (devalidated name); Sowerby, Engl. Fung. **3**: 44 *pl. 372.* 1803. — *Peziza stercorea* var. *equina* (O. F. Müller) *per* Pers., Mycol. europ. **1**: 247. 1822. — *Peziza equina* (O. F. Müller per Pers.) Sommerf., Plant. crypt. norv. Cent. I, No. 98. 1826. — *Ascobolus equinus* (O. F. Müller per Pers.) P. Karst. *in* Not. Sällsk. Fauna Flora fenn. Förh. **11**: 209. 1870. — *Ascophanus equinus* (O. F. Müller per Pers.) Speg. *in* An. Soc. ci. argent. **10**: 24. 1880. — *Lasiobolus equinus* (O. F. Müller per Pers.) P. Karst. *in* Acta Soc. Fauna Fl. fenn. II **6**: 122. 1885. — Type: represented by O. F. Müller *in* Fl. Dan. **5**, fasc. 13: *pl. 779 f. 3.* — Type locality: Denmark.

It seems impossible to distinguish this fungus from *Lasiobolus pilosus* (see also Heimerl, 1889: 23; Schroeter, 1893: 54; Rehm, 1895: 1096; Seaver, 1928: 155.).

The distinction of even two varieties or subspecies within one species (Karsten, 1871: 73; Karsten, 1885: 122; and Boudier, 1907: 78) is untenable because of the wide variation in almost all characters.

Since *Lasiobolus pilosus* is the earlier of the two names and because of the choice of Boudier (1869: 254) and Heimerl (1889: 23) of this epithet from a greater series of synonyms, I propose to use this name for the species in its broad sense.

equinus. — *Saccobolus equinus* Vel., Novit. mycol. 203. 1939. — Type specimen: non-existent. — Type locality: Mnichovice, Bohemia, Czechoslovakia.

A nomen dubium because of the insufficient description and the lack of a type specimen.

fallax. — *Ascobolus fallax* Auersw. *in* Hedwigia **4**: 52. 1868. — *Ascobolus crustaceus* subsp. *fallax* (Auersw.) P. Karst. *in* Notis. Sällsk. Fauna Fl. fenn. Förh. **11**: 208. 1870. — *Pezizula crustacea* subsp. *fallax* (Auersw.) P. Karst. *in* Bidr. Känn. Finl. Nat. Folk **19**: 82. 1871. — *Ascophanus fallax* (Auersw.) Sacc., Syll. Fung. **8**: 532. 1889; Boud., Hist. Class. Discom. Eur. 77. 1907. — Type locality: Rosenthal, Leipzig, Germany.

Although this species has the appearance of a *Rhyparobius* it should be placed in *Ascophanus* Boud. because of the eight-spored asci.

felinus. — *Rhyparobius felinus* Boud. *in* Annls Sci. nat. (Bot.) V **10**: 238 *pl. 10 f. 25.* 1869. — *Ascobolus felinus* (Boud.) Quél., Ench. Fung. 296. 1886. — Type locality: near Montmorency, France.

A representative of *Rhyparobius* Boud.

fuckelii. — [*Ascobolus testaceus* (Moug. apud Fr.) Wallr. sensu Fuck. *in* Jb. nassau. Ver. Naturk. **27–28**: 58. 1873; Fuck., Fungi rhen. fasc. 12, No. 2680. 1874; not *Ascobolus testaceus* (Moug. apud Fr.) Wallr. sensu Moug. *in* Wallr., Fl. crypt. Germ. 2: 513. 1833; nor *Ascobolus testaceus* P. Henn. *in* Hedwigia **41**: 32. 1902. —] *Ascobolus fuckelii* J. Kunze, Fungi sel., Fasc. **3**, No. 286. 1879; *in* Oest. bot. Z. **30**: 67. 1880. — *Ascophanus fuckelii* (J. Kunze) Rehm, Rab. Krypt.-Fl., Pilze **3**: 1090. 1895. — Type: Fuckel, Fungi rhen. No. 2680.

A synonym of *Fimaria hepatica* (Batsch per Pers.) Brumm. (see van Brummelen, 1962b: 322).

glaber γ ruber. — [*Ascobolus glaber* Pers. sensu Schum., Enum. Pl. Saell. **2**: 436. 1803 (devalidated name). —] *Ascobolus glaber γ ruber* Pers., Mycol. eur. **1**: 341. 1822. — Type: not known to be in existence. — Type locality: Sjaelland, Denmark.

A nomen dubium because of the insufficient description and the lack of a type specimen.

glaber β varius. — [*Ascobolus glaber* Pers. sensu Biv. Bern., Stirp. rar. Sicilia **4**: 27 *pl. 6 f. 4.* 1816 (devalidated name). —] *Ascobolus glaber β varius* Pers., Mycol. eur. **1**: 341. 1822. — Type: not known to be in existence. — Type locality: Sicilia, Italy.

This fungus is only known from the very brief description by Bivona Bernardi. It is considered a nomen dubium.

globulosus. — *Mollisia globulosa* Quél. *in* Bull. Soc. bot. Fr. **24**: 328 *pl. 6 f. 6.* 1877. — *Humaria globulosa* (Quél.) Quél., Ench. Fung. 287. 1886. — *Barlaea globulosa* (Quél.) Sacc., Syll. Fung. **8**: 115. 1889. — *Sphaeridiobolus globulosus* (Quél.) Boud., Hist. Class. Discom. Eur. 74. 1907. — *Barlaeina globulosa* (Quél.) Sacc. & Trav., Syll. Fung. **19**: 139. 1910. — Lectotype: *Quélet*, on fox dung, Jura, France, spring (K-A2516, part of type).

This name is a synonym of *Pulvinula constellatio* (Berk. & Broome) Boud.

granuliformis. — *Ascobolus granuliformis* Crouan *in* Annls Sci. nat. (Bot.) IV **10**: 195 *pl. 13 F fs. 27–31.* 1858. — *Ascophanus granuliformis* (Crouan) Boud. *in* Annls Sci. nat. (Bot.) V **10**: 245. 1869. — Holotype: *Crouan*, on cow dung, neighbourhood of Brest, Finistère, France, spring (CONC-A2376).

A species of *Ascophanus* Boud. Le Gal (1961: 445) gave a description with figures after specimens in the herbarium of the Crouans.

granulatus. — *Peziza granulata* Bull., Herb. Fr. *pl. 438 f. 3.* 1789; Hist. Champ. 258. 1791 (devalidated name). — *Peziza granulosa* Pers., Syn. fung. 667. 1801 (devalidated name, name change); not *Peziza granulosa* Schum., Enum. Pl. Saell. **2**: 415. 1803. — *Peziza granulata* Bull. *per* Fr., Syst. mycol. **2** (1): 67. 1822. — *Ascobolus granulatus* (Bull. per Fr.) Fuckel *in* Jb. nassau. Ver. Naturk. **23–24**: 287. 1870. — *Aleuria granulata* (Bull. per Fr.) Gill., Champ. Fr., Discom. 56. 1879. — *Humaria granulata* (Bull. per Fr.) Quél., Ench. Fung. 290. 1886. — *Coprobia granulata* (Bull. per Fr.) Boud., Hist. Class. Discom. Eur. 69. 1907. — Type: represented by Bulliard l.c. *pl. 438 f. 3.* — Type locality: France.

This species is the type of *Coprobia* Boud., a small genus that belongs to the Humariaceae.

guernisacii. — *Ascobolus guernisacii* Crouan, Fl. Finistère 56. 1867. — *Humaria guernisacii* (Crouan) Quél., Ench. Fung. 291. 1886. — *Ascophanus guernisacii* (Crouan) Sacc., Syll. Fung. **8**: 536. 1889. — *Selenaspora guernisacii* (Crouan) Heim & Le Gal *apud* Le Gal *in* Rev. Mycol. **18**: 88. 1953. — Type: *Crouan*, on old walls and slaty slopes, among small mosses, *s. loc.* 4.XI.1866 (CONC-A2419).

This species belongs to the genus *Selenaspora* Heim & Le Gal. The position of this genus is still somewhat doubtful. The rather broad asci and large ascospores might support its admission to the Theleboloideae but other characters are more in accordance with the Humariaceae.

Although Le Gal (1953b: 87–88) studied this species twice she was not certain about the position of the genus, which was expressed thus: — ". . . . . il se rattacherait à la tribu des Pseudo-Ascobolae." and further on "Mais actuellement, la position taxonomique exacte d'un tel genre ne nous apparaît pas encore bien clairement."

hansenianus. — *Saccobolus hansenianus* Speg. *in* Michelia **1**: 234. 1878. — Type: not known to be in existence. — Type locality: Conegliano, Italy.

"Ascomatibus primo conoideis, durissimis, flavo-viridulis, vertice atrovinoso, dein applanatis undique flavo-viridulis sed disco ob ascos exsilientes brunneo-punctato; ascis amplis saccatis elliptico-fusoideis, deorsum brevissime stipitatis, apice truncatis, 180–210 × 67–75, basidiis cylindraceis, vix clavulatis, 40–45 × 10–12, suffultis, paraphysibus filiformibus viridulis obvallatis; glomerulis sporidiorum elliptico-ovatis, 85–90 × 30, sacculo crassissimo inclusis; sporidiis ovato-ellipsoideis, inaequilateralibus, utrinque rotundato-truncatis, 35–40 × 25, primo opace violaceis, dein intense fuligineis".

"*Hab.* in fimo vaccino et equino in umbrosis herbidis *a Conegliano*, Oct. 1877, raro."

Known to the writer only from the description quoted above. The spore-measurements are rather extreme for *Saccobolus*. Also the colour of the apothecia ("flavo-viridulis") is not characteristic of this genus. Spegazzini's species might even have been a species of *Ascobolus* section *Dasyobolus*. In this section ascospores are often surrounded by an enveloping hyaline mucilaginous layer, which may sometimes look like a common hyaline sac, especially when the ascospores are more or less agglutinated by this substance.

hirsutus. — *Ascobolus hirsutus* Coem. An unpublished name in Herbarium Coemans (BR-A321).

The material shows a species of *Scutellinia* (Cooke) Lamb.

hirtellus. — *Ascobolus hirtellus* P. Karst., Fungi Fenn. exs. No. 657. 1867; P. Karst. *in* Not. Sällsk. Fauna Fl. fenn. Förh. **11**: 210. 1870. — *Peziza hirtella* (P. Karst.) P. Karst. *in* Bidr. Känn. Finl. Nat. Folk **19**: 74. 1871. — *Lasiobolus hirtellus* (P. Karst.) P. Karst. *in* Acta Soc. Fauna Fl. fenn. II **6**: 122. 1885. — Type distribution: P. Karsten, Fungi Fenn. exs. No. 657.

This species of *Lasiobolus* Sacc. is probably one of the many forms of *Lasiobolus pilosus* (Fr.) Sacc. (Heimerl 1889: 23).

holmskjoldii. — *Ascophanus holmskjoldii* E. C. Hansen *in* Vidensk. Meddr naturh. Foren. Kbh. 1876: 84 *pl. 6 fs. 1–8.* Jan. 1877. — *Ascobolus holmskjoldii* (E. C. Hansen) Winter *in* Hedwigia **17**: 91. 1878. — *Thecotheus holsmkjoldii* (E. C. Hansen) Chenant. *in* Bull. Soc. mycol. Fr. **34**: 39. 1918 (as the variety *major* of *Thecotheus cinereus*: not validly published). — Type locality: Denmark.

Of this rare fungus good descriptions were published by Hansen (l.c.) and Heimerl (1889: 20). Heimerl founded a special subgenus (*Holmskjoldia*) of *Ascophanus* Boud. for this species. The most conspicuous character of the fungus is the presence of a large cap-shaped or semiglobular body at each polar end of the ascospore. The epispore is covered by a layer of fine granules with the largest granules near the ends. Both ends of the ascospore bear a bundle of fine, hyaline, brush-shaped, mucilaginous appendages. The ascospores are surrounded also by a mucilaginous envelope. All these mucilaginous structures rapidly disappear in water and are not preserved in dried material.

Ascophanus cinereus (Crouan) Boud. may be a variation of the same species in which the episporium is only poorly developed or preserved.

Chenantais (1918: 39) considered Hansen's species a variety of *Thecotheus cinereus* (Crouan) Chenant. which name he misapplied. Le Gal (1961: 443, 1963: 406), who studied the type specimen of *Thecotheus cinereus*, still found some episporial remains and made *Ascophanus holmskjoldii* a synonym of *T. cinereus*.

I could not find any episporial granules in Crouan's material.

In the original drawing by Crouan which was made from fresh material, the ascospores are completely smooth, too.

incanus. — *Ascobolus* (*Ascophanus*) *incanus* Phill. *in* Grevillea **5**: 117 *pl. 88 f. 10.* March. 1877. — *Ascophanus incanus* (Phill.) Sacc., Syll. Fung. **8**: 529. 1889. — Type locality: Blue Canon, Sierra Nevada Mountains, California, U.S.A.

When Philips described *Ascobolus incanus*, the same species had been described two months earlier by Hansen (1877: 84) as *Ascophanus holmskjoldii*. It is, therefore, a later synonym of that species.

incolor. — *Ascobolus incolor* Quél. *in* C. r. Ass. franç. Avanc. Sci., Congr. Reims

1880: 674 *pl. 9 f. 17*. 1881; Quél. *in* Rev. mycol. **13**: 63. 1882. — Type specimen: not known to be in existence. — Type locality: Doubs, France.

The description leaves no doubt but that this is a species of *Ascobolus*. Because of the lack of sufficient characters its position in the genus remains doubtful. No author has as yet given an interpretation of this fungus. Quélet's original description runs:

"Cupule turbinée (0 m 002–3), tendre, épaisse, glabre, blanchâtre ou opaline, avec une marginelle *crénelée-furfuracée* d'un incarnat grisâtre. Hymenium concave puis plan, subtilement voilé d'une cortine fugace, blanchâtre puis pointillé de violet. Spore ellipsoïde oblongue (0 mm 025), réticulée-veinée, d'un beau violet."

"*Printemps*. — Sur les troncs de choux pourrissants. Il a l'aspect de *helotium clavus*."

indicus. — *Ascobolus indicus* Sanwal *in* Sydowia **7**: 202 *fs. 5–9*. 1953. — Type specimen: not known to be in existence. Type locality: Delhi, India.

Because of the very insufficient description and the lack of an available type specimen this is a nomen dubium.

Sanwal (l.c.) recorded oidia and chlamydospores for this species of *Ascobolus*.

inquinans. — *Peziza inquinans* Pers. *in* Neues Mag. Bot. (ed. Römer) **1**: 113. 1794; Pers., Syn. Fung. 631. 1801 (devalidated name). — *Ascobolus inquinans* (Pers.) Nees, Syst. Pilze Schwämme 268 *pl. 39 f. 296*. 1817 (devalidated name). — *Peziza inquinans* Pers. *per* Hook., Fl. scot. **2**: 32. May 1821. — *Bulgaria inquinans* (Pers. per Hook.) Fr., Syst. mycol. **2**: 167. 1822. — *Phaeobulgaria inquinans* (Pers. per Hook.: Fr.) Nannf. *in* Nova Act. Soc. Sci. upsal. IV **8**: 311. 1932. — Type locality: presumably Germany.

There are two different views as to the genus in which this species should be placed. The problem hinges on the typification of the genus *Bulgaria* Fr.

According to Brogniart (1824: 572; reprint: 83), Saccardo (1884: 249), Boudier (1885: 113), Clements & Shear (1931: 313), and Korf (1957: 105) *Peziza inquinans* is the type of the name *Bulgaria* Fr. and therefore the correct name should be *Bulgaria inquinans* (Pers. per Hook.) Fr.

According to Seaver (1932: 253) and Nannfeldt (1932: 310), however, the type of *Bulgaria* Fr. is *Burcardia globosa* Schmidel and *Peziza inquinans* Pers. the type of *Phaeobulgaria* Seaver. In the latter case the name should be *Phaeobulgaria inquinans* (Pers. per Hook.) Nannf.

The first point of view was amply discussed in a paper by Korf (1957: 102–5), which is based on Brogniart's choice of *Peziza inquinans* Pers. as the type of *Bulgaria* Fr.

A year before Brogniart, however, Ficinus & Schubert (1823: 463, 465) excluded

Peziza inquinans Pers. from *Peziza* section *Burcardia* (Schmidel) Pers., the name of which section is an isonym of *Bulgaria* Fr.

When Fries (1822: 166) published *Bulgaria*, it was clear that he merely introduced a new name for *Burcardia* Schmidel (1797), which was preoccupied by *Burcardia* Schreber (1789) and *Burcardia* Gmelin (1791). Fries's name recalls the sack-shaped form (bulga = leather sack): "Nomen dedi ob formam saccatum, cum Burcardiae plantae phanerogamae jam impositum." Of the two species of *Burcardia* described by Schmidel, only *Burcardia globosa* agrees strikingly with this form in this respect (Schmidel 1797: *pl. 69 f. 1–13*).

Schmidel appended the discussion on *Burcardia* as No. 5 of his "observationes" to *Burcardia globosa*.

Persoon (1801: 632) changed *Peziza burcardia* Pers. into *Burcardia globosa*.

These facts support the typification of *Bulgaria* by *Burcardia globosa*.

Since *Voeltzkowiella* P. Henn. (Hennings 1908: 31) is a nomen dubium (von Höhnel 1911: 175; Clements & Shear 1931: 313; Korf 1957: 104), *Peziza inquinans* should be placed in the genus *Phaeobulgaria* Seaver.

insignis. — *Ascobolus insignis* Crouan *in* Annls Sci. nat. (Bot.) IV **10**: 196 *pl. 13 H f. 38–43*. 1858. — *Humaria stercorea* var. *insignis* (Crouan) Quél., Ench. Fung. 286. 1886. — *Lachnea insignis* (Crouan) Sacc., Syll. Fung. **5**: 181. 1887. — *Cheilymenia insignis* (Crouan) Boud., Hist. Class. Disc. Eur. 63. 1907. — *Dasyobolus insignis* (Crouan) Le Gal *in* Annls Sci. nat. (Bot.) XII **1**: 455. 1961. — Type: *Crouan*, on cow dung, *s. loc.* XII. 1857 (CONC-A2394).

Boudier (1869: 257) excluded this species from his "Ascobolei", because the asci did not protrude and transferred it to *Cheilymenia* Boud. (Boudier 1907: 63).

Le Gal (1961: 455) studied specimens in Crouan's herbarium where she found ascospores having a sculpture typical of *Ascobolus* and placed the species in *Dasyobolus* Sacc.

In my opinion this species belongs to the hairy Humariaceae and agrees best with the generic description of *Cheilymenia* Boud. although this was strongly disputed by Le Gal. This conclusion is supported by the cylindrical, non-amyloid, and not protruding asci; the paraphyses with bright yellowish-orange contents; the smooth, uniseriate ascospores with only the contents coloured; and finally the thick-walled, rigid, brown hairs with strongly lobed bases. All these characters are shown in the original material of the Crouans and also illustrated in their coloured drawings drawn from fresh material.

Some of the apothecia of the specimens cited by Le Gal were found to be covered externally with ascospores of species of *Ascobolus*.

jungermanniae. — *Peziza jungermanniae* Nees *ex* Fr. Syst. mycol. **2** (1): 144. 1822. — *Ascobolus jungermanniae* (Nees ex Fr.) Berk. & Broome *in* Ann. Mag. nat.

Hist. Ser. III **15**: 447. 1865. — *Mollisia jungermanniae* (Nees ex Fr.) Rehm, Rab. Krypt. Fl., Pilze **3**, 548. — *Mniaecia jungermanniae* (Nees ex Fr.) Boud., Icon, mycol., Liste des espèces figurées dans la série II (p. 2). 1905. — Type locality: Germany.

This species belongs to *Mniaecia* Boud., a genus of the Lecanorales (Nannfeldt 1932: 326).

kerverni var. **anserinus.** — *Saccobolus kerverni* var. *anserinus* Vel., Monogr. Discom. Boh. **1**: 370. 1934. — Type specimen: non-existent. — Type locality: near Mnochovice, Bohemia, Czechoslovakia.

The very insufficient description and the lack of a type specimen make this a nomen dubium.

kerverni forma **minor.** — *Saccobolus kerverni* forma *minor* Rayss *in* Palest. J. Bot., J. Ser. **4**: 73. 1947 (without Latin diagnosis, a nomen nudum). — Type locality: Jerusalem, Israel.

According to the "International Code of Botanical Nomenclature" this name is not validly published and need not be taken into consideration from a nomenclative point of view. Moreover, judging from the description, the taxonomic position of this fungus in the genus *Saccobolus* is doubtful.

kerverni forma **vaccae.** — *Saccobolus kerverni* forma *vaccae* is a name used in the herbarium of von Thümen.

lacteus. — *Ascobolus* (*Ascophanus*) *lacteus* Cooke & Phill. *apud* Cooke, Fungi brit. exs. No. 560. 1872; Cooke *in* Grevillea **5**: 119. 1877. — *Ascophanus lacteus* (Cooke & Phill. apud Cooke) Sacc., Syll. Fung. **8**: 528. 1889. — Type locality: Shrewsbury, British Isles.

A species of *Ascophanus* Boud.

lapponicus. — *Ascobolus lapponicus* P. Karst. *in* Notis. Sällsk. Faun. Fl. fenn. Förh. **11**: 204. 1870. — Type locality: near Kola, Finland.

Judging from the very short description by Karsten, this fungus very probably belongs to *Ascobolus*.

The substratum of the type specimen in Karsten's herbarium shows only a few fruit-bodies of *Saccobolus versicolor*, a species that does not fit in with Karsten's description of *Ascobolus lapponicus*. So there is ample reason to consider that *Ascobolus lapponicus* should be a nomen dubium.

leporinus. — *Ascobolus leporinus* Vel., Nov. Mycol. 201. 1939. — Type: PR 150301.

Since no fruit-bodies could be found on the substratum in the type package and Velenovský's description is completely inadequate, this must be regarded as a nomen dubium.

leporinus. — *Saccobolus leporinus* Vel., Monogr. Discom. Boh. 370. 1934. — Type specimen: non-existent. — Type locality: near Mnichovice, Bohemia, Czechoslovakia.

This fungus is probably related to *Saccobolus dilutellus*, but the description by Velenovský is too inadequate to place it. *Saccobolus leporinus* must be treated as a nomen dubium.

leporum. — *Peziza granulosa* var. *ββ, leporum* Alb. & Schw., Consp. Fung. 337. 1805 (devalidated name). — *Peziza granulosa* var. *leporum* Alb. & Schw. *per* Pers., Mycol. eur. **1**: 298. 1822. — *Peziza leporum* (Alb. & Schw. per Pers.) Fuck., Fungi rhen. No. 1877. 1866. — *Ascobolus leporum* (Alb. & Schw. per Pers.) Fuck. *in* Jb. nassau. Ver. Naturk. **23–24**: 288. 1870. — *Humaria leporum* (Alb. & Schw. per Pers.) Quél., Ench. Fung. 291. 1886. — *Coprobia leporum* (Alb. & Schw. per Pers.) Boud., Hist. Class. Discom. Eur. 69. 1907. — *Fimaria leporum* (Alb. & Schw. per Pers.) Vel., Monogr. Discom. Boh. **1**: 331. 1934. — Type locality: Ober Lausitz, Germany.

This species belongs to *Fimaria* Vel. A description has been given in a previous paper (van Brummelen 1962b: 324).

leveillei Crouan. — *Ascobolus leveillei* Crouan, Fl. Finistère 57 *pl. suppl. f. 1* 1867; not *Ascobolus leveillei* Boud. *in* Annls Sci. nat. (Bot.) V **10**: 225 *pl. 7 f. 16.* 1869; nor *Ascobolus leveillei* Renny *in* J. Bot. (Lond.) **12**: 356 *pl. 154 fs. 1–5.* 1874. — *Thecotheus leveillei* (Crouan) Lamb, Fl. mycol. Belge, Suppl. **I**: 282. 1887. — *Comesia leveillei* (Crouan) Sacc., Syll. Fung. **8**: 468. 1889. — Type (lectotype): *Crouan*, on dung of field-mouse, Kervalon, Finistère, France, 17.I.1862 (CONC-A2381).

This fungus is characterized by cigar-shaped, 48-spored asci, showing a ring near the apex and opening by a bilabiate split. The spindle-shaped ascospores measure 12–14.5 × 2.5–4 *μ*.

It is a typical representative of *Ascozonus* (Renny) Boud. In fact it is the first described species of that genus. The correct name for it is **Ascozonus leveillei** (Crouan) Brumm., *comb. nov.* [not *Ascozonus leveillei* (Renny) Schroeter *in* Bot. Jb. (ed. Just) **2**: 283. 1876 (incidental mention, not validly published)].

leveillei Renny. — *Ascobolus leveillei* Renny *in* Trans. Woolhope Nat. Field Club

1873: 130 *plate opposite page 130 fs. 1–5.* 1873; Renny *in* J. Bot. (Lond.) **12**: 356 *pl. 154 fs. 1–5.* 1874; not *Ascobolus leveillei* Crouan, Fl. Finistère 57 *pl. suppl. f. 1.* 1867; nor *Ascobolus leveillei* Boud. *in* Annls Sci. nat. (Bot.) V **10**: 225 *pl. 7 f. 16.* 1869. — *Ascozonus leveillei* (Renny) Schroeter *in* Bot. Jb. (ed. Just) **2**: 283. 1876 (incidental mention, not validly published). — *Rhyparobius leveilleanus* (Renny) Phill., Brit. Discom. 301. 1887, name change. — *Ascozonus leveilleanus* (Renny) Boud., Hist. Class. Discom. Eur. 79. 1907. — Type locality: Hereford, British Isles.

The correct name for this species is *Ascozonus leveilleanus* (Renny) Boud.

lignatilis var. **exiguus.** — *Ascobolus lignatilis* var. *exiguus* Vel., Novit. Mycol. 201. 1939. — Type specimen: PR 150317 (destroyed by insects). — Type locality: "Strnad", Božkov, near Mnichovice, Bohemia, Czechoslovakia.

This fungus is probably related to *Ascobolus costantinii*, but the lack of a type specimen and the inadequate description make it impossible to place it. A nomen dubium.

lignieri. — *Ascobolus lignieri* L. Corbière *in* Mém. Soc. nat. Sci. nat. math. Cherbourg **45**: 91. "1951" (without latin diagnosis, a nomen nudum). — Type locality: "la Manche", France.

According to the "International Code of Botanical Nomenclature" this name is not validly published and need not be considered from a nomenclative point of view. The highly insufficient description, lacking all essential characters, makes it impossible even to guess at the genus.

lilacinus. — *Ascobolus lilacinus* Cooke *in* Greveillea **21**: 74. 1893. — *Ascophanus lilacinus* (Cooke) Sacc., Syll. Fung. **11**: 421. 1895. — Type locality: Poughkeepsie, New York, U.S.A.

This species belongs to *Ascophanus* Boud.

marginatus Pat. — *Ascobolus marginatus* Pat. *in* Rev. mycol. **4**: 211. 1882; not *Ascobolus marginatus* Schum., Enum. Pl. Saell. **2**: 437. 1803 (devalidated name); nor *Ascobolus marginatus* Mass. *in* Grevillea **22**: 98. 1893. — Type specimen: not known to be in existence. — Type: represented by Patouillard, op. cit., *pl. 32 f. F a.* — Type locality: Poligny, France.

Because of the lack of authentic material it is not possible to establish the exact position of this species in *Ascobolus*. However, judging from the description, it is likely that it is a synonym of *Ascobolus lignatilis*.

marginatus Mass. — *Ascobolus marginatus* Mass. ≡ *Ascobolus masseei.*

masseei. — *Ascobolus marginatus* Mass. *in* Grevillea **22**: 98. 1893; not *Ascobolus marginatus* Schum., Enum. Pl. Saell. **2**: 437. 1803 (devalidated name); nor *Ascobolus marginatus* Pat. *in* Rev. mycol. **4**: 211. 1882. — *Ascobolus masseei* Sacc. & Syd. *in* Syll. Fung. **14**: 794. 1899 (name change). — Type: not known to be in existence. — Type locality: Kew, England.

Massee's description runs:

"Ascophore sessile, at first almost globose, then becoming narrowed at the base, apex truncate, disc at length quite plane, bounded by a slightly raised, blunt margin, soft and pellucid, almost hyaline or with a slight tinge of olive, quite glabrous; ½–1 mm across; excipulum parenchymatous, cells almost regularly hexagonal, 10–16 μ diameter; asci clavate, apex slightly narrowed, pedicel short, slender, 8-spored, slightly projecting above the surface of the disc at maturity, 8-spored; spores irregularly 2-seriate, elliptical ends rather acute, continuous, epispore persistently smooth, pale rosy violet, then purple-brown, 15–16 × 6–7 μ; paraphyses hyaline, septate, about 2 μ thick, apex not thickened; hypothecium minutely parenchymatous."

"On dung of ass. Kew."

This fungus is known to me from the cited description only. It may be a good species of *Ascobolus*, distinguished by the small, perfectly smooth ascospores, perhaps to be placed in section *Dasyobolus* close to *Ascobolus mancus*. The slightly raised, blunt margin and the disc, which becomes quite flat, does not fully agree with such a disposition.

The species needs further study.

megalospermus. — *Ascobolus megalospermus* Speg. *in* An. Mus. nac. B. Aires **6**: 307. 1899. — Type: *Spegazzini*, on dung of *Hydrochoeris capybaris*, near Colonia Resistencia, Chaco, Argentina, I. 1887 (LPS 28164, as *Ascophanus megaloporus*).

Ascobolus megalospermus is a nomen confusum, which should be rejected. The description is based on two different elements: immature apothecia of *Ascobolus scatigenus* and ascospores of *Ascobolus immersus*.

In the type specimen both species were found mixed. Of *Ascobolus immersus* the immersed apothecia measured 0.3–0.6 mm across, while the ascospores were 54–69 × 34–37 μ.

melanospermus. — *Peziza melanosperma* Crouan, Fl. Finistère 50. 1867. — *Ascobolus melanospermus* (Crouan) Gill., Discom. 139. 1883. — *Phaeopezia melanosperma* (Crouan) Sacc., Syll. Fung. **8**: 471. 1889. — *Plicaria melanosperma* (Crouan) Boud.,

Hist. Class. Discom. Eur. 50. 1907. — Type: in Herbier Crouan (CONC) (see Le Gal 1953: 75). — Type locality: Morlaix, Finistère, France.

Regarded by Le Gal (1953b: 75) as a synonym of *Plicaria trachycarpa* (Curr.) Boud.

microscopicus Crouan. — *Ascobolus microscopicus* Crouan *in* Annls Sci. nat. (Bot.) IV **7**: 175 *pl. 4 E fs. 20–23.* 1857; not *Ascobolus microscopicus* (Wallr.) Sacc., Syll. Fung. **8**: 524. 1889. — *Boudiera microscopica* (Crouan) Cooke *in* Grevillea **6**: 76. 1877. — *Ascodesmis microscopica* (Crouan) Seaver *in* Mycologia **8**: 3. 1916 (misapplied). — Type: *Crouan*, on album graecum, near Brest, Finistère, France, *s. dat.* (PC-A2351).

This name was misapplied by Seaver (1916: 3). The species, he described as *Ascodesmis microscopica*, has spherical ascospores and was described by Obrist (1961: 948) as *Ascodesmis sphaerospora* Obrist.

Le Gal (1949: 93) published a description of Crouan's species drawn up from the type specimen. It is one of the most common species of *Ascodesmis* Tiegh.

microscopicus Wallr. — *Peziza microscopica* Wallr., Fl. crypt. Germ. **2**: 480. 1833; not *Peziza microscopica* Wallr., Fl. crypt. Germ. **2**: 471. 1833. — *Ascobolus microscopicus* (Wallr.) Sacc., Syll. Fung. **8**: 524. 1889; not *Ascobolus microscopicus* Crouan *in* Annls Sci. nat. (Bot.) IV **7**: 175. 1857. — *Lasiobolus microscopicus* (Wallr.) Rehm, Rab. Krypt.-Fl., Pilze **3**: 1098. 1895. — Type: not known to be in existence. — Type locality: Thüringen, Germany.

It is not possible to establish the genus from Wallroth's brief description. *Ascobolus* is a very unlikely genus for it and the arachnoid hairs at the base do not agree with *Lasiobolus* Sacc. A nomen dubium.

microspermus. — See under 'viridis subsp. microspermus'.

microsporus. — *Ascobolus microsporus* Berk. & Broome *in* Ann. Mag. nat. Hist. III **15**: 449. 1865; not *Ascobolus microsporus* Vel., Monogr. Discom. Boh. 365. 1934. — *Ascophanus microsporus* (Berk. & Broome) E. C. Hansen *in* Vidensk. Meddr naturhist. For. 1876: 287. 1877. — Type distribution (lectotype): Rabenhorst, Fungi eur. No. 977.

This is a very common species of *Ascophanus* Boud.

miniatus Preuss. — *Ascobolus miniatus* Preuss *in* Linnaea **24**: 147. 1851; not *Ascobolus miniatus* Crouan *in* Annls Sci. nat. (Bot.) IV **10**: 197. 1858. — *Ascophanus*

miniatus (Preuss) Sacc., Syll. Fung. **8**: 535. 1889. — Type: *Preuss 581*, on dirtied pieces of bark of walnut tree (*Juglans*), Hoyerswerda, Germany, 1844 (B).

The study of the type proved that this is a synonym of *Ascophanus carneus* (Pers. per Pers.) Boud. The fruit-bodies had grown on a layer of dirt or mud covering pieces of bark of a walnut tree.

miniatus Crouan. — *Ascobolus miniatus* Crouan *in* Annls Sci. nat. (Bot.) IV **10**: 197 *pl. 13 I fs. 44–47*. 1858; not *Ascobolus miniatus* Preuss *in* Linnaea **24**: 147. 1851. — *Crouania miniata* (Crouan) Fuck. *in* Jb. nassau. Ver. Naturk. **23–24**: 320. 1869. — *Humaria miniata* (Crouan) Quél., Ench. Fung. 288. 1886. — *Barlaea miniata* (Crouan) Sacc., Syll. Fung. **8**: 111. 1889. — *Plicariella miniata* (Crouan) Lindau *in* Engler & Prantl., Natürl. PflFam. I **1**: 180. 1897. — *Detonia miniata* (Crouan) Rehm *apud* Dodge *in* Trans. Wiscons. Acad. Sci. **17**: 1037. 1914. — Type (lectotype): *Crouan*, on soil among small mosses, Brest, Finistère, France (PC-A2352). → *Ascobolus crouanii* Cooke.

This species is the type of the generic names *Crouania* Fuck., *Barlaea* Sacc. and *Barlaeina* Sacc. The generic name *Lamprospora* De Not., based on *Lamprospora miniata* De Not., a closely related if not conspecific fungus, has priority over these names. The correct name for the species is *Lamprospora crouani* (Cooke) Seaver.

minutellus. — *Ascobolus minutellus* P. Karst. *in* Notis. Sällsk. Fauna Fl. fenn. Förh. **11**: 206. 1870. — *Peziza minutella* (P. Karst.) P. Karst. *in* Bidr. Känn. Finl. Nat. Folk **19**: 51. 1871. — *Ascophanus minutellus* (P. Karst.) P. Karst. *in* Acta Soc. Fauna Fl. Fenn. II **6**: 121. 1885. — Type locality: Mustiala, Finland.

This species belongs to *Ascophanus* Boud. (see also Saccardo, 1889: 531; Rehm, 1895: 1090; and Boudier, 1907: 77).

minutissimus. — *Ascophanus minutissimus* Boud. *in* Annls Sci. nat. (Bot.) V **10**: 243 *pl. 10 f. 29*. 1869. — *Ascobolus minutissimus* (Boud.) Quél., Ench. Fung. 296. 1886. — Montmorency, France.

A species of *Ascophanus* closely related to or perhaps even conspecific with *Ascophanus microsporus* (Berk. & Broome) E. C. Hansen.

mirabilis. — *Ascobolus mirabilis* Dangeard *in* Botaniste **10**: 321 *pls. 67–70*. 1907. — Type: represented by Dangeard, l.c. — Type locality: Laboratoire Botanique (culture), Poitiers, France.

This fungus cannot be recognized in Dangeard's description, which was made from incompletely developed material, without ripe asci and ascospores. A nomen dubium.

moellerianus. — *Ascobolus moellerianus* P. Henn. *in* Hedwigia **41**: 31. 1902. — Type specimen: very probably destroyed with the herbarium in Berlin during the last world-war. — Type locality: Sta. Catarina., near Blumenau, Brazil.

Hennings's description runs:

". . .; ascomatibus carnosis sessilibus, primo clausis subglobosis, dein cupulatis, extus levibus, brunneis ca. 2½–3 mm diametro, disco concavo, brunneo, margine crasso, levi; ascis clavatis apice applanatis vel obtuso-rotundatis, basi attenuatis curvulis, 170–200 × 18–22 μ, 8-sporis; paraphysibus filiformibus apice paulo clavatis, 3½–4 μ crassis, flavidulis; sporis oblonge ellipsoideis utrinque obtusis, primo flavis dein castaneis, 20–28 × 18–15 μ, levibus."

"St. Cathar. bei Blumenau auf der Strasse auf Kuhmist. 22. März 1891. No. 471."

This description leaves no doubt but that this is a species of *Ascobolus*. If the data are correct, it may even be a 'good' species. But because of the lack of material it is impossible to place Henning's species. A nomen inquirendum.

myriadeus. — *Ascobolus myriadeus* P. Karst., Fungi Fenn. exs. No. 552. 1866 (pro parte: the fungus with 48- to 64-spored asci). Type locality: near Wasa, Finland.

This fungus was identified with *Rhyparobius crustaceus* (Fuck.) Rehm by both Karsten (1871: 81) and Rehm (1895: 1103).

myriadeus. — *Ascobolus myriadeus* P. Karst., Fungi Fenn. exs. No. 552. 1866 (pro parte: the fungus with 24- to 32-spored asci). — *Ascobolus crustaceus* subsp. *myriadeus* P. Karst. *in* Notis Sällsk. Fauna Fl. fenn. Förh. **11**: 208. 1870. — *Pezizula myriadea* (P. Karst.) P. Karst. *in* Bidr. Känn. Finl. Nat. Folk. **19**: 81. 1871. — *Rhyparobius crustaceus* var. *myriadeus* (P. Karst.) Sacc., Syll. Fung. **8**: 539. 1889. — Type locality: near Wasa, Finland.

This fungus belongs to *Rhyparobius* Boud. and differs from *R. crustaceus* (Fuck.) Rehm only by the number of ascospores in an ascus.

myriosporus. — *Nectria myriospora* Crouan, Fl. Finistère 37 *suppl. pl. f. 15.* 1867. — *Rhyparobius myriosporus* (Crouan) Boud. in Annls Sci. nat. (Bot.) V **10**: 240. 1869. — *Chilonectria myriospora* (Crouan) Sacc. *in* Michelia **1**: 279. 1878. — *Ascobolus myriosporus* (Crouan) Quél., Ench. Fung. 296. 1886. — Type locality: Finistère, France.

According to Crouan (l.c.) this species has 100–150 ascospores in an ascus. Boudier (1869: 241) described it with 200–250 ascospores. It belongs to *Rhyparobius* Boud. and is related to *Thelebolus* Tode.

nitidus Fuckel. — *Ascobolus nitidus* Fuck. *in* Hedwigia **5**: 4 *pl. 1 f.* **4**. 1866; not *Ascobolus nitidus* Rodway *in* Pap. Proc. roy. Soc. Tasmania 1920: 153. 1921. — *Ascophanus nitidus* (Fuck.) Speg. *in* Michelia **1**: 235. 1878. — Type locality: Oestrich, Germany.

From Fuckel's insufficient description it seems likely that this is a species of *Ascophanus* Boud. (Spegazzini, l.c.; Saccardo, 1889: 529; Rehm, 1895: 1095; Boudier, 1907: 77), though a doubtful species; it is perhaps related to *Ascophanus carneus* (Pers. per Pers.) Boud.

nitidus Rodway. — *Ascobolus nitidus* Rodway *in* Pap. Proc. roy. Soc. Tasmania 1920: 153. 1921; not *Ascobolus nitidus* Fuck. *in* Hedwigia **5**: 4 *pl. 1 f. 4.* 1866. — Type: not known to be in existence. — Type locality: Cascades Hobart, Tasmania Australia.

This fungus "with oblong, uniseptate, smooth, sooty-black ascospores and pyriform asci" should be excluded from the Ascobolaceae and even from the operculate Discomycetes. To be considered a nomen dubium because of the highly insufficient description.

niveus. — *Ascobolus niveus* Fuck. *in* Hedwigia **5**: 4 *pl. 1 f. 3.* 1866; Fuck. *in* Jb. nassau. Ver. Naturk. **23–24**; 289. 1870; Fuck., Fungi rhen. No. 2375. 1871 (not the type); not *Ascobolus niveus* Quél. *in* C.r. Ass. franç. Avanc. Sci. (Congr. Reims, 1880) **9**: 674 *pl. 9 f. 18.* 1881. — *Rhyparobius niveus* (Fuck.) Sacc., Syll. Fung. **8**: 544. 1889. — *Ascozonus niveus* (Fuck.) Boud., Hist. Class. Discom. Eur. 79. 1907. — Type locality: Rabenkopf, Germany.

Boudier made an error when he included this species in *Ascozonus* (Renny) Boud.; in his figure Fuckel clearly indicated the large operculum of the ascus. This recalls the genus *Rhyparobius* Boud.

ochraceus. — *Ascobolus ochraceus* Crouan, Fl. Finistère 57. 1867. — *Ascophanus ochraceus* (Crouan) Boud. *in* Annls Sci. nat. (Bot.) V **10**: 247. 1869. — Type specimen: destroyed by insects (CONC-A2411). — Type locality: Finistère, France.

A species of *Ascophanus* Boud.

papillatus. — *Peziza papillata* Pers. *in* Neues Mag. Bot. **1**: 114. 1794 (= Tent. disp. Fung. 34. 1797); Pers., Syn. Fung. 650. 1801 (devalidated name). — *Peziza papillata* Pers. *per* Pers., Mycol. eur. **1**: 254. 1822; Fries, Syst. mycol. **2**: 88. 1822. — *Ascobolus papillatus* (Pers. per Pers.) Wallr., Fl. crypt. Germ. **2**: 514. 1833. — *Ascophanus papillatus* (Pers. per Pers.) Boud. *in* Annls Sci. nat. (Bot.) V **10**: 252. 1869. —

Lasiobolus papillatus (Pers. per Pers.) Sacc. *in* Bot. Cbl. **18**: 220. 1884. — *Ascobolus pilosus* var. *papillatus* (Pers. per Pers.) Quél., Ench. Fung. 297. 1886. — Type: not known to be in existence. — Type locality: presumably Germany.

This fungus must be excluded from *Ascobolus*. There is some doubt about its identity. Many authors regarded it as a synonym of *Lasiobolus equinus* (O. F. Müller per Pers.) P. Karst. (Karsten, 1870: 209; 1871: 73; 1885: 122; Schroeter, 1893: 54; Rehm, 1895: 1096; Seaver, 1928: 155).

According to Boudier (1869: 252), however, it is a flesh-coloured fungus covered with septate hairs. Although the fungus Boudier described under this name seems to agree better with Persoon's short description, it is impossible to establish the identity with certainty. I regret, that I do not know the fungus described by Boudier.

parasiticus. — *Ascobolus parasiticus* Wolk *in* Mycol. Cbl. **4**: 240 *unnumbered plate opposite page 241 fs. 7–9.* 1914. — Type: not known to be in existence. — Type locality: Buitenzorg (= Bogor), Java, Indonesia.

The fungus that van der Wolk studied belongs to *Ascobolus*. The description and illustrations are extremely poor. "There is nothing very interesting about it to say here, since it corresponds to the usual type."

To be considered a nomen dubium. According to van der Wolk this fungus has two "by-fruit forms" (imperfect states): *Rhizostilbella rubra* Wolk and *Sclerotium omnivorum* Wolk.

parvisporus. — *Ascobolus parvisporus* Renny *in* Trans. Woolhope Nat. Fld Club. 1872–3: 131 *pl. 3 fs. 1–5.* 1873; Renny *in* J. Bot. Lond. **12**: 356 *pl. 156 fs. 1–5.* 1874; not *Ascobolus parvisporus* Boud., Icon. mycol., ser. I, livr. 2, liste prélim. champ., unumbered page. 1904. — *Rhyparobius parvisporus* (Renny) Phill., Brit. Discom. 303. 1887. — *Ascozonus parvisporus* (Renny) Schroet. *in* Bot. Jber. (ed. Just) **2**: 283. 1876 (incidental mention: not validly published); Boud., Hist. Class. Discom. Eur. 79. 1907. — Type locality: Hereford, British Isles.

A representative of *Ascozonus* (Renny) Boud.

pelletieri. — *Ascobolus pelletieri* Crouan *in* Annls Sci. nat. (Bot.) IV **7**: 173 *pl. 4 A fs. 1–4.* 1857. — *Thecotheus pelletieri* (Crouan) Boud. *in* Annls Sci. nat. (Bot.) V **10**: 236. 1869. — *Pezizula pelletieri* (Crouan) Speg. *in* Michelia **1**: 238. 1879. — *Rhyparobius pelletieri* (Crouan) Sacc. *in* Michelia **1**: 605. 1879. — Parts of type: *Crouan*, on cow dung in a marsh, near Brest, Finistère, France, 20.VI.1857 (lectotype, PC-A2353); *Crouan*, on horse dung and old cow dung in marshes and meadows near Brest, Finistère, France, spring, autumn (cotype, CONC-A2390c).

For this species Boudier introduced the new genus *Thecotheus* Boud. Le Gal

(1961: 447), studied two specimens of this species in the herbarium of the Crouans also and maintained it as a good genus, clearly distinct from the genus *Rhyparobius* Boud.

The position of this genus in the Theleboloideae and its relationship to the other genera of this subfamily are not yet well understood.

persoonii. — *Ascobolus persoonii* Crouan, Fl. Finistère 56. 1867. — *Humaria persoonii* (Crouan) Quél. *in* C.r. Ass. franç. Avanc. Sci. (Congrès Grenoble, 1885) **14**: 451. 1886. — *Barlaea persoonii* (Crouan) Sacc., Syll. Fung. **8**: 116. 1889 (misapplied). — *Plicaria persoonii* (Crouan) Boud., Ic. mycol. sér. I, livr. 2, Liste prélim. champ., unnumbered page. 1904. — *Barlaeina persoonii* (Crouan) Sacc. & Trav. *in* Syll. Fung. **19**: 140. 1910 (misapplied). — Lectotype: *Crouan*; on soil of excavation among small mosses, "Moulin à poudre", Finistère, France, 12.X.1866 (CONC-A2413 in part; only the rough-spored fungus).

Under this epithet two closely related fungi are described in literature, a rough-spored one (Crouan, 1867: 56; Boudier, Ic. mycol. *pl. 308*; Velenovský, 1934: 321; Le Gal, 1947: 108, *f. 8 H*) and a smooth-spored one (Saccardo, 1889: 166; Rehm, 1894: 929; Lagarde, 1911: 41, *pl. 1*; Le Gal, 1953b: 75).

The same fungi have also been described as *Peziza violascens* Cooke (Cooke, 1876: 46, rough-spored; Phillips, 1887: 88, smooth-spored), *Humaria violascens* (Cooke) Quél. (Quélet, 1880: 234, rough-spored), *Humaria persoonii* var. *amethystina* Quél. (Quélet, 1886: 451, rough-spored) and *Barlaea amethystina* (Quél.) Sacc. (Saccardo 1889: 116, rough-spored).

Macroscopically both fungi look strikingly similar, microscopically there is only significant difference in the ascospore-sculpture. The rough-spored fungus shows ascospores with an almost complete net-work of ridges with stronger elevations at the points of intersection, while in the smooth-spored fungus the ascospores are always completely smooth.

A complication arose when it was found that both fungi grew together in the Crouan's original specimen. Le Gal (1953b: 75), studied this specimen and described only the smooth-spored fungus, which she considered to belong to *Ascobolus persoonii* Crouan sensu Crouan. There can, however, be no doubt that the fungus described by the Crouans had rough ascospores. In the description they call the ascospores "granuleuses", while in the small drawing after the original material in their herbarium the ascospores clearly show a net-work. So the material of the rough-spored fungus should be considered lectotype.

Peziza violascens Cooke has to be considered a name change for *Ascobolus persoonii* Crouan to avoid homonomy with *Peziza persoonii* Moug. apud Pers. The first part of Cooke's description is a translation in Latin from the description by the Crouans. The specimens figured by Cooke were sent by Phillips and represent the smooth-spored fungus as described by Phillips (1887: 88). I have examined Phillips' original material preserved at the British Museum.

Humaria persoonii var. *amethystina* seems also to be a synonym of the Crouans' species, as was stated by Boudier (1907: 50).

As pointed out by Le Gal (1953b: 80), these fungi should be placed in a genus other than *Galactinia* (Cooke) Boud. and *Plicaria* Fuck. She suggests that the genus *Barlaeina* Sacc. should be emended to accomodate them. However, if *Barlaeina* Sacc. were to be emended thus, then the type species of this genus, *Ascobolus miniatus* Crouan, would be excluded. Such action is contrary to the rules of botanical nomenclature. Since *Lamprospora* De Not. is an older typonym of *Barlaeina* Sacc., the latter name should be regulated to the synonymy of the former.

As for *Barlaeina* Sacc. sensu Le Gal no generic name is available, the generic name **Marcelleina** Brumm., Korf & Rifai, dedicated to Dr. Marcelle Le Gal, is proposed.[13] The name for the Crouans' species becomes: **Marcelleina persoonii** (Crouan) Brumm., *comb. nov.*[14]

For the smooth-spored fungus the following names are available: *Peziza atroviolacea* Delile ex de Seynes (1886: 84), *Plicaria planchonis* Boud. (1887: 92), and *Barlaea cookei* Massee apud Crossland (1900: 9). The name **Marcelleina atroviolacea** (Delile ex de Seynes) Brumm., *comb. nov.*[15] is proposed for it.

phasaneus. — *Ascobolus phasaneus* Vel., Monogr. Discom. Boh. **1**: 368. 1934. — Type: not known to be in existence. — Type locality: near Mnichovice, Bohemia, Czechoslovakia.

This is very probably a representative of *Ascobolus* sect. *Dasyobolus*. Since no original material is preserved and the description is insufficiently accurate to establish the identity *Ascobolus phasaneus* Vel. is considered a nomen dubium.

piceus. — [*Peziza picea* Limminghe in Herb. —] *Ascobolus piceus* (Limminghe) *ex* Cooke *in* Grevillea **21**: 74. 1893. — Type: *Limminghe*, on sandy soil, *s. loc.*, I. 1818 ("*Peziza picea* in herb. Limminghe", BM-A2815, K-A1998).

A synonym of *Fimaria hepatica* (Batsch per Pers.) Brumm., a description of which was given in an earlier paper (van Brummelen 1962a: 323).

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[13] Independently and simultaneously the same conclusions were reached by Drs. R. P. Korf and M. A. Rifai in a publication by the latter author now also in press. In joining forces the following new genus is proposed.

Marcelleina Brumm., Korf & Rifai, *gen. nov.*

Apothecia sessilia, interdum ad basin paullo constricta, terricola. Receptaculum carnosum, molle, sat parvum, demum expansum. Discus e plano convexus, violaceus, brunneo-violaceus, brunnescens aut nigrescens, pigmento carotenoideo miniato aut rubro destitutus. Asci cylindracei, operculati, pariete iodo non caerulescente. Ascosporae globulosae, ornatae aut laeves. Paraphyses tenues, apice incrassatae saepe curvatae vel curvulae. Typus: *Ascobolus persoonii* Crouan.

[14] Basionym: *Ascobolus persoonii* Crouan (1867: 56).

[15] Basionym *Peziza atroviolacea* Delile ex de Seynes (1886: 84).

pilosus. — *Ascobolus pilosus* Fr., Syst. mycol. **2** (1): 164. 1822. — *Ascophanus pilosus* (Fr.) Boud. *in* Annls Sci. nat. (Bot.) V **10**: 254. 1869. — *Ascobolus equinus* subsp. *pilosus* (Fr.) P. Karst. *in* Notis. Sällsk. Fauna Fl. fenn. Förh. **10**: 210. 1870. — *Peziza equina* O. F. Müll. var. *pilosus* (Fr.) P. Karst. *in* Bidr. Känn. Finl. Nat. Folk. **19**: 73. 1871. — *Lasiobolus pilosus* (Fr.) Sacc. *in* Bot. Cbl. **18**: 220. 1884. — *Lasiobolus equinus* subsp. *pilosus* (Fr.) P. Karst. *in* Acta Soc. Fauna Fl. fenn. II **6**: 122. 1885. — Type locality: probably Sweden.

This is one of the names given to a very variable species of the genus *Lasiobolus* Sacc. As already noticed by Boudier (1869: 256) this species is best described by Fries (l.c.) under the name *Ascobolus pilosus*:

"En présence des caractères particuliers de cette espèce, j'ai dû accepter le nom de Fries qui l'a le mieux décrite sous le nom d'*Asc. pilosus*; toutefois l'espèce du savant cryptogamiste répond seulement à ma variété A. Quant aux autres synonymes donnés pour les auteurs anciens, il est presque impossible de les déterminer avec certitude absolue, privé que l'on est de planches exactes; je ne les indique donc qu'avec une certaine réserve, quoique ces espèces m'aient paru représenter certaines variétés de l'*Asc. pilosus*."

Lasiobolus pilosus is accepted by me as the correct name for the species in the broad sense (see under 'equinus').

For further discussion on the often cited synonyms *Ascobolus papillatus*, *A. ciliatus*, and *A. equinus*, see there.

polysporus P. Karst. — *Ascobolus polysporus* P. Karst., Fungi Fenn. exs. No. 656. 1867; P. Karst. *in* Not. Sällsk. Fauna Fl. fenn. Förh. **11**: 208. 1870; not *Ascobolus polysporus* Auersw. *in* Hedwigia **7**: 51. 1868. — *Pezizula polyspora* (P. Karst.) P. Karst. *in* Bidr. Känn. Finl. Nat. Folk **19**: 82. 1871. — *Rhyparobius polysporus* (P. Karst.) Speg. *in* An. Soc. cient. argent. **10**: 24. 1880. — Type distribution: P. Karsten, Fungi Fenn. exs. No. 656.

A species of *Rhyparobius* Boud. with 150–200 spores in an ascus.

polysporus Auersw. — *Ascobolus polysporus* Auersw. *in* Hedwigia **7**: 51. 1868; not *Ascobolus polysporus* P. Karst., Fungi Fenn. exs. No. 656. 1867. — Type locality: Rosenthal, Leipzig, Germany.

This species of *Rhyparobius*, with 60 or more spores in an ascus, is generally considered a synonym of *Rhyparobius crustaceus* (Fuckel) Rehm (see Karsten, 1870: 208; Phillips, 1887: 299; Saccardo, 1889: 539; Schroeter, 1893: 52; Rehm, 1895: 1103).

porphyrosporus. — *Octospora porphyrospora* Hedw., Descriptio et adumbratio microsc.-anal. Musc. frond. etc. . . Stirp. crypt. **2**: 25 *pl. 7 f. A.* 1788 (devalidated

name). — *Peziza porphyrospora* (Hedw.) Lam., Encycl. meth. Bot. **4**: 211. 1796 (devalidated name). — *Ascobolus porphyrosporus* (Hedw.) *per* Fr., Syst. mycol. **2** (1): 163. 1822. — *Dasyobolus porphyrosporus* (Hedw. per Fr.) Sacc., Syll. Fung. **11**: 421. 1895. — *Dasyobolus immersus* var. *porphyrosporus* (Hedw. per Fr.) Boud., Hist. Class. Discom. Eur. 73. 1907. — Type; represented by Hedwig l.c.

EXCLUDED: *Ascobolus porphyrosporus* (Hedw.) per Fr. sensu Montagne *in* Annls Sci. nat. (Bot.) II **5**: 284. 1836 (without description) = *Ascobolus boudieri* Quél.

Ascobolus porphyrosporus (Hedw.) per Fr. sensu Fuckel *in* Jb. nassau. Ver. Naturk. **27–28**: 57. 1873 = *Ascobolus rosec purpurascens* Rehm.

Although Hedwig's description and the accompanying microscopical analysis are a sample of, for that time, very advanced methods, there is no acceptable, modern interpretation of his species.

Fuckel's interpretation of the species is not acceptable because it lacks the characteristic soft hairs on the upper part of the excipulum of the fruit-bodies.

Montagne listed *Ascobolus porphyrosporus* as a species new to France after material sent by Lamy from Limoges. However, this material belongs to *Ascobolus boudieri* Quél. which also lacks soft hairs on the upper part to the excipulum and has an entirely different colour of the hymenium.

Rehm (1896: 1123), who merely reproduced Fuckel's description, called the species "Höchst fraglich".

Since there are no sufficient microscopical characters available and no species of *Ascobolus* is known with the type of hairs as described, *Ascobolus porphyrosporus* should be considered a nomen dubium.

pulcherrimus. — *Ascobolus pulcherrimus* Crouan *in* Annls Sci. nat. (Bot.) IV **10**: 196 *pl. 13 G. f. 32–37*. 1858. — *Peziza* (*Sarcoscypha*) *pulcherrima* (Crouan) Cooke, Mycographia 84. 1876. — *Humaria pulcherrima* (Crouan) Speg. *in* Michelia **1**: 37. 1878. — *Lachnea pulcherrima* (Crouan) Gill., Champ. Fr. 76. 1880. — *Humaria stercorea* var. *pulcherrima* (Crouan) Quél., Ench. Fung. 286. 1886. — *Scutellinia pulcherrima* (Crouan) O. Kuntze, Rev. Gen. Pl. **2**: 869. 1891. — *Lasiobolus pulcherrimus* (Crouan) Schroet. *in* Krypt.-Fl. Schles. (ed. Cohn) **3** (2): 54. 1893. — *Cheilymenia pulcherrima* (Crouan) Boud., Hist. Class. Discom. Europ. 63. 1907. — *Patella pulcherrima* (Crouan) Seaver, North Am. Cup-fungi (Op.) 172. 1928. — Type: *Crouan*, on cow dung, Brest, Finistère, France, summer (PC-A2355, CONC-A2388).

As already noticed by Boudier (1869: 257), this species with cylindrical, not protruding asci should be excluded from the Ascobolaceae and placed close to *Peziza subhirsuta* Schum. and *P. stercorea* Pers. Later Boudier (1885: 105) introduced his genus *Cheilymenia* for these three species.

A description drawn up from original material in Herbier Crouan was published by Le Gal (1961: 451), who, like Schroeter (1893: 54) and Rehm (1895: 1098), placed the species in *Lasiobolus* Sacc. She excluded it from *Cheilymenia* because of the

yellowish or yellowish-brown contents of the ascospores and the hairs which are more superficial in origin.

The occurrence of yellowish contents in the ascospores is not restricted to the genus *Lasiobolus*. It is also rather frequent in certain genera of Humariaceae, for instance in *Fimaria* Vel. I could not find any purplish hue in the colour of the ascospores as mentioned by Le Gal. The relationship with *Ascobolus* sect. *Dasyobolus* is not as close as suggested in her paper. The generic limits within the Humariaceae need a profound revision before this species can be adequately placed.

punctiformis P. Karst. — *Ascobolus punctiformis* P. Karst., Fungi Fenn. exs. No. 655. 1867. — *Ascobolus polysporus* P. Karst. subsp. *punctiformis* (P. Karst.) P. Karst. *in* Notis. Sällsk. Fauna Fl. fenn. Förh. **11**: 209. 1870. — *Pezizula polyspora* subsp. *punctiformis* (P. Karst.) P. Karst. *in* Bidr. Känn. Finl. Nat. Folk **19**: 82. 1871. — *Ascophanus punctiformis* (P. Karst.) Sacc., Syll. Fung. **8**: 532. 1889. — Type distribution: P. Karsten, Fungi Fenn. exs. No. 655.

This fungus belongs to *Ascophanus* Boud. and is closely related to *Ascophanus microsporus* (Berk. & Broome) E. C. Hansen.

punctiformis Ces. — *Sordaria punctiformis* Ces. *in* Atti Accad. Sci. fis. mat. Napoli **8** (3): 23. 1879. — *Hypocrea punctiformis* (Ces.) Sacc., Syll. Fung. **1**: 247. 1882. — *Saccobolus punctiformis* (Ces.) Petch *apud* Petch & Bisby *in* Peradeniya Manual **6**: 21. 1950. — Type locality: Pedrotallagalla, Ceylon.

This species should be excluded from the Ascobolaceae. It may be a coprophilous pyrenomycete, but Cesati's description is too short even to guess at the family.

raripilus. — *Ascobolus raripilus* Phill. *in* Grevillea **7**: 23. 1878. — *Lasiobolus raripilus* (Phill.) Sacc., Syll. Fung. **8**: 537. 1889. — *Patella raripila* (Phill.) Seav., North Amer. Cup-fungi (Op.) 173. 1928. — Type locality: California, U.S.A.

This is probably a species of *Lasiobolus* Sacc.

rhizophorus. — *Peziza rhizophora* Willd., Fl. berol. Prodr. 402. 1787 (devalidated name). — *Octospora rhizophora* (Willd.) Hedw., Descr. et adumbr. microsc.-anal. Musc. frond., Stirp. crypt. **2**: 15. 1788 (devalidated name). — *Ascobolus rhizophorus* (Willd.) *per* Spreng., Syst. veg. (C. Linn.) **4** (1): 517. 1827. — Type locality: near Berlin, Germany.

This fungus does not belong to the Ascobolaceae. Fries (1828: 16; 1832: 53) placed it in the synonymy of *Rhizina laevigata* Fr. per Pers.

rhododendri. — *Ascobolus rhododendri* Ellis & Everh. *ex* Cash, Record Fungi named by J. B. Ellis 17. 1952 (nomen nudum, incidental mention). — Type: Nuttall, Flora of Fayette County, W. Va., No. 633 (NY).

The material on which this name was based belongs to *Pestalopezia rhododendri* Seaver.

ruber. — *Ascophanus ruber* Quél. *in* Grevillea **8**: 117 *pl. 131 f. 8.* 1880. — *Ascobolus ruber* (Quél.) Quél., Ench. Fung. 297. 1886. — *Lasiobolus ruber* (Quél.) Sacc., Syll. Fung. **8**: 537. 1889. — Type locality: Jura, France.

This fungus belongs to *Lasiobolus* Sacc.

rufopallidus. — *Ascobolus rufopallidus* P. Karst., Syn. Pez. Ascob. fenn. 44. 1861; P. Karst. *in* Notis. Sällsk. Fauna Fl. fenn. Förh. **11**: 205. 1870. — Type specimen: not known to be in existence. — Type locality: near Kola, Finland.

A species not sufficiently known to Karsten himself. According to the original diagnosis the ascospores finally became black. In a later description based on the same material (Karsten, 1870: 205) the ascospores were described as colourless; no dark spores could be found: "Sporae ex Syn. Pez. Asc. l.c. demum nigrae, sed in speciminibus denuo examinatis incolores mode invenimus. Species ceteroquin ulterius inquirenda."

Karsten (1885: 123) placed this species with doubt in the genus *Ascobolus*. Since no original material is preserved. *Ascobolus rufopallidus* has to be considered a nomen dubium.

saccharinus. — *Ascobolus saccharinus* Berk. & Curr. *apud* Berk., Outl. Brit. Fungol. 374. 1860 (nomen nudum). — *Ascobolus saccharinus* Berk. & Curr. *ex* Cooke *in* J. Bot. (ed. Seemann) **2**: 154 *f. 10.* 1864 (with description and drawing); Berk. & Broome *in* Ann. Mag. Nat. Hist., Ser. III **15**: 450 *pl. 17 f. 36.* 1865. — *Ascophanus saccharinus* (Berk. & Curr. ex Cooke) Boud. *in* Annls Sci. nat. (Bot.) V **10**: 251. 1869. — *Ascobolus carneus* var. *saccharinus* (Berk. & Curr. ex Cooke) Quél., Ench. Fung. 297. 1886. — *Ascophanus carneus* var. *saccharinus* (Berk. & Curr. ex Cooke) Phill., Brit. Discom. 310. 1887. — Type locality: Chiselhurst, Kent, England.

This fungus belongs to *Ascophanus* Boud. It is closely related to, or even conspecific with, *Ascophanus carneus* (Pers. per Pers.) Boud. (Boudier, 1869: 251; Phillips, 1887: 310).

sarcoides. — *Lichen sarcoides* Jacq., Misc. austr. **2**: 378 *pl. 22.* 1781 (devalidated name). — *Peziza sarcoides* (Jacq.) Pers., Syn. Fung. 633. 1801 (devalidated name). —

Ascobolus sarcoides (Jacq.) Nees, Syst. Pilze Schwämme 269. 1816 (devalidated name). — *Octospora sarcoides* (Jacq.) *per* S. F. Gray, Nat. Arr. Brit. Pl. **1**: 667. 1821. — *Bulgaria sarcoides* (Jacq. per S. F. Gray) Fr., Syst. mycol. **2**: 168. 1822. — *Coryne sarcoides* (Jacq. per S. F. Gray) Tul., Sel. Fung. carp. **3**: 190. 1865; not *Coryne sarcoides* (With. per Hook.) Bonord., Handb. allgem. Mykol. 149. 1851 (= imperfect state). — *Sarcodea sarcoides* (Jacq. per S. F. Gray) P. Karst. *in* Notis. Sällsk. Fauna Fl. fenn. Förh. **11**: 232. 1870. — *Ombrophila sarcoides* (Jacq. per S. F. Gray) P. Karst. *in* Bidr. Känn. Finl. Nat. Folk **19**: 86. 1871. — Type: represented by Jacquin l.c. (= perfect state).

This fungus, of which a shortened synonymy is given, belongs to the genus *Coryne* Tul. This generic name should be conserved against *Coryne* Nees per S. F. Gray.

sexdecimsporus. — *Ascobolus sexdecimsporus* Crouan *in* Annls Sci. nat. (Bot.) IV **10**: 195 *pl. 13 fs. 21–26.* 1858. — *Ascophanus sexdecimsporus* (Crouan) Boud. *in* Annls Sci. nat. (Bot.) V **10**: 247. 1869. — *Rhyparobius sexdecimsporus* (Crouan) Sacc., Syll. Fung. **8**: 541. 1889. — Type specimen: non-existent. — Type locality: Brest, Finistère, France.

VARIANT SPELLING: *Ascobolus 6–10 sporus* Crouan *in* Rabenhorst, Fungi eur. exs. No. 781. 1865.

This fungus belongs to *Ascophanus* Boud. It has been redescribed by Le Gal (1961: 446) after collections in the herbarium of the brothers Crouan.

solms-laubachii. — *Ascobolus solms-laubachii* Rabenh. *in* Fungi europ. exs., Cent. V, No. 420. 1862; Rabenh. *in* Bot. Ztg. **20**: 198. 1862. — *Rhyparobius solms-laubachii* (Rabenh.) Rehm, Rab. Krypt.-Fl., Pilze **3**: 1101. 1895. — Type distribution: Rabenhorst, Fungi europ. exs. No. 420.

This fungus belongs to *Rhyparobius* Boud. and possesses 32-spored asci.

sphaericus. — *Ascobolus sphaericus* Preuss *in* Bot. Cbl. **1**: 201. 1846. (nomen nudum). — *Ascobolus sphaericus* Preuss *in* Linnaea **24**: 147. 1851 (with description). — Type specimen: not known to be in existence. — Type locality: near Hoyerswerda, Lusatia, Germany.

This fungus which is only known from the very brief original description is considered a nomen dubium (Boudier, 1869: 233; Schroeter, 1893: 56; Rehm, 1896: 1128).

stercoreus. — *Myrothecium stercoreum* Tode, Fungi Meckl. **1**: 26 *pl. 5 f. 40.* 1790 (devalidated name). — *Myrothecium stercoreum* Tode *per* Steudel, Nomencl.

bot. 294. 1824. — *Ascobolus stercoreus* (Tode per Steudel) Quél., Ench. Fung. 296. 1886. — Type locality: Mecklenburg, Germany.

This fungus should be excluded from *Ascobolus*. Boudier (1869: 239) regarded it as a possible synonym of both *Rhyparobius cookei* (Crouan) Boud. and *Ascophanus subfuscus* (Crouan) Boud. Since both species look macroscopically quite similar and Tode gave no microscopical details, it is impossible to establish the identity of Tode's species with certainty.

strobolinus. — *Ascobolus strobolinus* G. Schweizer *in* Planta **12**: 589, with 10 text-figures. 1931. — Type specimen: not known to be in existence. — Type locality: Hohenheim, Württemberg, Germany.

"Apothecien: 2–4 mm gross, anfangs tonnenförmig, ungestielt, dann schwach becherförmig, mit glattem Rand sich öffnend, grasgrün und aussen stark behaart. Haare ebenfalls grün. Bei der Reife die Fruchtscheibe stark hervorgewölbt und durch die vielen weit über das Hymenium hervorragenden Asci violett punktiert."

"Asci: Keulig, 230–250 μ lang, 25–30 μ breit, in grosser Zahl, mit einem deutlich abgesetzten, bei der Reife sich öffnenden Deckel. Jod färbt die jungen Asci in der Deckelregion intensiv dunkelblau."

"Sporen: Zuerst farblos, dann dunkelviolett, ohne besondere charakteristische Lagerung im Ascus. 18–19 μ lang, 16–18 μ breit, elliptisch stumpf derbwandig, mit wenigen feinen, zum Teil zusammenfliessenden Längsstreifen."

"Paraphysen: Fädig septiert, oben schwach zugespitzt, 3 μ breit, grünlich gefärbt, unverzweigt. Jod färbt die Paraphysen an der Spitze schwach blau."

"Gehäuse: Parenchymatisch grünlich, durch Jod schwach bläulich gefärbt."

"Fundort. Auf Hammelkot aus der Stallung der Landesversuchsanstalt für landwirtschaftliche Chemie in Hohenheim (Württemberg)."

This fungus, which is only known from the cited, original description, certainly belongs to *Ascobolus*. If the description is correct, it may well be a good species. The green hairy apothecia and the characteristic ascospores easily characterize this species. It is to be hoped that future mycologists will find this fungus again to establish its variation and true relationship.

subfusca. — *Peziza subfusca* Crouan, Fl. Finistère 53. 1867. — *Ascophanus subfuscus* (Crouan) Boud. *in* Annls Sci. nat. (Bot.) V **10**: 242. 1869. — *Ascobolus subfuscus* (Crouan) Rehm *in* Ascomyceten exs. No. 167. 1873; Cooke *in* Fungi brit. exs. (ed. II) No. 657. 1874; Quél., Ench. Fung. 296. 1886. — Type: *Crouan*, on dog dung *s. loc.*, 28.II.1864 (CONC-A2432).

This fungus, of which the type has been described by Le Gal (1953b: 89), belongs to *Ascophanus* Boud. It is a synonym of *Ascophanus microsporus* (Berk. & Broome) E. C. Hansen.

subhirtus. — *Ascobolus subhirtus* Renny *in* Trans. Woolhope Nat. Field Club

1872–3: 131 *pl. 2 fs. 4–7.* 1873; Renny *in* J. Bot., Lond. **12**: 357 *pl. 155 fs. 4–7.* 1874. — *Rhyparobius subhirtus* (Renny) Phill., Brit. Discom. 302. 1887. — *Ascozonus subhirtus* (Renny) Schroet. *in* Bot. Jb. (ed. Just) **2**: 283. 1876 (incidental mention); Boud., Hist. Class. Discom. Eur. 79. 1907. — Type locality: Hereford, British Isles.

This fungus is a member of *Ascozonus* (Renny) E. C. Hansen.

testaceus Moug. — *Peziza testacea* Moug. *apud* Fr., Elench. Fung. **2**: 11. 1828. — *Ascobolus testaceus* (Moug. apud Fr.) Wallr., Fl. crypt. Germ. 2, **4**: 513. 1833; Berk. & Broome *in* Ann. Mag. nat. Hist. III, **15**: 447. 1865; not *Ascobolus testaceus* P. Henn. *in* Hedwigia **41**: 32. 1902. — *Helotium testaceum* (Moug. apud Fr.) Berk., Outl. Brit. Fungol. 372. 1860. — *Ascophanus testaceus* (Moug. apud Fr.) Phill., Brit. Discom. 310. 1887. — *Humaria testacea* (Moug. apud Fr.) Schroet. *in* Krypt.-Fl. Schles. (ed. Cohn) **3** (2): 36. 1893. — *Ascophanus carneus* var. *testaceus* (Moug. apud Fr.) Mass., Brit. Fungus-Fl. **4**: 178. 1895. — *Humarina testacea* (Moug. apud Fr.) Seaver, North Am. Cup-fungi (Op.) 125. 1928. — Type specimen: not known to be in existence. — Type locality: probably France.

This fungus belongs to *Ascophanus* Boud. It is closely related to, or conspecific with, *Ascophanus carneus* (Pers. per Pers.) Boud. Probably there is only a difference in substratum.

testaceus P. Henn. — *Ascobolus testaceus* P. Henn. *in* Hedwigia **41**: 32. 1902; not *Ascobolus testaceus* (Moug. apud Fr.) Wallr., Fl. crypt. Germ. 2, **4**: 513. 1833. — Type specimen: very probably destroyed with the herbarium of Berlin. — Type locality: Sta. Catarina, near Blumenau, Brazil.

"*A. testaceus* P. Henn. n. sp.; ascomatibus carnosis primo hemisphaericis, dein explanato-scutellatis emarginatis, 2–3 mm diametro, extus levibus testaceis, disco plano, levi concolori; ascis clavatis apice applanatis, basi attenuato-stipitatis, 140–160 × 20–33 μ; paraphysibus filiformibus apice clavatis, 7–9 μ crassis, pluriguttulatis, flavidis; sporis monostichis subglobosis vel late ellipsoideis, 1-guttulatis, hyalino-brunneolis, levibus 15–19 × 14–16 μ."

"St. Cathar., Aipiberg, auf verfaultem Pferdemist. 18 Juli 1892. No. 660."

This fungus, which is only known from the quoted original description, was placed by Hennings in *Ascobolus*. In the discussion of his species he remarks that, according to Saccardo, it would belong to the genus *Phaeopezia* (Sacc.) Sacc., which is a conglomeration of unrelated, operculate cup-fungi with brownish ascospores. From the description it is very doubtful if this fungus belongs to the genus *Ascobolus*. The colour of the fruit-body, the smooth disk and the hyaline-brownish ascospores oppose such a disposition. It might well be a species of the Humariaceae. Until this fungus is found again, *Ascobolus testaceus* P. Henn. must be considered a nomen dubium.

tetrasporus. — *Ascobolus tetrasporus* Fuck. *in* Hedwigia **5**: 4 *pl. 1 f. 5.* 1866; Fuck., Fungi rhen. No. 1856. 1866. — *Leucoloma tetraspora* (Fuck.) Fuck. *in* Jb. nassau. Ver. Naturk. **23–24**: 317. 1870. — *Peziza tetraspora* (Fuck.) Cooke *in* Grevillea **3**: 73. 1874. — *Aleuria tetraspora* (Fuck.) Gill., Champ. Fr., Discom. 207. 1886. — *Humaria muralis* var. *tetraspora* (Fuck.) Quél., Ench. Fung. 287. 1886. — *Humaria tetraspora* (Fuck.) Sacc., Syll. Fung. **8**: 121. 1889. — *Humarina tetraspora* (Fuck.) Seaver, North Am. Cup-fungi (Op.) 134. 1928. — *Octospora tetraspora* (Fuck.) Korf *in* Mycologia **46**: 838. 1954. — Type distribution: Fungi rhen. No. 1856.

This is a member of *Octospora* Hedw. per S. F. Gray emend. Korf.

tetricum. — *Ascobolus tetricum* Carestia *in* Rabenhorst, Fungi eur. No. 1236. 1869. — *Ascophanus tetricum* (Carestia) Rehm, Rab. Krypt.-Fl., Pilze **3**: 1087. 1895. — Type distribution: Rabenhorst, Fungi eur. No. 1236.

This name is synonymous with *Ascophanus microsporus* (Berk. & Broome) E. C. Hansen, as could be concluded from different parts of the type.

thwaitesii. — *Ascobolus thwaitesii* Berk. & Broome *in* J. Linn. Soc. (Bot.) **14**: 109. 1875. — Type: *Thwaites No. 1059*, on rotten wood, Central province, Ceylon, XII. 1868 (K-A1974).

This name must be excluded from *Ascobolus* and reduced to the synonymy of *Ascophanus carneus* (Pers. per Pers.) Boud., as could be verified from the type specimen.

trifolii. — *Ascobolus trifolii* Biv. Bern., Stirp. rar. minusque cogn. Sicilia **4**: 27 *pl. 6 f. 3.* 1816 (devalidated name). — *Ascobolus trifolii* Biv. Bern. *per* Pers., Mycol. europ. **1**: 342. 1822. — *Pseudopeziza trifolii* (Biv. Bern. per Pers.) Fuck. *in* Jb. nassau. Ver. Naturk. **23–24**: 290. 1870. — Type specimen: not known to be in existence. — Type locality: Sicily.

This is the type species of the name *Pseudopeziza* Fuck.

vicinus. — *Ascophanus vicinus* Boud. *in* Annls Sci. nat. (Bot.) V **10**: 246 *pl. 11 f. 33.* 1869. — *Ascobolus vicinus* (Boud.) Cooke & Ellis *in* Grevillea **6**: 8. 1877. — *Ascobolus granuliformis* var. *vicinus* (Boud.) Quél., Ench. Fung. 296. 1886. — Type locality: Montmorency, France.

This belongs to *Ascophanus* Boud. and is closely related to *Ascophanus granuliformis* (Crouan) Boud.

vinosus. — *Ascobolus vinosus* Berk. *in* Hook., Engl. Fl. **5** (2): 209. 1836. —

Ascophanus vinosus (Berk.) Dennis, Brit. Cup Fungi 41. 1960. — Holotype: *Berkeley*, "on a mole-hill overgrown with moss, and covered with rabbits' and sheeps' dung", England (K-A1927).

MISAPPLIED NAMES. — *Ascobolus vinosus* Berk. sensu Berk. & Broome *in* Ann. Mag. nat. Hist. **15**: 448 *pl. 16 f. 25.* 1865 = *Saccobolus versicolor* (P. Karst.) P. Karst. overgrown by a sporulating Hyphomycete (K-A1939).

Ascobolus vinosus Berk. sensu Broome *in* Rabenhorst, Fungi eur. No. 658. 1864 = *Lamprospora miniata* (Crouan) De Not. (BM, G, M).

Ascobolus vinosus Berk. sensu Fuck., Fungi rhen. No. 1852; *in* Jb. nassau. Ver. Naturk. **23–24**: 289. 1870; P. Syd., Myc. march. No. 2168. 1888 = *Ascophanus carneus* (Pers. per Pers.) Boud.

Ascobolus vinosus Berk. sensu Boud. *in* Annls Sci. nat. (Bot.) V **10**: 221–222 *pl. 6 f. 11.* 1869. = *Ascobolus roseopurpurascens* Rehm. This is the conception of *A. vinosus* accepted by most authors of floras and handbooks since 1869.

Ascobolus vinosus Berk. sensu Ellis & Everhart, N. Am. Fungi No. 2620. 1891 = *Ascobolus amoenus* Oudemans.

According to the type, *Ascobolus vinosus* belongs to *Fimaria* Vel. and goes into the synonymy of *Fimaria hepatica* (Batsch per Pers.) Brumm. (van Brummelen, 1962b).

viridis subsp. **microspermus.** — *Ascobolus viridus* Curr. subsp. *microspermus* Speg. *in* An. Soc. cient. argent. **12**: 88. 1881. — Type locality: Recoleta, Buenos Aires, Argentina.

When I received on loan the types of *Ascobolus* from Spegazzini's herbarium the type specimen could not be found (van Brummelen, 1962: 198). Recently Dr. I. Gamundí de Amos informed me that she studied the type material and that a paper with figures and description is in press.

vitis. — *Ascobolus vitis* Wallr. ("ined."): Fr., Elench. **2**: 9. 1828 (as a synonym of *Peziza alboviolascens*). — Type locality: presumably Thüringia, Germany.

A synonym of *Lachnella alboviolascens* (Alb. & Schwein. per Pers.) Fr. (see Donk, 1959: 101, 103).

woolhopensis. — *Ascobolus woolhopensis* Renny *in* Trans. Woolhope Nat. Field Club 1871: 47. 1871. — *Rhyparobius woolhopensis* (Renny) Berk. & Broome *in* Ann. Mag. nat. Hist. IV **11**: 348. Mai 1873. — *Ascobolus* (*Ascozonus*) *woolhopensis* Renny *in* Trans. Woolhope Nat. Field Club 1872–3: 130. end 1873; Renny *in* J. Bot., Lond. **12**: 356 *pl. 153.* 1874. — *Ascozonus woolhopensis* (Renny) Schroeter *in* Bot. Jb. (ed. Just) **2**: 283. 1876 (incidental mention); Boud., Hist. Class. Discom. Eur. 79. 1907 ("wollopensis"). — *Streptotheca woolhopensis* (Renny) Seaver, N. Am. Cup-fungi (Op.) 143. 1928. — Type locality: Hereford, England.

A species of *Ascozonus* (Renny) E. C. Hansen.

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New names are in **bold-face** type. Subdivisions of genera are indicated by the sign §, illustrations by an asterisk (*).

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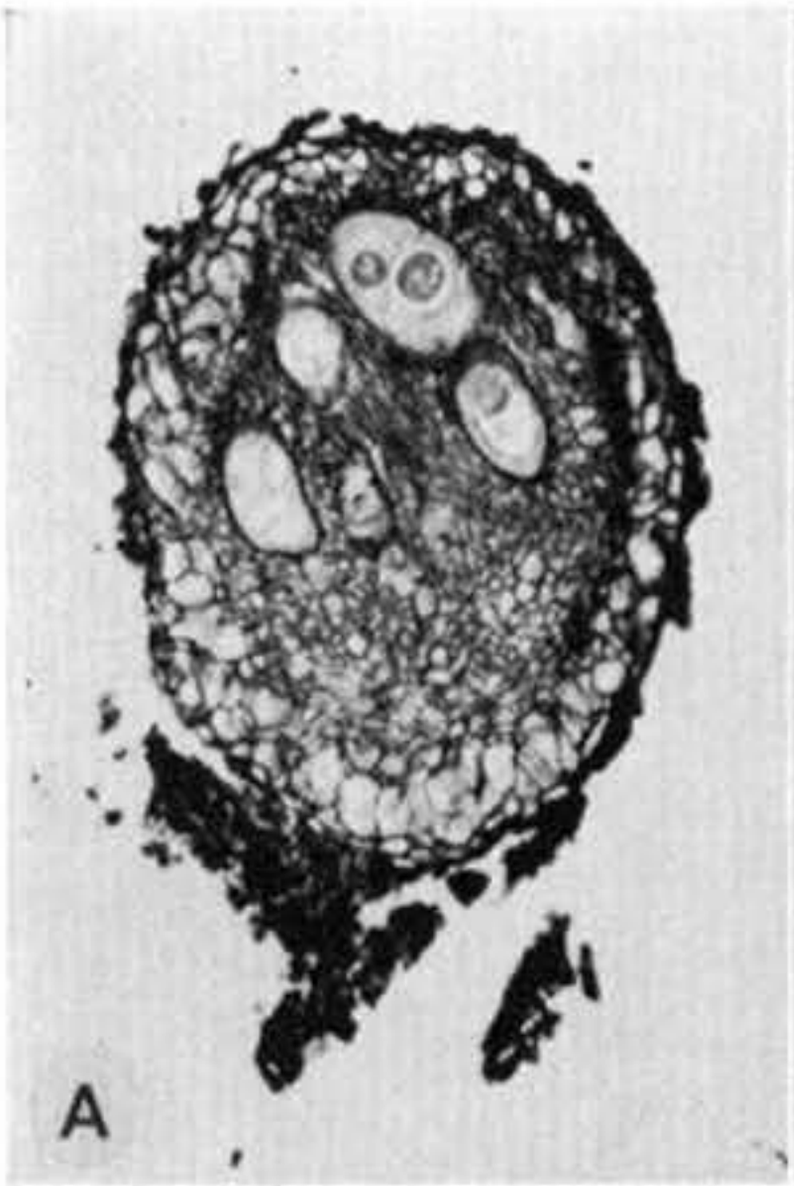
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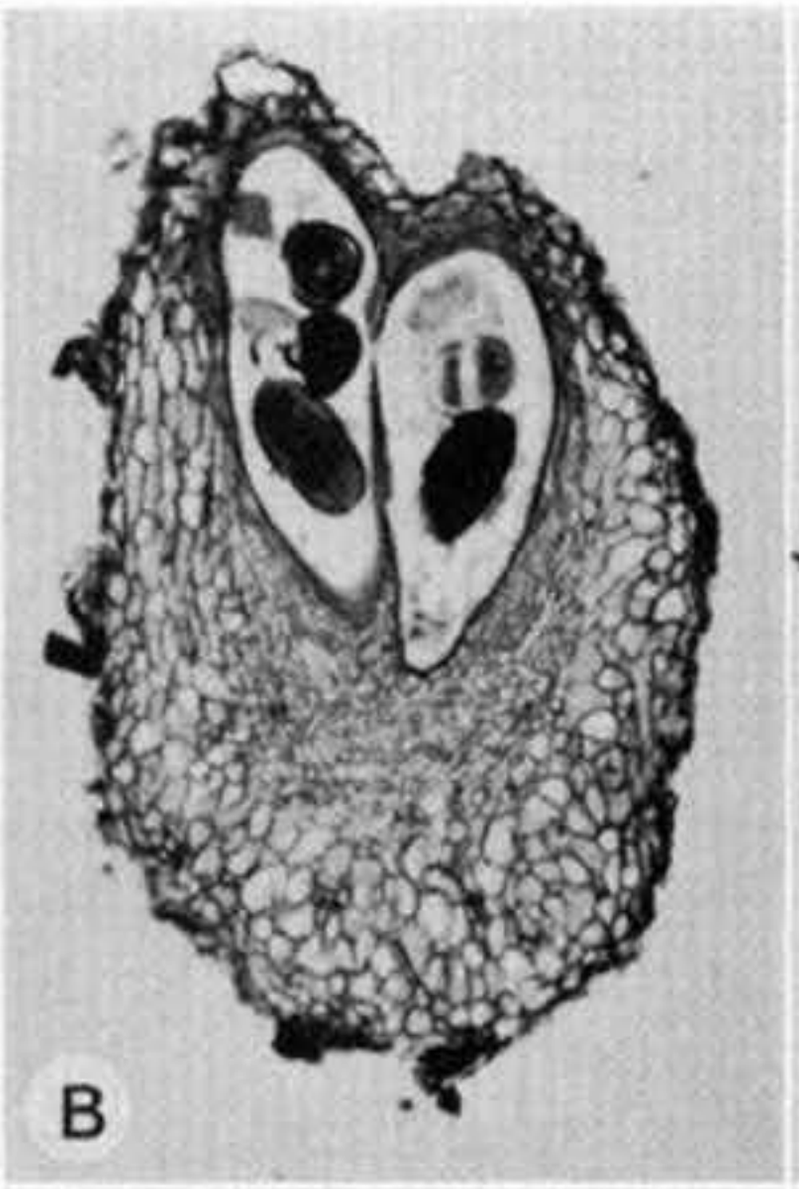
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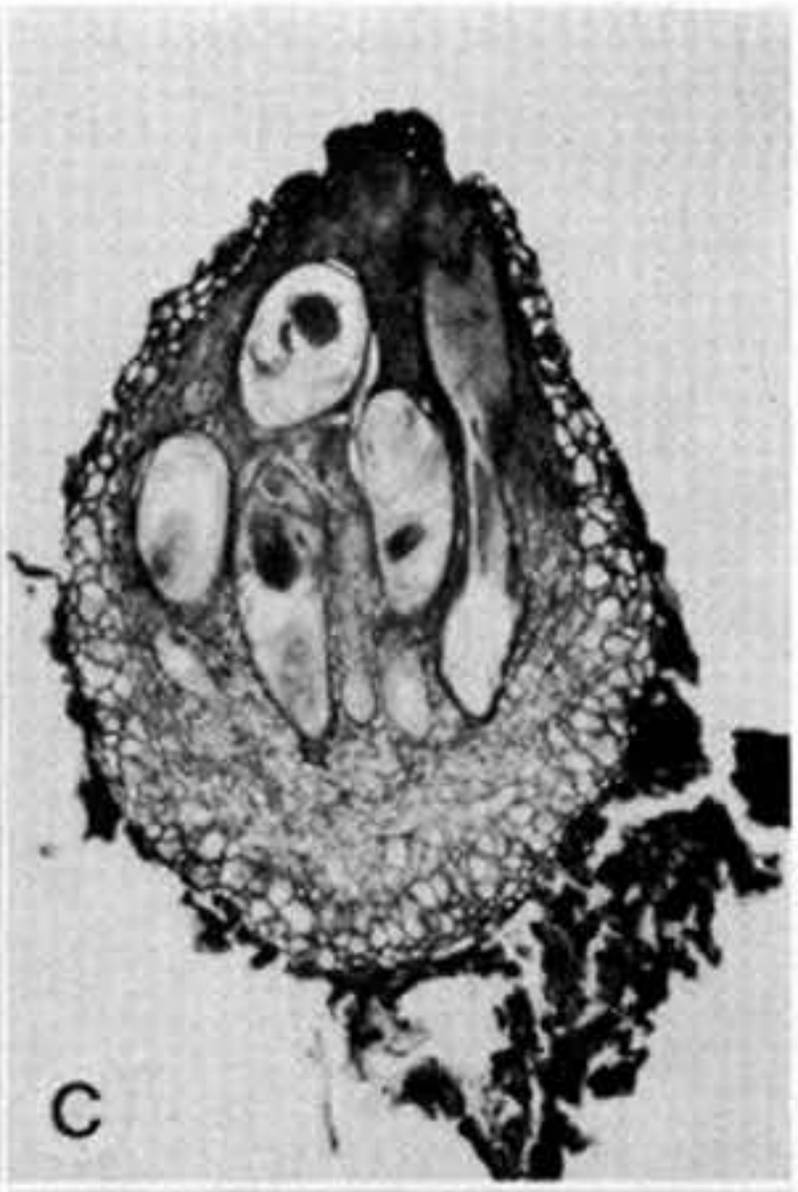
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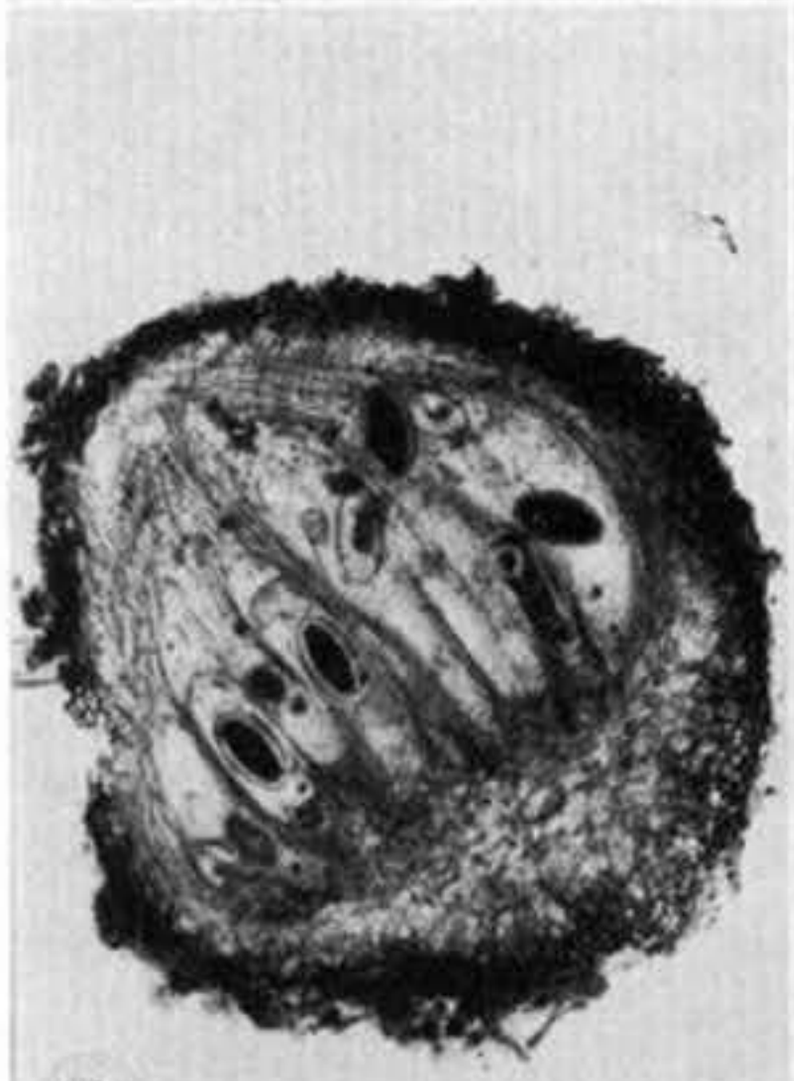
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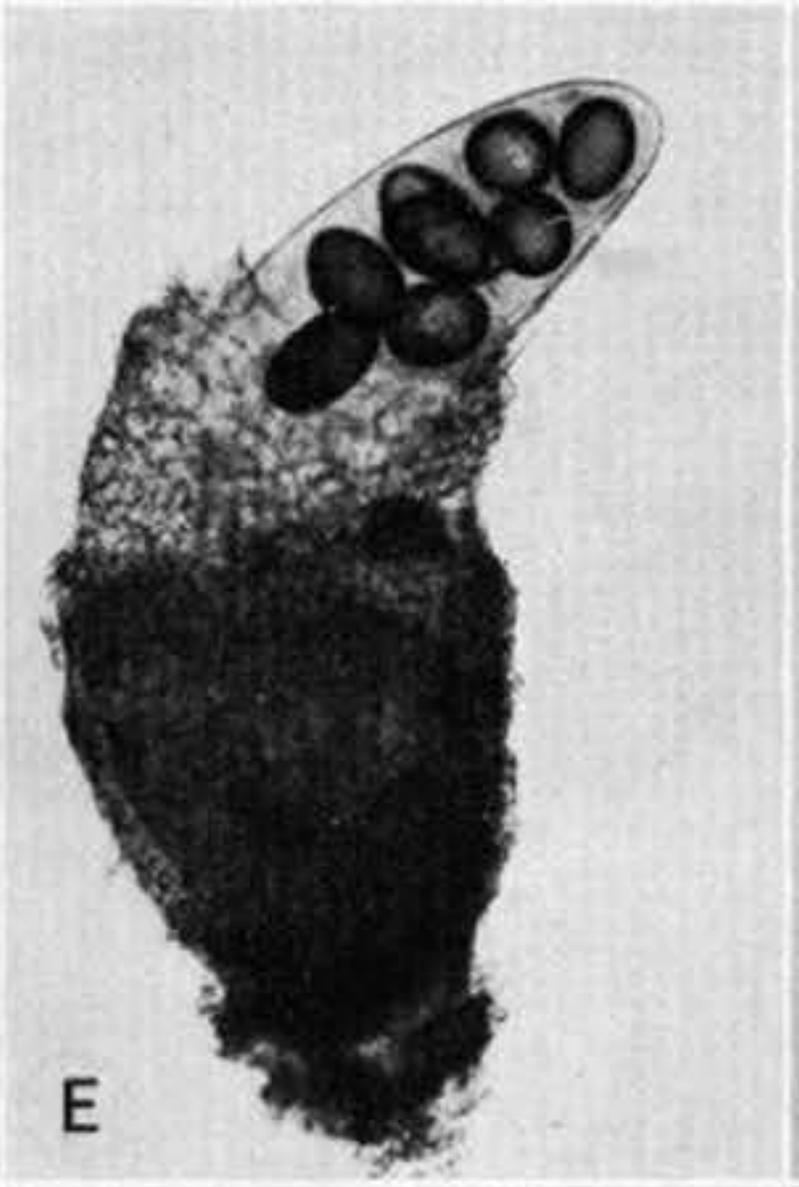
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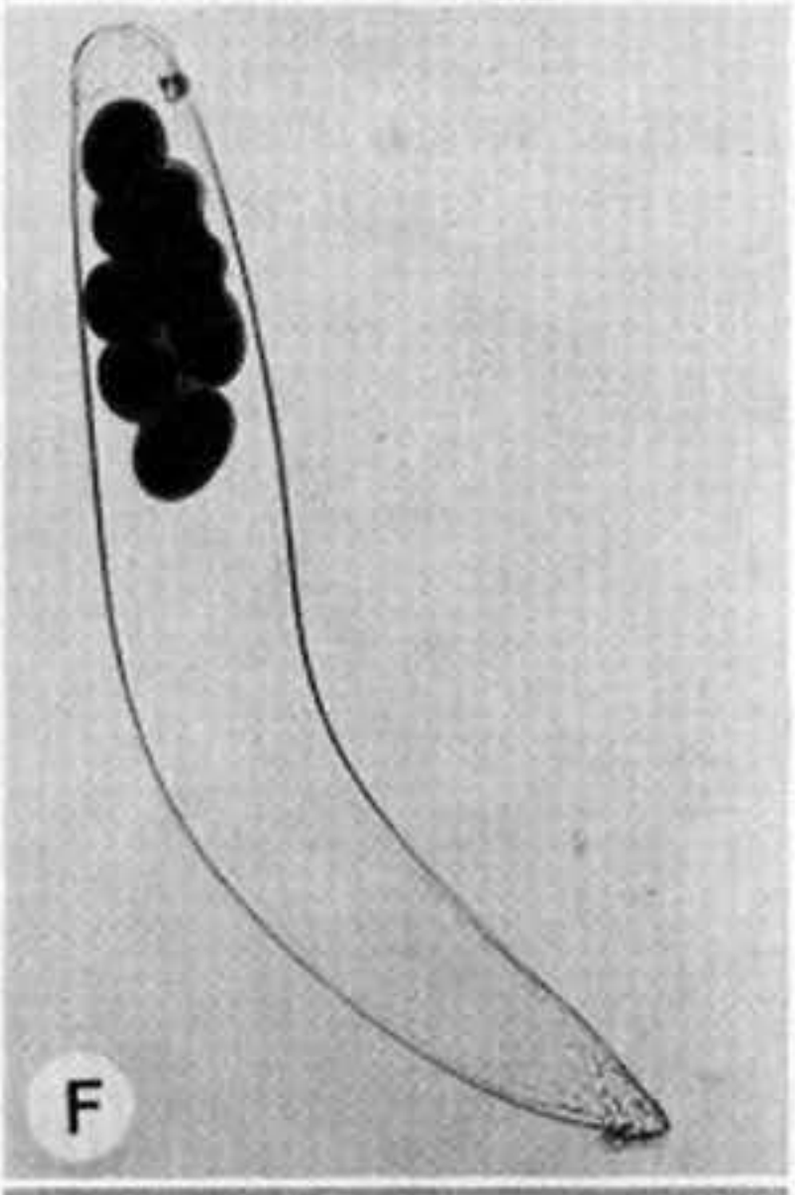
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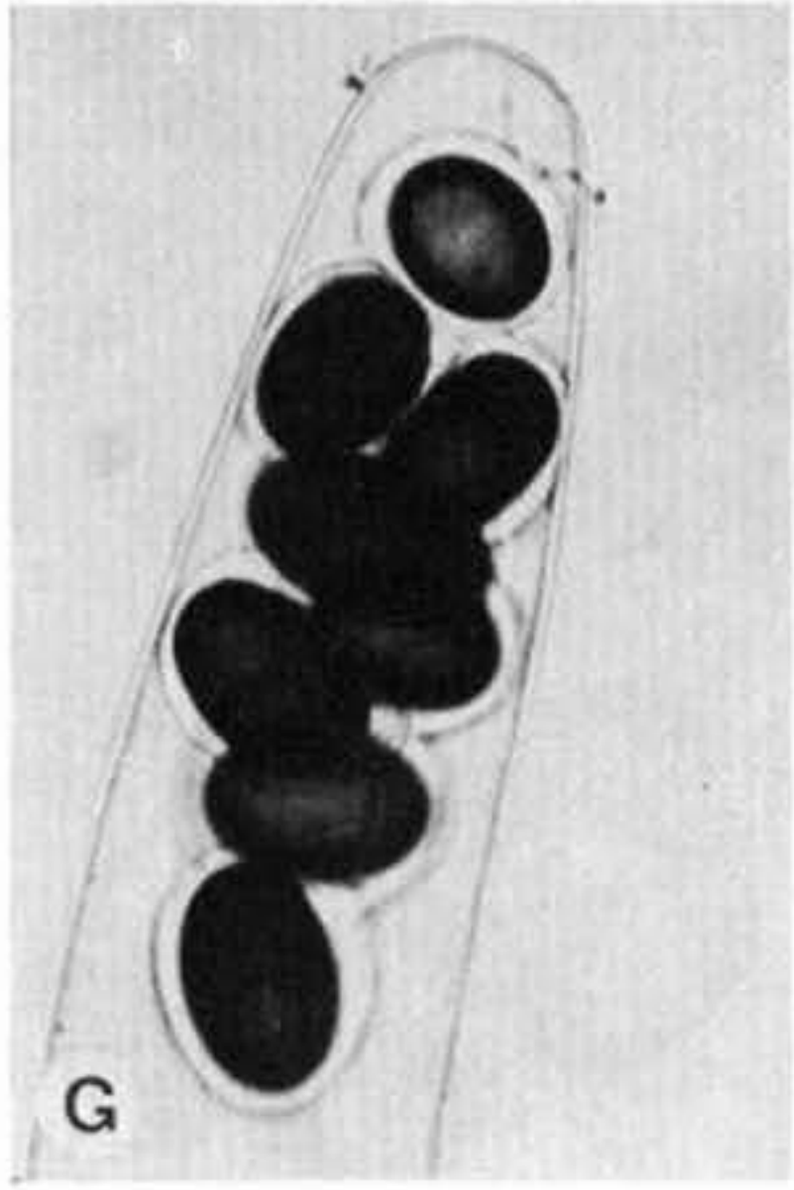
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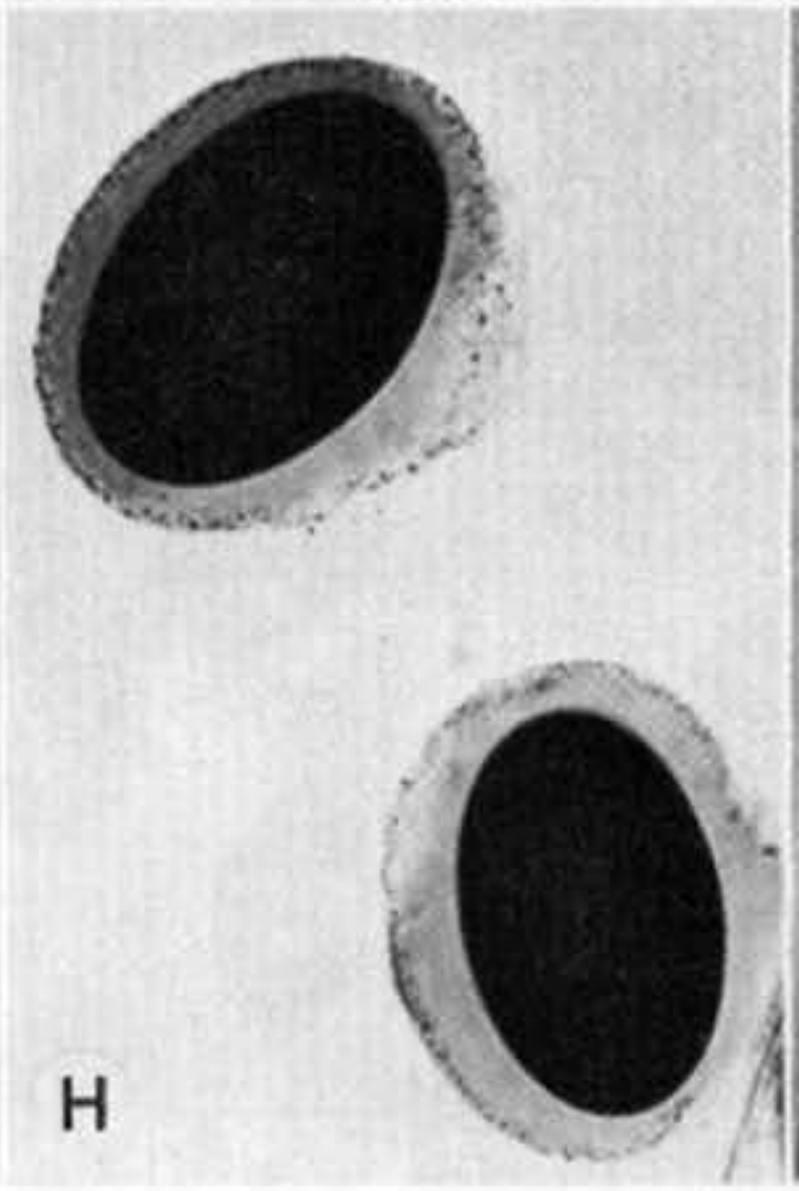
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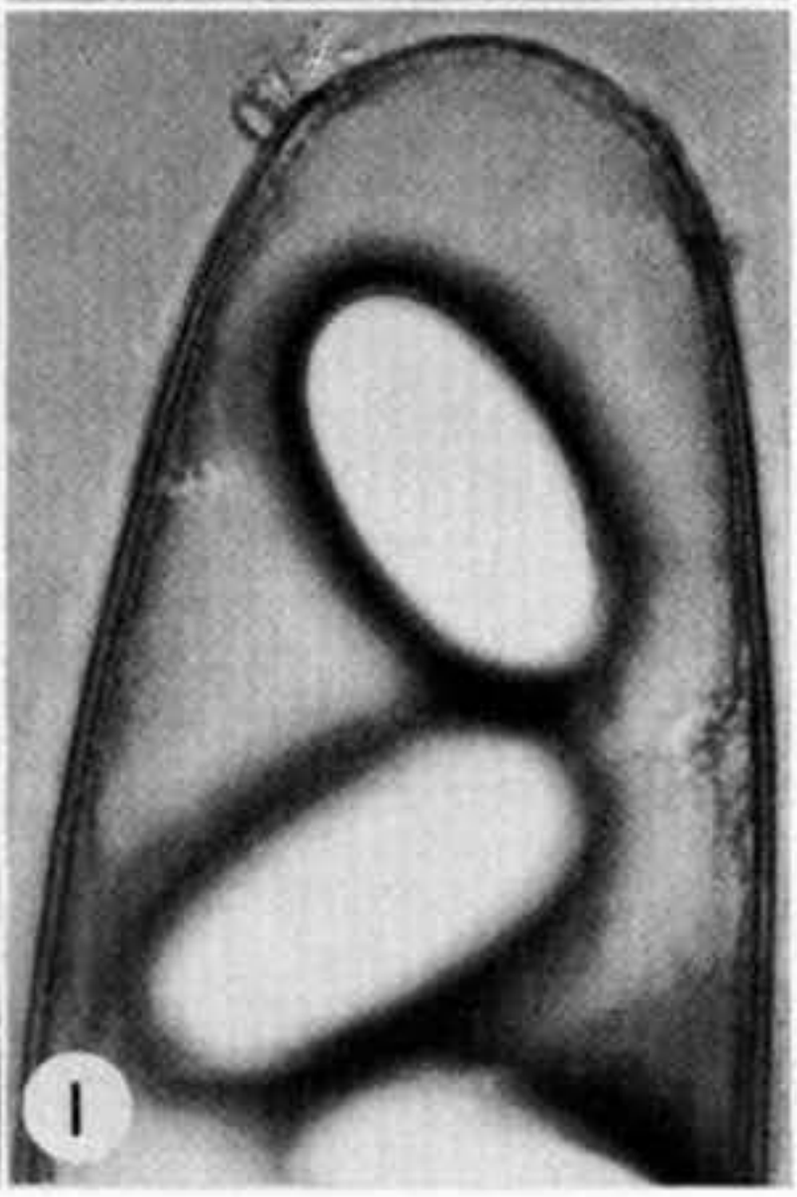
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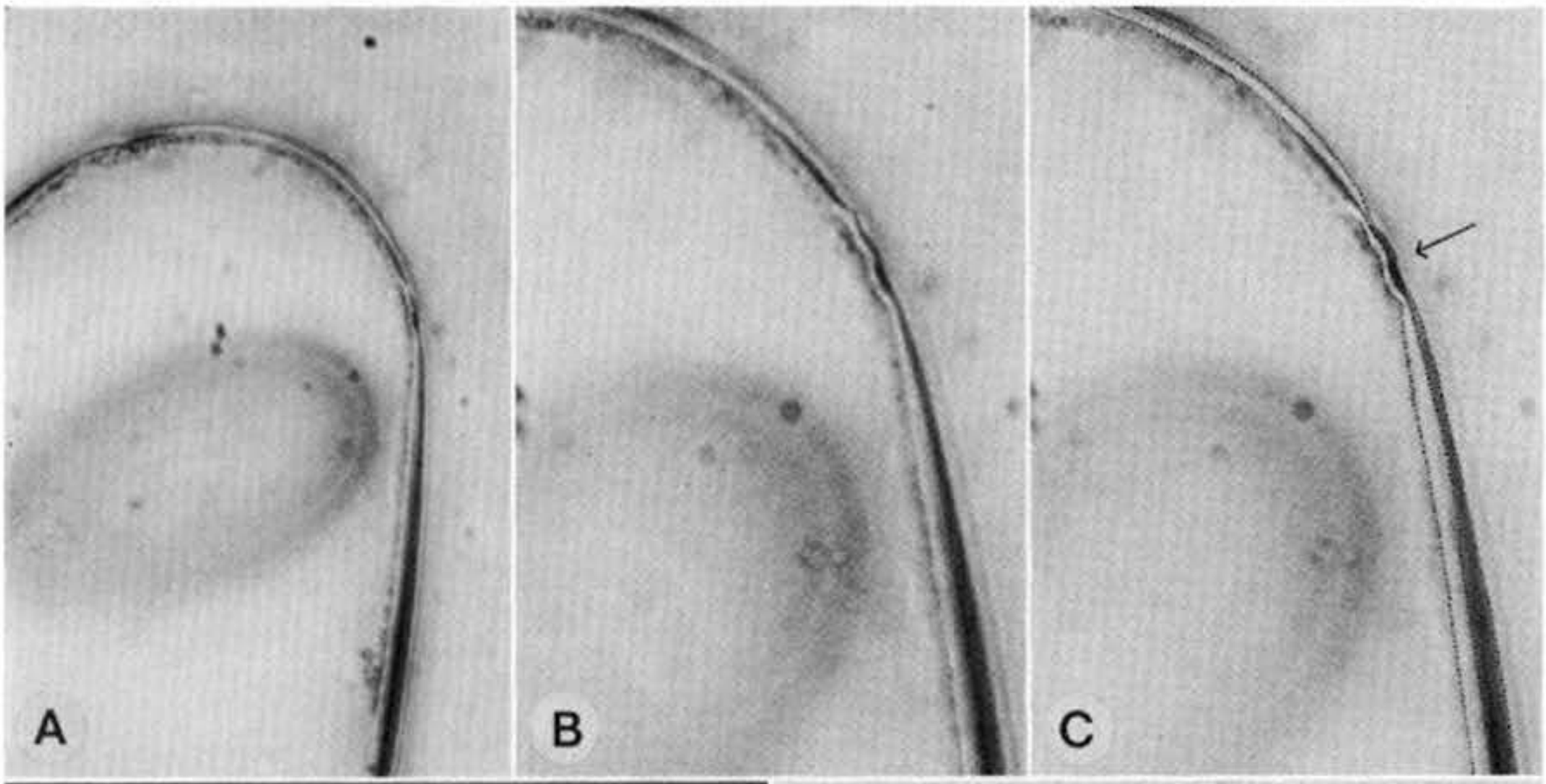

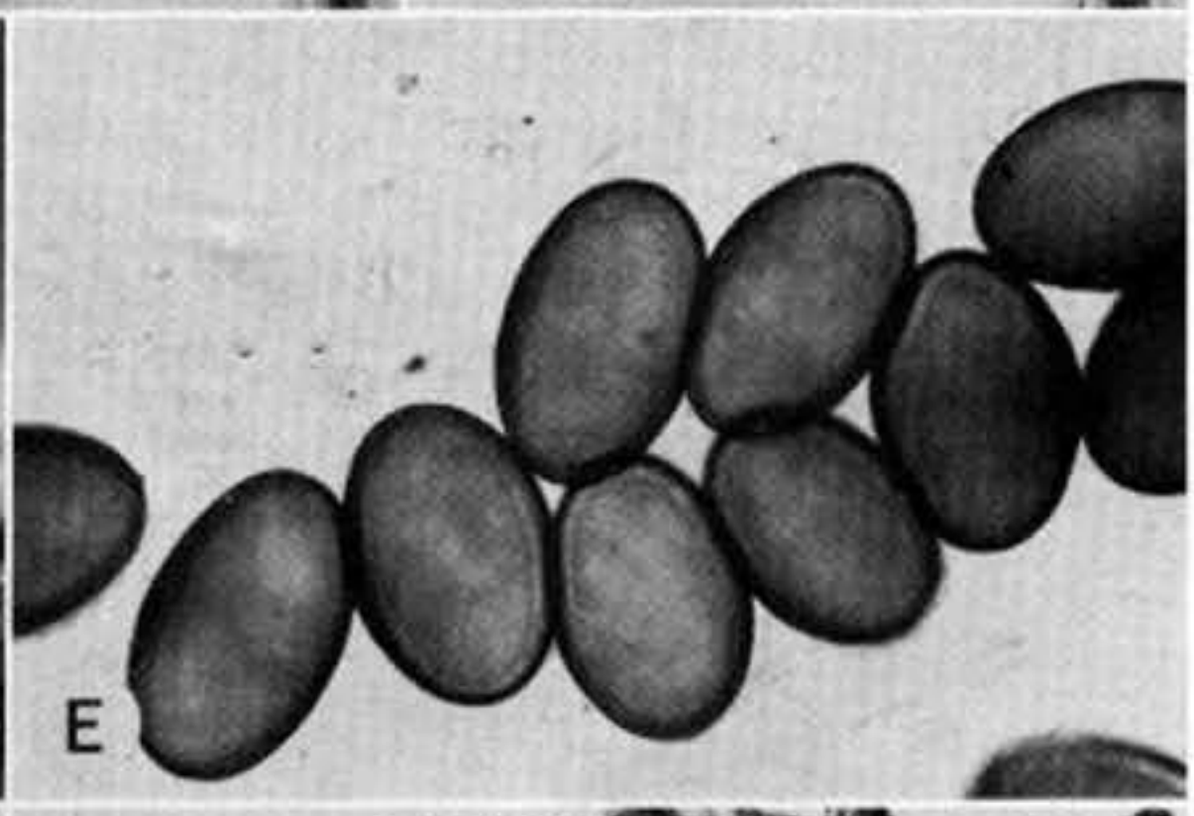

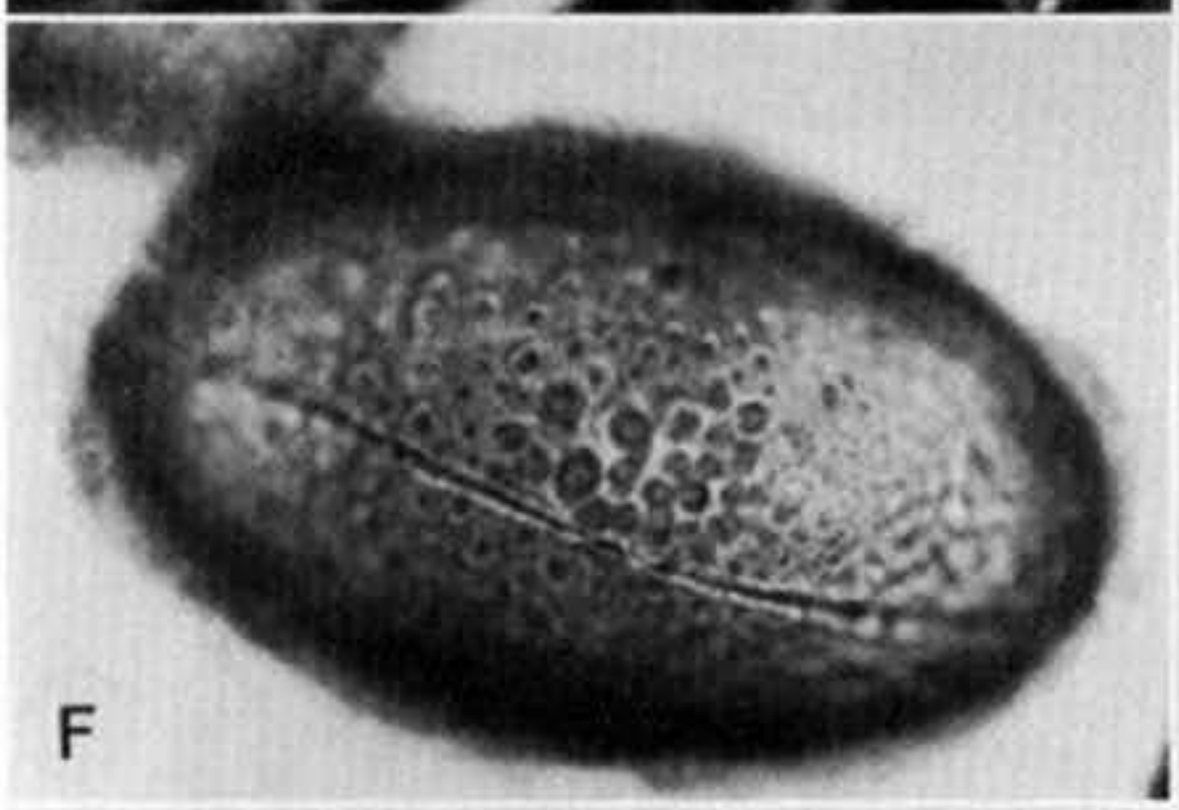

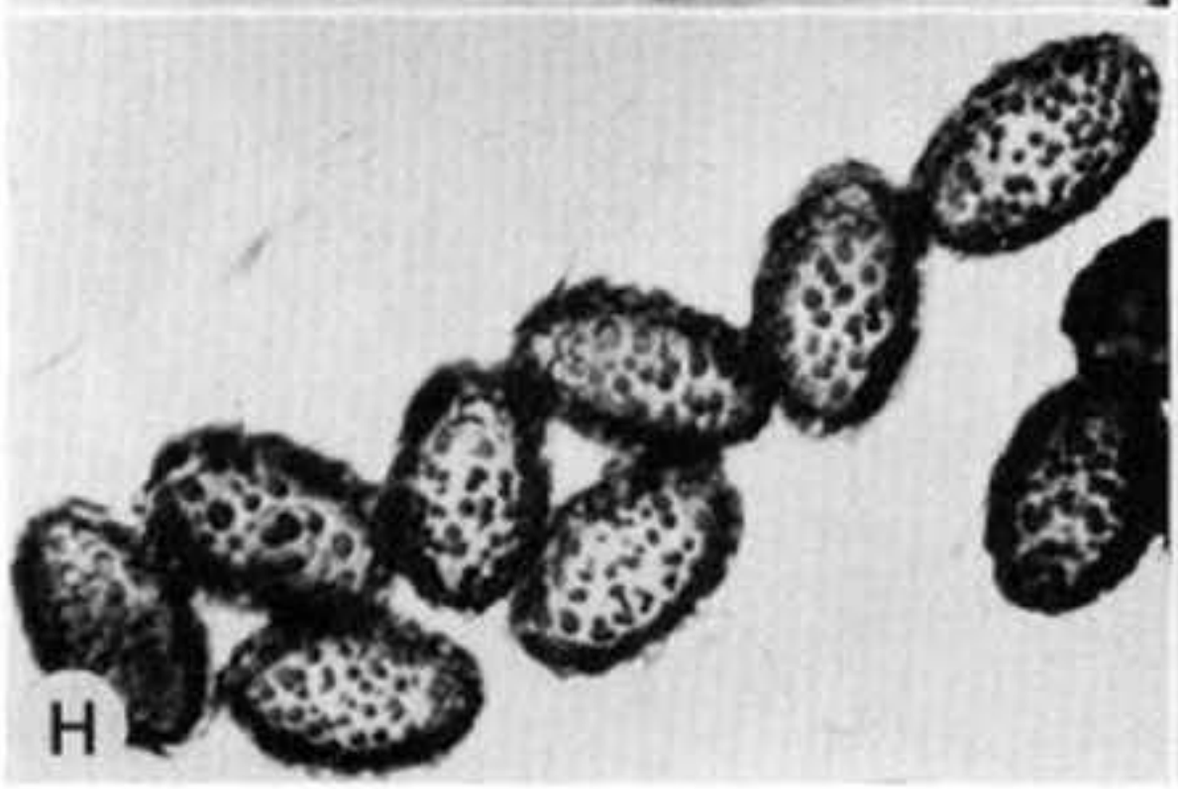

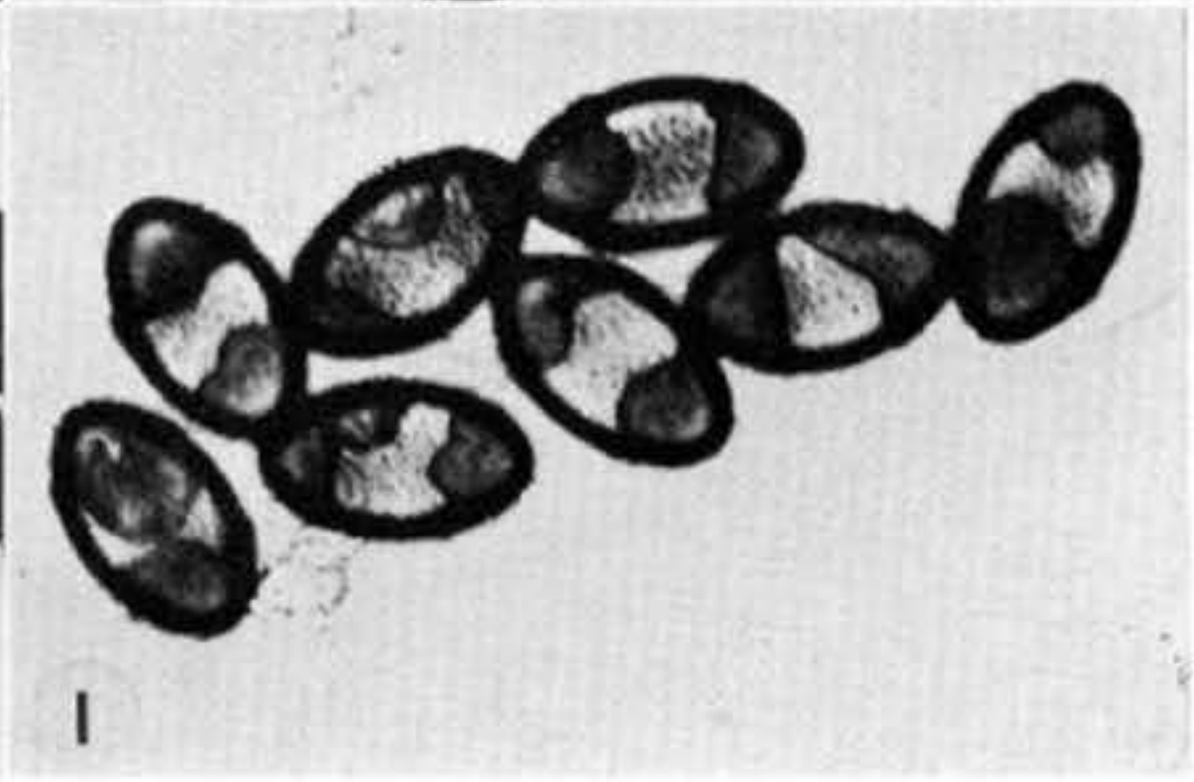

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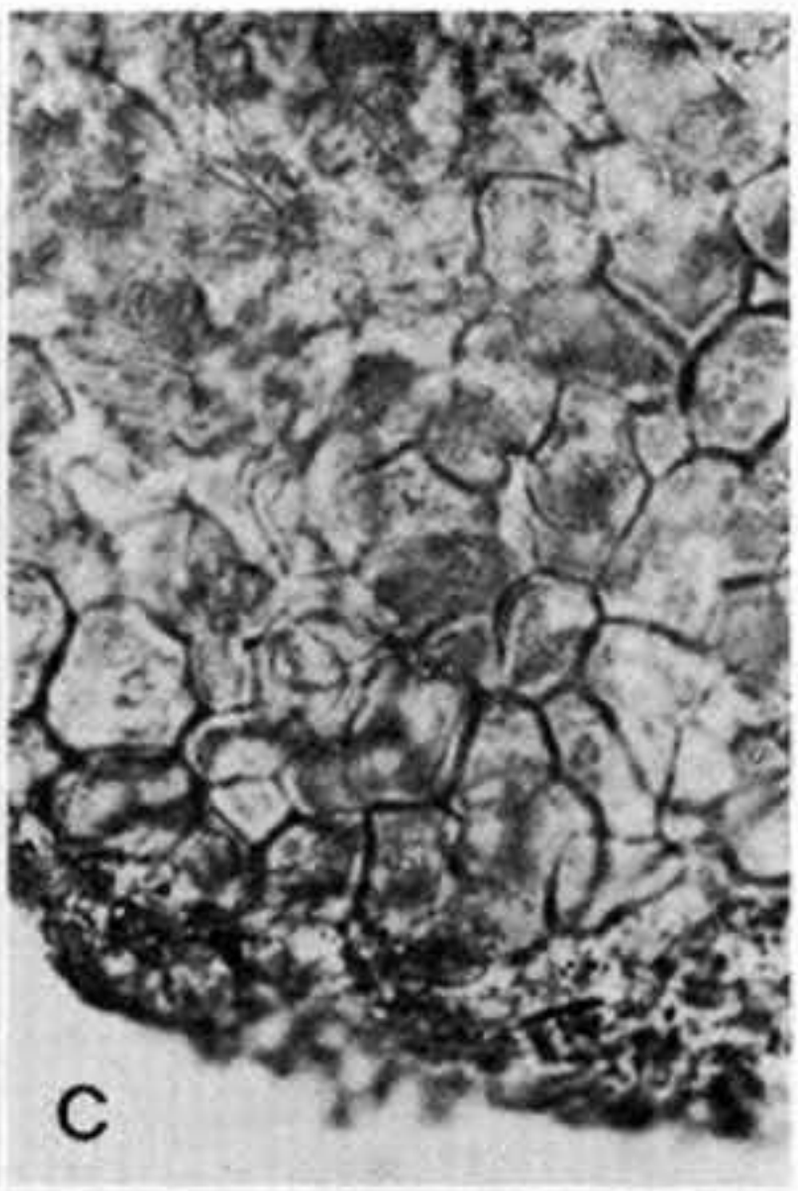
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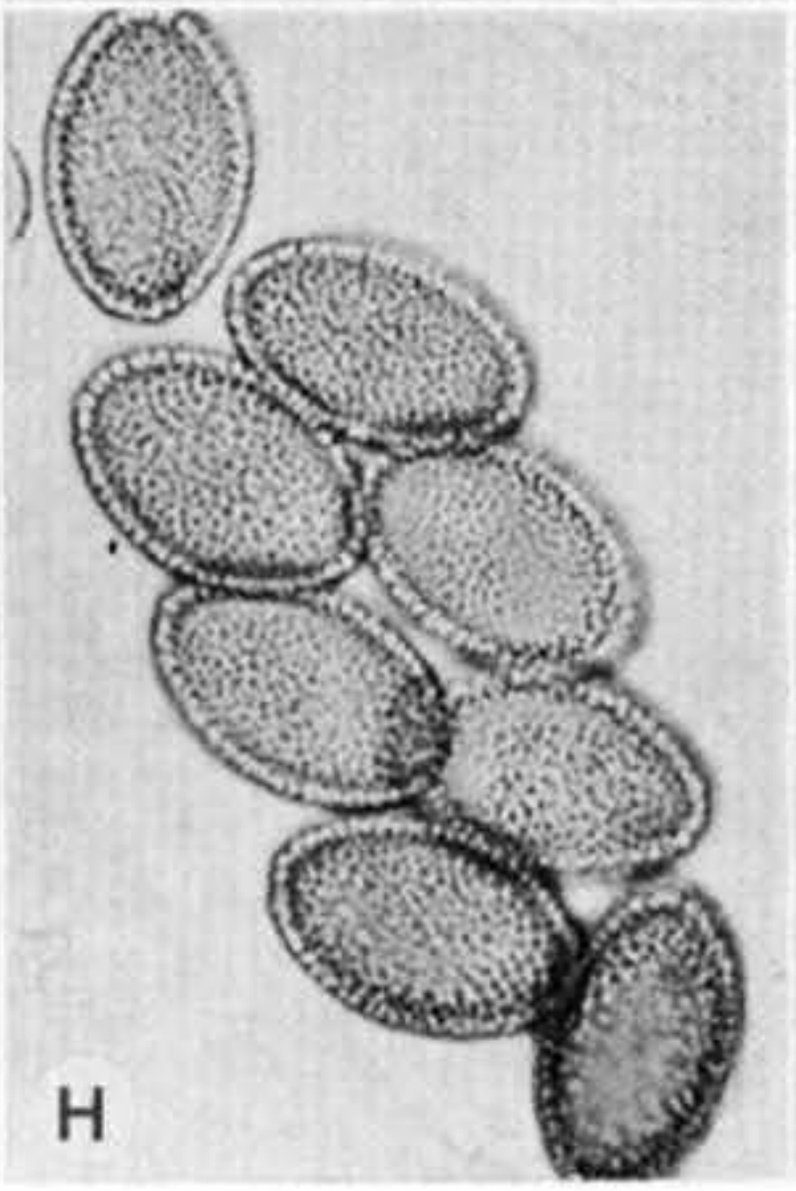
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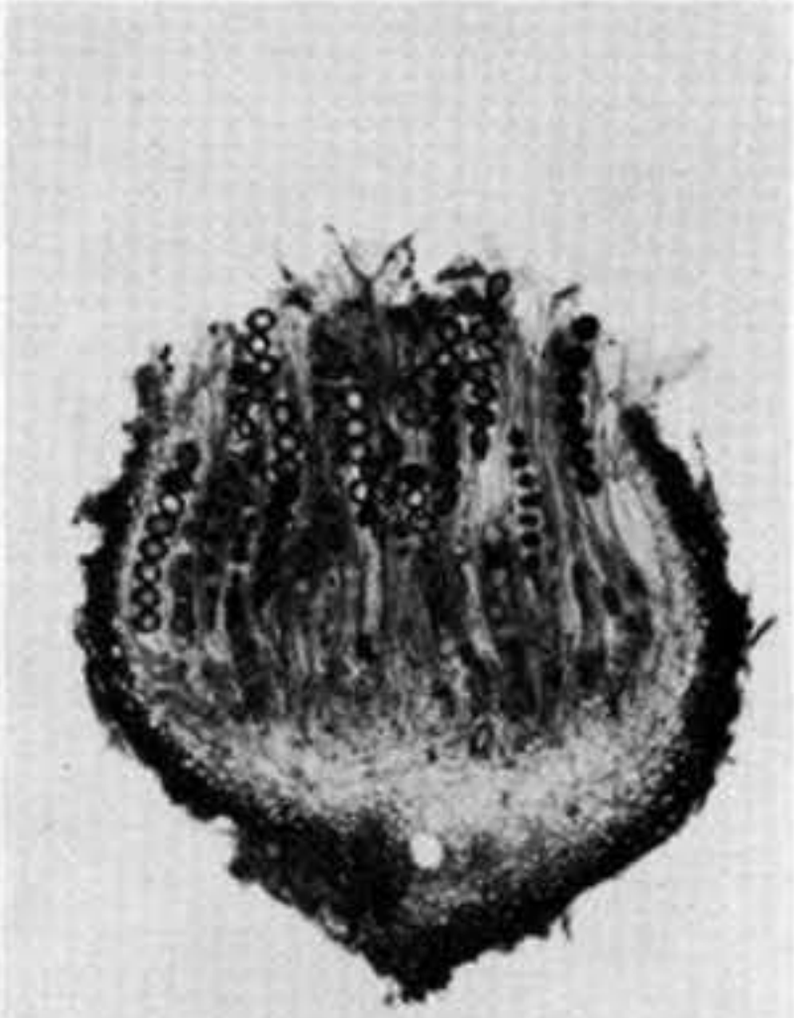
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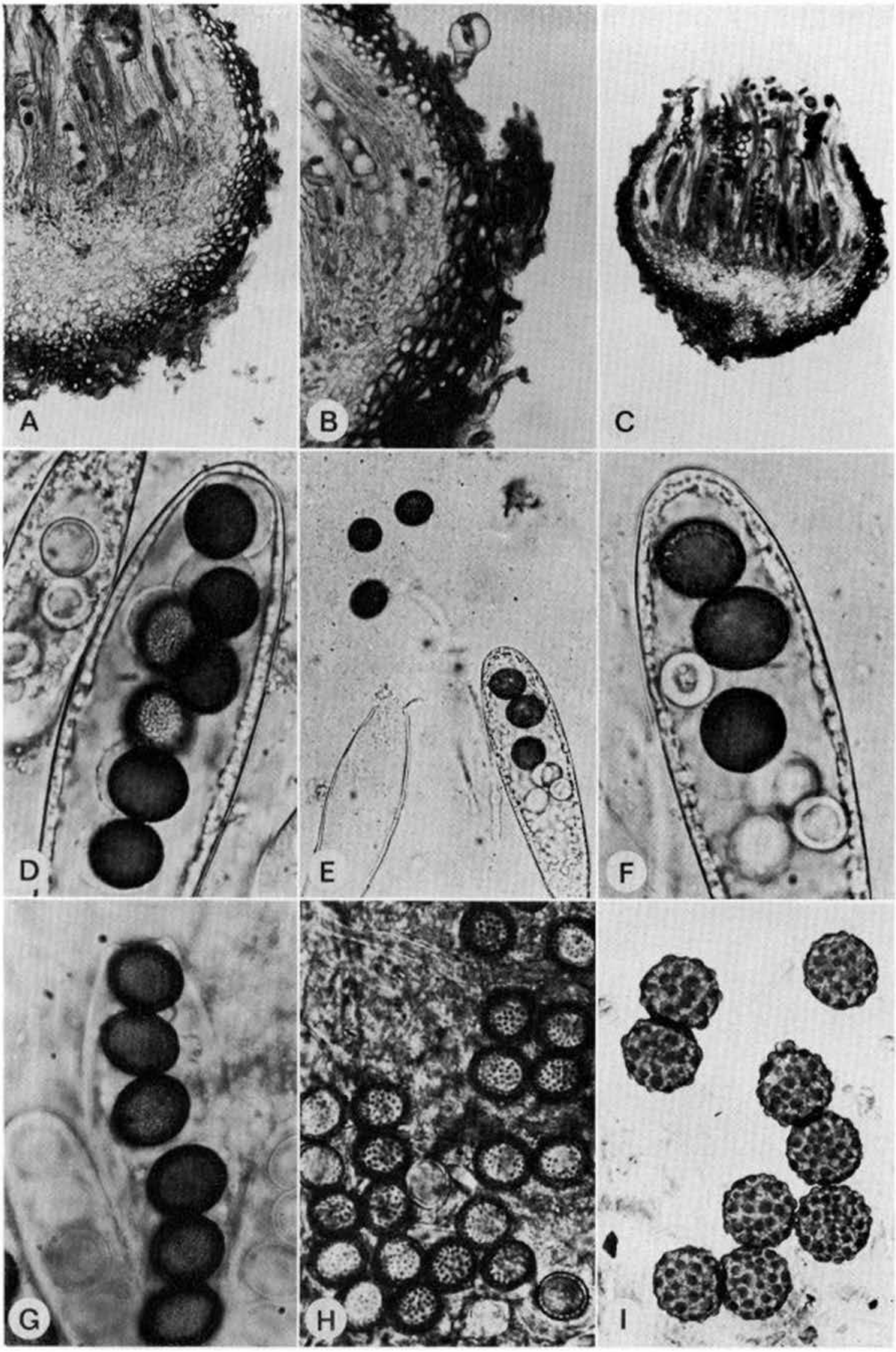

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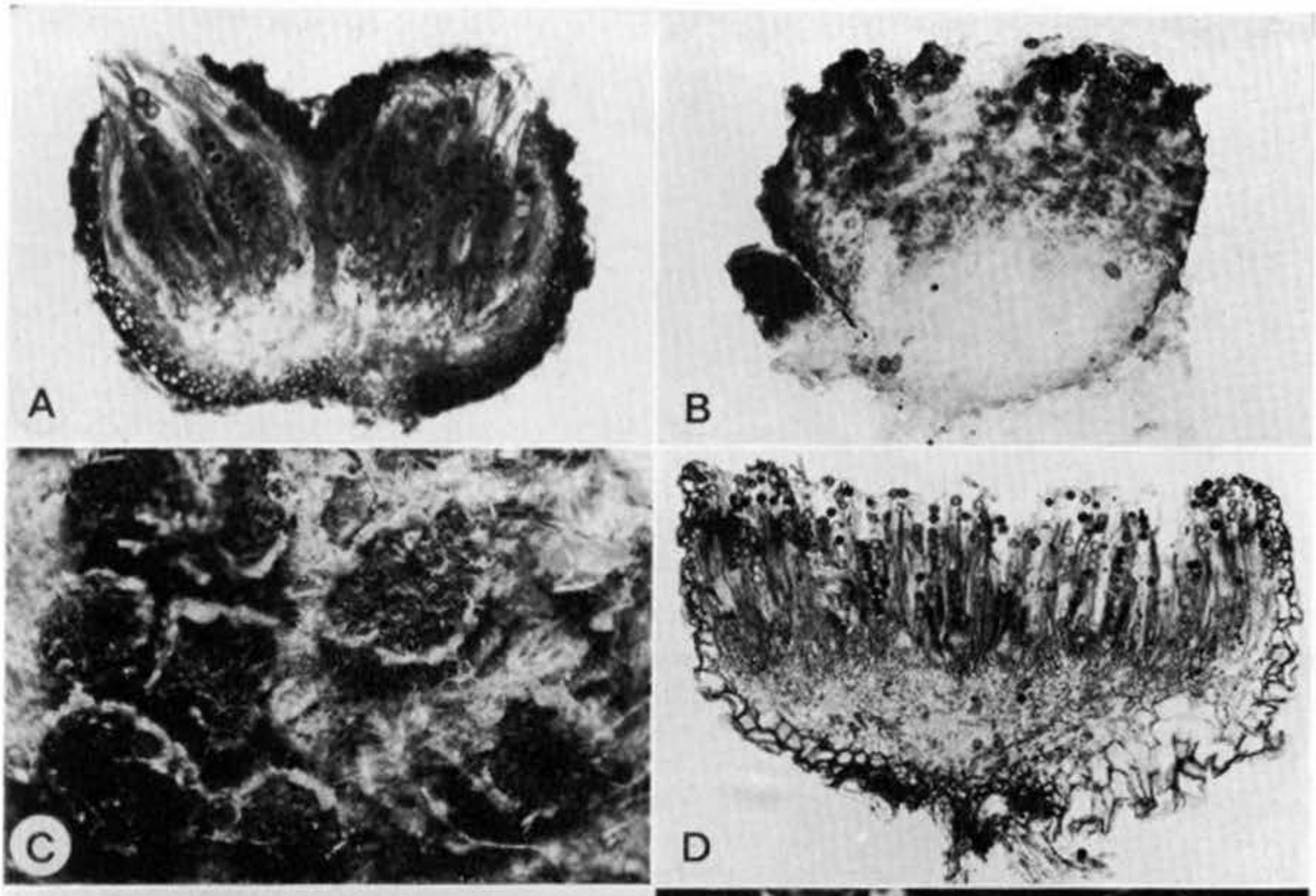

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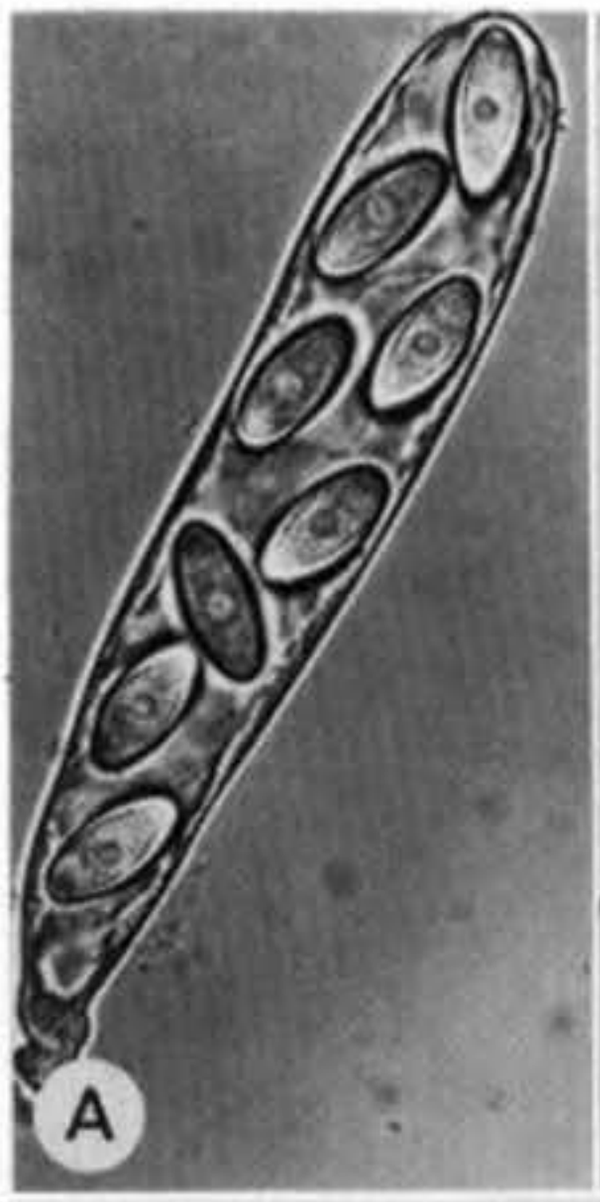

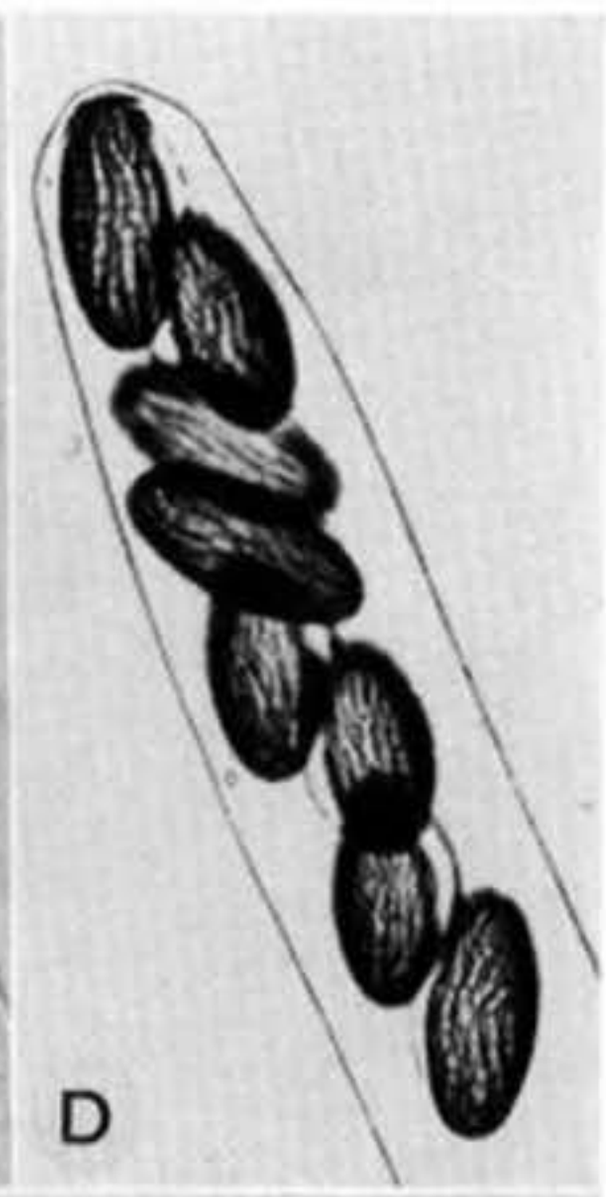

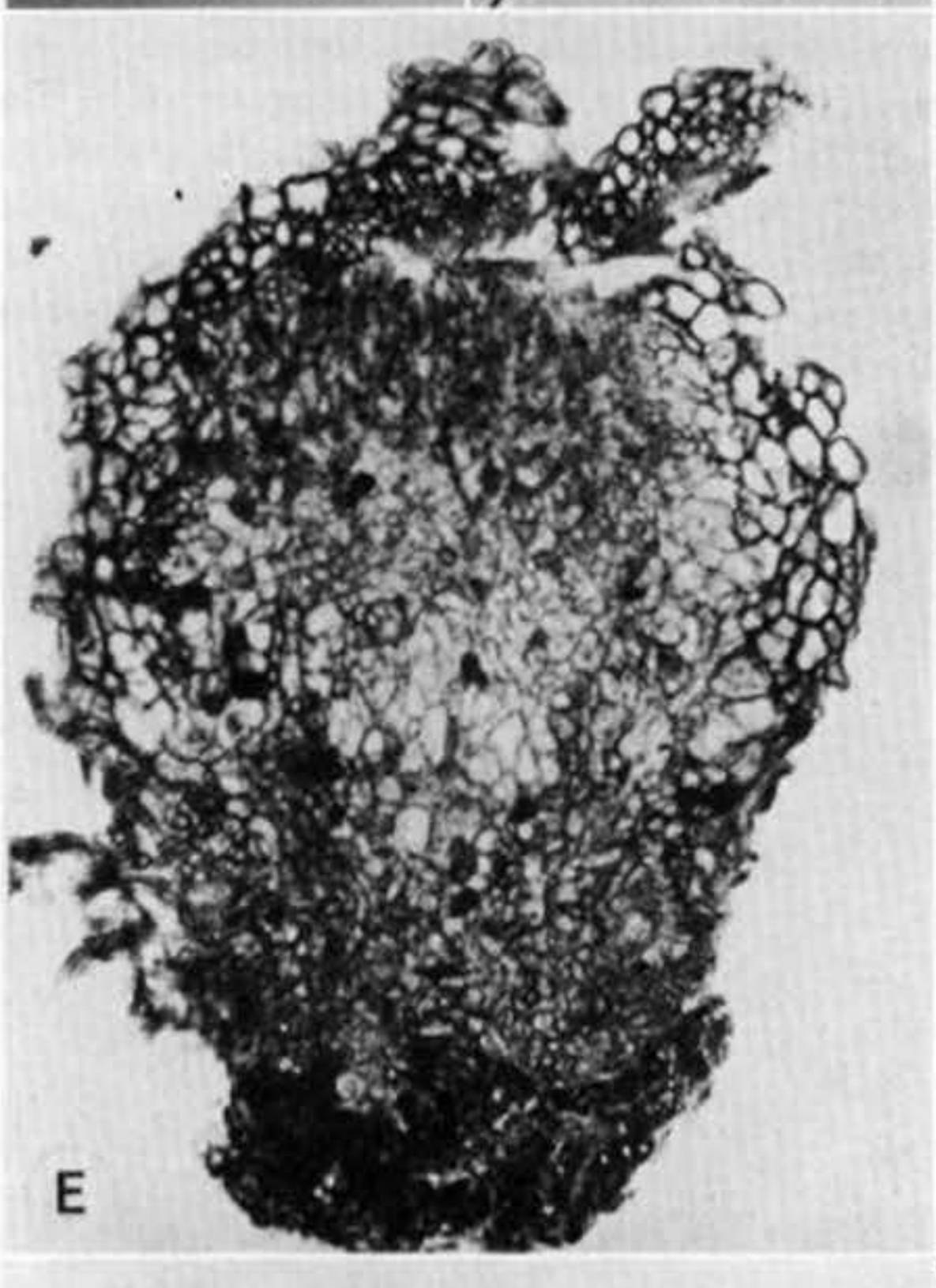

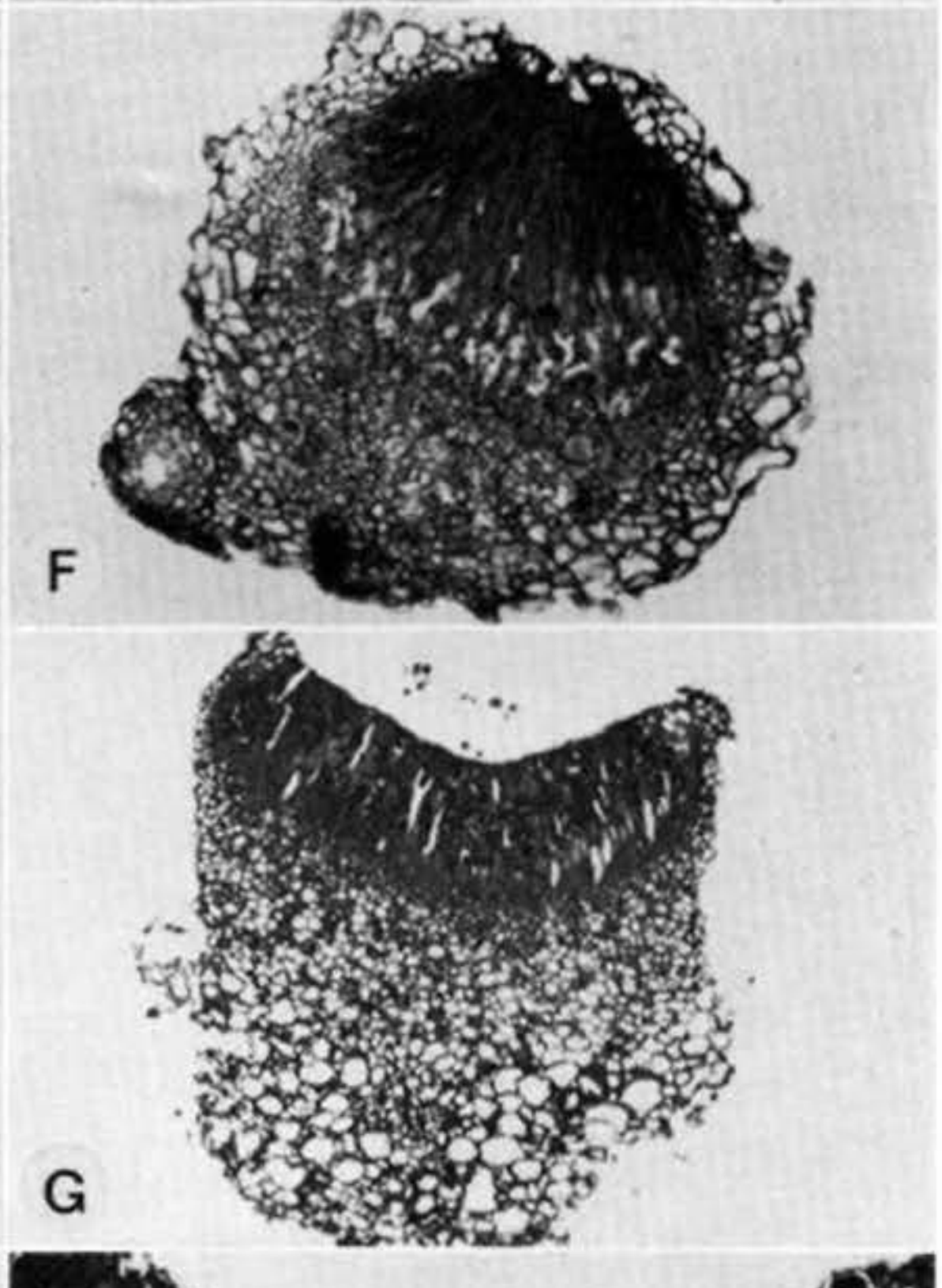

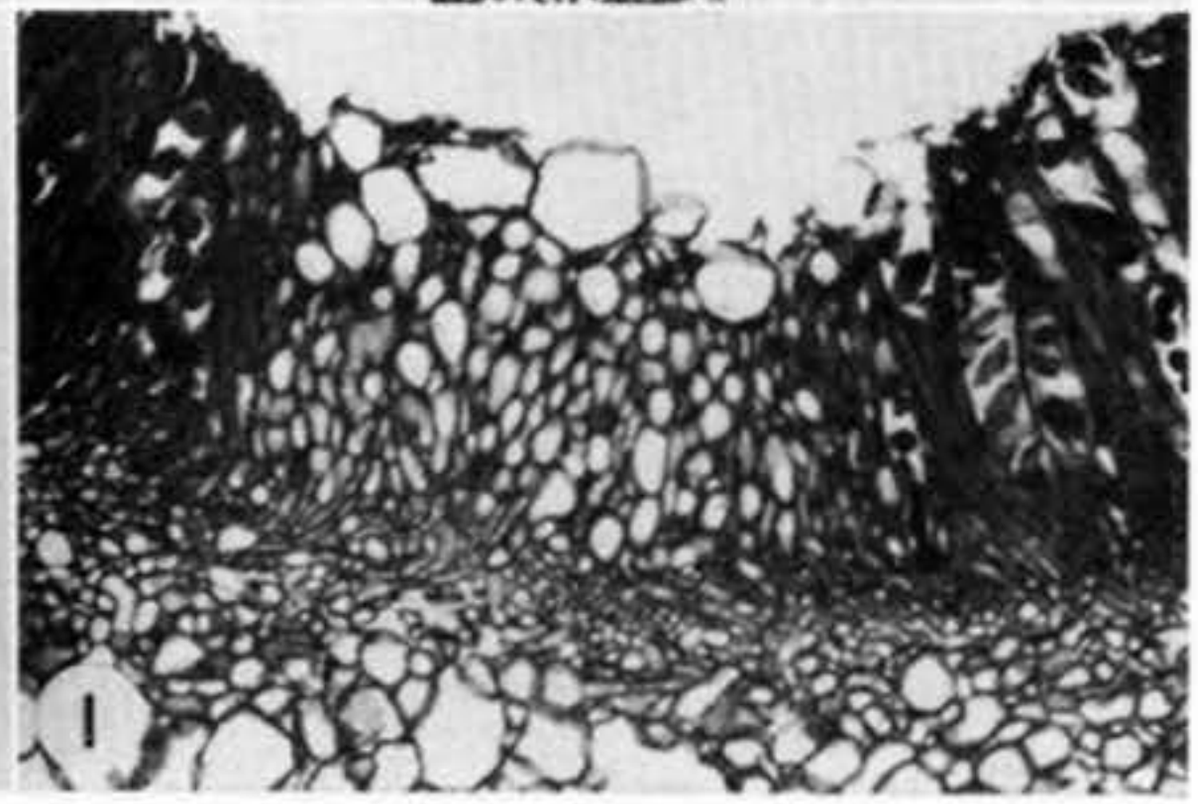

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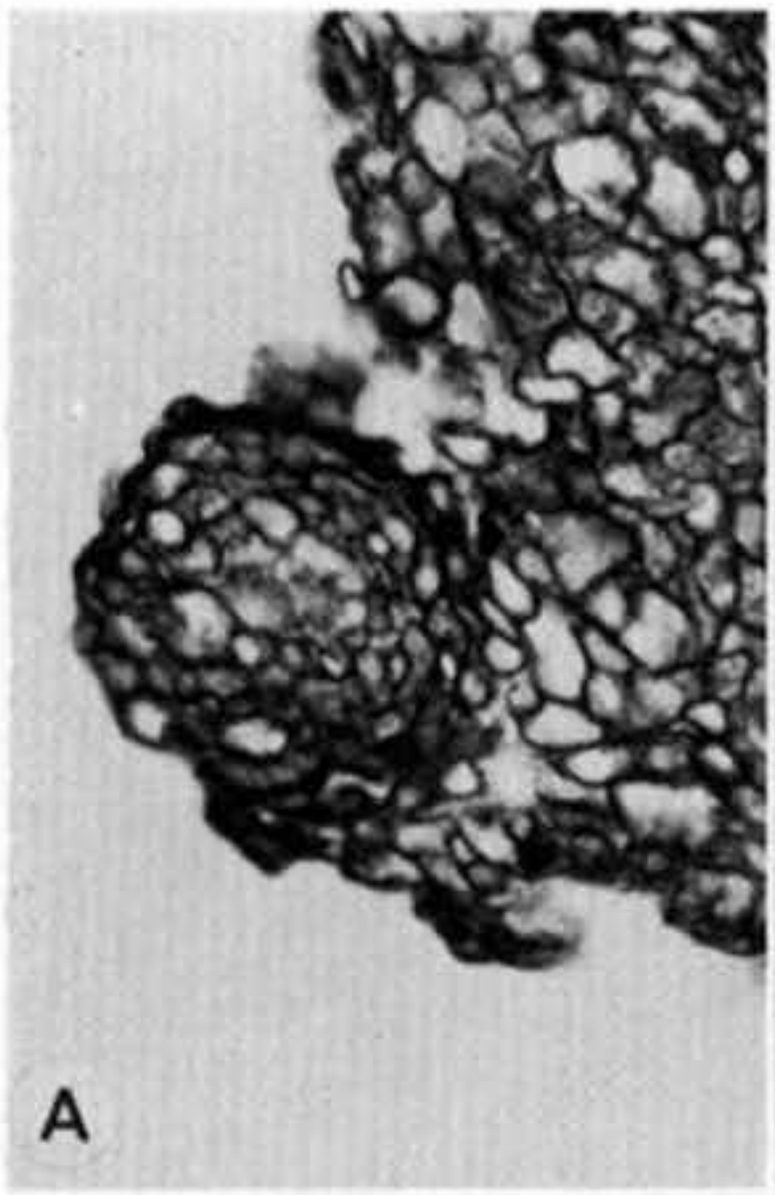

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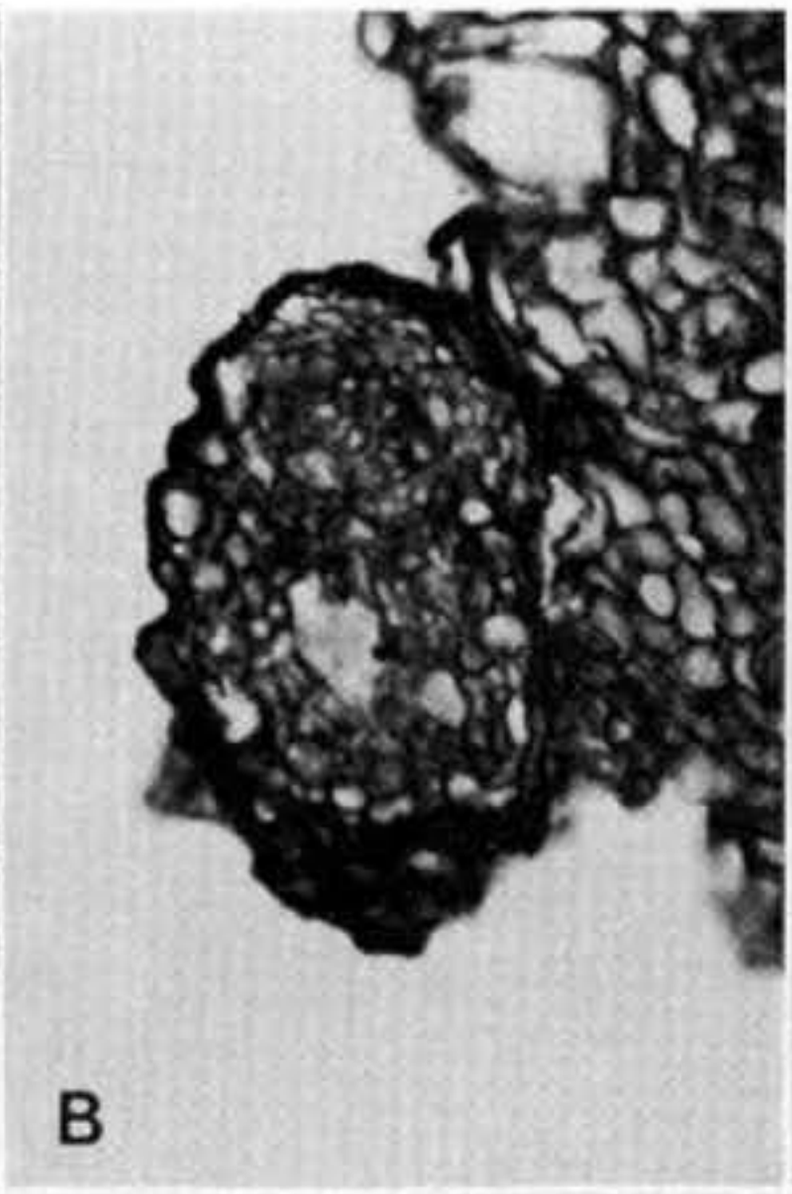

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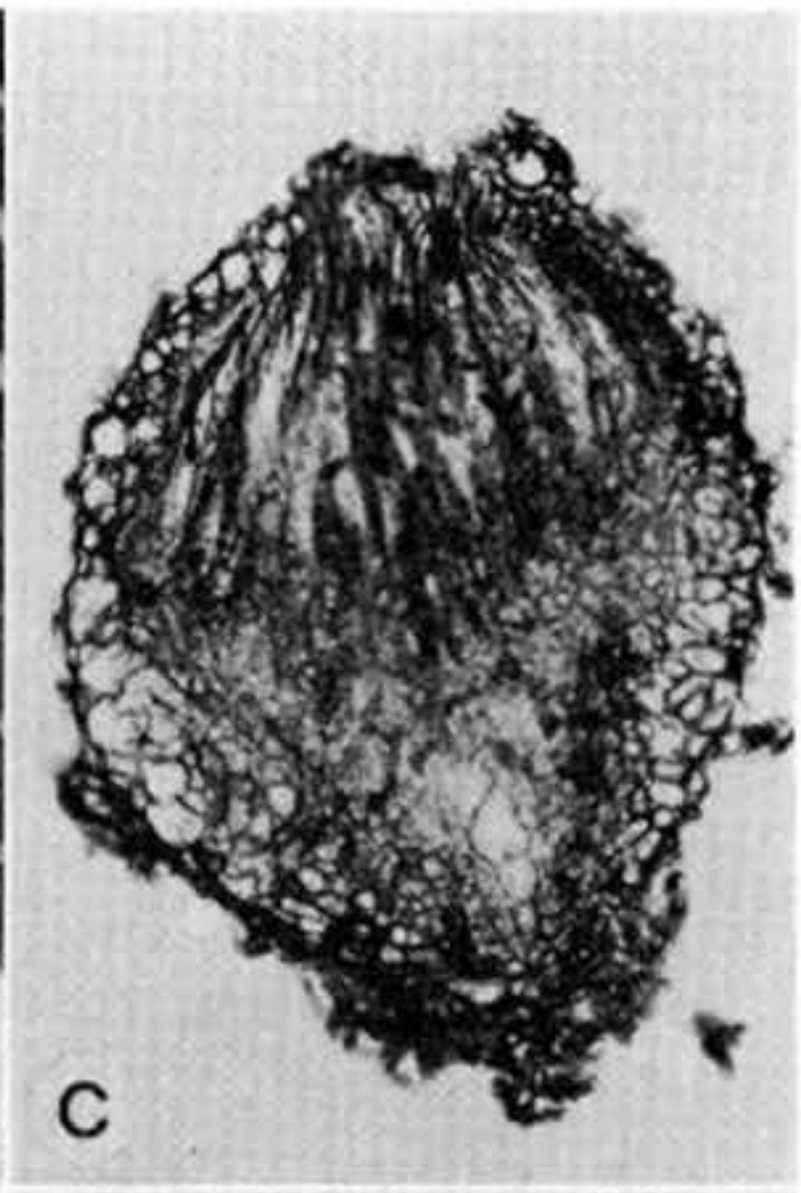

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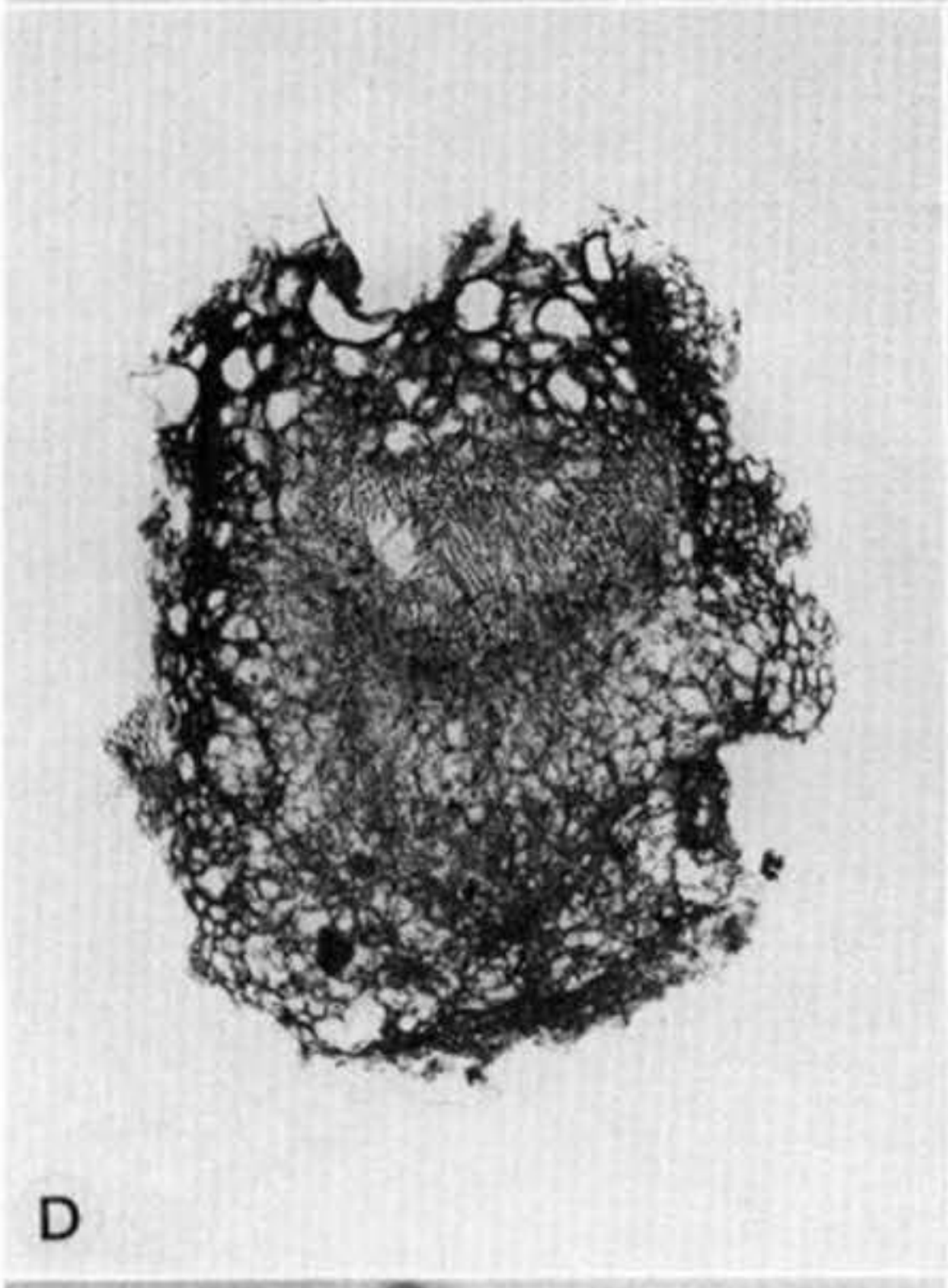

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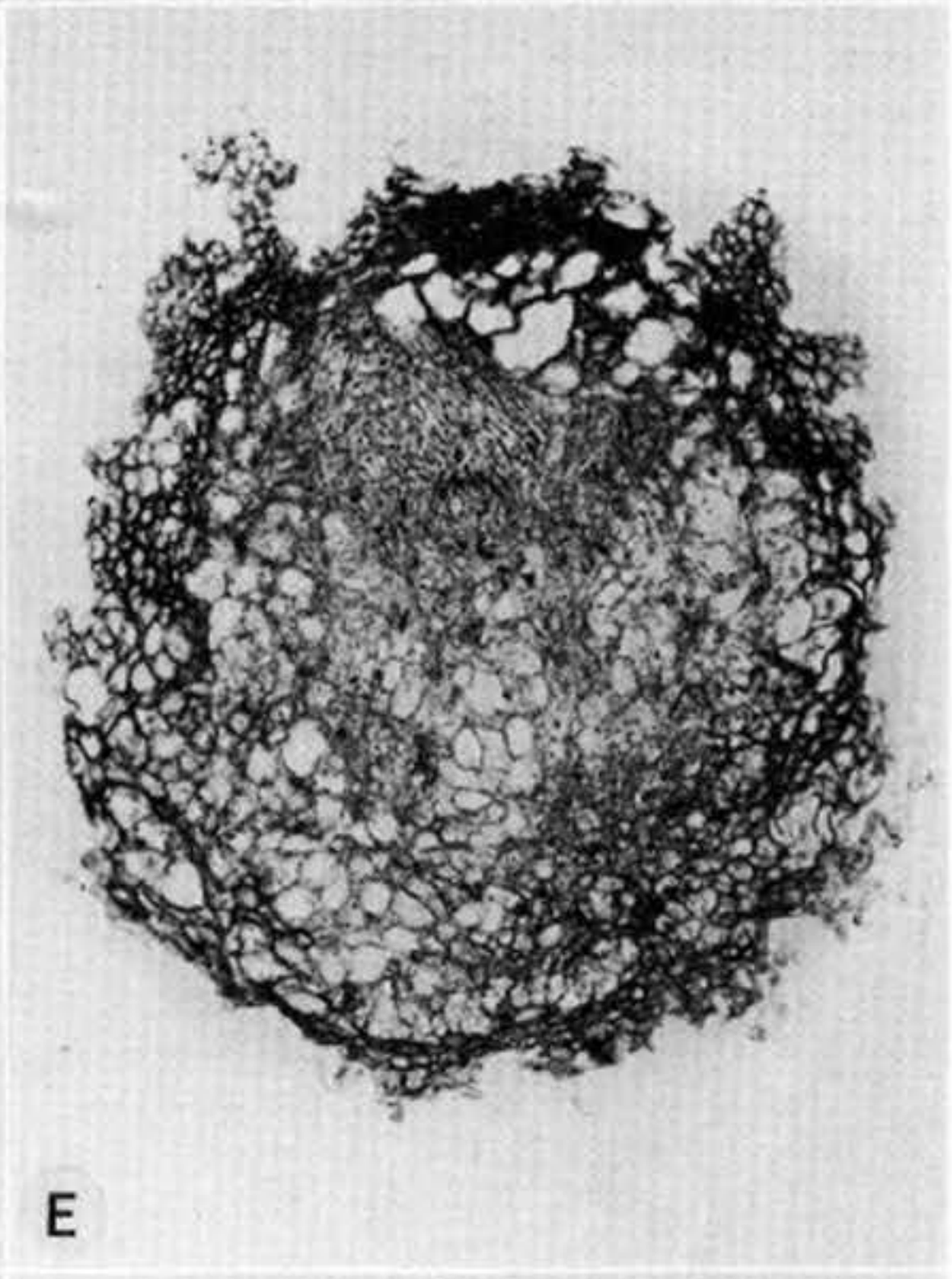

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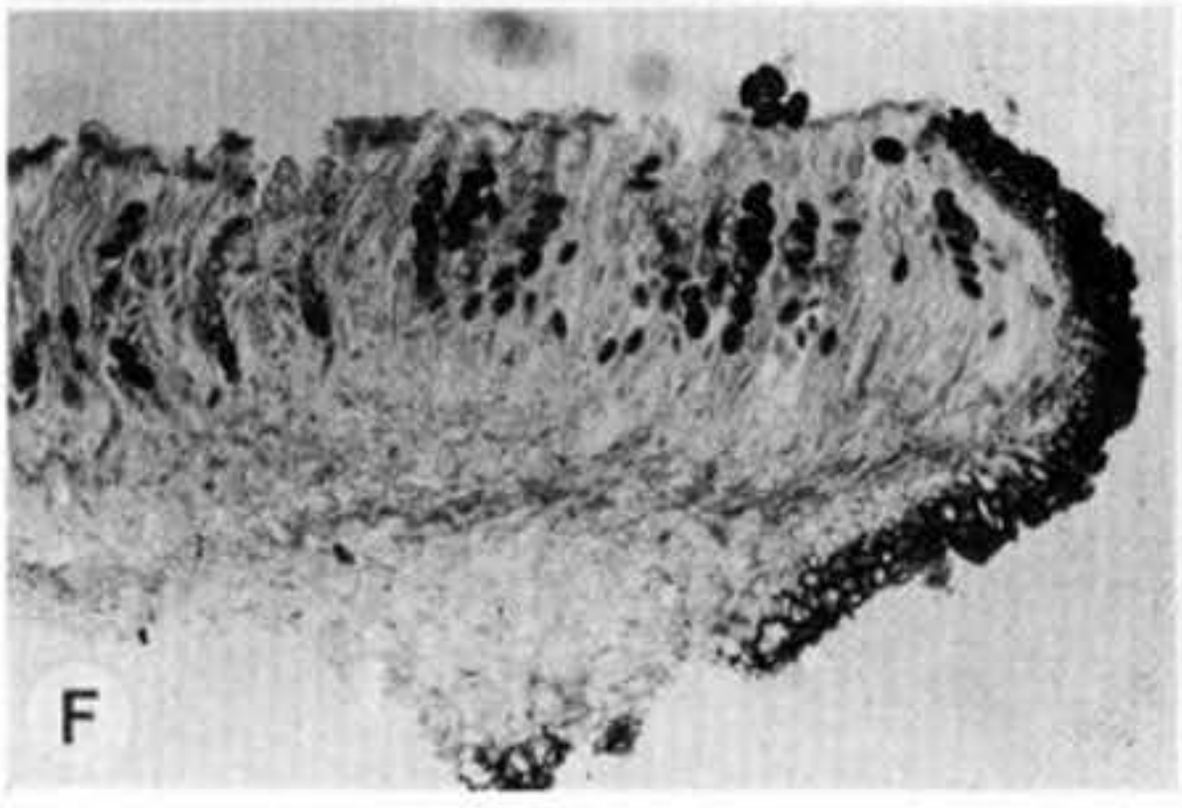

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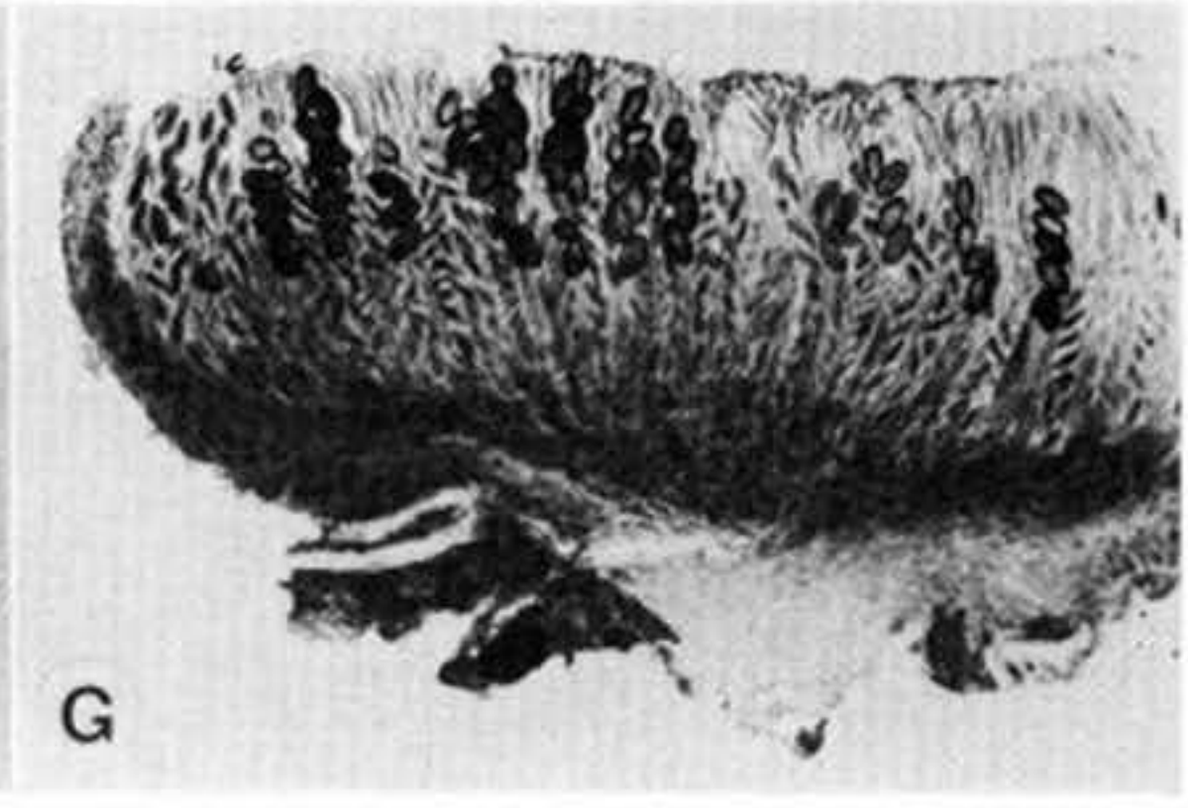

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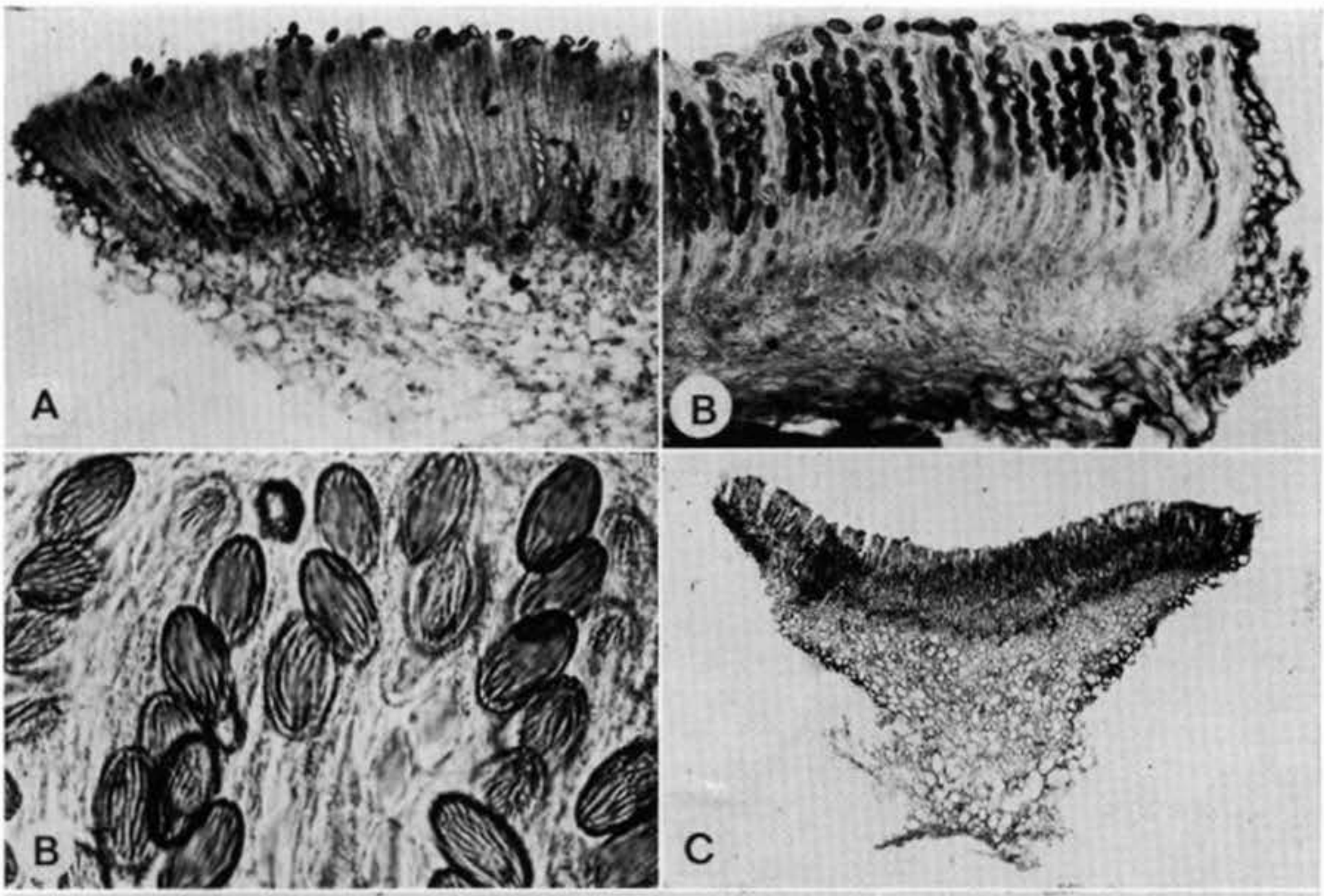

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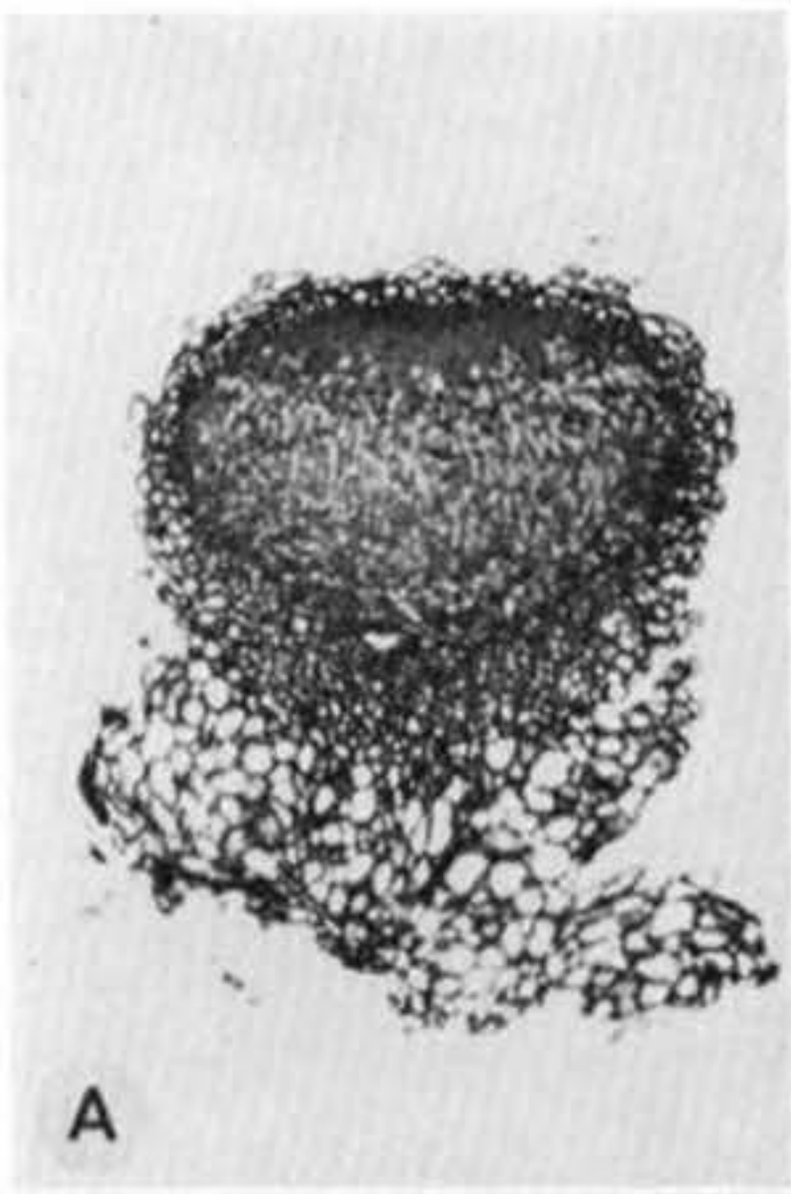
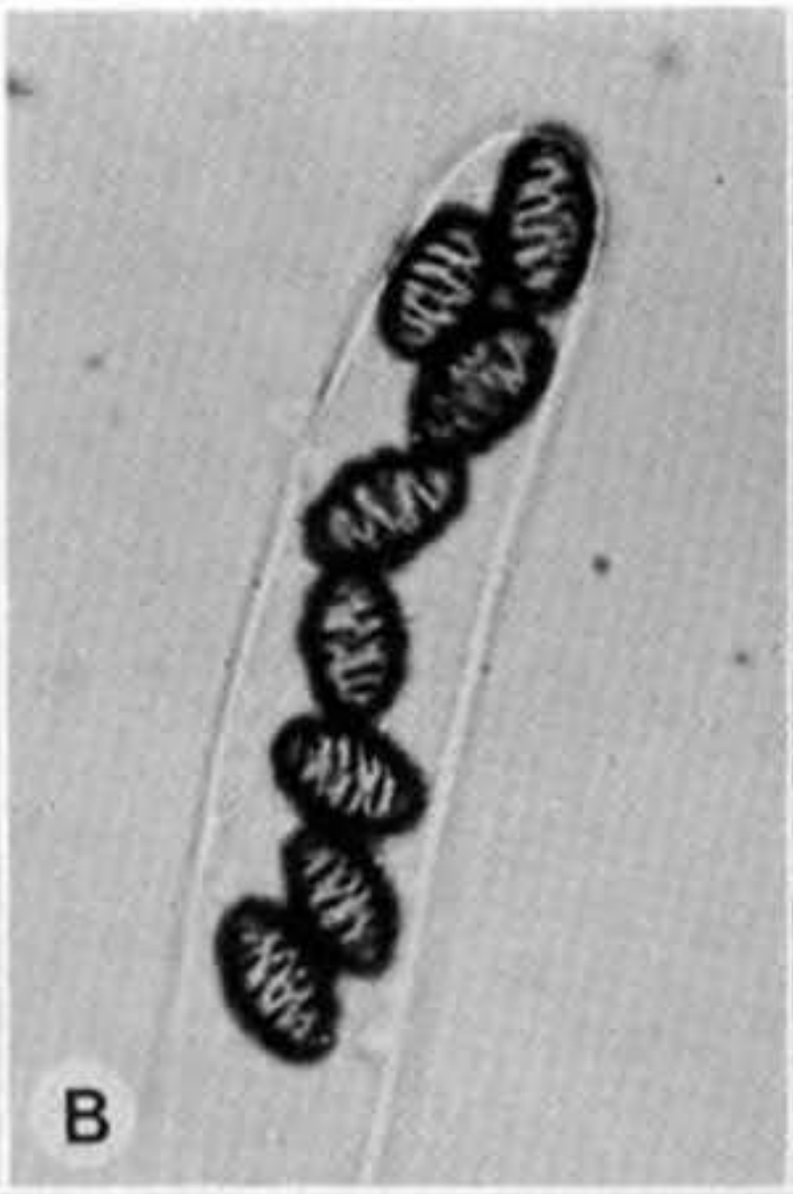
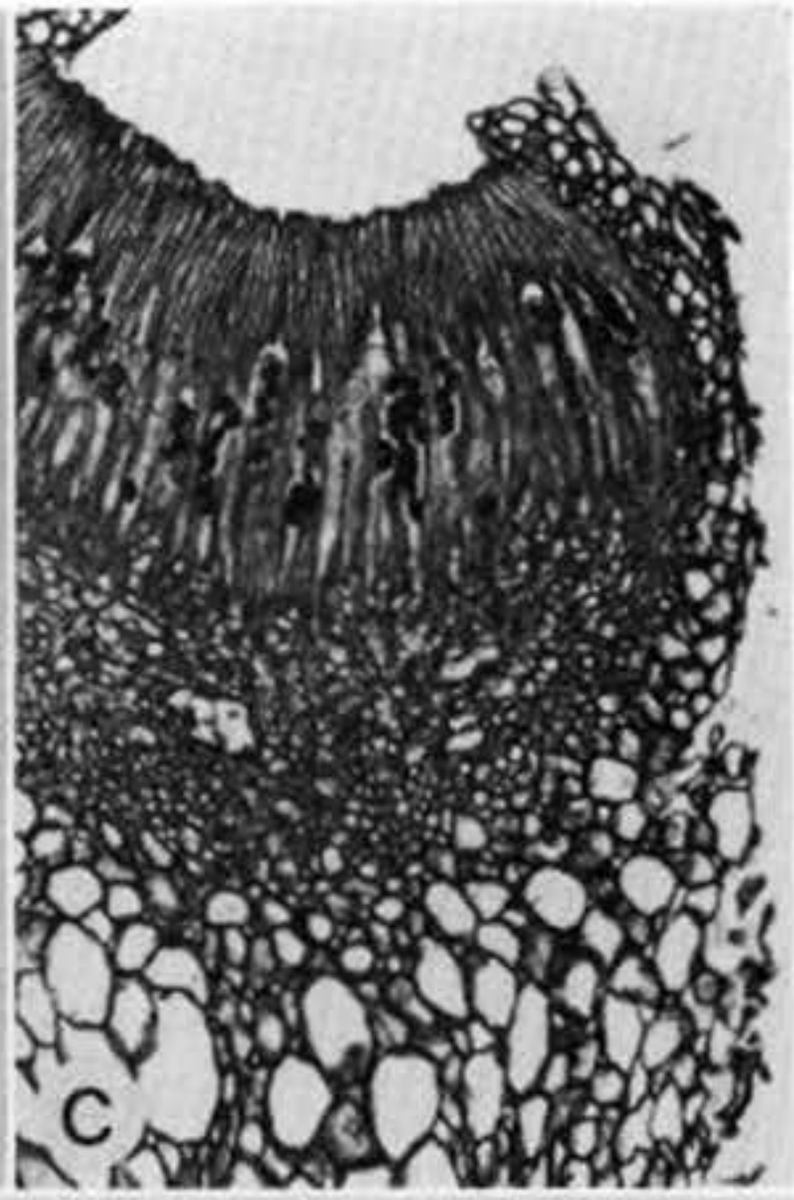
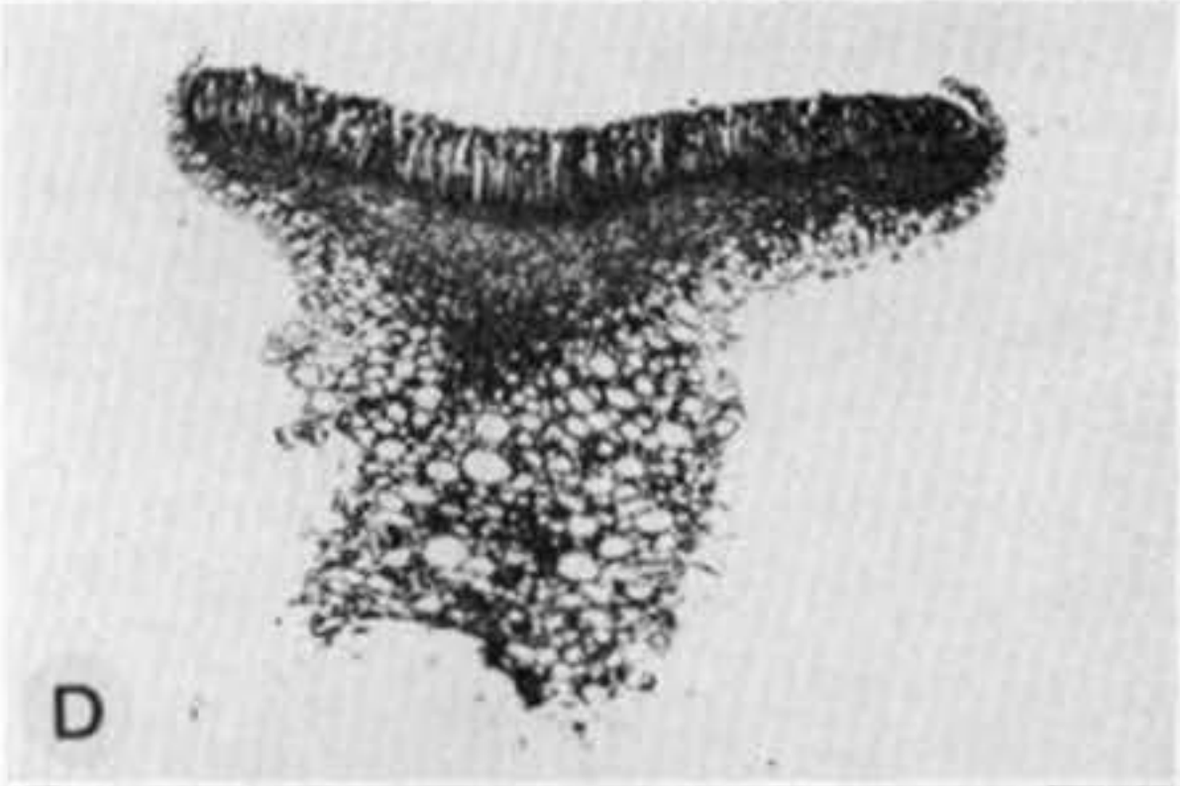
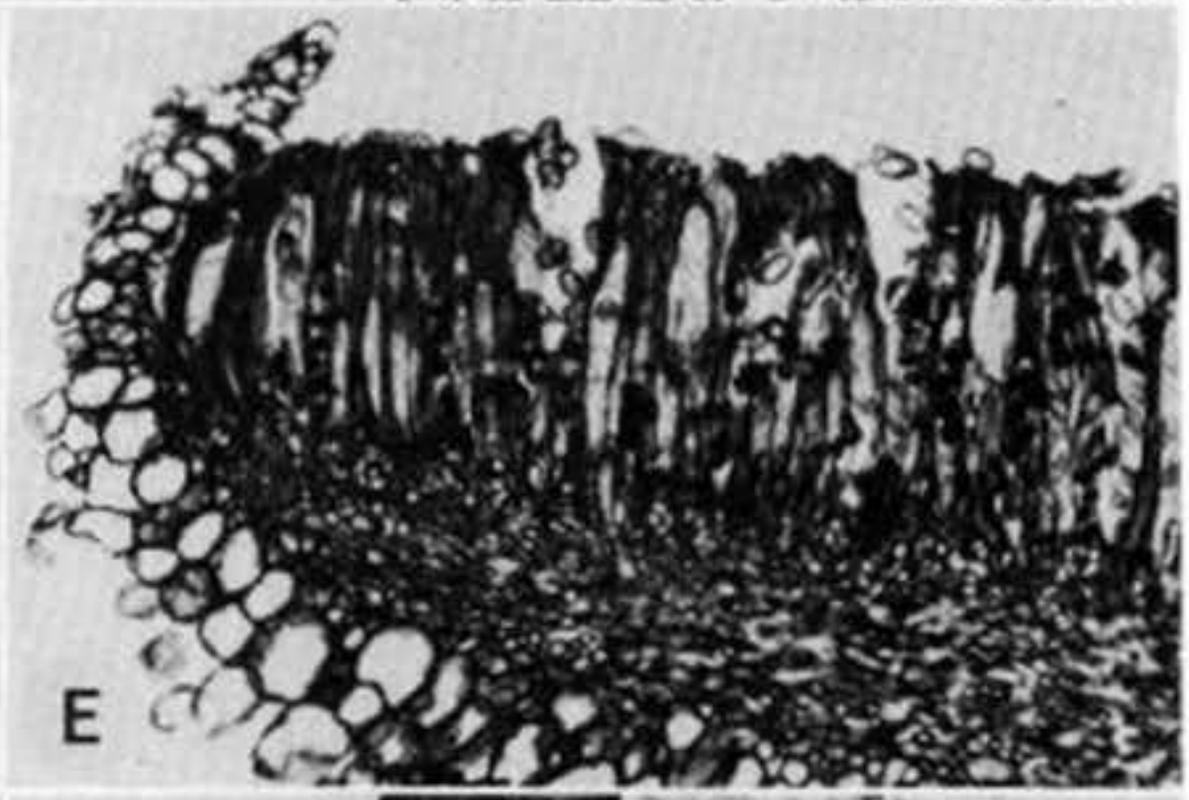
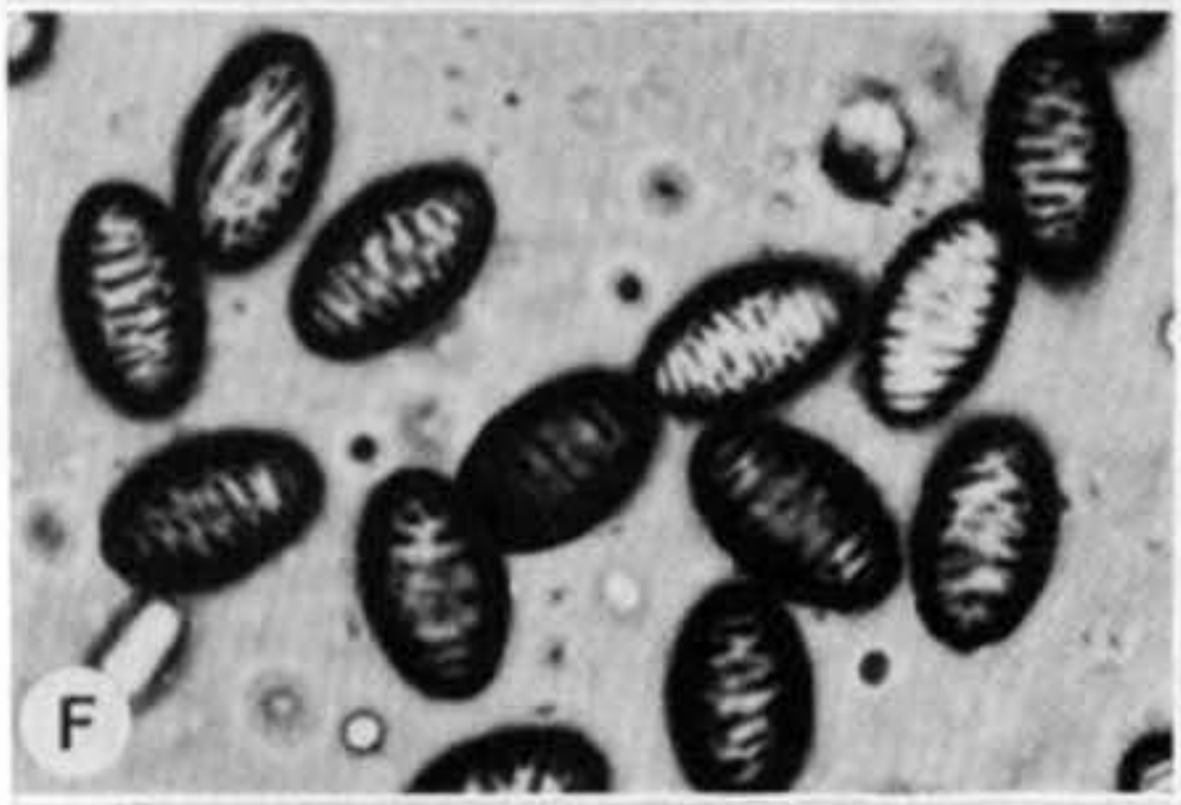


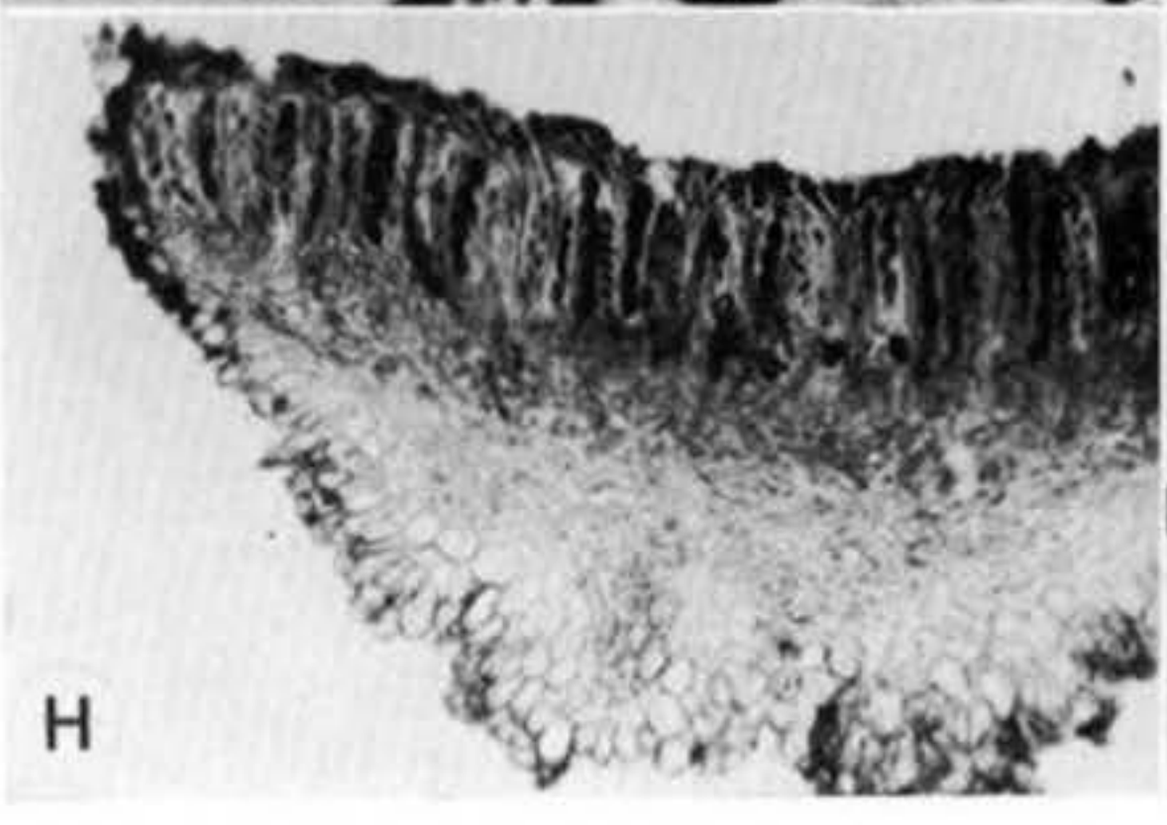












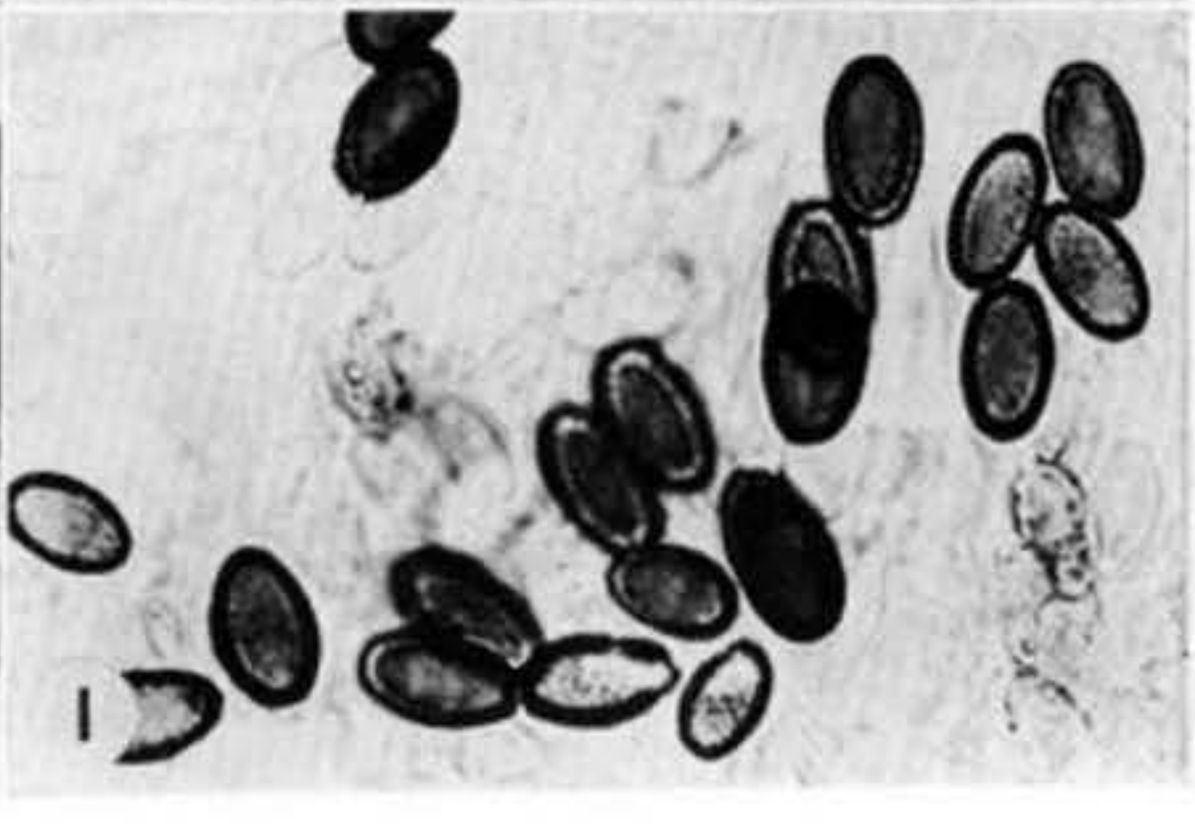
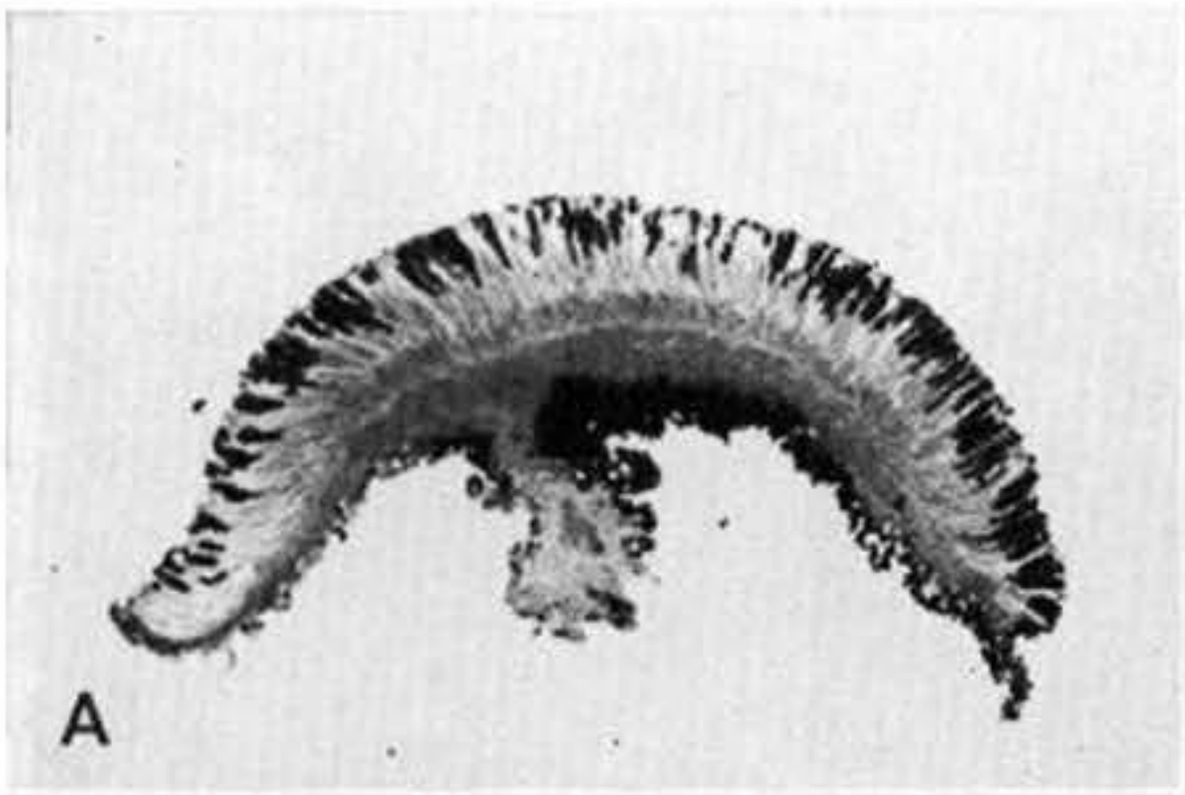
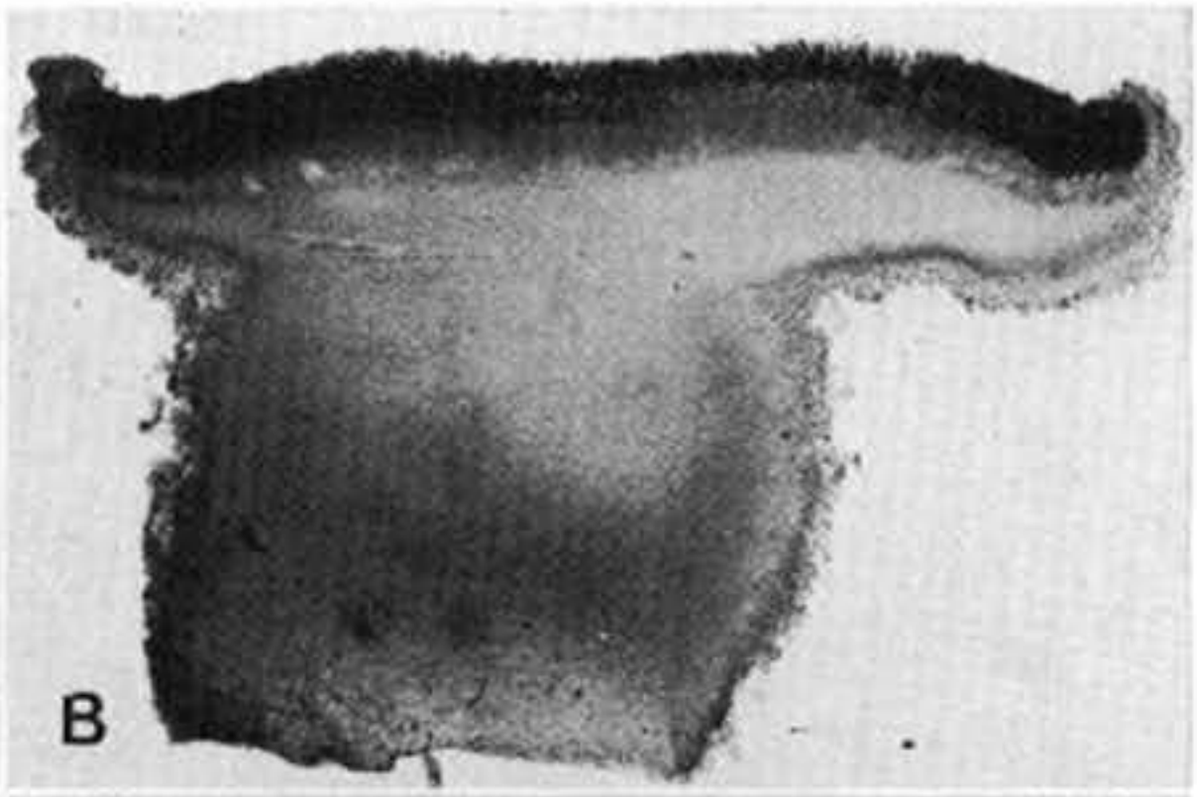
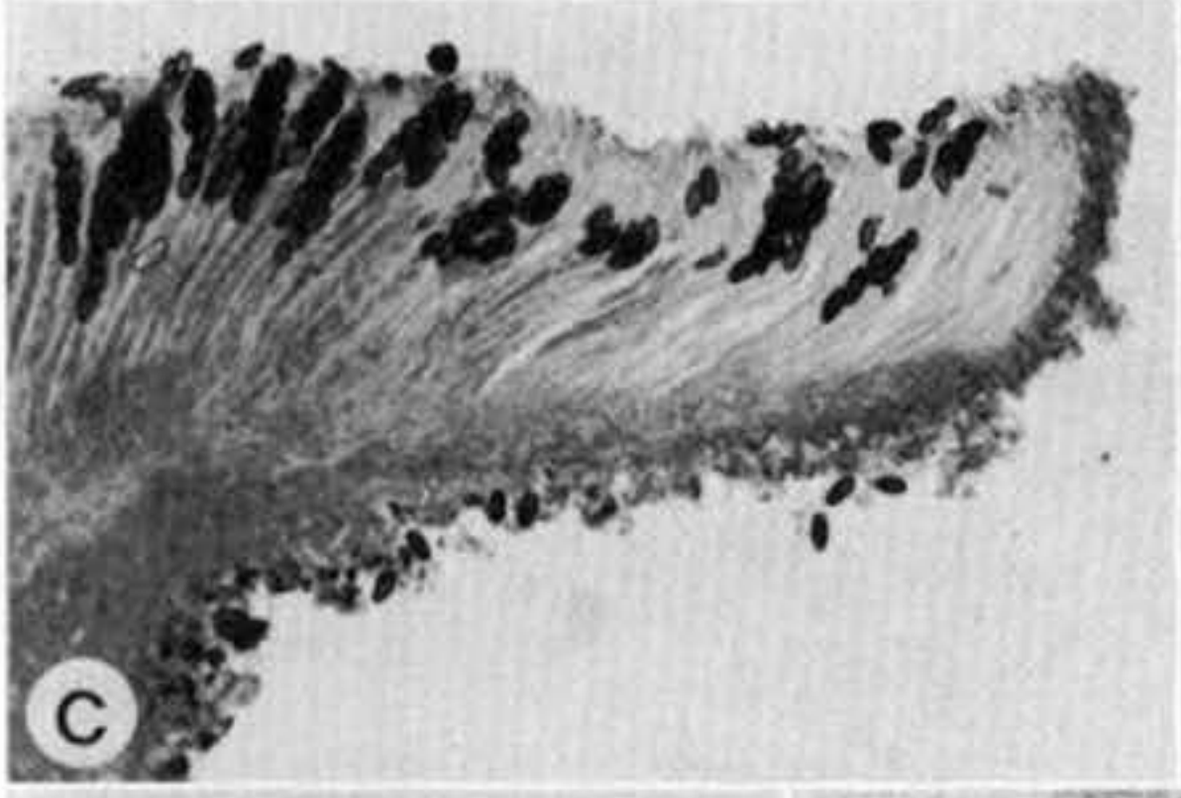
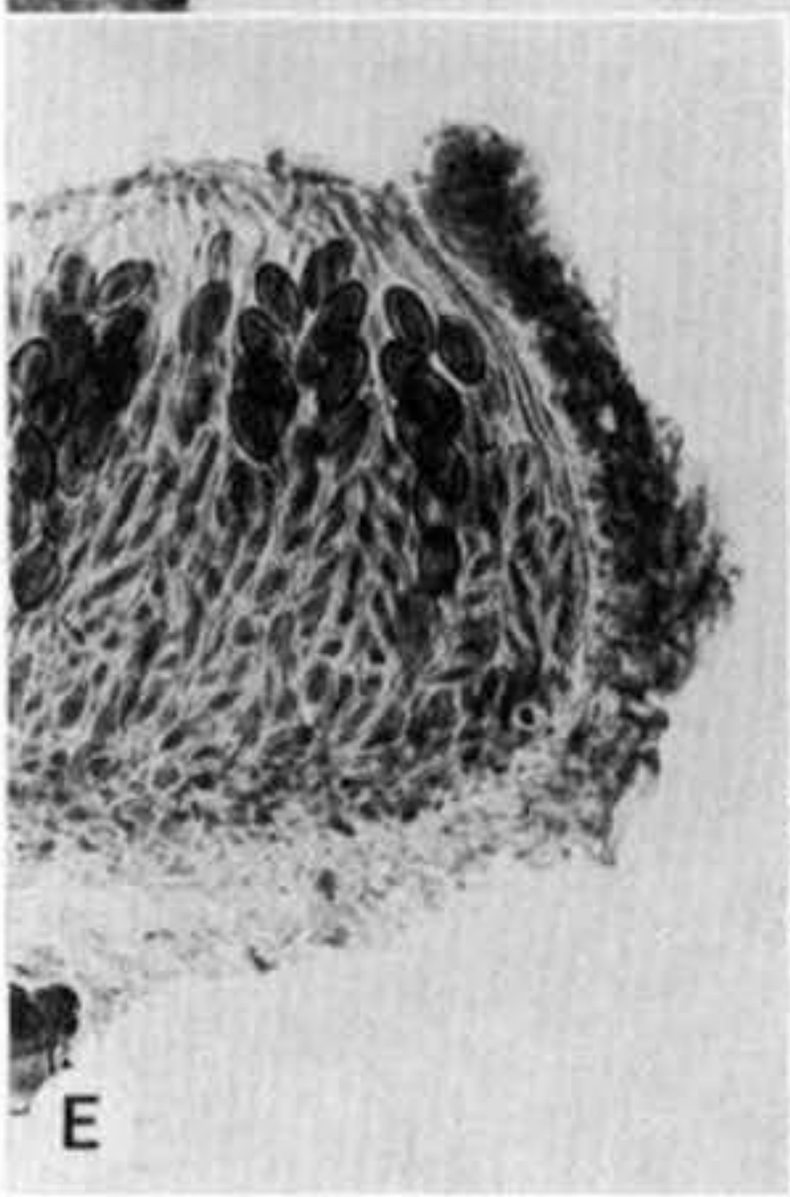


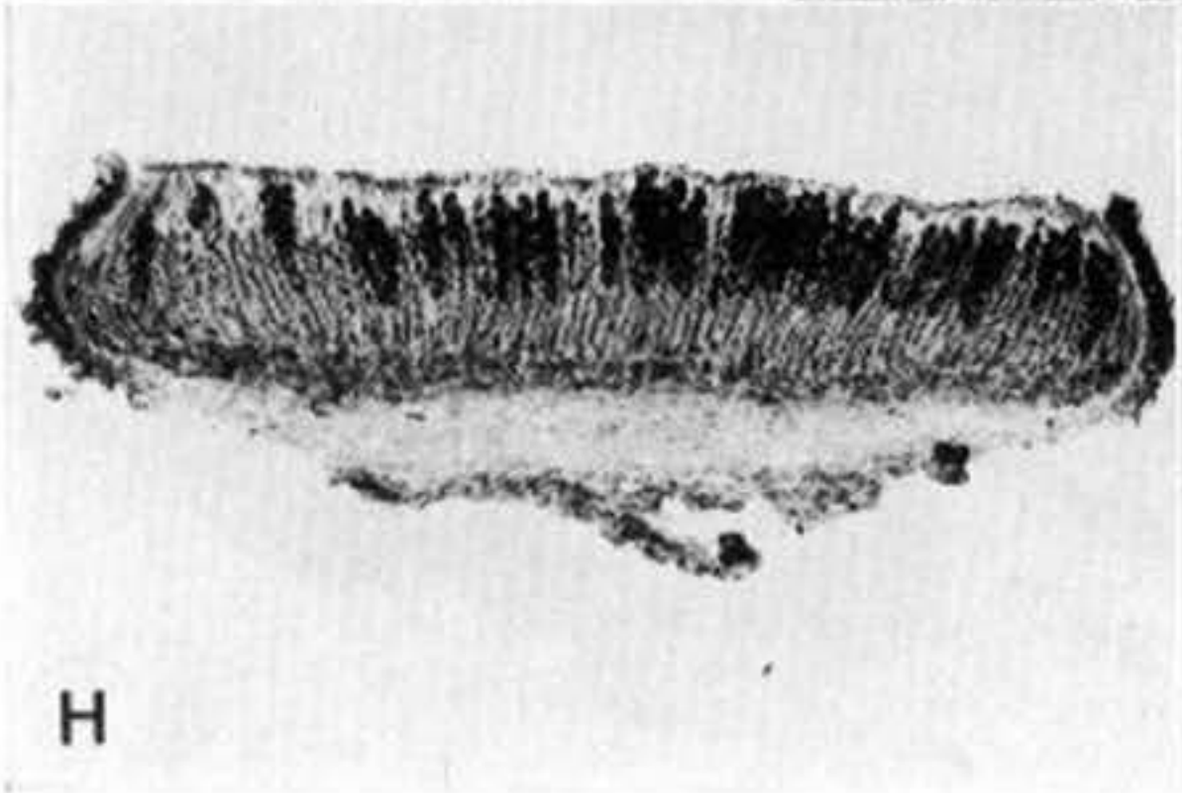
PLATE 10











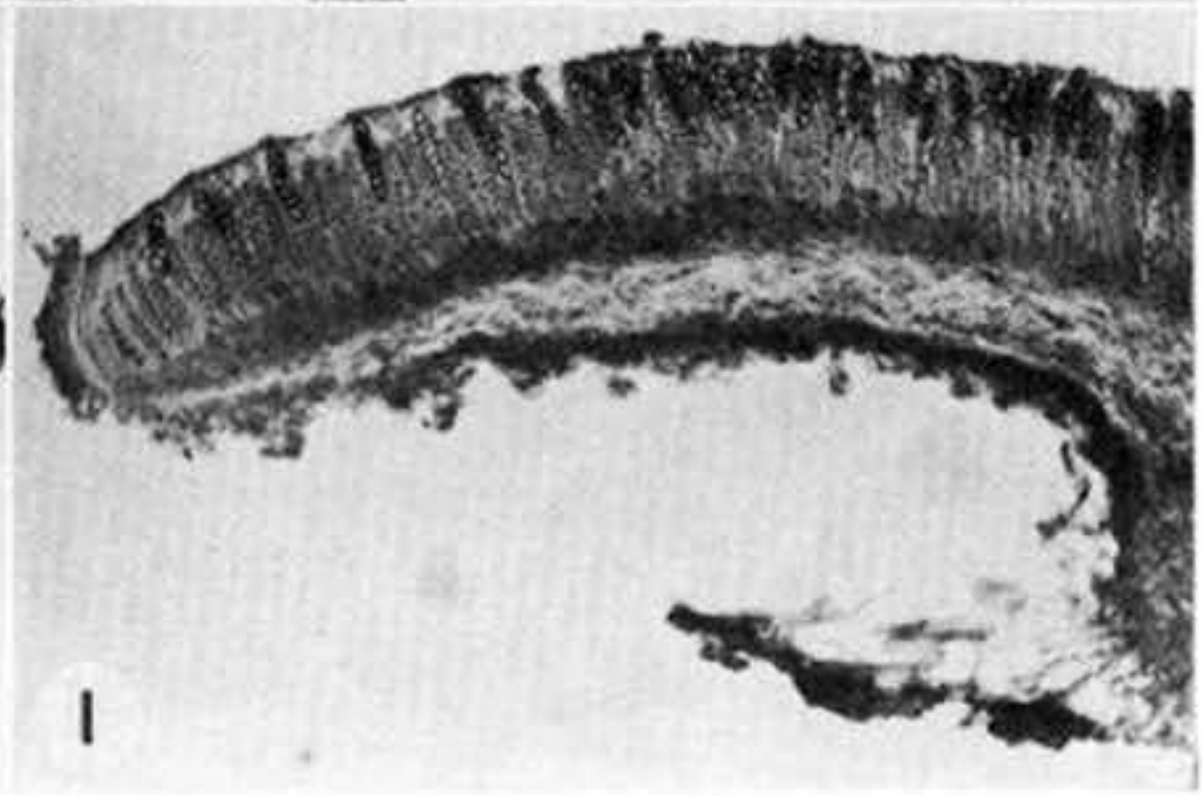
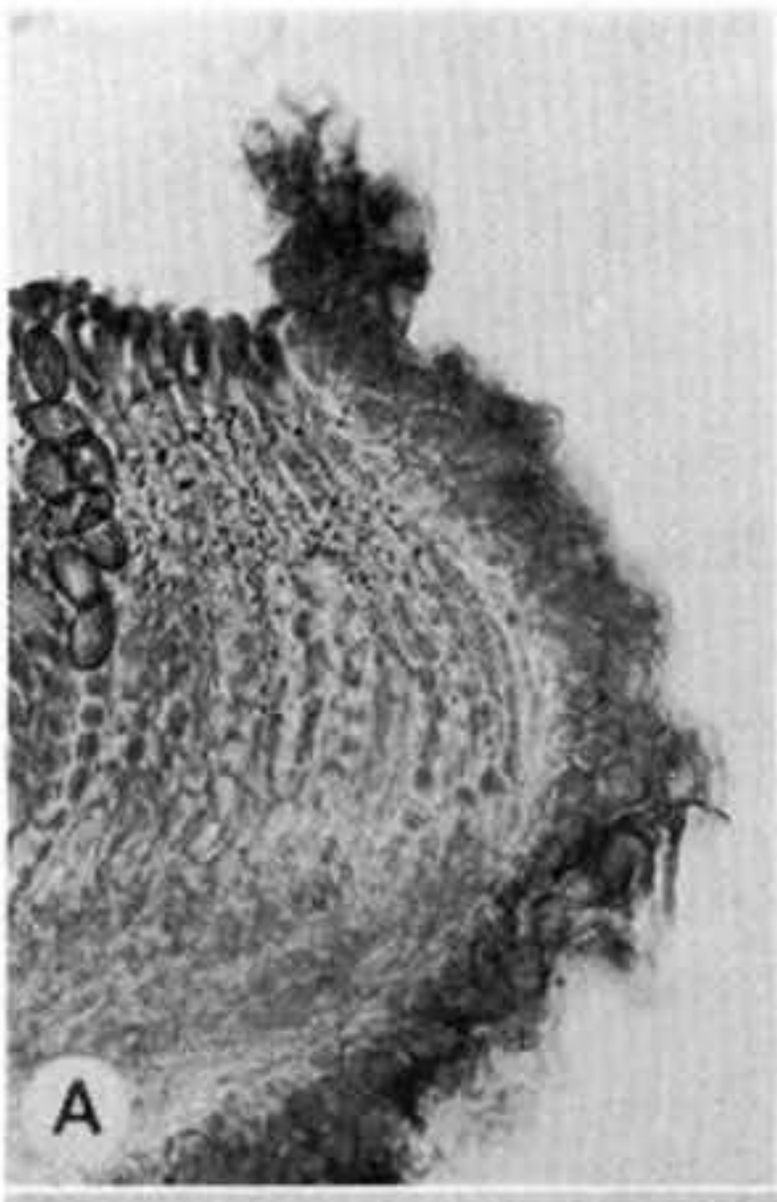


PLATE 11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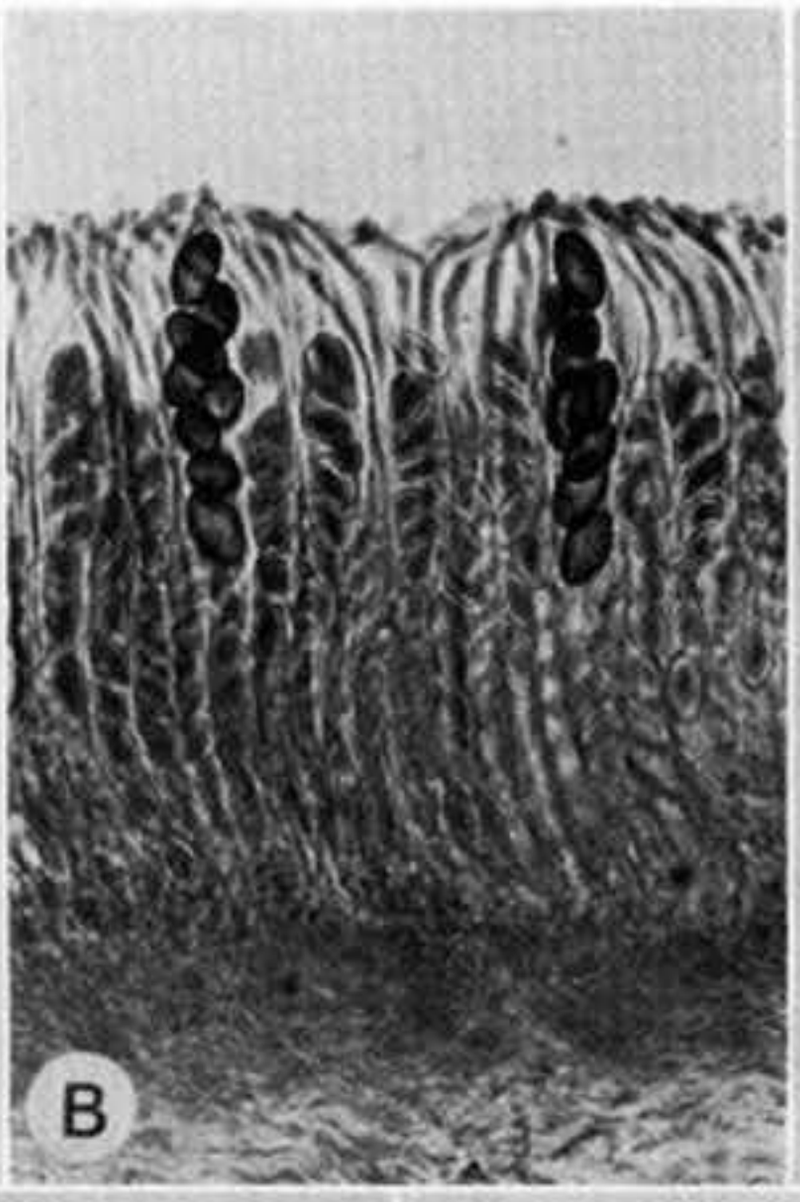
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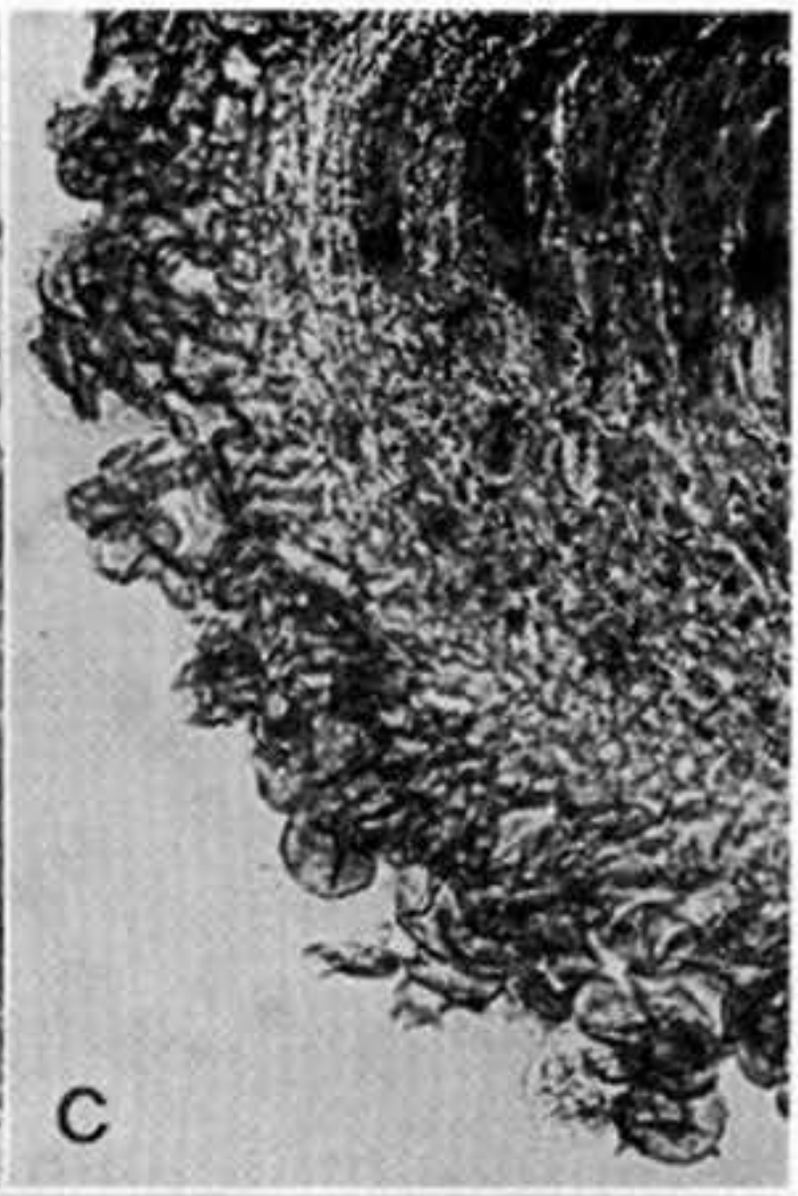
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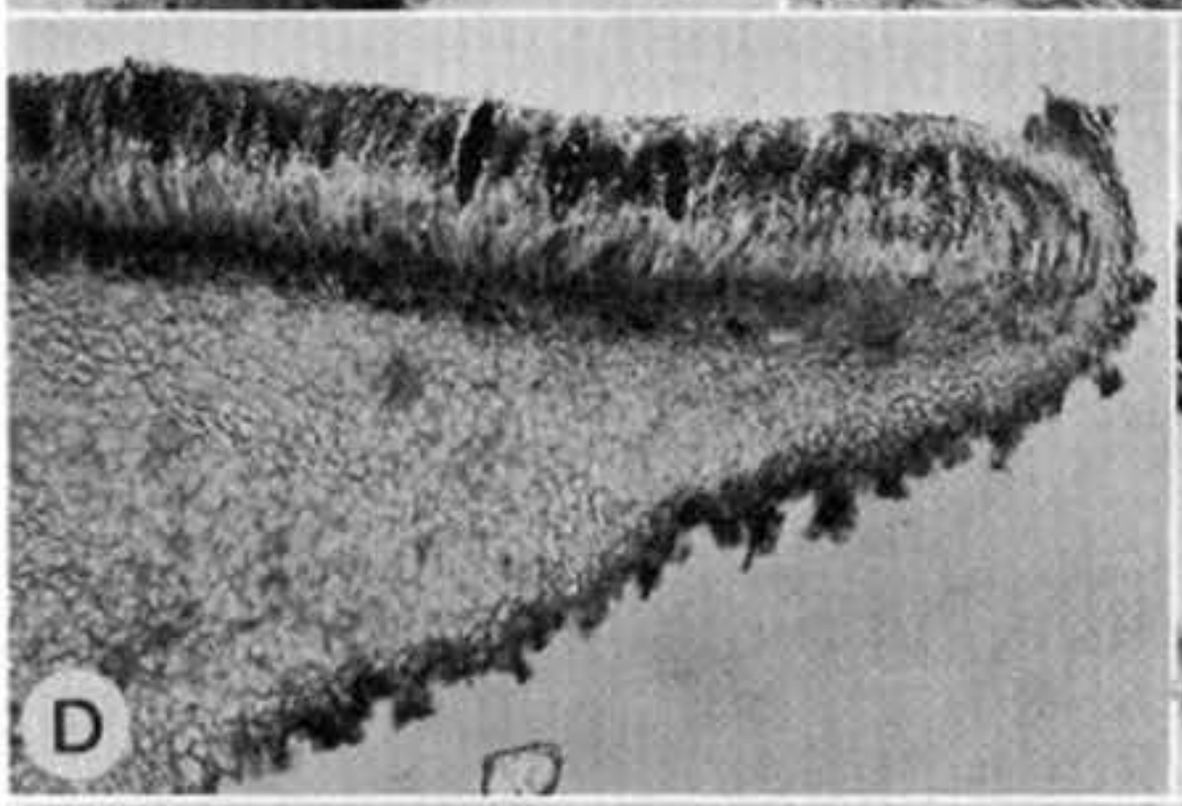
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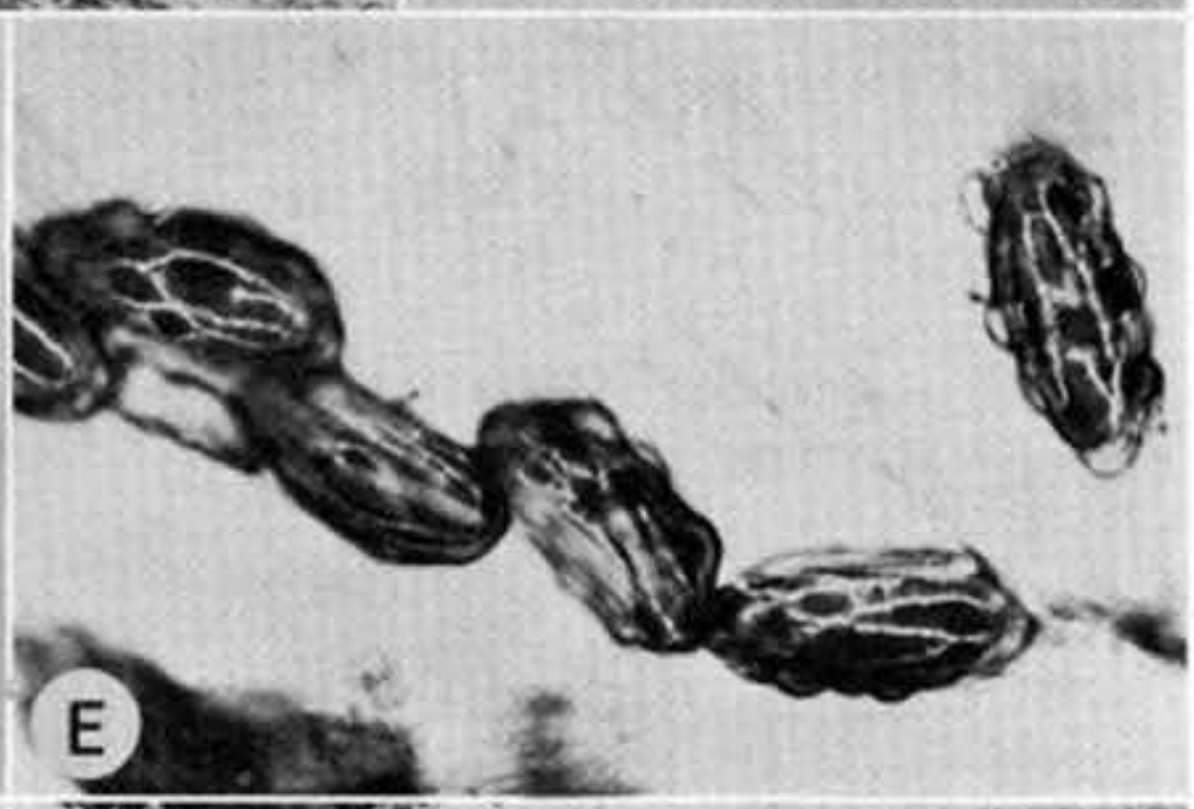
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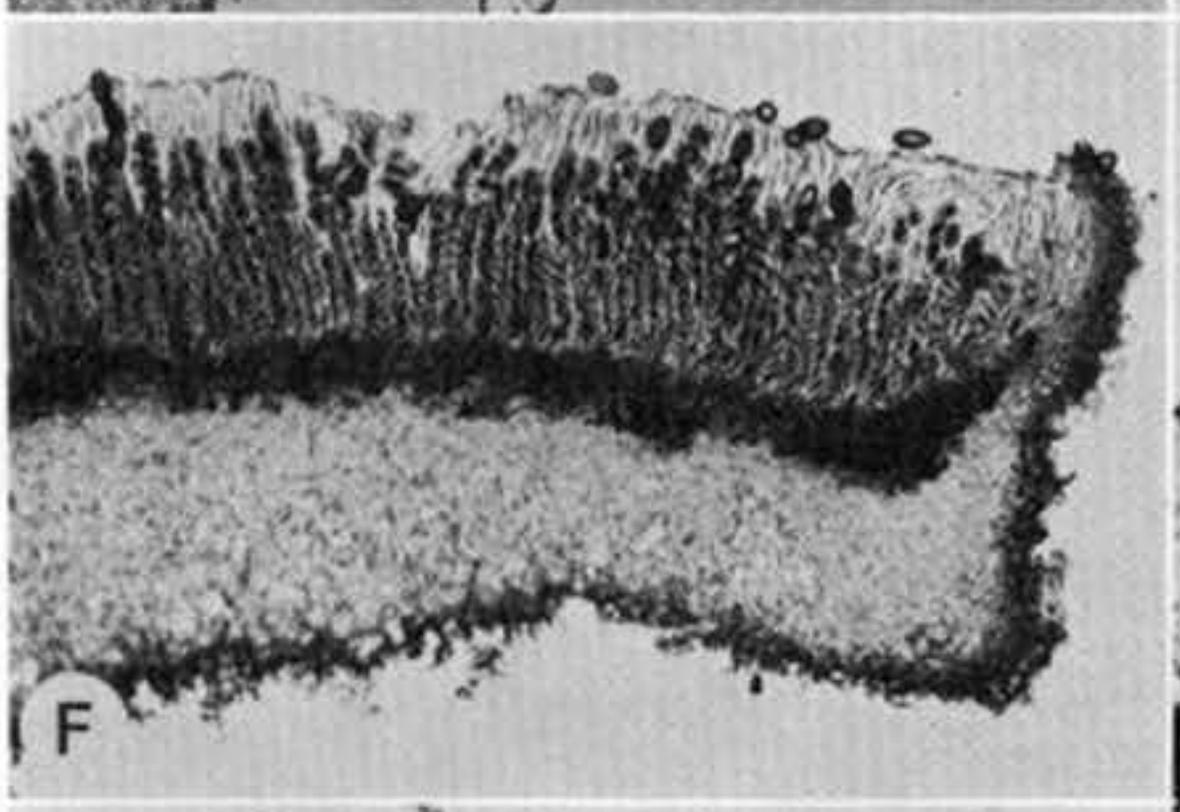
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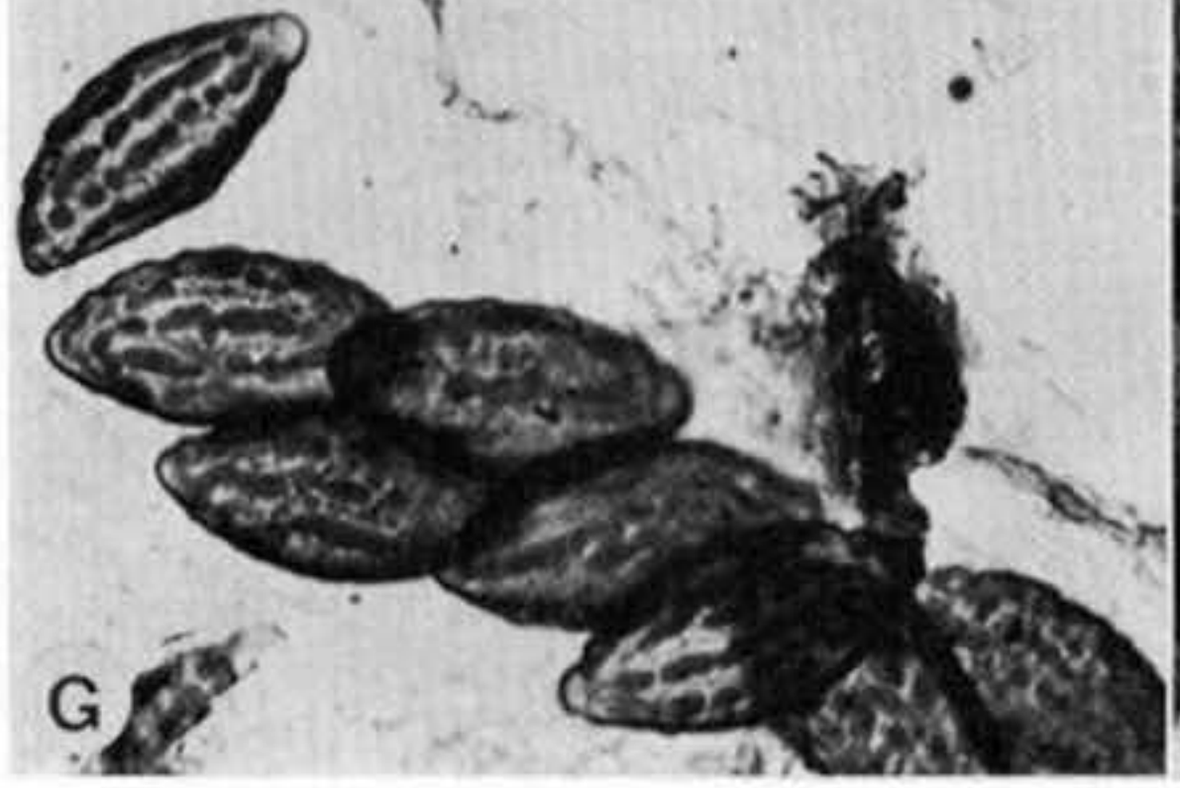
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PLATE 12

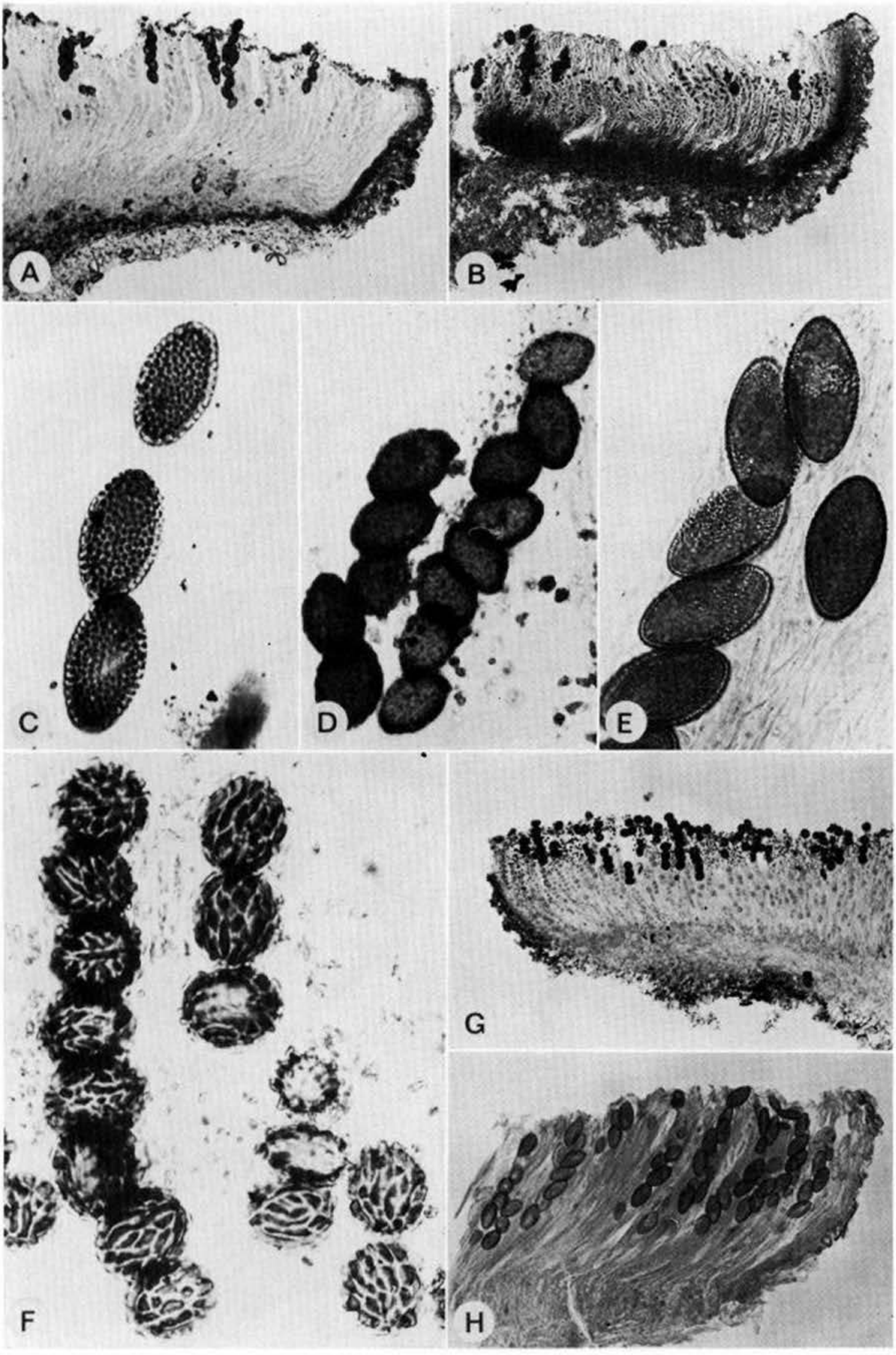


PLATE 13

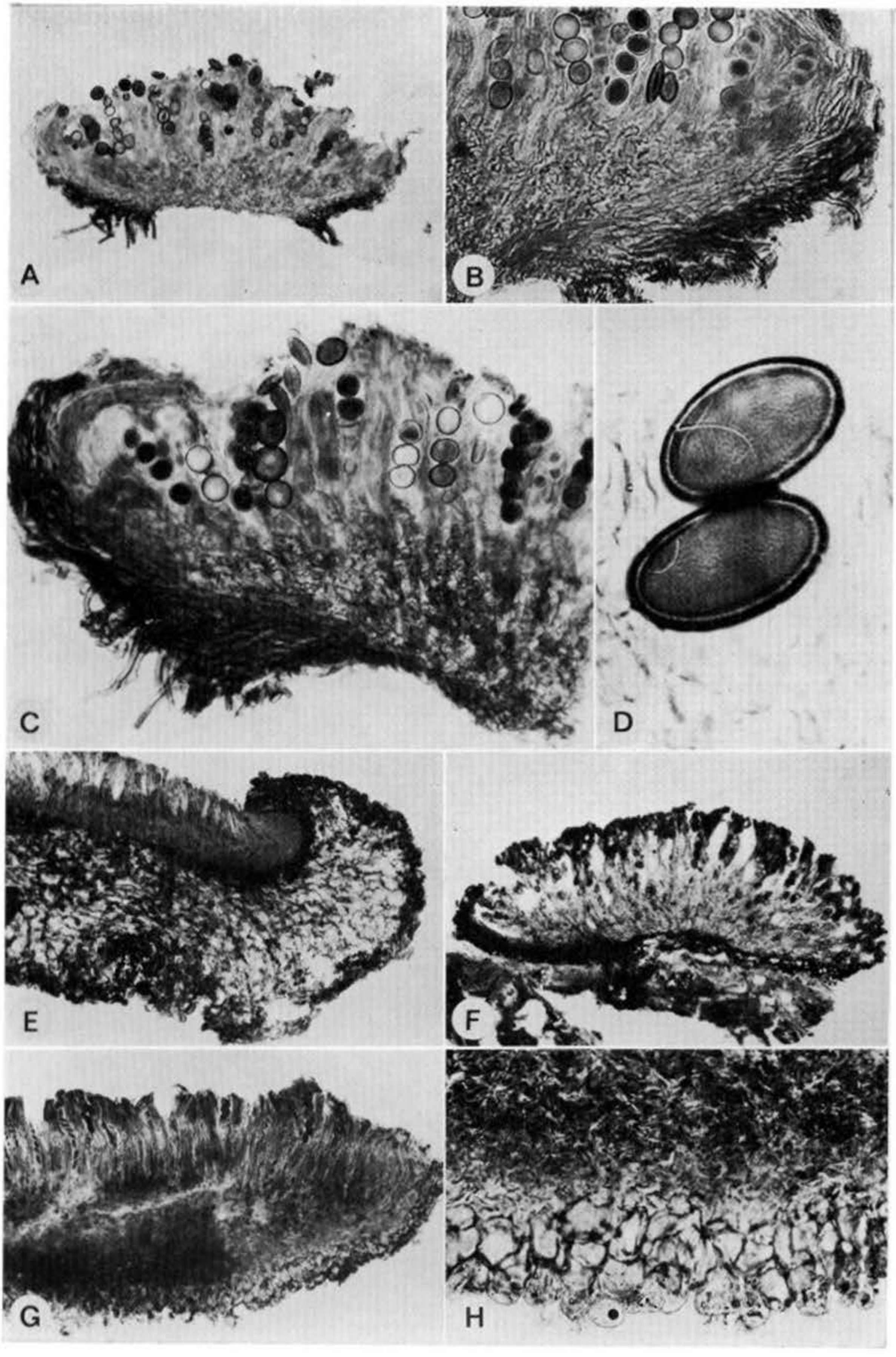
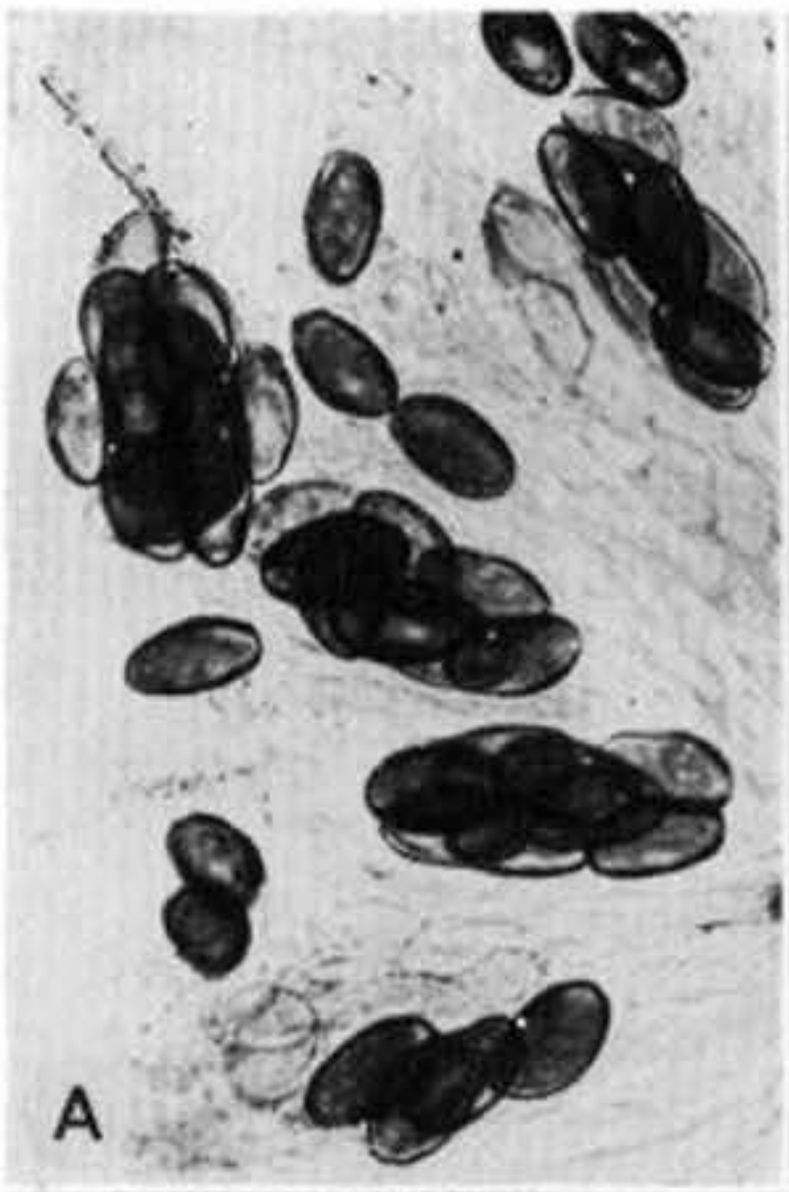
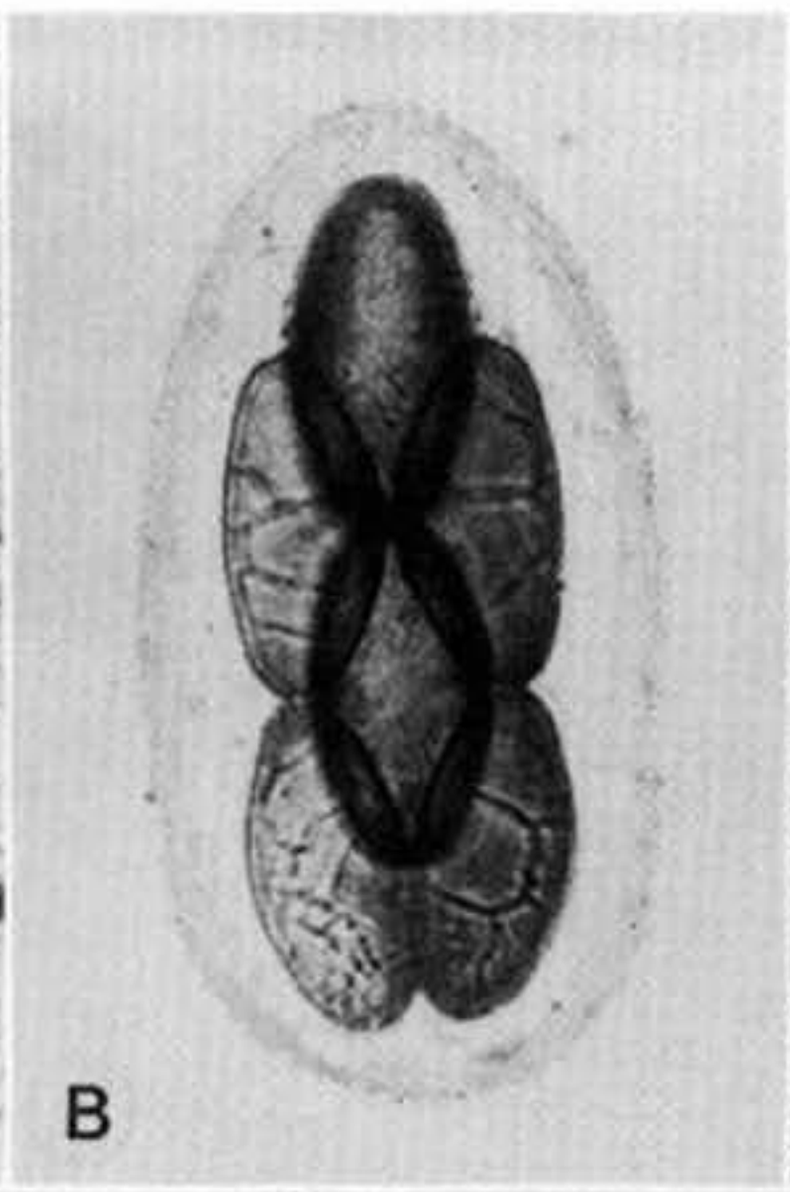
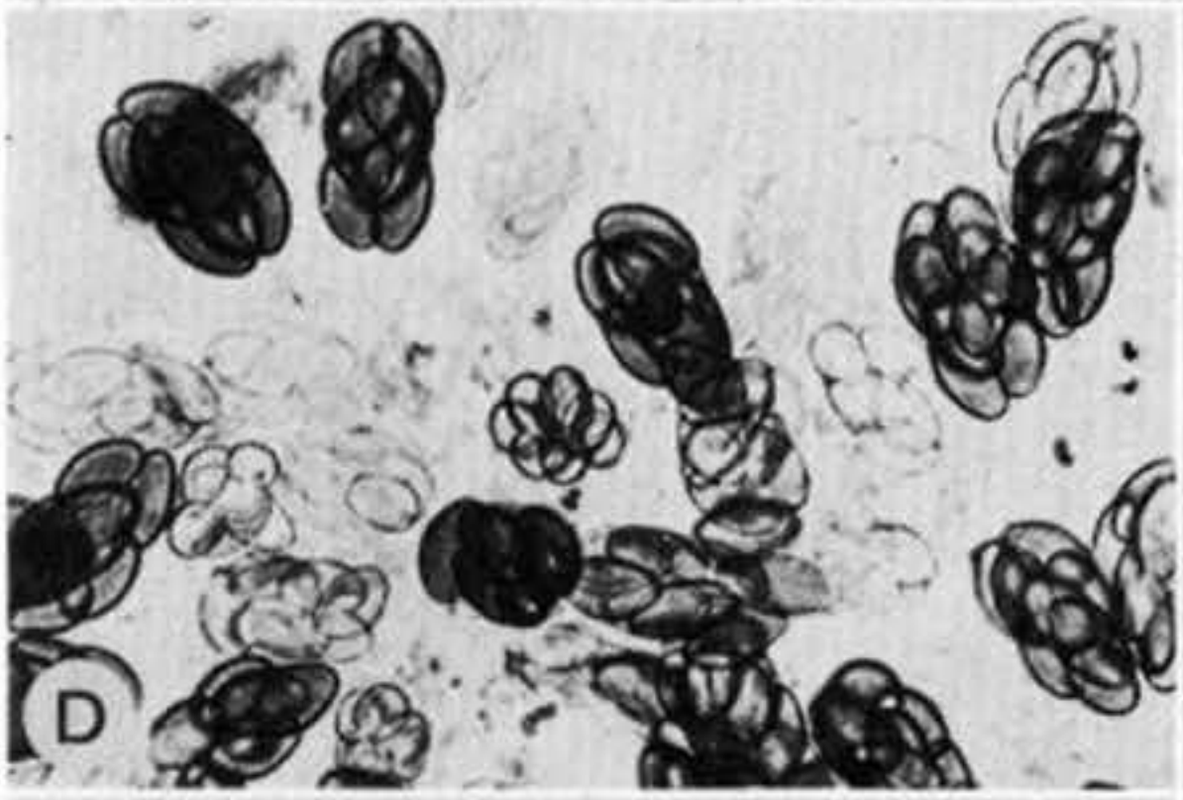
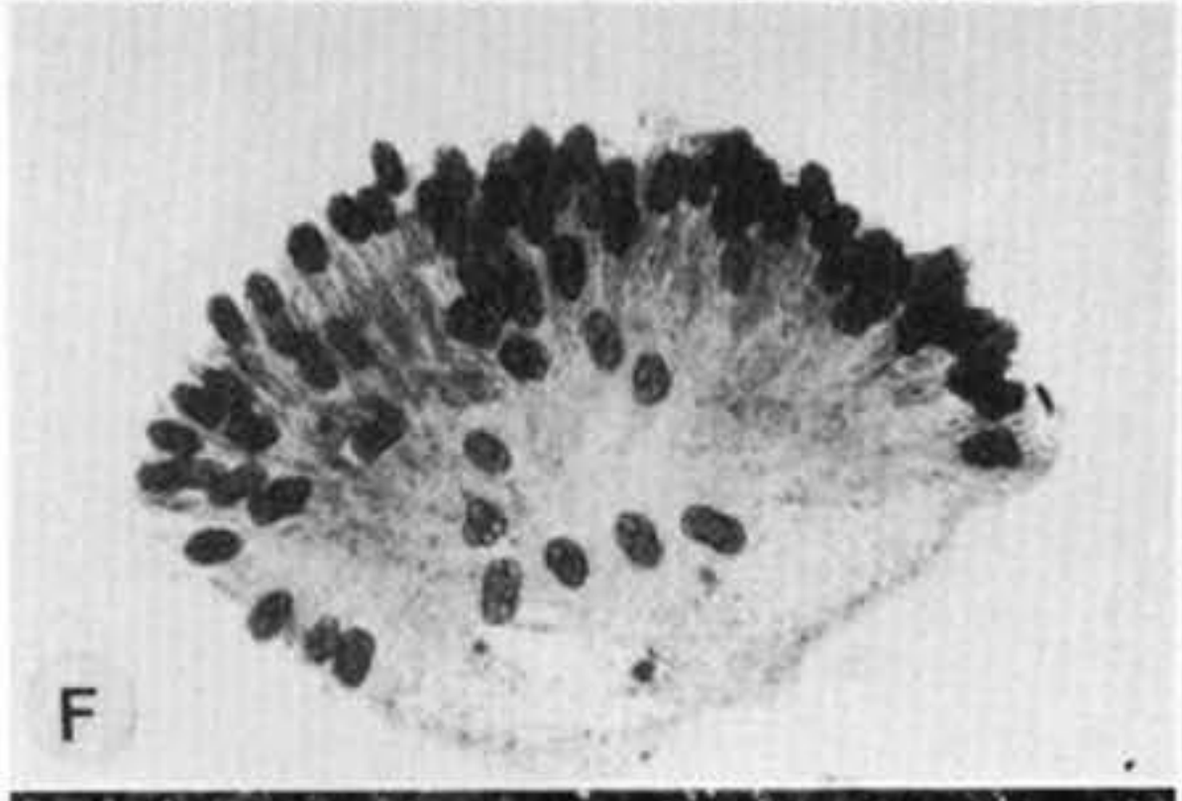


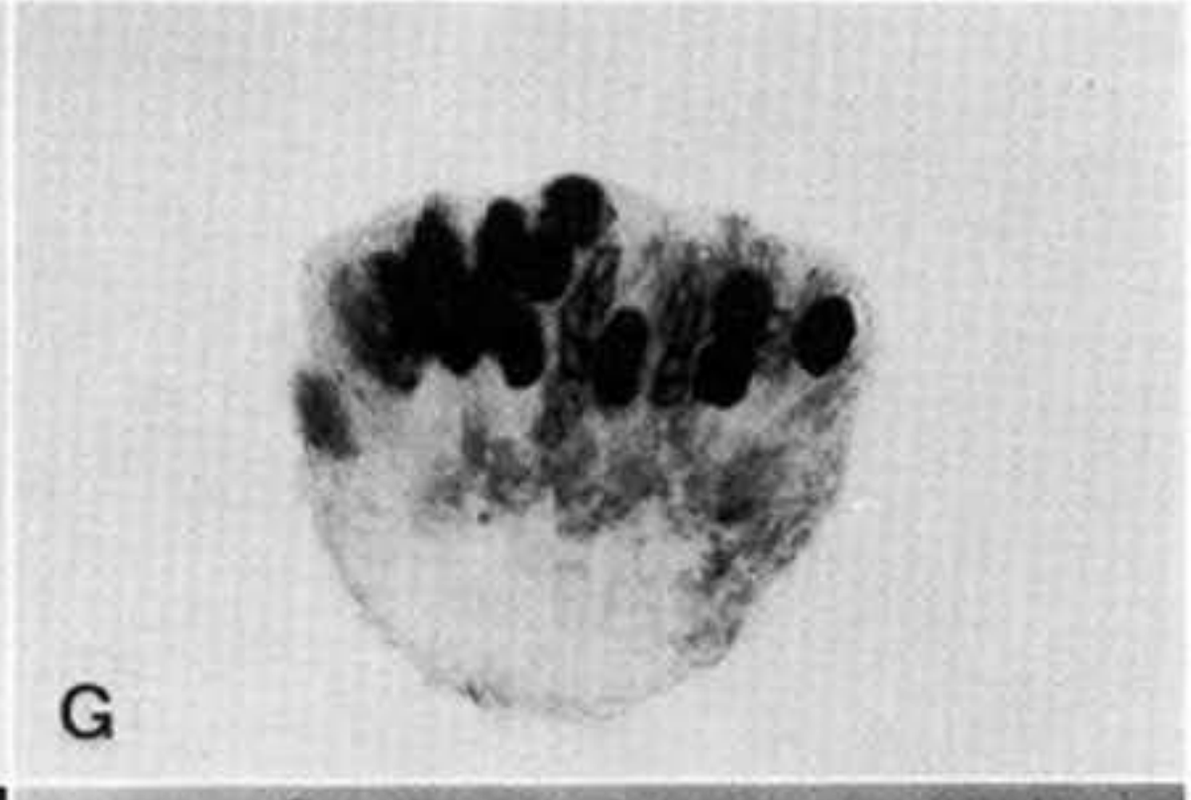
PLATE 14

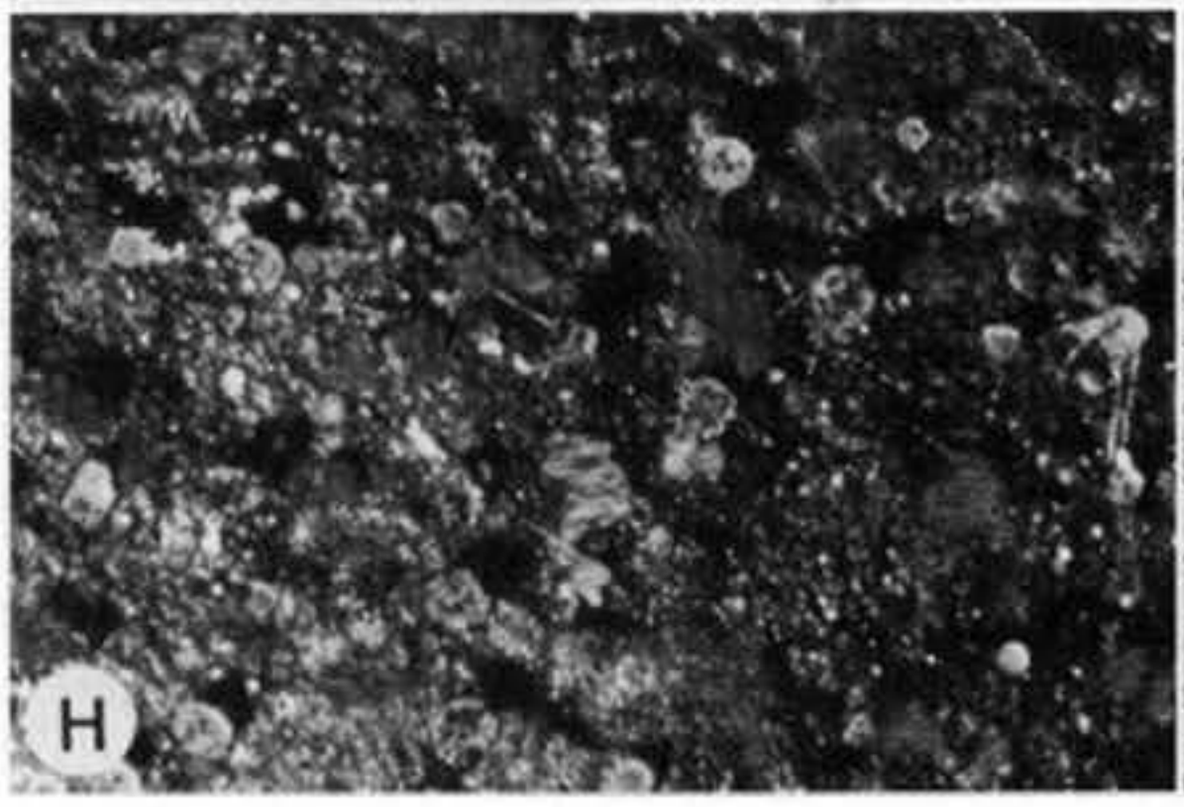












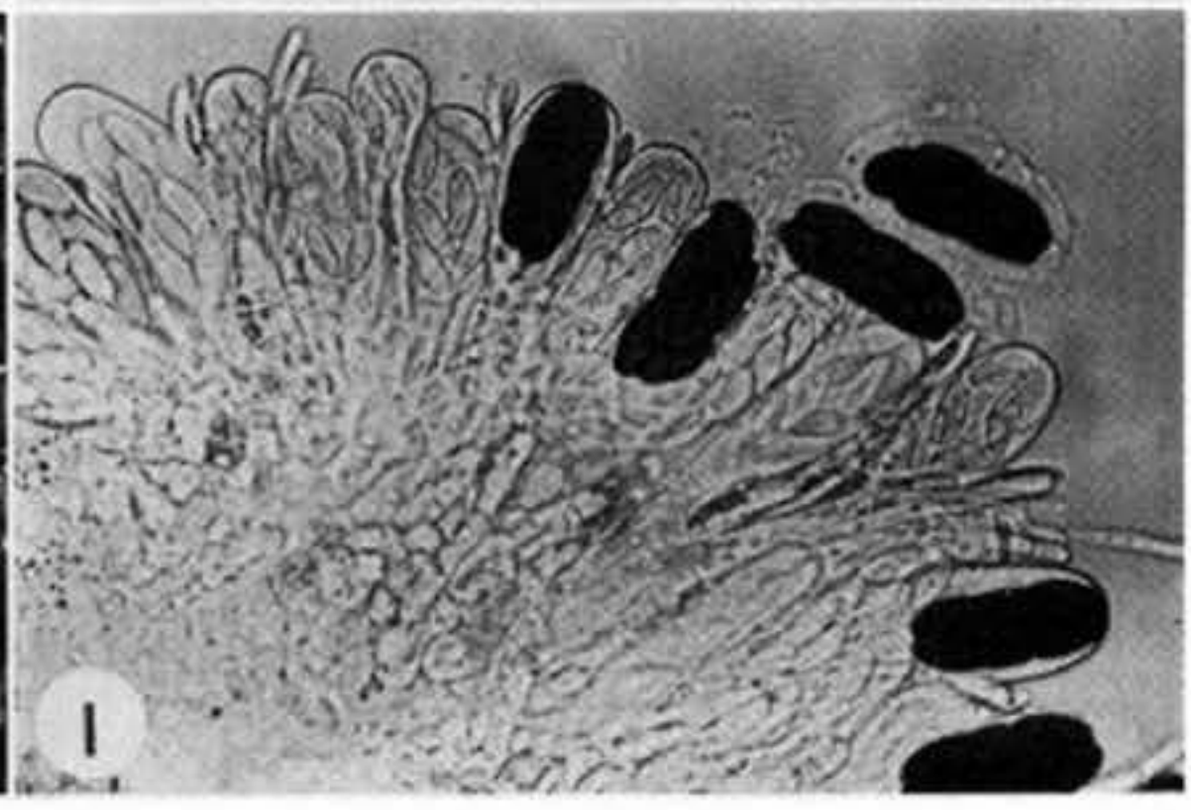


PLATE 15

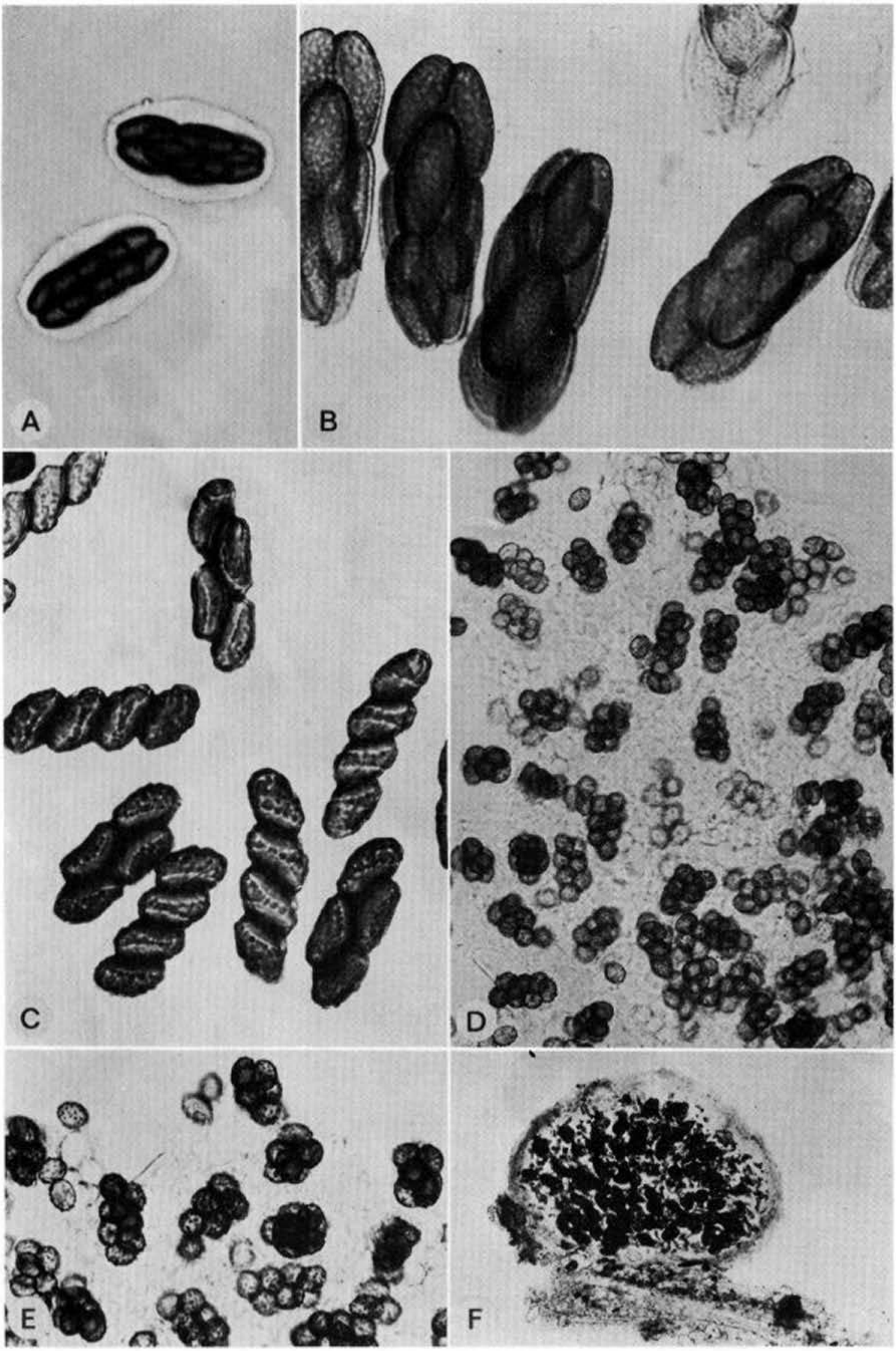
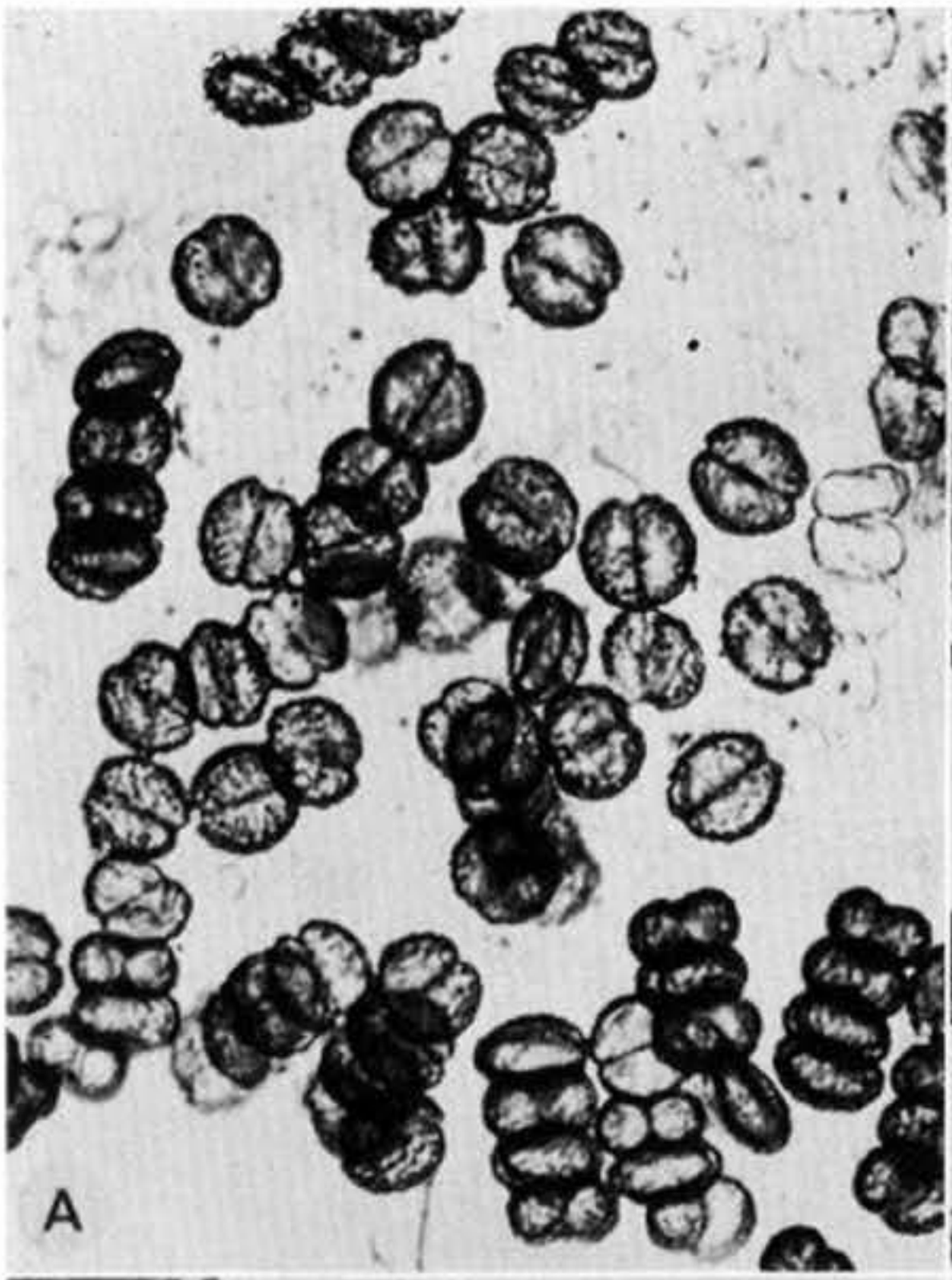
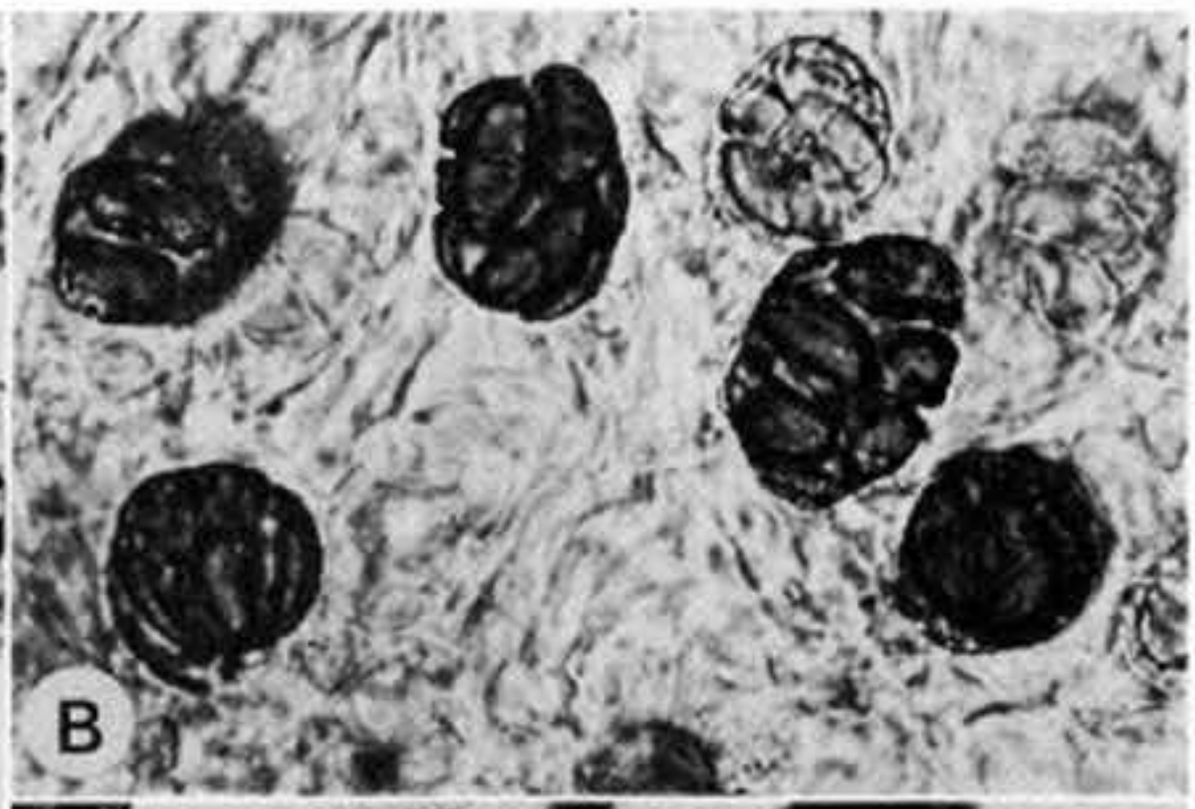
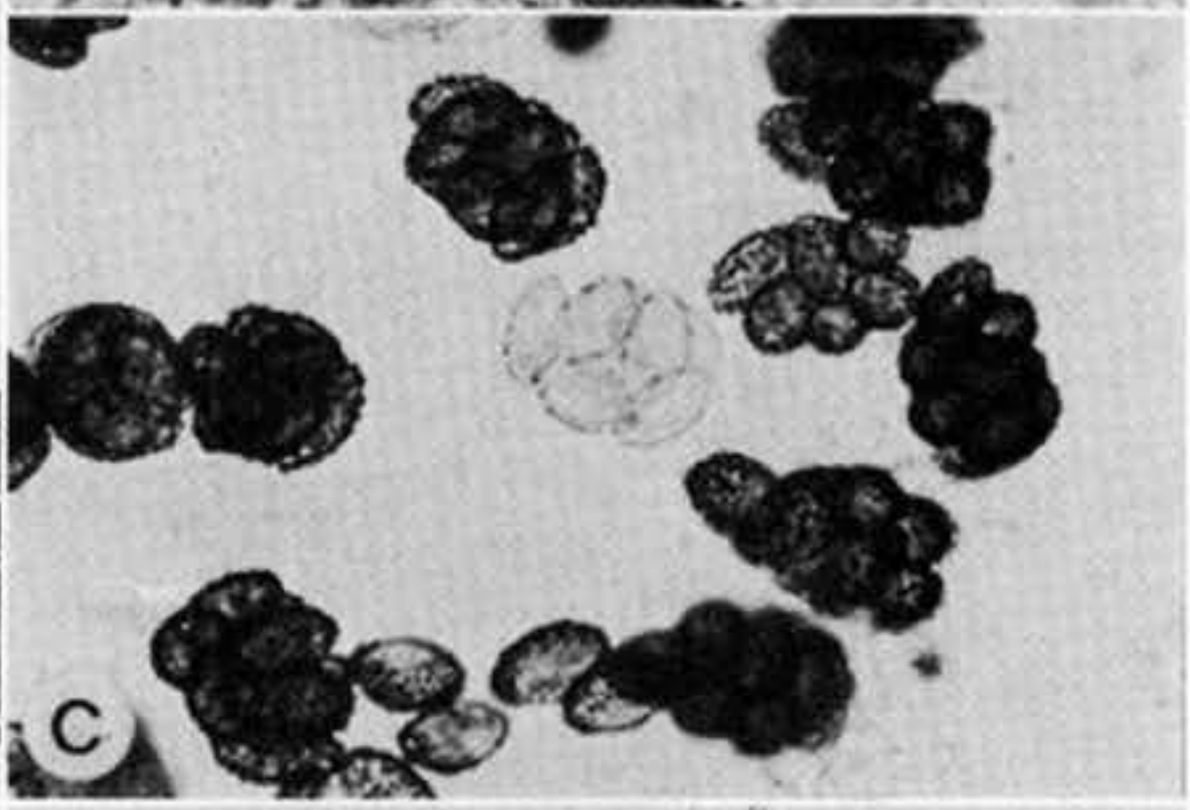
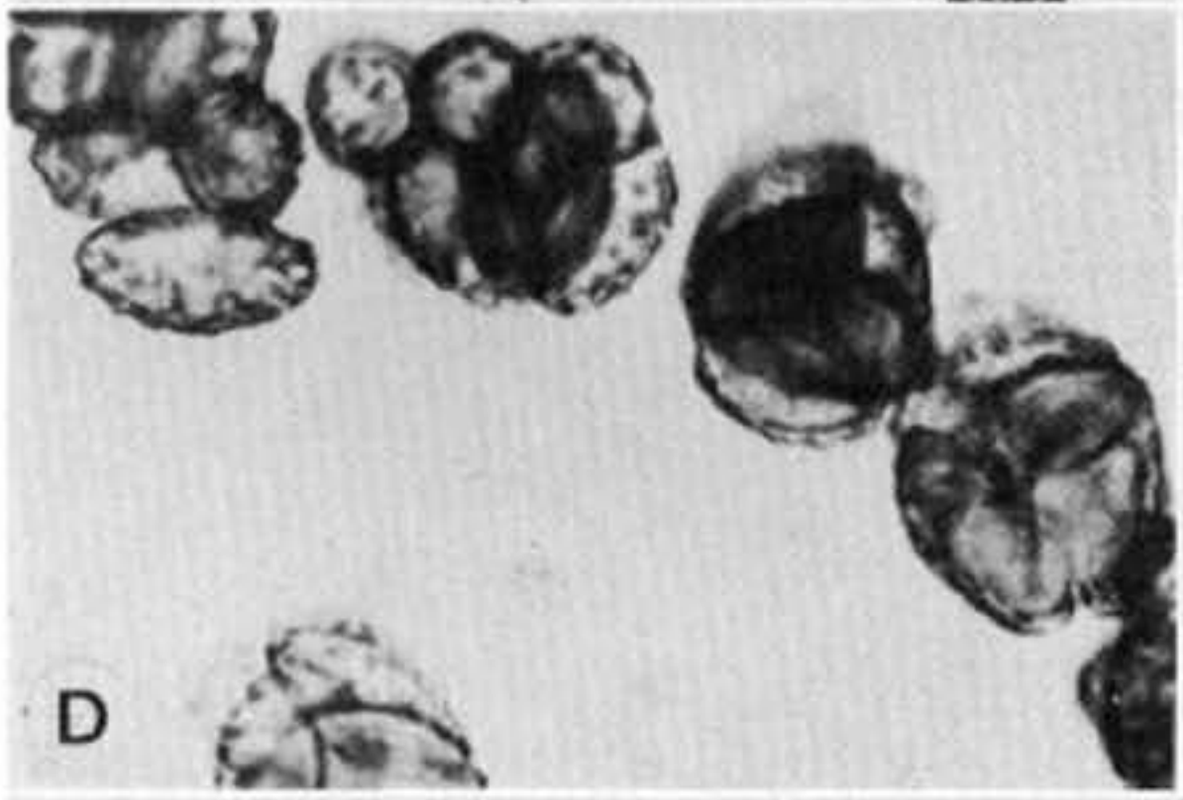


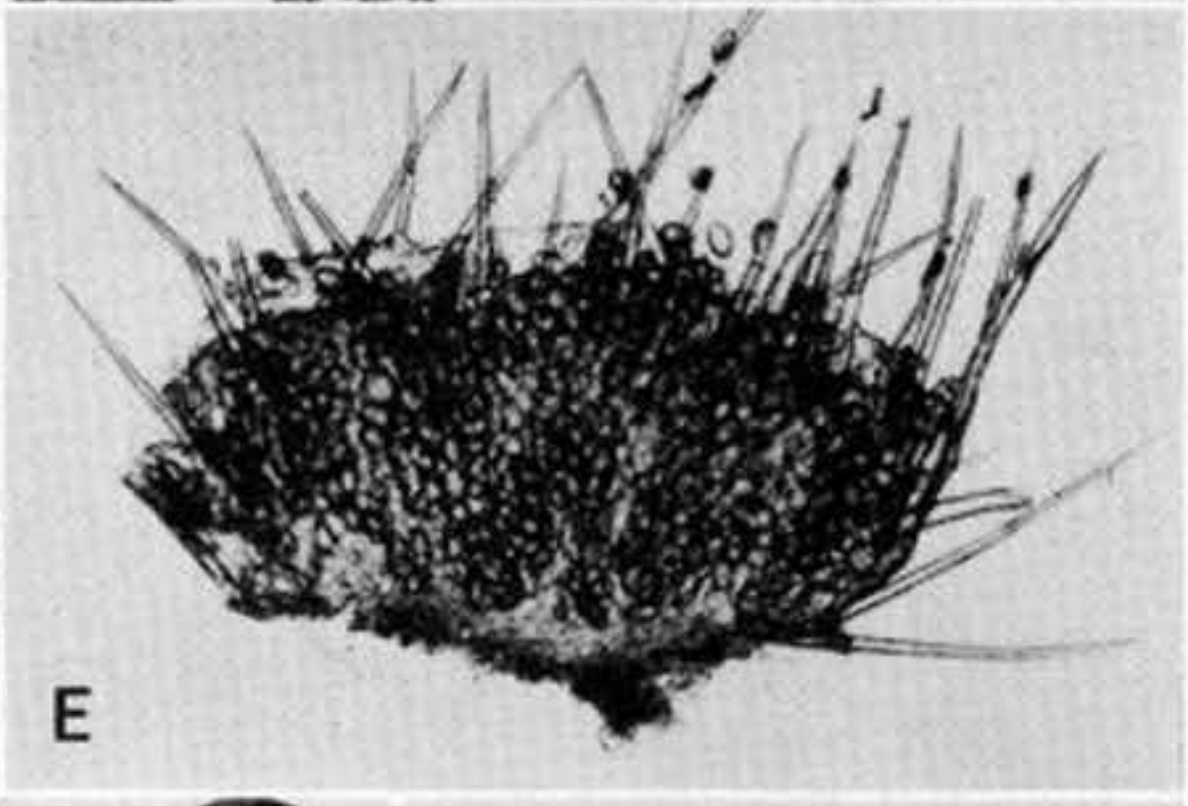
PLATE 16

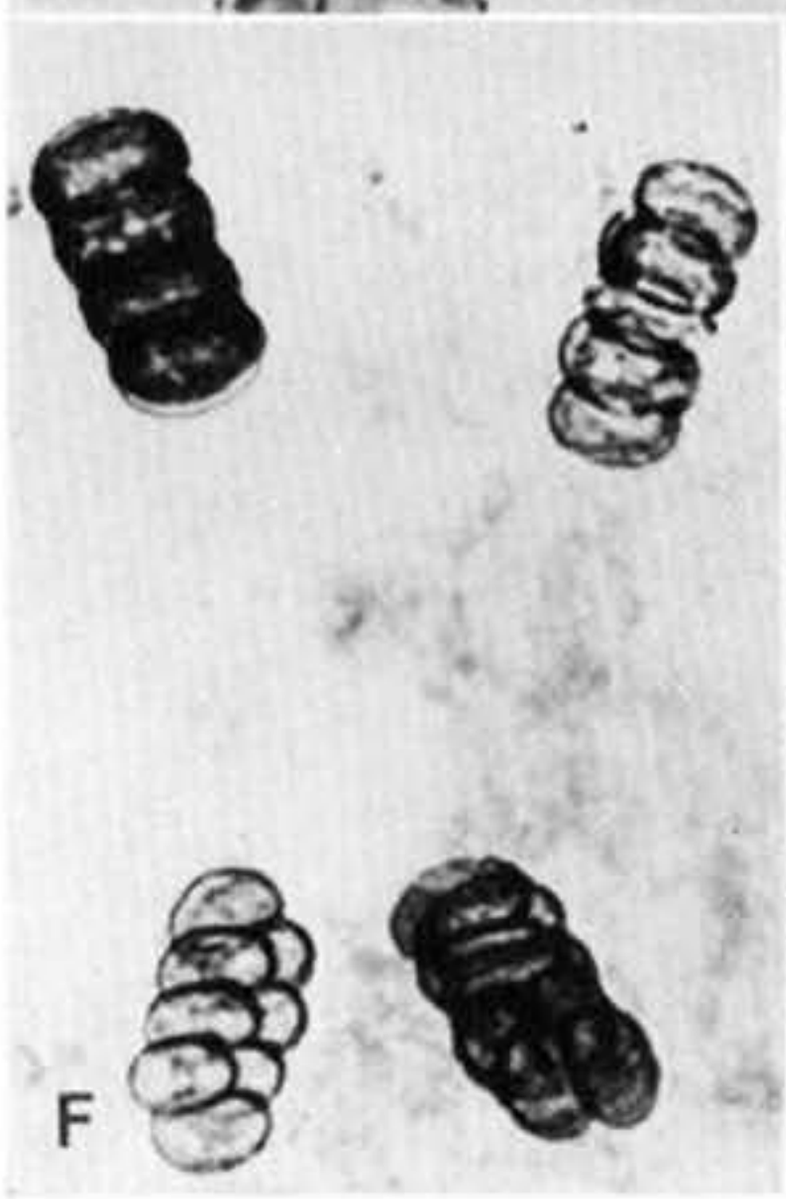












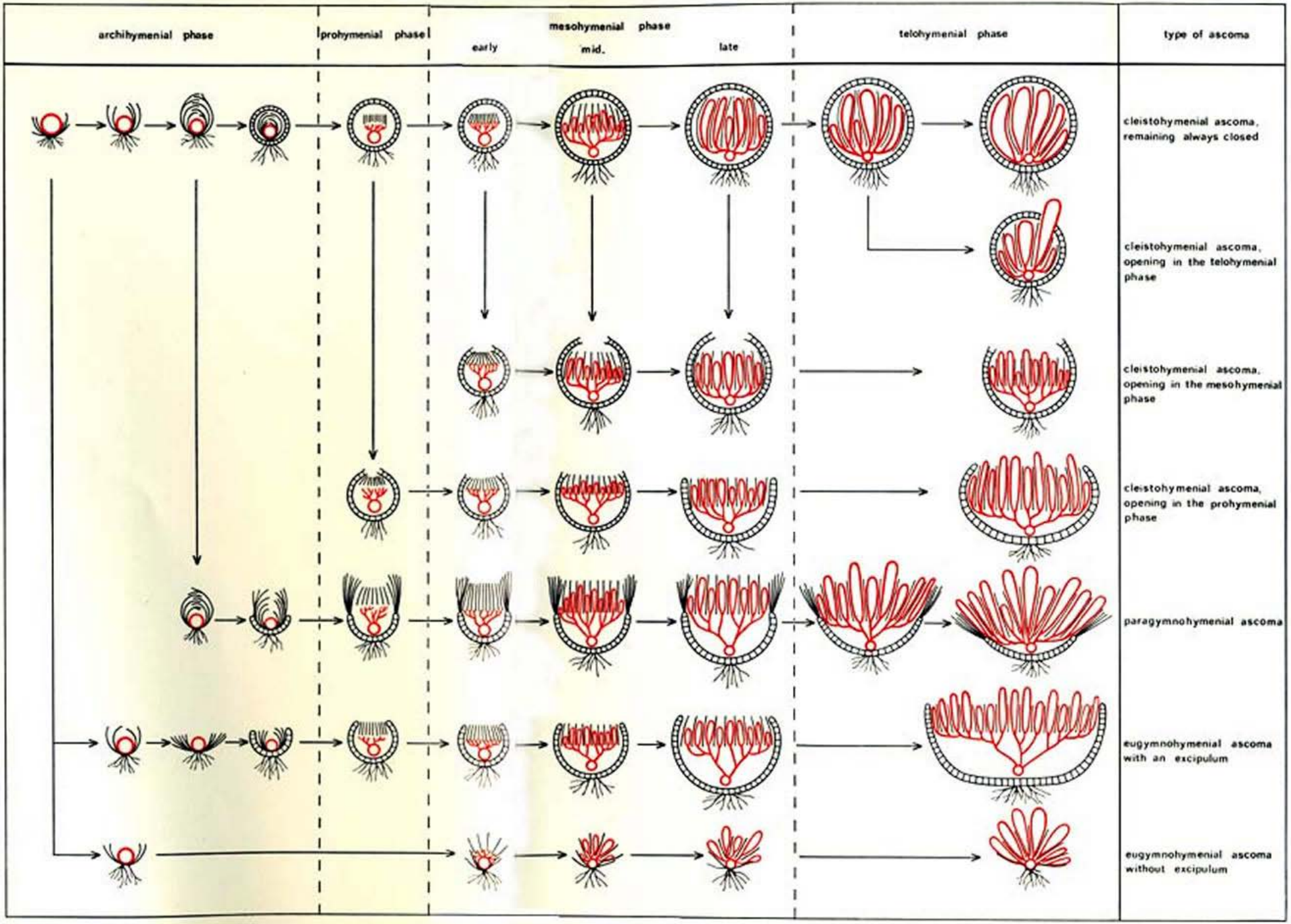

archihymenial phase
prohymenial phase
mesohymenial phase
early
mid.
late
telohymenial phase
type of ascoma
cleistohymenial ascoma, remaining always closed
cleistohymenial ascoma, opening in the telohymenial phase
cleistohymenial ascoma, opening in the mesohymenial phase
cleistohymenial ascoma, opening in the prohymenial phase
paragymnohymenial ascoma
eugymnohymenial ascoma with an excipulum
eugymnohymenial ascoma without excipulum

PLATE 1

FIGS. A–I. *Ascobolus immersus:* Figs. A, B. median section through young fruit-body × 160 (from *van Brummelen 1963*); Fig. C. id. × 125; Fig. D. id. × 100 (from *van Brummelen 1445*); Fig. E. ripe fruit-body with single ascus × 125 (culture from *van Brummelen 652*); Fig. F. ripe ascus × 100; Fig. G. upper part of ripe ascus × 250; Fig. H. ripe ascospores with slightly coloured mucilage × 400; Fig. I. tip of ripe ascus × 500.

PLATE 2

FIGS. A–D. *Ascobolus immersus:* Fig. A. operculum of ripe ascus (stained with Congo red) × 800; Fig. B. detail of wall of ripe ascus in optical section (stained with Congo red) × 1600; Fig. C. id. with essential details indicated by dotted lines, place of dehiscence of operculum indicated by arrow; Fig. D. habit of ripe fruit-bodies × 25 (from *van Brummelen 1445*).

FIGS. E, F. *Ascobolus bistisii* (from type): Fig. E. group of ascopspores × 320; Fig. F. detail of episporium of ascospore × 1000.

FIGS. G, H. *Ascobolus stictoideus:* Fig. G. median section through young fruit-body × 150; Fig. H. ascospores × 630 (from *Thaxter*, FH-A3109).

FIG. I. *Ascobolus degluptus*, ascospores × 500.

PLATE 3

FIG. A. *Ascobolus degluptus*, ripe ascospores with girdles of mucilage × 800.

FIGS. B–D. *Ascobolus amoenus:* Fig. B. fruit-body in transmitted light × 100 (from type of *A. americanus*); Fig. C. detail of median section near base of fruit-body × 500 (from *Seaver*, NY-A1246); Fig. D. detail of median section in upper part of fruit-body × 500 (from *Seaver*, NY-A1246).

FIG. E. *Ascobolus elegans*, ripe fruit-body in transmitted light × 80 (from Rehm, Ascom. 211, E).

FIG. F. *Ascobolus mancus*, three ripe fruit-bodies in transmitted light × 80 (from type).

FIGS. G, H. *Ascobolus hawaiiensis* (from type): Fig G. fruit-body in transmitted light × 160; Fig. H. ascospores × 1000.

FIG. I. *Ascobolus siamensis*, median section through ripe fruit-body, with ascogonium visible near base × 100 (from *van Brummelen 1776*).

PLATE 4

FIGS. A–G. *Ascobolus siamensis* (from *van Brummelen 1776*): Fig. A. detail of median section near base of fruit-body × 200; Fig. B. detail of median section in upper part of fruit-body × 320; Fig. C. median section through ripe fruit-body × 100; Fig. D. almost ripe ascus × 700; Fig. E. ripe ascus and ascus which discharged its contents × 320; Fig. F. ripe ascus with anisospory (3 normal spores together with 5 smaller spores without pigment) × 800; Fig. G. ripe ascospores × 800.

FIG. H. *Ascobolus brassicae*, ascospores × 630 (from type of *A. hyperboreus*, H-A2746).

FIG. I. *Ascobolus nodulosporus*, ascospores × 500 (from type).

PLATE 5

FIG. A. *Ascobolus siamensis*, median section through 'twin fruit-body' × 125 (from *van Brummelen 1776*).

FIG. B. *Ascobolus boudieri*, slightly squeezed fruit-body in transmitted light × 80 (from *Boudier*, PC-A2198).

FIGS. C, D. *Ascobolus brassicae* (from *Harper* 1. I. 1962, L): Fig. C. habit of fruit-bodies × 20; Fig. D. median section though ripe fruit-body × 80.

FIG. E. *Ascobolus nodulosporus*, median section through ripe fruit-body × 100 (from type).

FIGS. F–I. *Ascobolus albidus:* Fig. F. habit of fruit-bodies × 12.5 (from *van Brummelen 1443*); Fig. G. median section through ripe fruit-body × 160 (from *van Brummelen 1964*); Fig. H immature asci and paraphyses with subglobular elements × 160; Fig. I. detail of paraphyses with subglobular elements × 400.

PLATE 6

FIGS. A–D. *Ascobolus albidus:* Fig. A. young ascus with still unpigmented spores, with unilateral mucilaginous appendages × 400; Figs. B, C. asci with anisospory × 500; Fig. D. ripe ascus with 8 normal spores.

FIGS. E–I. *Ascobolus furfuraceus:* Fig. E. median section through fruit-body in prohymenial phase × 160; Fig. F. median section through fruit-body in early mesohymenial phase × 200; Fig. G. median section through fruit-body in telohymenial phase × 50; Fig. H. median section through ripe fruit-body with hymenium interrupted by sterile excipular tissue × 40; Fig. I. detail of interrupted hymenium × 160.

PLATE 7

FIGS. A–F. *Ascobolus furfuraceus:* Fig. A. median section through fruit-body in early archihymenial phase, ascogonium surrounded by some pseudoparenchymatous layers × 500; Fig. B. id. with incipient differentiation between flesh and excipulum, ascogonium in basal part; Fig. C. median section of fruit-body in late mesohymenial phase, excipular roof opening near the top × 125; Fig. D. median section of fruit-body in prohymenial phase, outside coarsely furfuraceous × 100; Fig. E. median section through fruit-body in early mesohymenial phase, with incipient formation of croziers × 125; Fig. F. part of median section through ripe fruit-body with smooth receptacle × 100 (form C; from *Jackson & Cain*, TRTC 34706).

FIG. G. *Ascobolus roseopurpurascens*, part of median section through ripe fruit-body × 125 (from type).

PLATE 8

FIGS. A–B. *Ascobolus crenulatus:* Fig. A. part of median section through ripe fruit-body × 125 (from *van Brummelen 684*); Fig. B (top row). id. × 200 (from type); Fig. B (second row). ascospores × 1000 (from type).

FIGS. C–E. *Ascobolus michaudii* (from type): Fig. C. median section through ripe fruit-body × 32; Fig. D. id. detail of part × 125; Fig. E. ascospores with anisospory × 630.

FIG. F. *Ascobolus minutus*, ascospores × 630 (from type).

FIG. G. *Ascobolus carletonii*, median section through young fruit-body × 125 (from type).

PLATE 9

FIGS. A–F. *Ascobolus lineolatus* (from type): Fig. A. median section through fruit-body in mid-mesohymenial phase × 100; Fig. B. upper part of ascus with ripe spores × 800; Fig. C. part of median section through young fruit-body, with excentric ascogonium × 200; Fig. D. median section through ripe fruit-body × 40; Fig. E. id. with detail of excipular margin and hymenium × 200; Fig. F. ascospores × 1000.

FIG. G. *Ascobolus crosslandii*, ascospores × 630 (from type).

FIGS. H, I. *Ascobolus cainii* (from type): Fig. H. part of median section through ripe fruit-body × 200; Fig. I. ascospores × 1000.

PLATE 10

FIGS. A–D. *Ascobolus lignatilis:* Fig. A. median section through ripe fruit-body × 32 (from type); Fig. C. id. with detail near margin × 100; Fig. B. median section of ripe fruit-body × 32 (from type of *A. marchalii*); Fig. D. ascospores × 2000 (from type of *A. lignatilis*).

FIGS. E, F, H. *Ascobolus epimyces:* Fig. H. median section through fruit-body × 100 (from type); Fig. E. id. with detail near margin × 320; Fig. F. ascospores × 630 (from type of *A. lignatilis* var. *fagisedus*, PR 149852).

FIG. G. *Ascobolus cainii*, detail of median section through ripe fruit-body near margin × 320 (from type).

FIG. I. *Ascobolus costantinii*, median section through ripe fruit-body × 80 (from type of *A. schweersii*).

PLATE 11

FIGS. A, B. *Ascobolus costantinii* (from type of *A. schweersii*): Fig. A. median section through ripe fruit-body, detail near margin × 320; Fig. B. id. detail of hymenium.

FIGS. C, D. *Ascobolus singeri* (from type): Fig. D. part of median section through ripe fruit-body × 80; Fig. C. id. detail of receptacle half-way between margin and base × 400.

FIGS. E, F. *Ascobolus denudatus:* Fig. E. ascospores × 800 (from type of *A. angulisporus*); Fig. F. part of median section through ripe fruit-body × 100 (from type of *A. immarginatus*).

FIG. G. *Ascobolus viridis*, ascospores × 630 (from *Mouton*, BR-A328).

FIG. H. *Ascobolus behnitziensis*, ascospores × 1000 (optical sections at different levels of the episporium result in different views of the pattern of ornamentation; from type).

PLATE 12

FIGS. A, C. *Ascobolus archeri* (from type): Fig. A. part of median section through fruit-body × 125; Fig. C. ascospores × 1000.

FIGS. B, D. *Ascobolus carbonarius* (from type): Fig. B. part of median section through ripe fruit-body × 100; Fig. D. ascospores × 630.

FIGS. E, H. *Ascobolus xylophilus* (from "cotype"): Fig. E. ascospores × 630; Fig. H. part of median section through ripe fruit-body × 125).

FIGS. F, G. *Ascobolus subglobosus* (from type): Fig. F. ascospores × 800; Fig. G. part of median section through fruit-body × 80.

PLATE 13

FIGS. A–C. *Ascobolus reticulatus* (from type): Fig. A. median section through ripe fruit-body × 125; Fig. B. id. detail of excipulum × 320; Fig. C. id. showing ripe ascospores.

FIGS. D, E. *Ascobolus scatigenus:* Fig. D. ascospores × 1250 (from type of *A. scatigenus*); Fig. E. part of median section through fruit-body × 80 (from part of type of *A. leiocarpus*, K-A1947).

FIG. F. *Ascobolus aglaosporus*, median section through ripe fruit-body × 100 (from *Cain*, TRTC 24287).

FIGS. G, H. *Ascobolus castaneus* (from type): Fig. G. part of median section through fruit-body × 100; Fig. H. id. detail near base, with pigment visible in some of the excipular cells × 320.

PLATE 14

FIG. A. *Saccobolus saccoboloides*, ascospores, partly regularly arranged × 500 (from type).

FIGS. B, C. *Saccobolus glaber:* Fig. B. spore-cluster × 800; Fig. C. ripe asci × 400.

FIG. D. *Saccobolus truncatus*, spore-clusters × 400 (from type).

FIGS. E–G. *Saccobolus portoricensis* (from type): Fig. E. spore-clusters × 500; Fig. F. ripe fruit-body in transmitted light × 80; Fig. G. id. × 125.

FIGS. H, I. *Saccobolus minimus:* Fig. H. habit of fruit-bodies × 25 (from *van Brummelen 1789*); Fig. I. asci and paraphyses × 400 (from *van Brummelen 1783*).

PLATE 15

FIGS. A, B. *Saccobolus minimus:* Fig. A. spore-clusters surrounded by mucilage × 800 (from *van Brummelen 1783*); Fig. B. spore-clusters × 1250 (from type).

FIG. C. *Saccobolus quadrisporus*, spore- clusters × 630 (from type).

FIGS. D, E. *Saccobolus thaxteri* (from type): Fig. D. spore-clusters × 320; Fig. E. id. in detail × 500.

FIG. F. *Saccobolus obscurus*, fruit-body in transmitted light × 125 (from type).

PLATE 16

FIG. A. *Saccobolus geminatus*, spore-clusters and pairs of spores × 630 (from type).

FIG. B. *Saccobolus dilutellus*, spore-clusters × 630 (from type).

FIGS. C, D. *Saccobolus globuliferellus:* Fig. C. spore-clusters × 500 (from *Cain*, NY-A1206); Fig. D. id. in detail × 1000 (from type).

FIG. E. '*Ascobolus brunneus*' Cooke, fruit-body in transmitted light × 80 (from Cooke, F. Brit. exs. 286, E.).

FIGS. F, G. *Saccobolus infestans*, spore-clusters × 800 (from type).

FIG. H. *Saccobolus verrucisporus*, fruit-body with ripe ascospores in transmitted light × 250 (from type).

PLATE 17

Scheme of the developmental types in Ascobolaceae. The gametophytic system in black, the sporophytic system in red.