Zygopleurage and Zygospermella (Sordariaceae s. lat., Pyrenomycetes)

By Nils Lundqvist

Institute of Systematic Botany,
University of Uppsala, Sweden

ABSTRACT

Zygopleurage, Zygospermella, and their known species are described and discussed, and all finds known to the author are compiled. *Zygopleurage faiyumensis* LUNDQ. and *Zygospermella striata* LUNDQ. are new species, whereas *Zygospermella setosa* (CAIN) CAIN has been found to be a synonym of the misinterpreted *Z. insignis* (MOUTON) CAIN.

INTRODUCTION

The present article is part of a larger treatise dealing with the taxonomy of the *Sordariaceae* s. lat. The living specimens studied have been collected by the author in Sweden, Corsica and Egypt, by Dr. R. SANTESSON in U.S.A., and by Dr. M. J. RICHARDSON in Scotland. Dried material for examination has also been gratefully received from BR, FH, NY, O, PAD. LMH means Lyallpur Mycological Herbarium (Lyallpur, West Pakistan). Some duplicates will be distributed to various herbaria.

ZYGOPLEURAGE BOEDIJN

Zygopleurage BOEDIJN, Persoonia 2: 316, 1962. — Type species and originally only species: *Sordaria zygospora* SPEG.

Fimicolous. *Perithecia* non-stromatic, obpyriform, ostiolate, with a pseudoparenchymatous, membranaceous to subcoriaceous peridium of 3 different layers with tangentially flattened cells in the medium layer. Paraphyses indistinct. *Asci* clavate, unitunicate, long-stipitate, rounded at the apex, without apical ring, or any thickened membranes, swelling at maturity, with longitudinal, cytoplasmic ribs visible after spore discharge. *Spores* at first hyaline, one-celled, fusiform, then strongly elongating, ± cylindrical, vermiform, straight, or spirally coiled around each other, arranged on about the same level, then normally 3-celled

by a transverse septum laid down near both ends; end cells swelling, becoming dark brown, smooth, ± ellipsoidal, with a germ pore at the end; intercalary cell hyaline, with or without a small inflation in the middle, sometimes multiseptate and multinucleate, devoid of plasma, collapsing at maturity; gelatinous equipment present in the known species. Spores discharged in their pigmented stage.

The species of this characteristic genus have the strangest spores of all known coprophilous *Pyrenomycetes* and are equalled by few other *Ascomycetes*. I think this spore model must be explained as being advantageous for the fungus at its spore discharge. Such long spores with a heavy lump at each end swirling through the air have a large hitting surface or range, which augments the chances of striking a piece of vegetation. In reality the projectile is even larger, as all spores in an ascus are certainly ejected simultaneously, entangled in each other.

The origin of *Zygopleurage* should be sought close to *Lasiosphaeria*, where the vermiform, septate spore type still exists. At the transition to coprophily the presumed ancestor may be expected to have evolved pigmented spores, postponing their maturation and discharge to this stage. A reduction of the paraphyses and the apical apparatus of the asci followed too. What was left is the long type of immature spore only, and *Zygopleurage* has thus reached the same evolutionary level as the *Podospora decipiens* group. The occasional, multicellular nature of the connecting appendage is certainly a reminiscence of an ancestor with long, multiseptate spores. This opinion was also held by LEWIS (1911).

KEY TO THE KNOWN SPECIES

1. Spores strongly coiled in the ascus; end cells with c. 4 short, distal caudae; intercalary cell 130—185 µ long ..... 3. *Z. zygospora*
1. Spore not coiled or coiled loosely in the ascus; end cells with short caudae all over; intercalary cell shorter
   2. End cells 35—46×20—28 µ; intercalary cell 75—95 µ long, inflated in the middle and covered all over with a gelatinous sheath .... 1. *Z. faiyumensis*
   2. End cells 21.5—32.5×14.5—19.5 µ; intercalary cell 43—80 µ long, without inflation (and sheath) ..... 2. *Z. multicaudata*

1. **Zygopleurage faiyumensis** LUNDQ. sp. nov. (Figs. 1—4 A)

DERIVATION: Named after Faiyum, an Egyptian province and oasis.

Fimicola. *Perithecia* solitaria vel aggregata, semiimmersa vel fere superficialia, late obpyriformia, 1200—1500×860—960 µ, collo cylindraceo vel

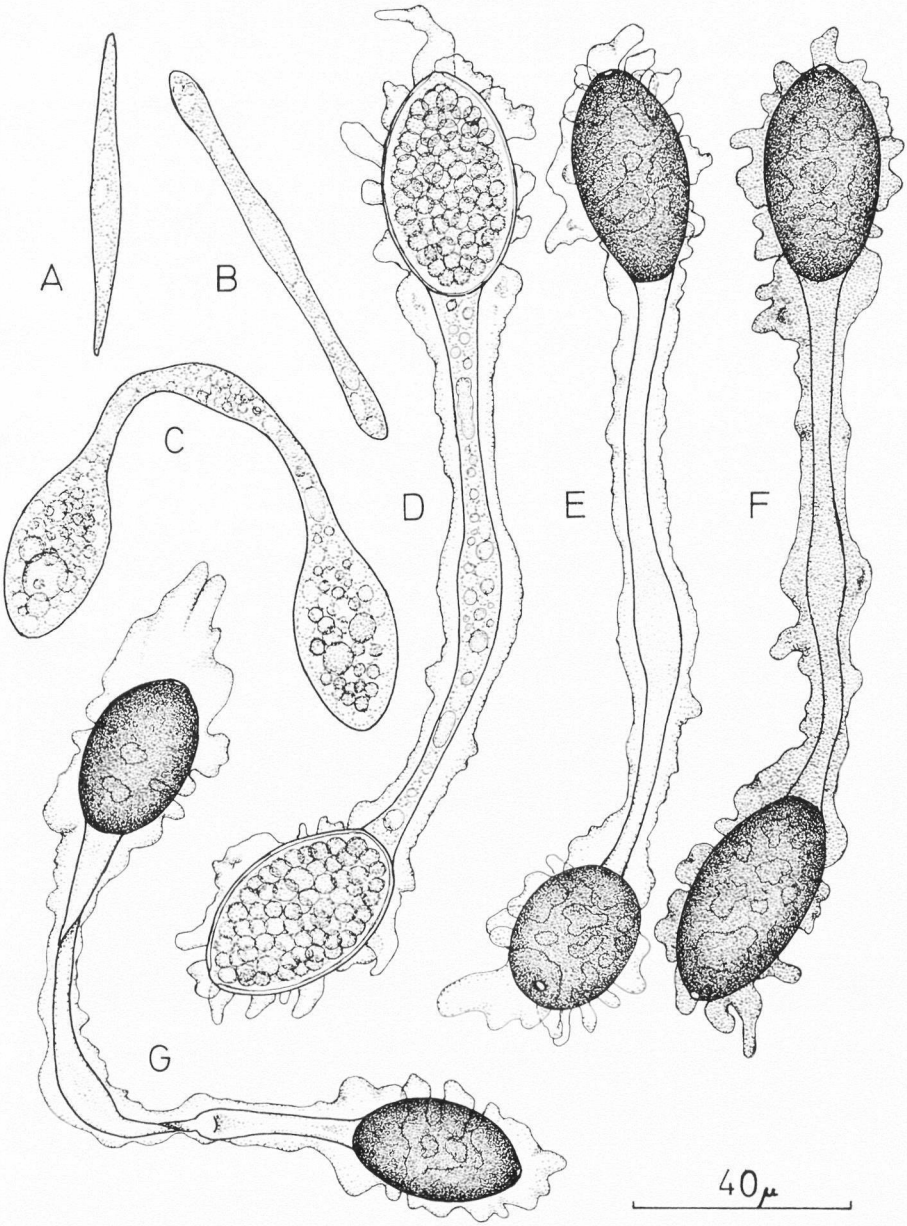

Fig. 1. *Zygopleurage faiyumensis*, holotype. All figures drawn from living specimens. — A—C: Young, hyaline spores in various stages of development. — D: Young, olivaceous spore with oil drops. — E—G: Mature spores; the strongly stippled figure shows the appearance of the gelatinous coating in Indian ink. — G: Spore with collapsed intercalary cell.

conico, 240—500×240 μ, pilis flexuosis, olivaceo-brunneis, c. 2.8 μ crassis obtecta. Peridium membranaceum vel subcoriaceum, subopacum, olivaceo-brunneum vel nigro-brunneum; cellulae externae peridii angulatae 4—9 μ diam., parietibus undulatis, modice incrassatis. *Asci* (4—6—) 8-spori, 350—420×60—70 μ, clavati, apice late rotundato. *Sporae* initio hyaline, fusiformes, unicellulares, deinde usque ad 200—240 μ, elongatae, 8-seriatae, partibus extremis transversaliter uniseptatis et tumescentibus; cellulae extremae demum nigro-brunneae, ellipsoideae, aequilaterales, 35—46 (—50)×20—28 μ, ad septa truncatae, extremo poro germinali instructa; cellula intercalaris ± recta, cylindracea, 75—95 μ longa, parte angustissima 4.5—6 μ lata, parte media inflata, 8—10 μ lata, strato gelatinoso cincta, maturitate sine plasmate, collabens. Caudae gelatinosae breves, magnitudine et forma irregulares cellulis extremis passim affixae; gelatina homogena, in aqua persistens, non vel vix tumescens, in atramento Indico nigrescens.

Perithecia scattered or in small groups, semi-immersed to almost superficial, broadly obpyriform, 1200—1500×860—960 μ, with a cylindrical or tapering neck, 240—500×240 μ, covered with simple, flexuous, olivaceous brown, septate, c. 2.8 μ thick hairs. Peridium 3-layered, pseudoparenchymatous, membranaceous, semitransparent to almost opaque, olivaceous brown to blackish brown, with irregularly shaped outer cells, 4—9 μ in diam., having slightly thickened, usually undulating walls; middle peridial layer composed of tangentially flattened cells, merging into a thin, inner layer of hyaline cells. Typical paraphyses not observed. *Asci* (4—6—) 8-spored, 350—420×60—70 μ (swelling up to 110 μ in width), clavate with a broadly rounded apex and a long stipe, unitunicate, J—, with longitudinal, cytoplasmic ribs visible after spore discharge; apical ring not observed; calotte thin; subapical chamber narrow. *Spores* at first hyaline, fusiform, one-celled, then vermiform, strongly elongating up to 200—240 μ, 8-seriate, not coiled, with monostichous oil drops, then swelling at both ends, becoming 3-celled by a transverse septum below and above each swelling, 2—4-seriate; end cells ranging through olivaceous to dark brown with a plasma containing large oil drops, ± ellipsoidal, equilateral, 35—46 (—50)×20—28 μ, a little truncate at the septum, with an apical and a basal germ pore respectively; intercalary cell more or less straight and cylindrical, 75—95 μ long, with an 8—10 μ wide inflation in the middle, 7—10 μ broad at the septa, 4.5—6 μ broad at the narrowest part between the septa and the inflation, hyaline, at maturity devoid of plasma and collapsing. Gelatinous caudae short, cylindrical or tapering, of irregular size and form sparsely attached to the end cells, sometimes drawn out at the spore ends to 40 (—60) μ; intercalary cell in its whole

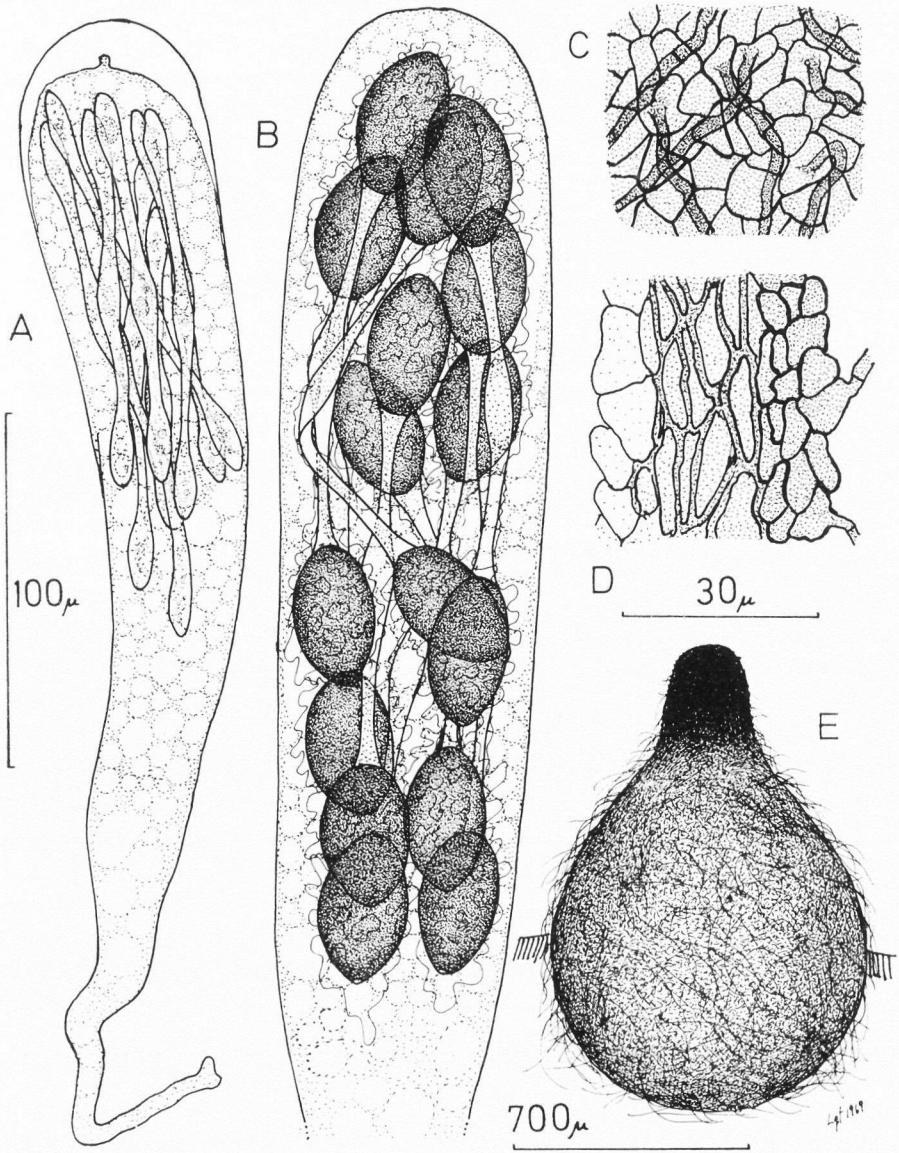

Fig. 2. *Zygopleurage faiyumensis*, holotype. All figures drawn from living specimens. — A: Young ascus and spores. — B: Ripe ascus and spores. — C: Peridium in horizontal view. — D: Peridium in median vertical section. — E: Perithecium.

length surrounded by a coating of mucus of irregular outline that increases in width at the septa and the adjoining parts of the end cells; all gelatinous equipment solid, homogenous, swelling little or not at all in water, blackening in Indian ink.

SPECIMENS EXAMINED: **Egypt:** Faiyum, 10 km NE of Lake Qarun at the dried-up marshes of Kom Aushim, on cow dung 1.III. 1968, LQT 5870-n, holotype (UPS); developed in moist chamber, Uppsala. Isotypes will be placed at IMI (slide), LMH, S, TRTC.

2. **Zygopleurage multicaudata** MIRZA

Zygopleurage muticaudata MIRZA in MIRZA & NASIR, Nova Hedwigia 16: 286, pl. 102, 1968. Holotype on cow dung from Lyallpur, West Pakistan (LMH 1081, not seen).

Perithecia 600—1200×480—865 µ, obpyriform, usually covered with flexuosus hairs. Peridium membranaceous, olivaceous, with angular outer cells, 4.9—12 µ in diam. *Asci* 8-spored, 190—250×54—60 µ, clavate, broadly rounded at the apex. *Spores* at first cylindrical, one-celled, hyaline, in parallel fascicles, then loosely coiled; end cells brown, 21.5—32.5×14.5—19.5 µ, ± ellipsoidal, truncate at the septa and with a basal and an apical germ pore respectively, covered all over with short, scattered, gelatinous caudae; intercalary cell cylindrical, 43—80×6 µ, without median inflation and sheath.

The description is a modified version of the original one. As I have not examined of the species, the micro-morphology of its gelatinous equipment is not quite clear to me. There may thus be a sheath around the intercalary cell. This is rather difficult to discern without the help of India ink and the authors may have overlooked it. Although the variation in size and form in the *Zygopleurage* spores is considerable, I think the differences between *Z. multicaudata* and *Z. faiyumensis* are sufficient both as to number and quality to distinguish these fungi as separate species.

MIRZA and NASIR also reported the species from Lahore, and AHMED and ASAD (1968 p. 60, pl. III K) found it (under the name *Z. zygospora*) several times in the Karachi area. Unfortunately the reports are not detailed enough to inform about the number of finds and kind of substrate.

3. **Zygopleurage zygospora** (SPEG.) BOEDIJN (Figs. 4 B—E, 5).

Sordaria zygospora SPEG., Michelia 1: 227, 1878. Holotype on cow dung from Conegliano, Venezia, Italy, 5.IX. 1877, SPEGAZZINI (LPS 2981). — *Philo-*

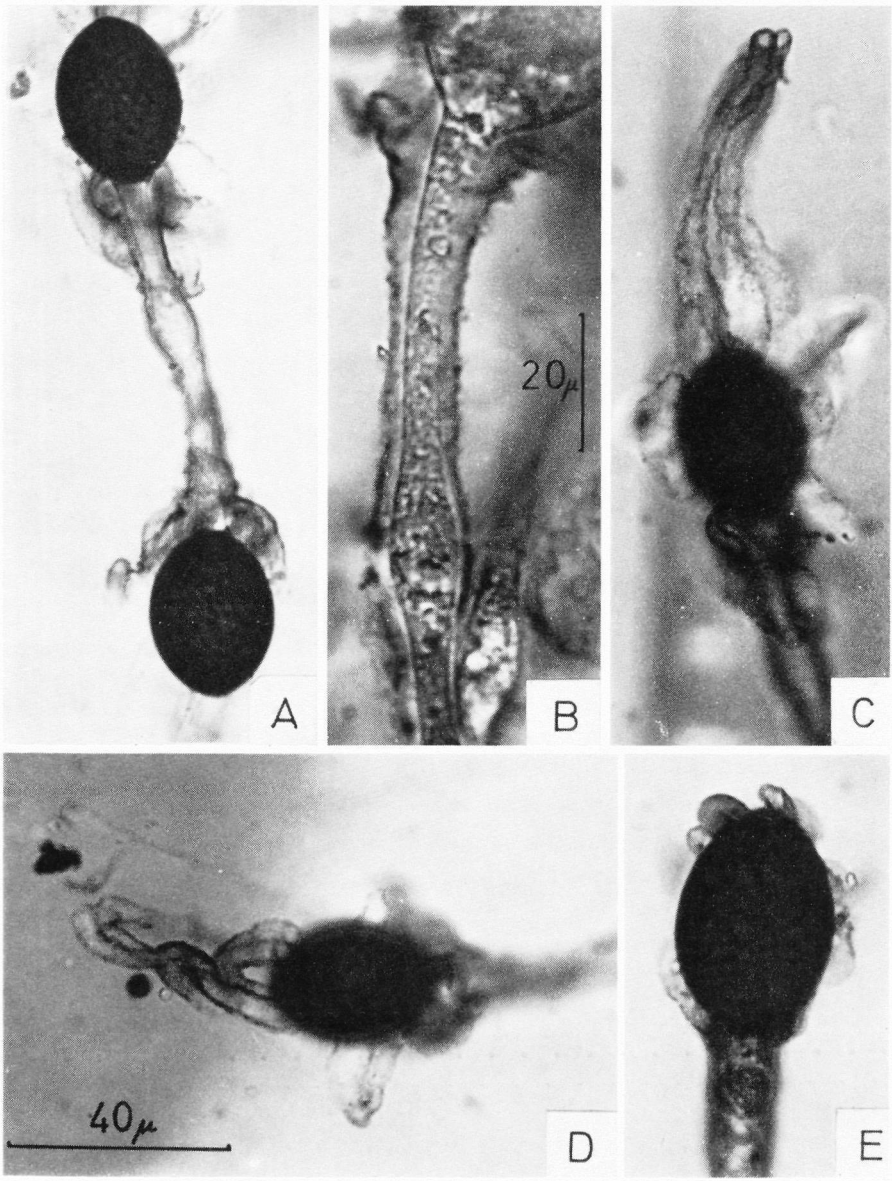

Fig. 3. *Zygopleurage faiyumensis*, holotype. — A—E: Spores in Indian ink; only A shows an entire spore; note the sheath around the intercalary cell and the median swelling in B. Magnifications: A, C, E = D.

copra zygospora (SPEG.) SACC., Syll. Fung. 1: 251, 1882. — *Podospora zygospora* (SPEG.) NIESSL, Hedwigia 22: 156, 1883. — *Pleurage zygospora* (SPEG.) O. K., Rev. Gen. Plant. 3(3): 505, 1898. — *Zygopleurage zygospora* (SPEG.) BOEDIJN, Persoonia 2: 316, 1962.

Perithecia obpyriform, 770—1200×480—815 µ, with a neck 190—620×135—240 µ. Peridium membranaceous, semitransparent, olivaceous brown. *Asci* 8-spored, 250—270×40—60 µ, swelling up to 90 µ in width. Young *spores* vermiform, elongated up to 200—230 µ, spirally coiled around each other; end cells dark brown, ellipsoidal, 29—38×15—23 µ; intercalary cell (100—) 130—185 (—200)×5—6 µ, occasionally multiseptate and multinucleate, cylindrical, sometimes with an inconspicuous inflation in the middle; both end cells with 2—4 tapering, flattened, straight or curved, gelatinous caudae, 12—25 (—30)×6—8×3.5—4 µ, attached to the germ pore; each cauda either with a longitudinal furrow or split in two filaments (of unequal width); intercalary cell with small caudae of irregular size and form attached near the septa and usually also with small patches or sheaths of mucus sparsely distributed all over; gelatinous equipment not swelling in water. Other characters as in *Z. faiyumensis*.

SPECIMENS EXAMINED: **Sweden:** Blekinge, Kristianopel, 7.VI. 1962, LQT 3364-h, EXS ined. (NY, slide, UPS). — Småland, Vimmerby, 3 km S of Storebro, 31.V. 1959, LQT 2307-b (BPI, IMI, L, M, S, TRTC, UPS). — Öland, Köping, between Borgholm and Köpingvik, 14.VII. 1960, LQT 2569-b (UPS). — Halland, Torpa, NE of Tångaberg, 4.VIII. 1961, LQT 3119-b (UPS); all on cow dung. — **France:** Corsica, Belgodere, Tour de Lozari (=6 km ENE of l'Ile Rousse), on the seashore, on cow dung, 21.V. 1965, LQT 4485-d (UPS). — Bonifacio, at the bridge over Ventilegne R. (=7 km NW of Bonifacio), on cow dung, 13.V. 1965, LQT 4425-u (UPS). — **Canada:** Ontario, Brant, Eatonia, on cow dung, 16.XI. 1929, CAIN (FH, slide 1754). — York, Maple, on cow dung, 1.X. 1938, CAIN 12309 (FH). — **U.S.A.:** Colorado, Boulder, W base of Mt. Steamboat in Front Range (= 3 km NW of Lyons near mouth of St. Vain Creek), alt. 1900 m, on cow dung, 30.IV. 1966, SANTESSON 18499-A (UPS, slide). — South Dakota, Aberdeen, on cow dung, IX. 1899, TOWNE, herb. GRIFFITHS (NY). — Redfield, on cow dung, 8.VII. 1899, CARTER, herb. GRIFFITHS (NY); GRIFFITHS 1901. — New Jersey, Fort Lee, on cow dung, 3.VIII. 1899, GRIFFITHS (NY, 2 slides); GRIFFITHS 1901. — S. loc., on guinea pig dung, IV. 1918, MCFARLANE, herb. FAULL 12055 (FH). — Massachusetts, Cambridge, on horse dung, X. 1897, FARLOW (?) as *Podospora vestita* (FH). — **Puerto Rico:** Mayaguez, on cow dung, s. dat., FINK (NY). — S. loc., on horse dung, 19.XII. 1901, THAXTER (FH 1116). — **Egypt:** Faiyum, in the dried-up salt marsh at Kom Aushim, c. 10 km NE of Lake Qarun, on cow dung, 1.III. 1968, LQT 5870-h (BUCU, C, PC, S, UC, UPS, W). — **Liberia:** S. loc., on horse dung (?), XII. 1896, THAXTER (FH 1096A, 1087A).

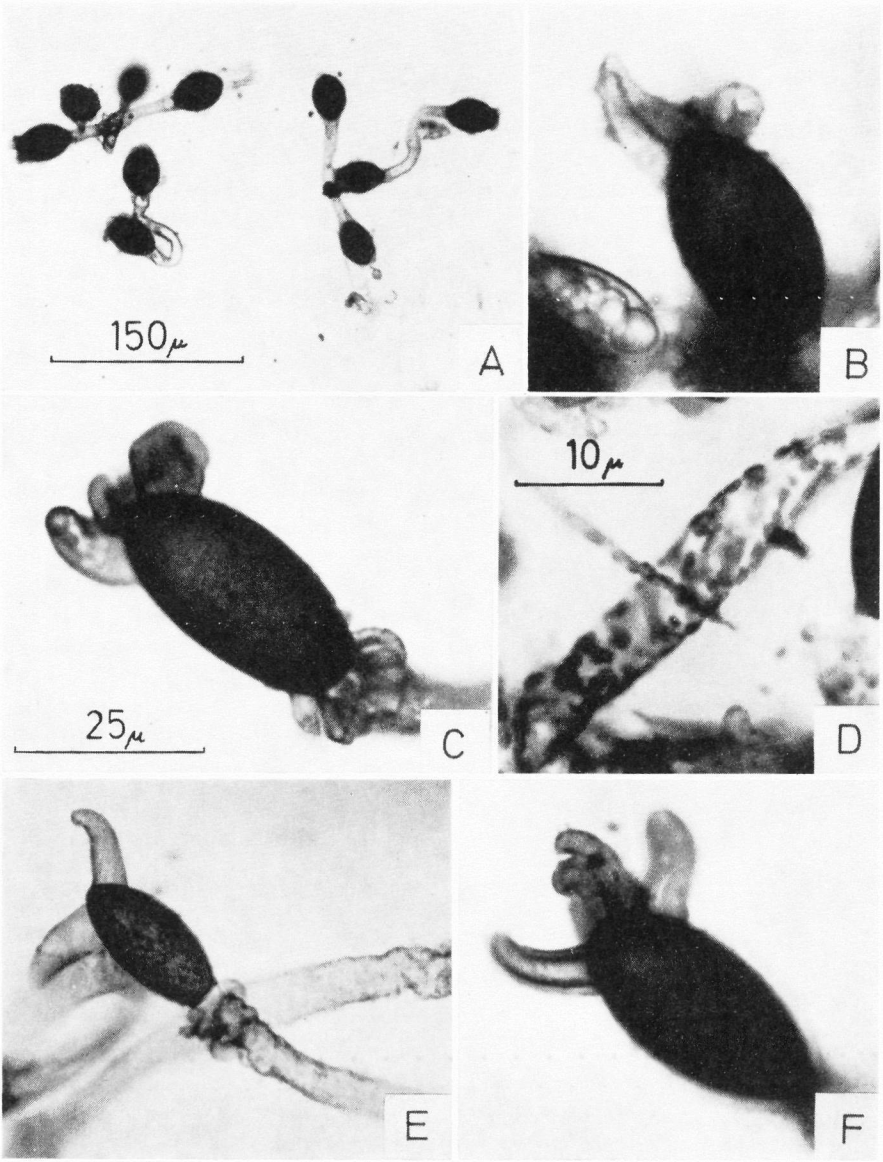

Fig. 4. A: *Zygopleurage faiyumensis*, holotype. — B: *Z. zygospora* LQT 5870-h. — E—F: Ditto, SANTESSON 18499-A.; — A—F: Spores in India ink; note the cross section of the cauda in B and the scattered, gelatinous covering on the intercalary cell in D; E shows an end cell with only two, distal caudae. Hagnifications: B, E, F = C.

UNVERIFIED RECORDS: **France:** on cow dung, MOREAU 1953; La Mycothèque 2, 1949; on dung of cow 3, and horse, BRETON 1966. — **Poland:** on cow dung, KOHLMAN-ADAMSKA 1965. — **Hungary:** on dung of hare and cow, TÓTH 1965. — **Bulgaria:** on dung of cow and sheep, FAKIROVA 1968, 1969. — **Canada:** on horse dung, GRIFFITHS 1901; substrate not mentioned, MAINS et al. 1939; esp. on dung of cow and horse, CAIN 1934. — **U.S.A.:** on dung of cow 7, horse 7, pig 2, goat, and sheep, GRIFFITHS 1901; substrate not mentioned, LEWIS 1911; on horse dung, MEYER 1941; on dung of cow and horse, STRATTON 1921; on horse dung, WILSON 1947. — **Algeria:** on human excrements, FAUREL & SCHOTTER 1965. — **Tchad:** on dung of donkey and camel, FAUREL & SCHOTTER 1966. — **Tanzania:** on dung of sheep and mule, SCHMIDT 1913. — **Indonesia:** on dung of rabbit, goat, and sheep, BOEDIJN 1962. — **West Pakistan:** substrate not mentioned 8 (?), AHMED & ASAD 1968.

CHOICE OF SUBSTRATE: (Figures without parentheses are the collections examined by the author; those within represent all records.) 18 (> 71): on dung of cow 14 (> 30), horse 3 (> 16), sheep (4), goat (2), pig (2), donkey (1), mule (1), camel (1), rabbit (1), hare (1), man (1), guinea pig 1; substrate not mentioned (c. 10).

ILLUSTRATIONS: SACCARDO 1879, fig. 618. GRIFFITHS 1901, pl. 1: 3; 9: 1—4; 15: 22; 18: 1, 9—13. TRAVERSO 1907, fig. 88: 8. LEWIS 1911, pl. 19. STRATTON 1921, pl. 10: 1—5. CAIN 1934, fig. 31. MOREAU 1953, figs. 51 a—e, 52 a—f. HESLOT 1958, pl. A 8, B 9, C 3; 24: 3—5. BOEDIJN 1962, figs. 8—10. KOHLMAN-ADAMSKA 1965, fig. 15 a—c. AHMED & ASAD 1968, pl. III. K. FAKIROVA 1968, fig. 23.

Little is known about the biology of *Z. zygospora*. According to my experience its development takes 3—4 weeks, which is normal for such a big species, but GRIFFITHS mentions 10 days (1901 p. 17). The fungus seems to belong mainly to warm-temperate and subtropical regions and prefer the dung of domesticated herbivores.

Z. zygospora varies considerably as to the size and form of the end cells of the spores, number of spores per ascus, and septation of the intercalary cell. These extremes are not all included in the description above. LEWIS, who in 1911 investigated its cytology and spore ontogeny, found similar anomalies. The genetics of the species was treated of by HESLOT (1958).

The American specimens have narrower spores than those from the Old World I have seen. (GRIFFITHS 1901: 24—40×13—19 μ; SANTESSON 18499-A: 30—41×15—19 μ). The Indonesian specimens examined by BOEDIJN have narrow spores too, and the ascus tip is said to have a thickened ring, although the latter feature cannot be seen on his drawings. In the Liberian specimens the spores are unusually long (up to 200 μ) with a multiseptate, intercalary cell. Very probably, however, all records refer to one and the same species.

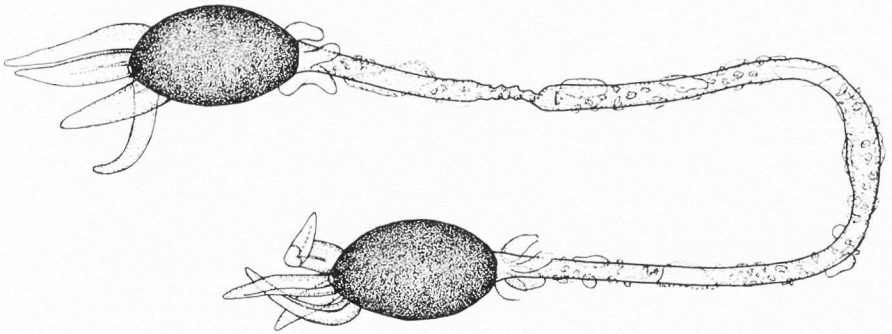

Fig. 5. *Zygopleurage zygospora*, LQT 2569-b. Mature spore. — Same magnification as in Fig. 1.

SPEGAZZINI's description is somewhat misleading, as it states the asci to be "12-spored" (=6-spored), the end cells of the spores 40×20—25 µ, and the intercalary cell 70—100 µ long, which reminds one more of *Z. faiyumensis*. SACCARDO's drawing, which was based on authentic specimens, gives a false picture, too. In the type specimens, however, the end cells measure 30—40×17—20 µ, having distinct, distal caudae. The intercalary cells, the length of which cannot be discerned, are strongly coiled, not only "subtortous". A perithecium measured 815× 625 µ (thus more than said by SPEGAZZINI), and the asci are 8-spored.

ZYGOSPERMELLA CAIN

Zygospermum CAIN, Univ. Toronto Stud. Biol. Ser. 38: 73, 1934. — T y p e s p e c i e s: *Z. setosum* CAIN, selected by CAIN 1934; non *Zygospermum* THWAITES ex BAILLON 1858 (*Euphorbiaceae*).

Zygospermella CAIN, Mycologia 27: 227, 1935.

Fimicolous. *Perithecia* non-stromatic, ± obpyriform, ostiolate. Peridium pseudoparenchymatous, 3-layered, with an outer textura angularis, a middle layer of tangentially flattened cells, and an inconspicuous inner layer of hyaline, angular cells. Paraphyses longer than the asci and mixed with them, simple, filiform-ventricose, septate. *Asci* unitunicate, subclavate, long-stipitate, with a non-amyloid, hardly visible apical apparatus, at maturity swelling, rupturing below the tip which forms an adherent operculum, and provided with longitudinal, cytoplasmic ribs. *Spores* at first hyaline, one-celled, cylindrical, then equatorially constricted and transversely uniseptate at the constriction previous to the pigmentation; both cells finally dark brown, smooth, often separating, truncate at the septum and with a germ pore at the narrow end, gela-

tinous equipment present in the known species. Spores discharged at their pigmented stage.

Zygospermella is a very characteristic genus because of its two-celled, *Delitschia*-like spores. The genus is, I think, remotely related to *Bombardia* (FR.) ex KARST. s. lat. and *Lasiosphaeria* CES. & DE NOT., and its origin ought to be looked for in the *Lasiosphaeria* pool. The perithecial setae resemble those of *B. muskokensis* CAIN and some *Lasiosphaeria* species. The additional, transverse septa in the spores are exactly the kind found in several *Bombardiae* and *Zopfiella* WINT. as regards their position and late appearance in the spore ontogeny. The hollow, gelatinous caudae in *Z. insignis* have a counterpart in *Podospora appendiculata* (AWD ex NIESSL) NIESSL which species shows many connections with *Bombardia*. The basal cell in the *Zygospermella* spore is undoubtedly homologous with the pedicel of the spore in, for example, *Bombardia* and *Podospora*. It deserves being mentioned that an anomalous pigmentation of the pedicel is not uncommon in *Bombardia* spores.

Even though the origin of *Zygospermella* is indicated by a number of morphological features, the recent genus has evolved far beyond the limit of the *Bombardia* assemblage. The genus holds a position similar to *Podospora* regarding the reduction of the apical apparatus of the asci and the incapacity of the spores to germinate and be discharged in their hyaline state. *Zygospermella* and *Podospora* have probably separated early in their "*Lasiosphaeria*" period and then evolved in different directions. From the *Zygospermella* spore type I see a possible evolutionary bridge to *Arnium* NITSCHKE ex WINT. (=*Pleurosordaria* FERNIER). A more thorough analysis of the phylogenetic problems in the family is found in my above-mentioned, larger work.

KEY TO THE KNOWN SPECIES

1. Spores 38—48×11—14 μ; gelatinous caudae longitudinally fibrillate .... 1. *Z. striata*
1. Spores (46—) 50—68×11—17 μ; caudae hollow, not fibrillate ..... 2. *Z. insignis*

1. **Zygospermella striata** LUNDQ. sp. nov. (Figs. 6—7, 8 B, D—E).

DERIVATION: Latin *striatus*, striped or striate, referring to the fibrillate nature of the gelatinous caudae of the spores.

Fimicola. *Perithecia* dispersa, immersa, obpyriformia, 625—670×335—

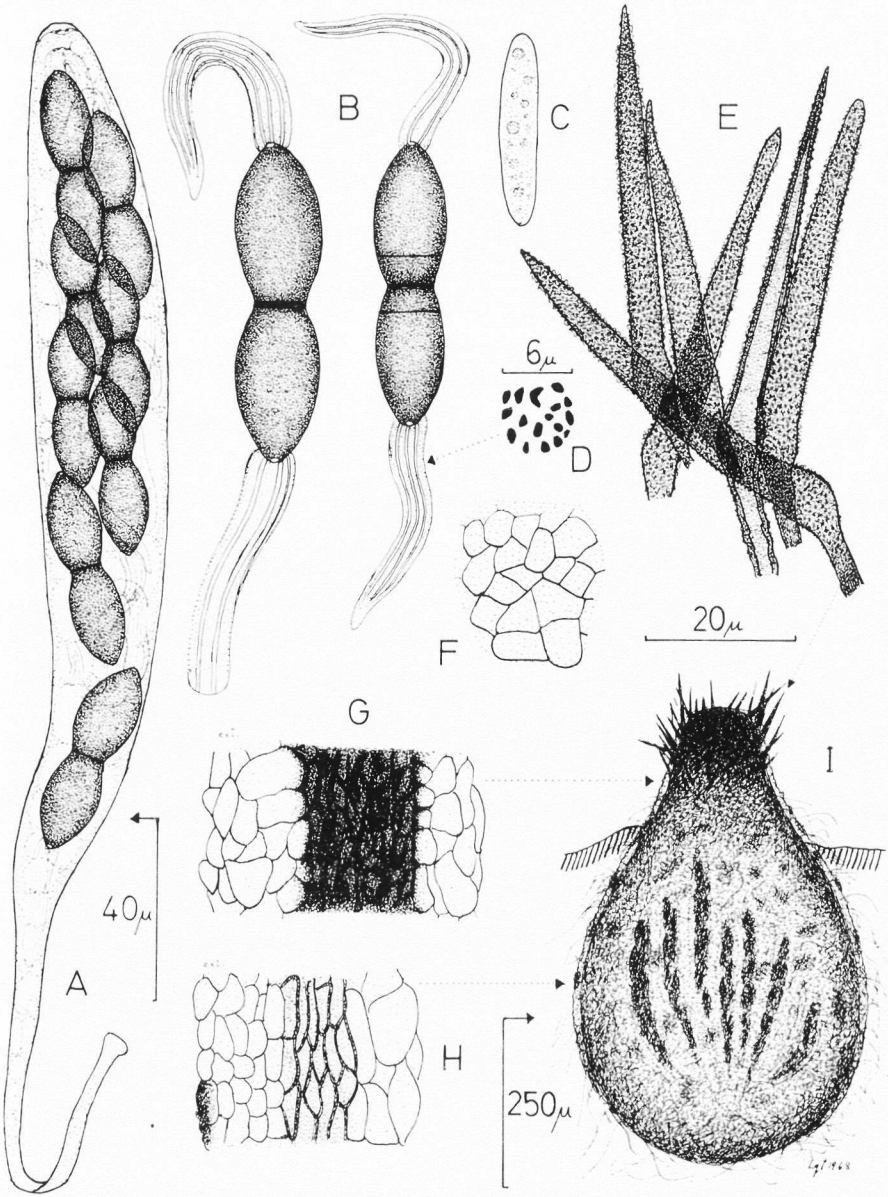

Fig. 6. *Zygospermella striata*, holotype. All figures drawn from specimens in water. — A: Mature ascus and spores. — B: Mature spores. — C: Young, hyaline spore. — D: Cross section of cauda. — E: Setae. — F: Peridium in horizontal view from middle part of the perithecium. — G—H: Vertical, median sections of peridium. — I: Perithecium.

400 µ, pilis flexuosis, ramosis, hyalinis, c. 2 µ crassis sparse obtecta; collum perithecii 145—240×135 µ, conicum, setis rectis vel modice curvatis, angustatis, acutis, unicellulatis vel raro 1—3-septatis, verrucosis, parietibus crassis, brunneis, profunde radicatis, 2—90×4.5—7.5 µ obtectum. Peridium 35—45 µ crassum, membranaceum, semipellucidum, ochraceo-olivaceum, in collo opaco, fusco, subcarbonaceo; cellulae externae peridii angulatae, hyalinae 5—10 µ diam., parietibus tenuibus. Paraphyses ascis longiores et mixtae, simplices, filiformi-ventricosae. *Asci* 8-spori, 290—370×25—32 µ, subclavati, longe stipitati, apicaliter rotundati et modice umbonati, apparato apicali indistincto instructi. *Sporae* biseriatae, initio hyaline, unicellulares, cylindraceae, deinde medio constrictae et transversaliter uniseptatae, saepe secedentes; ambae cellulae maturitate fusco-brunneae, ± ellipsoideae, ad septum truncatae, aequilaterales, 19—24×11—14 µ, extremo poro germinali instructae, plerumque transversaliter uniseptatae. Cauda gelatinosa c. 25×5—6 µ, ambobus extremis sporae affixa, angustata vel cylindracea, aliquot fibrillis composita, in aqua persistens, non tumescens, in atramento Indico nigrescens.

Perithecia scattered, immersed, obpyriform, 625—670×350—400 µ, with a conical neck, 145—240×135 µ, covered on the neck with straight or somewhat curved, usually tapering, pointed, one-celled or rarely 1—3-septate, thickwalled, mostly verrucose, brown setae, 20—90×4.5—7.5 µ, with a tapering or swollen, deeply rooted base, and provided also on the lower part with ± hyaline, flexuous, ramified, septate, c. 2 µ thick hairs. Peridium 35—45 µ thick, membranaceous, pseudoparenchymatous, semitransparent, yellowish to olivaceous except in the brown-black, opaque, subcarbonaceous neck, 3-layered; cells in the outer layer angular, thin-walled, 5—10 µ in diam., almost hyaline, forming scattered, low, reddish-brown, almost amorphous, flattened agglomerations or crusts; second layer composed of tangentially flattened cells, yellowish to olivaceous brown, becoming gradually darker and carbonized in the upper part of the perithecium. Paraphyses longer than the asci and mixed with them, simple, filiform-ventricose, septate. *Asci* 8-spored, 290—370×25—32 µ, with an almost cylindrical, sporidial part and a 100—120 µ long, tapering stipe, at maturity rupturing just below the rounded, slightly umbonate apex, which forms an adherent operculum; apical cushion well developed, but apical ring hardly viisble, non-amyloid, c. 2.8 µ in diam. *Spores* biseriate, at first hyaline, cylindrical, one-celled, then narrowly ellipsoidal, filled with numerous small oil drops, sometimes also with a few large drops, then a little equatorially constricted, finally transversely uniseptate at the constriction; both cells ranging from ochraceous, olivaceous to dark brown, of similar form and size, 19—25×11—14 µ, equilateral, ± ellipsoidal, smooth, truncate at the 6—7 µ wide septum, broadest in the

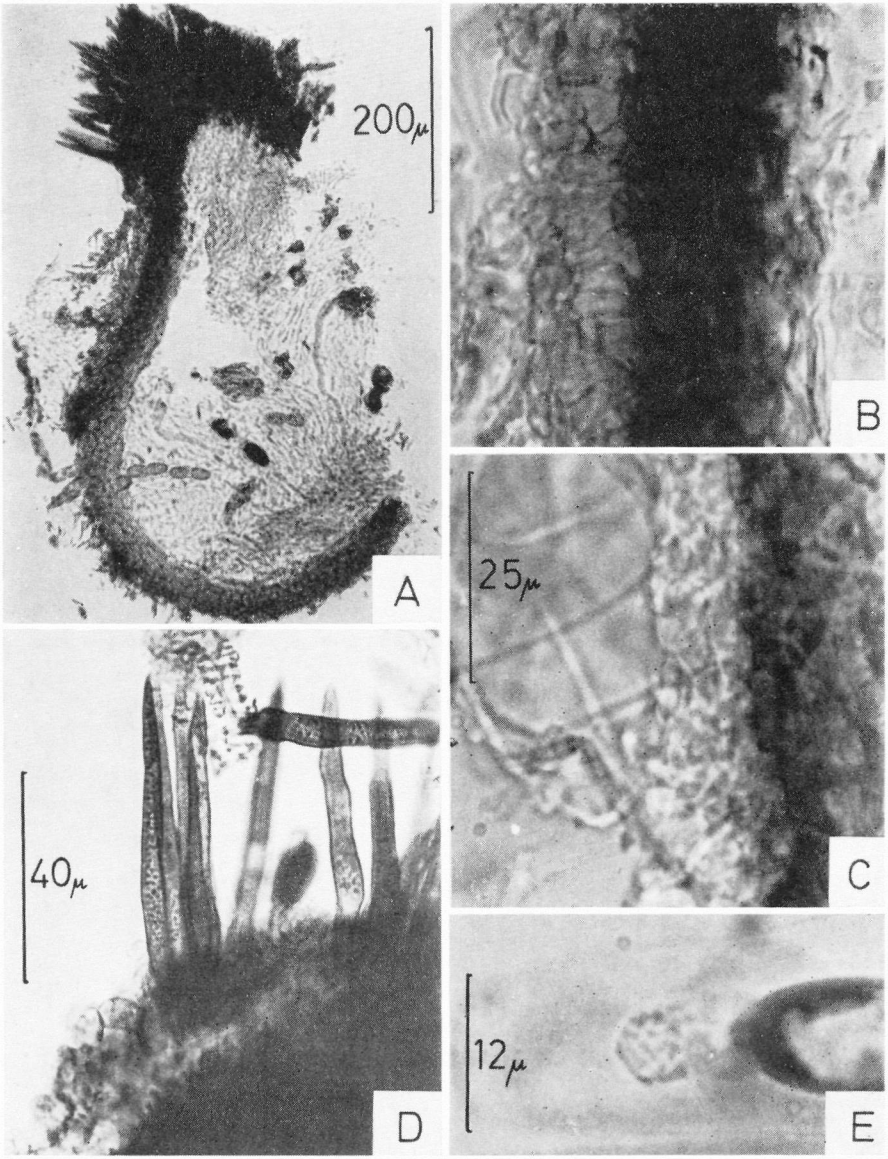

Fig. 7. *Zygospermella striata,* holotype. Material in water (A), lactophenol (B, D—E), Lactic blue (C). — A: Perithecium in median, vertical section (not intact). — B: Part of the peridium in the same section from upper part of the perithecium; note the dark, middle layer; exterior to the left. — C: Peridium in optical, vertical section; exterior to the left. — D: Setae from the perithecial neck; the crystals are dissolved. — E: Cauda in cross section showing the fibrils. — Magnification: B = C.

middle, at last often separating and frequently provided with a transverse septum c. 5 µ from the truncate end; whole spore 38—50 µ long with a germ pore and a gelatinous cauda at each end; both caudae of similar form, size and structure, tapering or cylindrical, 25×5—8 µ round in cross section, composed of a dozen or more longitudinally arranged fibrils, persistent, not swelling in water, blackening in Indian ink.

SPECIMENS EXAMINED: **Sweden:** Gotland, Hall par., at the church on horse dung, 5.VI. 1959, LQT 2083-j, holotype (UPS); developed after one month in moist chamber, Uppsala. — **Canada:** Ontario, Muskoka, Fraserburg, on cow dung, 24. VIII. 1932, CAIN 5529 (FH slide 1781).

Z. striata is at first glance very similar to *Z. insignis*; the smaller perithecia, asci, and spores, and the fibrillate nature of the caudae being the distinguishing characters. The Canadian specimen deviates in being larger throughout with perithecia 1100×570 µ, spores 44—56×12—15 µ, and tapering caudae, 43—54×11 µ. It would have been referred to *Z. insignis*, had not the caudae been fibrillate. I am uncertain about the identity of this fungus, as long as I know it from this slide only.

2. **Zygospermella insignis** (MOUTON) CAIN. (Figs. 8 A, C, 9—10).

Delitschia insignis MOUTON, Bull. Soc. Roy. Bot. Belg. 36: 13, 1897. Holotype on cow dung from Gomzé near Liège, Belgium, s. dat., MOUTON (BR). — *Zygospermum insigne* (MOUTON) CAIN, Univ. Toronto Stud. Biol. Ser. 38: 76, 1943. — *Zygospermella insignis* (MOUTON) CAIN, Mycologia 27: 227, 1935.

Zygospermum setosum CAIN, Univ. Toronto Stud. Biol. Ser. 38: 74, 1934. Holotype on cow dung from Palmyra, Kent Co., Ontario, Canada, CAIN, TRTC 5310 (not examined). — *Zygospermella setosa* (CAIN) CAIN, Mycologia 27: 227, 1935.

Perithecia 700—1000×480—730 µ, with a conical to cylindrical neck, 145—385×135—200 µ. Setae amost always one-celled, sometimes scarce or lacking. *Asci* 360—400×30—48 µ, with a c. 150 µ long stipe and a 3.5 µ wide and 0.7—1 µ thick apical ring. *Spores* (46—) 50—68×11—17 µ, 5—9 µ wide at the septum. Caudae 25—50×6—10 µ, tapering, non-fibrillate, homogenous, but furnished with a narrow, longitudinal, central canal. Other characters same as those of *Z. striata*.

SPECIMENS EXAMINED: **Sweden:** Öland, Bredsätra, Kapelludden, near the beach, 15.VII. 1960, LQT 2593-j (UPS, slide). — Resmo, 4 km E of the church on the Great Alvar, 2.VI. 1968, SANTESSON 19615-m (M, UPS). — Västergötland, Hassle, NE of Hasslerör railway station, 13.VI. 1960, LQT 2444-h (IMI, UPS). — Södermanland, Aspö, on the N. shore of

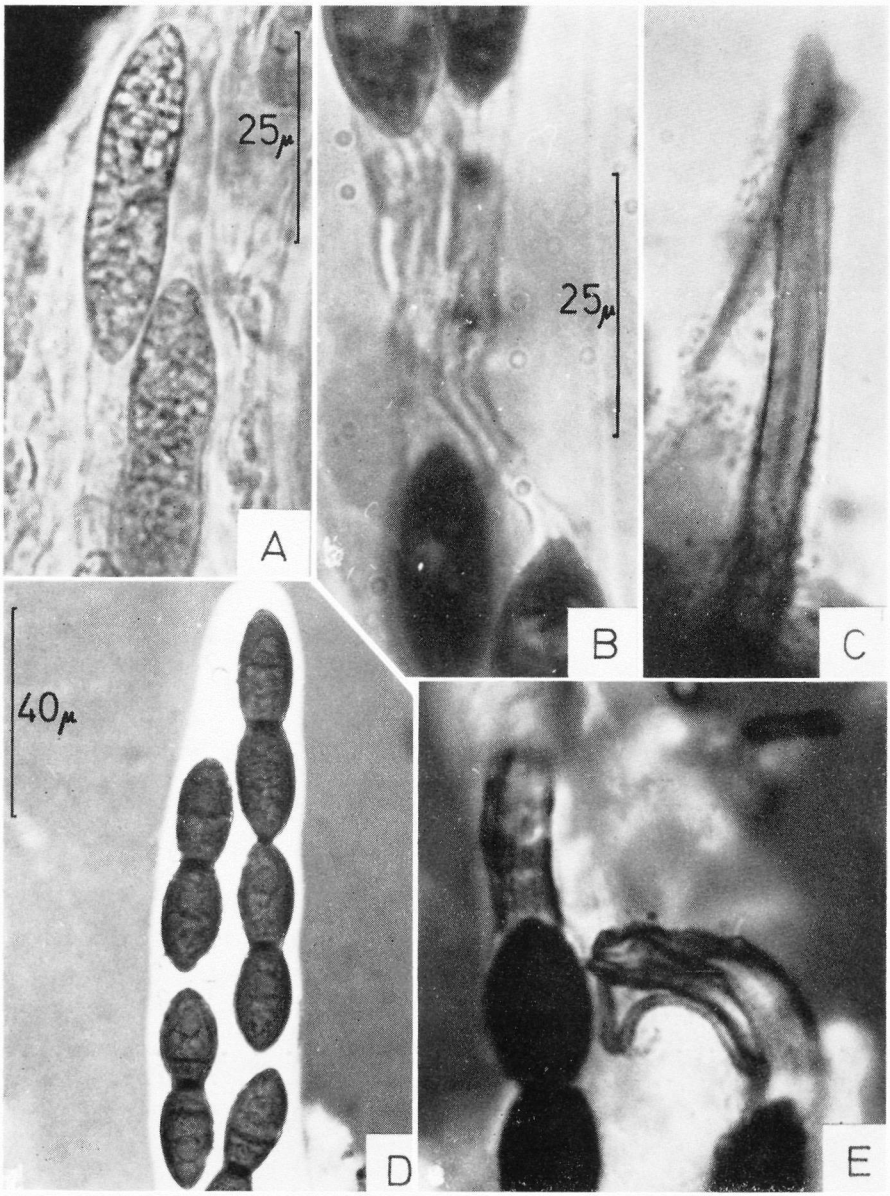

Fig. 8. A: *Zygospermella insignis*, LQT 2593-j. — C: Ditto: LQT 2022-m. — B, D—E: *Z. striata*, holotype. Material in Lactic blue (A—C), Indian ink (D—E). — A: Young, hyaline spores. — B: Caudae (spores in ascus). — A: Setae from the perithecial neck; note the narrow lumen. — D: Mature ascus and spores. — E: Caudae; one fibril has become somewhat detached. — Magnifications: C = B; E = A.

Aspö Isl., 30.V. 1959, LQT 2022-m (UPS). — U p p l a n d, Husby-Långhundra, Steninge, 18.IX. 1960, LQT 2827-b (UPS). — Läby, Solsäter, 24.VIII. 1963, LQT 4074-d (UPS). — Vadbacka, 5.VIII. 1967, LQT 4656 (UPS); all on cow dung; the two latter collections will be distributed in LUNDELL & NANNFELDT's Fungi Exs. Suec. — **Norway:** T r o m s, Kvenangen, Olderfjord, Kjeldnes, on cow dung, ECKBLAD, herb. EGELAND 102 pp. (O, slides). — **Belgium:** the holotype (BR). — **Scotland:** S t i r l i n g, University of Stirling grounds, on cow dung, 5.X. 1968, RICHARDSON (UPS, slide). Dr. RICHARDSON has also communicated (in litt.) another Scottish find on sheep dung from Selmmuir Forest, Kirknewton near Edinburgh, 27.XI. 1965. — **England:** E s s e x, Epping Forest, on cow dung, [sic!] X. 1900, SALMON (PAD, herb. SACCARDO, (slide). MASSEE & SALMON 1901. — **Spain:** A s t u r i a s, Covadonga, 2 km W of the Parador, on goat dung [sic!], 1.V. 1959, LQT 1895-j (UPS slide); LUNDQVIST 1960. — **Canada:** O n t a r i o, York, Nashville, on cow dung, 17.VIII. 1960, CAIN, TRTC 359 03 (UPS). — Lake Timagami, Bear Isl., on cow dung, 17.VI. 1933, CAIN 5533 (FH).

UNVERIFIED RECORDS: **England:** on horse dung, MASSEE & SALMON 1901. — **France:** on cow dung, BRETON 1965, 1966. — **Bulgaria:** on dung of cow and horse, FAKIROVA 1967. — **Canada:** on horse dung, BISBY et al. 1929; on dung of cow, horse, and rabbit, CAIN 1934. — **Indonesia:** on dung of sheep and rabbit, BOEDIJN 1962.

CHOICE OF SUBSTRATE: 14 (> 26): On dung of cow 13 (>17), horse (> 4), sheep (2), rabbit (> 2), goat 1.

ILLUSTRATIONS: MOUTON 1897, pl. A: 7[8?]. MASSEE & SALMON 1901, pl. 17: 20. CAIN 1934, fig. 53. BOEDIJN 1962, figs. 11—12. MÜLLER & VON ARX 1962, fig. 282. BRETON 1965, pl. 1.

Z. insignis seems to prefer the dung of domesticated herbivores and be distributed principally in temperate regions. BOEDIJN's Javanese records must be taken with some caution (see below).

The species has a detailed and fairly correct descriptions by CAIN, MÜLLER and VON ARX, and particularly by BRETON. They overlooked, however, that the setae are verrucose and deeply roted, nor did they clarify the microstructure of the gelatinous caudae. The longitudinal canal can be seen on a number of drawings, but is not recognized as such. BRETON was the first to notice the operculum formed at the ascus dehiscens, and concluded that *Z. insignis* thus has a functional, apical appartus. One may object that the spores must pass through the ring or the apex, leaving other parts of the ascus intact, before one can designate the apparatus as functional.

The setae are often short and few in the species, and sometimes lacking, as is often the case in many other coprophilous *Pyrenomycetes* with setose ascocarps. The deep roots of the setae are a property that should be emphasized and compared with the superficial origin of the

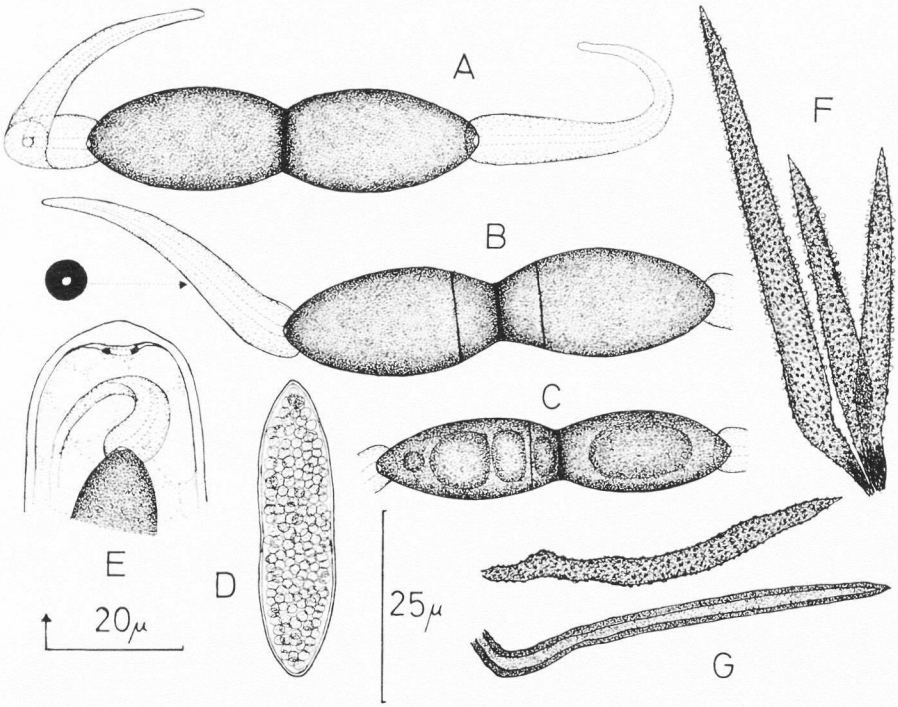

Fig. 9. *Zygospermella insignis*. A—B, D, F. LQT 2593-j. — C, E, G. RICHARDSON 5.X. 1968. All figures drawn from specimens in lactophenol. — A—C: Mature spores; note the cross section of the caudae. — D: Young, hyaline spore. — E: Ascus tip. — F—G: Setae from the perithecial neck.

rigid hairs in many *Podospora* species. MOUTON himself never observed the setae, and, besides, characterized incorrectly the peridium as coriaceous, which obviously misled CAIN to establish his *Zygospermum setosum*. CAIN referred to a Canadian find of "*Delitschia insignis*" by BISBY et al. (1929), but did probably not examine the material. The holotype of *Zygospermella insignis* in MOUTON's herbarium (BR) is in excellent condition and contains only fungi conspecific with *Zygospermella setosa*. This does not exclude, however, the possibility that there might exist an unnamed *Zygospermella* species with non-setose perithecia. It should be observed that BOEDIJN's specimens of *Zygospermella insignis* have glabrous ascocarps, and, what is most interesting, spores with a subapical and suprabasal germ pore. I have not investigated his material.

The origin of the reddish crusts on the peridium, found in both

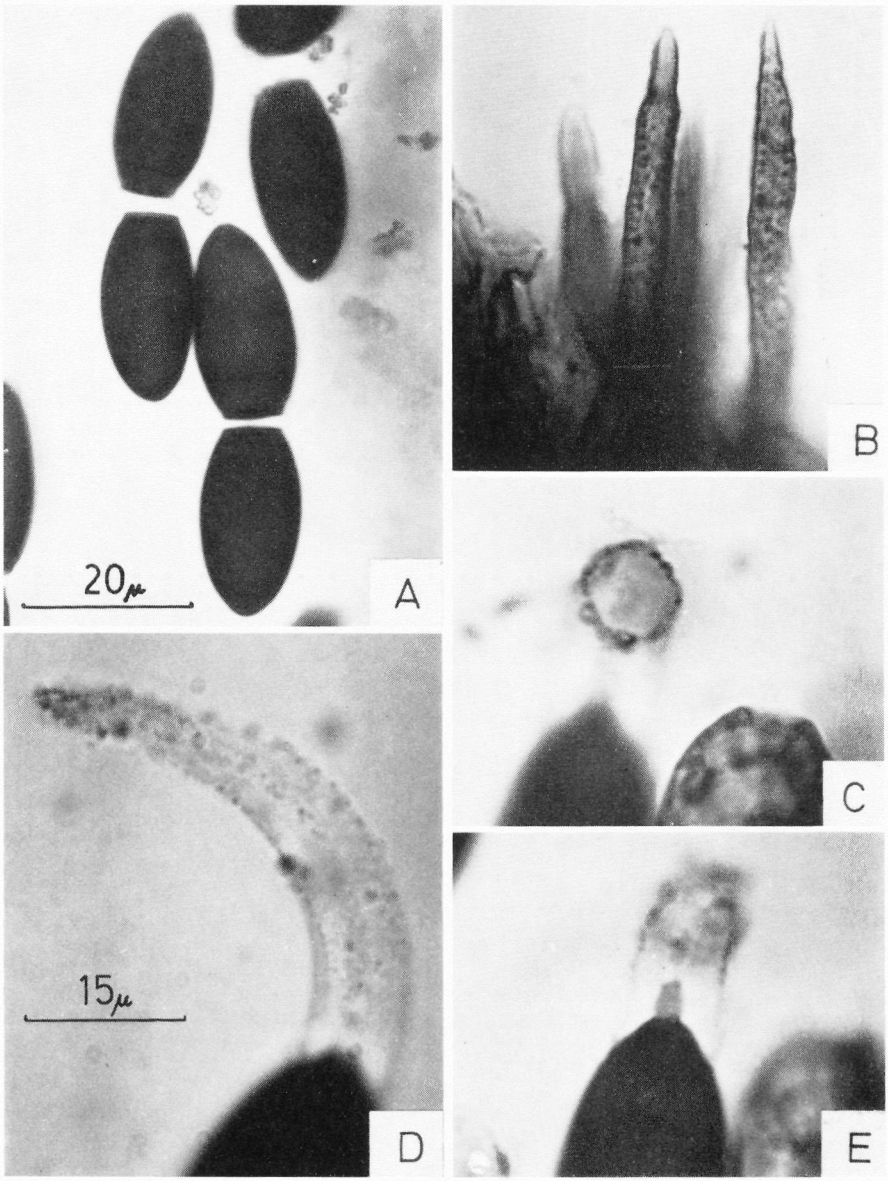

Fig. 10. A—B: *Zygospermella insignis*, holotype. — C—E: Ditto, LQT 2022-m. Material in Lactic blue. — A: Mature spores. — B: Setae from the perithecial neck. — C: Cauda in cross section. — D: Caudae in lateral view; note the narrow, inner canal. In fig. E one can see that some stained cytoplasm has entered the canal from the germ pore. Magnifications: B—C, E = D.

Zygospermella species, may be disputed. I do not think they are fragments from the substrate as they are seldom met with in other species. Perhaps these structures are of a kind similar to those found on the perithecial necks in *Fimetariella* and some *Bombardiae*. The crusts are loosely attached and very amorphous, and it hard to say whether they are exudates from the perithecium or transformed cell agglomerations. MÜLLER and VON ARX (1962 p. 709) observed the phenomenon, calling the peridium "höckerig". Their drawing of a sectioned peridium shows protuberances with a distinct cell structure, but their figures are as a rule rather idealized.

The number of nuclei in the spores is two or more per cell in the 2-celled stage.

ACKNOWLEDGEMENTS

I am indebted to Dr. H. SMITH, Uppsala, and Mr. M. BRANDT, Uppsala, for correcting the Latin and the English respectively. Dr. R. SANTESSON, Uppsala, has kindly discussed some points in the manuscript.

LITERATURE CITED

AHMED, S. I. & ASAD, F. 1968. Coprophilous fungi of West Pakistan. I. Karachi. — Pakist. Journ. Sci. Ind. Res. 11: 57—60, pl. 1—3.

BISBY, G. R., BULLER, A. H. R. & DEARNESS, J. 1929. The fungi of Manitoba, pp. 1—194, fig. 1 (map). — London, New York, Toronto.

BOEDIJN, K. B. 1962. The Sordariaceae of Indonesia. — Persoonia 2: 305—320, figs. 1—12.

BRETON, A. 1965. A propos de deux espèces rares de Sordariacées récoltées en France: Zygospermella setosa (Cain) Cain et Pleurage arizonensis Griff. — Bull. Soc. Myc. France 81: 227—242, pl. 1—2.

— 1966. Champignons coprophiles des départements du Lot, du Puy-de-Dome et du Finistère. — Ibid. 81: 607—622, figs. 1—13.

CAIN, R. F. 1934. Studies of coprophilous Sphaeriales. Ontario. — Univ. Toronto Stud. Biol. Ser. 38: 1—126, figs. 1—96.

FAKIROVA, V. 1967. Studies on the coprophilous Ascomycetes in Bulgaria, I. — Nevest. Bot. Inst. (Sofija) 17: 225—230 (in Bulgarian).

— 1968. Ditto, II. — Ibid. 18: 141—156, figs. 1—30.

— 1969. Ditto, III. — Ibid. 19: 199—210, figs. 1—20.

FAUREL, L. & SCHOTTER, G. 1965. Notes mycologiques. II. Quelques champignons coprophiles des environs d'Alger. — Revue Mycol. 29: 267—283, fig. 1.

— — 1966. Ditto, V. Champignons coprophiles du Tibesti. — Ibid. 30: 330—351, figs. 1—7.

GRIFFITHS, D. 1901. The North American Sordariaceae. — Mem. Torrey Bot. Club 11: 1—134, figs. 1—6, pl. 1—19.

HESLOT, H. 1958. Contribution à l'étude cytogénétique et génétique des Sordariacées. — Rev. Cytol. Biol. Veg. 19. Suppl. 2: 1—235, tables 1—49, pl. A—C; 1—38.

KOHLMAN-ADAMSKA, A. 1965. Quelques champignons coprophiles aux environs de Varsovie. — Acta Mykol. 1: 77—103, figs. 1—20 (in Polish).

LEWIS, I. M. 1911. The development of the spores in Pleurage zygospora. — Bot. Gaz. 51: 369—373, pl. 19.

MAINS, E. B., OVERHOLTS, L. O. & POMERLEAU, R. 1939. Mycological Society of America. Fungi collected at the Foray, August 1938. — Mycologia 31: 728—736.

MASSEE, G. & SALMON, E. S. 1901. Researches on coprophilous fungi. I. — Ann. Bot. 15: 313—357, pl. 17—18.

MEYER, S. L. 1941. Coprophilous Ascomycetes of Tennessee. I. — Journ. Tenn. Acad. Sci. 16: 401—405.

MOREAU, C. 1953. Les genres Sordaria et Pleurage. — Encycl. Mycol. 25: 1—330, figs. 1—79.

MOUTON, V. 1897. Troisième notice sur des Ascomycètes nouveaux ou peu connus. — Bull. Soc. Roy. Bot. Belg. 36: 10—21, pl. A.

MÜLLER, E. & ARX, J. A. VON, 1962. Die Gattungen der didymosporen Pyrenomyceten. — Beitr. Krypt.-Fl. Schweiz 11: 1—992, figs. 1—323.

SACCARDO, P. A. 1879. Fungi Italici. 4, pl. 481—640. — Patavii.

SCHMIDT, A. 1913. Beitrag zur Kentnnis der deutsch-ostafrikanischen Mistpilze. — 90. Jahresber. Schles. Ges. Vaterl. Cultur I. 2. Abt. b. Zool.-bot. Sekt. 1913: 17—25.

STRATTON, R. 1921. The Fimetariales of Ohio. — Ohio Biol. Survey 3: 75—144, pl. 1—18.

TÓTH, S. 1965. Data to the knowledge of the coprophilous microscopic fungi in Hungary. II. — Ann. Hist.-Nat. Mus. Nat. Hung. 57 (Bot.): 150—157, figs. 1—2 (in Hungarian).

TRAVERSO, J. B. 1907. Pyrenomycetae, Sphaeriales 1(2). — In: Fl. Ital. Crypt. 1: 353—700, figs. 69—116.

WILSON, C. M. 1947. Coprophilous Ascomycetes of Virginia. — Mycologia 39: 374—377.