The genus Thelomma

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The originally monotypic genus *Thelomma* Mass. (lichenized fungi, Caliciales) is emended, and seven species occurring in North America and Europe are included. *Thelomma* is characterized by immersed apothecia with mazaedium, thick, dark hypothecium and dark simple or one-septate spores. One species is new, new combinations have been proposed for five species and three genus names and three species names are considered taxonomic synonyms. Four lectotypes have been selected and one neotype proposed.

Descriptions of the species and nomenclatural comments are given. Information on the general morphology, spore ultrastructure, chemistry, distribution and ecology of the species is also included.

Thelomma comprises crustaceous to placoid species with apothecia immersed in prominent verrucae. The apothecia have a mazaedium and a very thick dark brown to black hypothecium. The edge of the excipulum proprium is uncoloured and very thin. Spores dark brown to black, simple and spherical or one-septate and ellipsoidal.

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In connection with previous studies on *Cyphelium* (Tibell 1969, 1971) the subgeneric division of this genus was considered. It was pointed out that a grouping of the species on the basis of the anatomy of the apothecia and the structure of the spores was possible, and that these groups corresponded in part to three sections described by Nádvorník (1942). The species of the section *"Biatorium"* Nádv. (not validly published) attracted my attention and a short note on the structure of the spore wall as studied by Transmission Electron Microscopy was included in Tibell (1971 p. 144). It was also pointed out that this spore structure occurred in species with one-septate as well as non-septate spores. To me it seemed evident that this group of species represented a distinct genus and so an investigation of possibly related species was carried out. These species are here placed in the emended genus *Thelomma*, and a revision of the genus is presented.

Historical survey

The first species of *Thelomma* to be described was *T. siliceum* in 1831 when Fée referred it to *Gassicurtia*, a name rejected by Hawksworth (1975). Next, *T. mammosum* (as *Cyphelium mammosum*) was described by Hepp from the Canary Islands (1857) and *T. ocellatum* (as *Acolium ocellatum*) from Europe by Koerber (1861). Thus at that time all species occurring outside the main distributional area of *Thelomma* (i.e. North America) had been described.

In 1860 Massalongo erected the new monotypic genus *Thelomma* for *Cyphelium mammosum* Hepp. However, *Thelomma* was not accepted in the lichenological literature and was not, for example, mentioned in Fünfstück & Zahlbruckner (1907 and 1926).

Thelomma californicum (as *Trachylia californica* Tuck.), *T. carolinianum* (as *Acolium carolinianum* Tuck.) and *T. occidentale* (as

Cyphelium occidentale Herre) were all described from California in 1864–1910. The fourth endemic North American species, *T. santessonii*, is described in this paper.

In 1927 Vainio described the monotypic genus *Cypheliopsis*, based on *Acolium bolanderi* Tuck. (=*T. mammosum*) and since then *Cypheliopsis* has been a generally accepted genus, even though in 1923 Sampaio had described the monotypic genus *Carlosia* with the same diagnostic features as *Cypheliopsis*. In Europe *Carlosia* has been a generally accepted genus. Except for the two last-mentioned species (both with spherical, non-septate spores) the other species of *Thelomma* have usually been included in *Cyphelium*.

However, it is interesting to note that the separation of the species with non-septate spores from those with one-septate spores also has met with objections. Tuckerman (1872 p. 237) makes the following comment on *Acolium bolanderi* (=*T. mammosum*) and *A. californicum* (=*T. californicum*): "The general agreement, in all most important structural details, of these two lichens, taken in connection with the difference in their spores, furnishes evidently a new argument against the generical separation of the round-spored *Calicia* (*Cyphelium* Koerb. Anzi. *Chaenotheca* Th. Fr.)" Although Tuckerman was wrong with regard to his criticism of the separation of *Chaenotheca* from *Calicium* he was undoubtedly correct in his particular example.

In 1942 Nádvorník united *Cyphelium caliciforme* (Flot.) Zahlbr. (=*T. ocellatum*) and *C. carolinianum* (Tuck.) Zahlbr. (=*T. carolinianum*) in the section *Biatorium* Nádv. (not validly published) of *Cyphelium*. This section was characterized by immersed apothecia and a thick, dark hypothecium. In the same paper *Cypheliopsis* was accepted, but it was pointed out that *Carlosia* and *Cypheliopsis* could possibly be united in a single genus.

In a recent taxonomic survey by Poelt (1974) *Carlosia* and *Cypheliopsis* are still kept separate, while *Thelomma* is neglected.

Material and methods

Specimens from the following herbaria were investigated (abbreviations according to Index Herbariorum 1974): BM, CANL, DS, F, FH, G, H, H-NYL, L, LISU, S, SFSU, UAC, UBC, UC and UPS. I was also given the opportunity to study material from the private herbaria of Dr K. Kalb, Neumarkt/Opf. and Prof. J. Poelt, Graz. The author's herbarium is abbreviated Tib., and presently kept in UPS.

Light Microscopy (LM). For light microscopic studies sections 15–20 μm thick were cut on a freezing microtome. Lactic blue was used as a standard clearing and staining agent. It is very useful, particularly if heated, but it should be observed that the crystals in the cortex and medulla are dissolved by this method. LM figures as well as measurements were recorded from water-mounts.

Transmission Electron Microscopy (TEM). Material prepared as described in Tibell (1975).

Scanning Electron Microscopy (SEM). Ascospores from the upper part of the mazaedium were gently dusted directly onto a specimen stub. The specimens were in some cases pre-coated with carbon, but in most cases directly coated with gold or palladium during rotation. No particular advantage was noted when the material was pre-coated with carbon. The specimens were examined in a JEOL JSM U-3 Scanning Electron Microscope operating at 10 or 15 kV. The spores of the *Thelomma*-species are very thick-walled when mature, and in mature spores no specimen damage caused by low pressure or other factors were observed.

Thin Layer Chromatography (TLC). TLC was carried out in accordance with the method described by Culberson (1972). System B (n-hexane–diethyl ether–formic acid, 13:8:2) was used as a standard system for routine identifications as well as for TLC separation and isolation of substances to be investigated by MS. After elution the thin-layer plates were investigated in UV-light, 254 and 350 nm. Then they were sprayed with 10% H_2SO_4 and heated at about 110°C for 10–15 min.

Mass Spectrometry (MS). The mass spectra were recorded with an LKB A 9000 Mass Spectrometer, using the heated direct inlet system. Spectra were recorded at ionization chamber temperatures from 80–130°C. The energy of the ion beam was 70 or 20 eV, the lower energy yielding a higher proportion of high molecular weight ions. MS was carried out on substances isolated with TLC or on fragments of lichen thalli (cf. Santesson 1969). In some cases particular parts of the lichen thallus – e. g. the mazaedium – were investigated.

Taxonomically important characters

Thallus

The thallus of the species is crustaceous, thin and smooth in *T. carolinianum*, verrucose in *T. mammosum*, *T. occidentale*, *T. ocellatum*, *T. santessonii* and *T. siliceum* and placoid in *T. californicum*.

The cortex in *T. californicum*, *T. mammosum* and *T. santessonii* is thick and densely interspersed with granular crystals (Fig. 13 C). *T. occidentale* and *T. ocellatum* have a thin cortex without granular crystals (Fig. 9 B). *T. siliceum* has a rather thin cortex densely interspersed by granules, but the cell walls are less conspicuously thickened than in the three first-mentioned species. *T. carolinianum* has a rather thick paraplectenchymatous cortex filled with granular crystals. In *T. californicum, T. mammosum, T. santessonii* and to a lesser extent in *T. siliceum,* massive strands of cortical tissue penetrate far down into the medullary layer of the verrucae and the dividing-line between cortex and phycobiont-containing layer is very irregular (Fig. 13 B).

Apothecia

The apothecia are immersed in smooth, semiglobose to conical verrucae in *T. californicum, T. mammosum* and *T. santessonii.* The surface of the verrucae is much more uneven in *T. occidentale, T. ocellatum* and *T. siliceum.* The verrucae of the last three species are also much less regular in shape. Fertile verrucae in *T. carolinianum* are very low, gradually rising from the thallus. The excipulum is very thick at the base in all species. The lateral part of the excipulum is very thin, and usually hyaline, more rarely slightly brownish. The central part of the excipulum is dark brown to black. A faint greenish-yellow pruina is sometimes seen on the surface of the mazaedium in *T. occidentale* and *T. ocellatum.*

Asci

The asci in all species except for *T. carolinianum* are cylindrical with uniseriate spores. In *T. carolinianum* the asci are obovate, with partly overlapping spores. The asci disintegrate at an early stage leaving the maturing spores free in the mazaedium.

Spores

T. californicum, T. carolinianum, T. occidentale and *T. ocellatum* have one-septate spores. In the other species the spores are spherical and non-septate. The spore wall is very dark, blackish-brown, and thick in all species, except for *T. carolinianum* which has a moderately thick spore wall. In TEM the spore wall structure is fairly similar and characteristic in all species except for *T. carolinianum.* Electron-dense and electron-lucent areas alternate in a spot-like, ± reticulate pattern (Figs. 3 A, 8 A–B). In *T. carolinianum* (Fig. 6 A) the spore wall has a much more minutely granular appearance. When young the spores in this species are provided with a distinct, thin and homogeneous outer, primary wall. This outer wall soon disintegrates, ruptures, and gives rise to an irregular ornamentation of the spore (Fig. 6 B). In the other species of *Thelomma* ornamentation of the spores does not originate from the disintegration of such a distinct primary wall. As to formation of spore ornamentation *T. carolinianum* shows considerable similarities to several species of *Calicium* as described by Tibell (1975). *T. californicum* is peculiar in having a distinct pattern of light and dark strands in the spore wall as seen in LM. A fairly regular ornamentation of low ridges arranged in a spiral pattern is also seen in SEM (Fig. 3 B–C). A weak striation pattern is also sometimes seen in LM in semi-mature spores of *T. ocellatum* (cf. Tibell 1971) and *T. mammosum.*

Chemistry

Epanorin, rhizocarpic acid and usnic acid were reported from *T. ocellatum* by Tibell (1971). This seems to be the only previous report on secondary constituents from *Thelomma.*

The chemistry of *Thelomma* is rather complex, and since the structure of one of the major secondary constituents has not yet been clarified the taxonomic conclusions in this report may be somewhat preliminary. It is noteworthy that the secondary constituents in *Thelomma* represent biogenetically different groups. Divaricatic acid, norstictic acid, salazinic acid and usnic acid (Fig. 1 A) originate from the acetate-polymalonate pathway, while epanorin and rhizocarpic acid originate from the shikimic acid pathway. Moreover, the constituents derived from the acetate-polymalonate pathway vary considerably as to biogenesis. Divaricatic acid is an orcinol type depside, while norstictic and salazinic acid are β-orcinol type depsidones. The substance here called "446 Cl" is a depside or depsidone structurally related to divaricatic

Table 1. Secondary constituents in *Thelomma*.

Species	Hymenium and mazaedium	Thallus
californicum	–	"446 Cl"
mammosum	norstictic acid salazinic acid	"446 Cl"
santessonii	norstictic acid salazinic acid	divaricatic acid
siliceum	norstictic acid salazinic acid	"446 Cl"
occidentale	epanorin rhizocarpic acid	usnic acid
ocellatum	epanorin rhizocarpic acid	usnic acid
carolinianum	–	norstictic acid

acid. Divaricatic and salazinic acid have not earlier been reported from Caliciales.

The secondary constituents are very specifically localized, and either contained in the hymenium and mazaedium or in the vegetative thallus. In Table 1 the occurrence and location of major secondary constituents in different taxa is summarized.

The hymenium and mazaedium contain either a mixture of norstictic and salazinic acid (*T. mammosum, T. santessonii* and *T. siliceum*), epanorin and rhizocarpic acid (*T. occidentale* and *T. ocellatum*) or no secondary constituent has been found (*T. californicum* and *T. carolinianum*). The thallus contains either "446 Cl" (*T. californicum, T. mammosum* and *T. siliceum*), divaricatic acid (*T. santessonii*), norstictic acid (*T. carolinianum*) or occasionally usnic acid (*T. occidentale* and *T. ocellatum*).

The distribution of secondary constituents among the species also agrees well with morphological, ecological and distributional data to form a subgrouping of the genus, which however, is not at present formally recognized (cf. p. 226).

The structurally unknown substance "446 Cl" has been investigated by TLC, MS and NMR. For the interpretation of data I am very much indebted to Dr J. Santesson, Uppsala. "446 Cl" was isolated by TLC. It is KC + rose red, has M = 446 and contains one chlorine. The acid part of the molecule seems to be very similar to a chlorinated acid part of divaricatic acid. The alcoholic part of the molecule, however, shows several differences as compared with the alcoholic part of divaricatic acid. It is thus not likely that there is a very simple biogenetic relationship between "446 Cl" and divaricatic acid, but rather that in any biosynthetic pathway between these substances several steps might be assumed.

A proper thallus reaction is only met with in *T. californicum, T. mammosum* and *T. siliceum*, which react KC + rose red due to the presence of "446 Cl". *T. ocellatum* is unique in having an I + dark blue medulla reaction. A reaction with PD may of course be obtained if a solution is applied to the apothecia, then the thallus will also be slightly coloured due to diffusion from the mazaedium and hymenium.

The investigations on the location of substances were carried out by TLC and MS of selected parts of the specimens, and investigation of PD reaction in sections. All specimens were routinely investigated by TLC in Culberson's solvent system B (1972). A representative plate developed in UV_{254} is shown in Fig. 1 B. Several minor, unidentified constituents have been met with, but they are omitted in the following treatment.

Ecology and distribution

The majority of the species (*T. californicum, T. mammosum, T. santessonii* and *T. siliceum*) occur on siliceous rocks. *T. californicum*, however, is not rarely found on lignum. The other species (*T. carolinianum, T. occidentale* and *T. ocellatum*) occur exclusively on lignum. The rock-inhabiting species seem to have a more uniform habitat ecology, occurring mainly in coastal areas, though often ascending rather high in altitude. In California *T. californicum, T. mammosum* and *T. santessonii* often occur together, and in some areas they evidently form an important part of the vegetation of exposed rocks. *T. californicum* is known from a restricted area in California only (Fig. 4 A), *T. santessonii* occurs in California and Baja California (Fig. 4 D), while *T. mammosum* occurs from Baja California to Vancouver Island on the American W coast (Fig. 4 B), in the Canary Islands and in Portugal. *T. siliceum* is known from a few localities in C and S Europe only (Fig. 12).

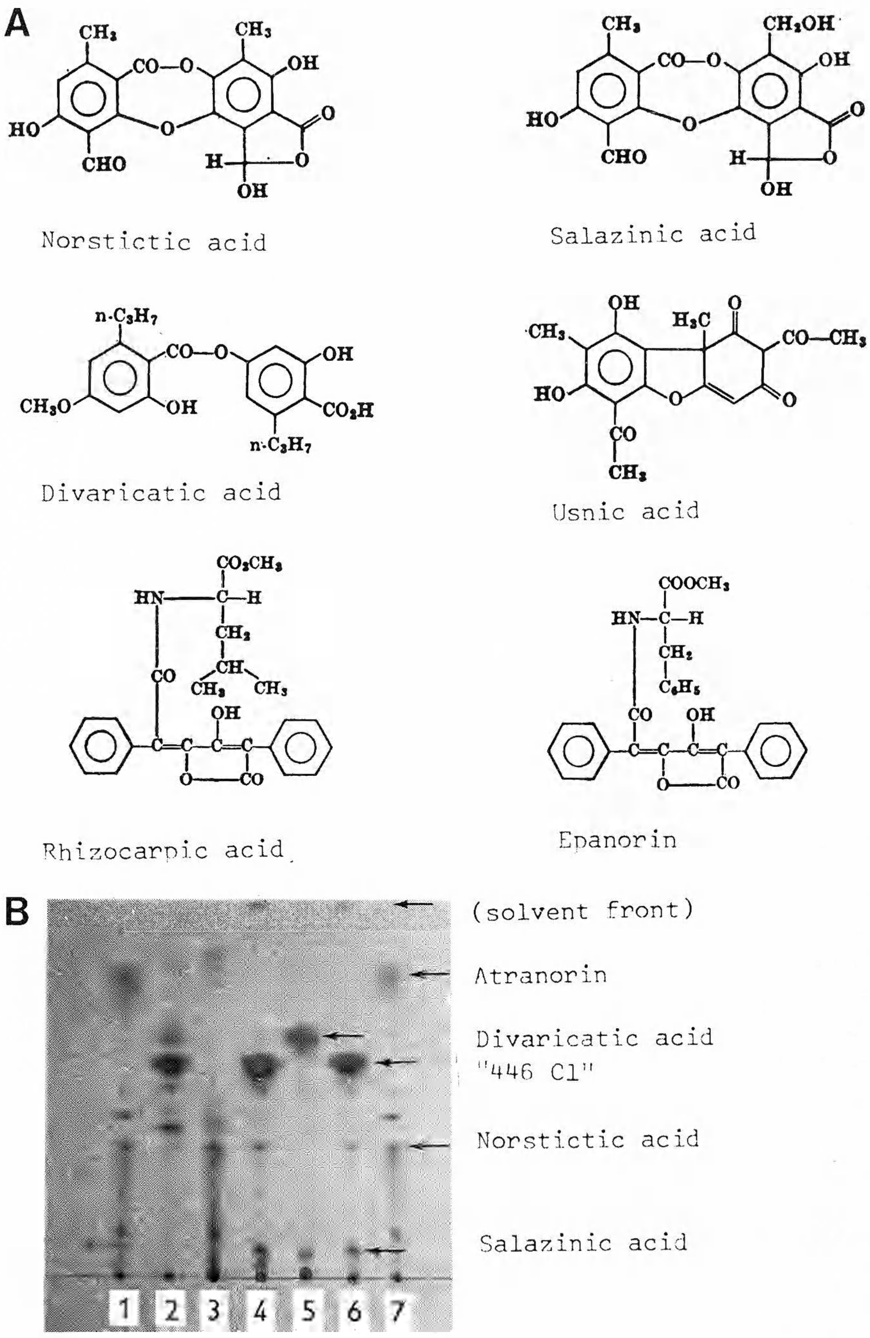

Fig. 1. Secondary constituents in *Thelomma*. – A: Structure of identified secondary constituents. – B: Thin-layer chromatogram of *Thelomma* species containing depsides and depsidones. Merck Silica Gel F_{254} plate, developed in solvent system B of Culberson (1972). Recorded in UV light (254 nm). – 1 Reference, 2 *T. californicum,* 3 *T. carolinianum,* 4 *T. mammosum,* 5 *T. santessonii,* 6 *T. siliceum,* 7 reference. – In *T. californicum* the substance above "446 Cl" is not identical with divaricatic acid as proved by TLC in other solvent systems and by MS.

Table 2. Comparison of *Cyphelium* and *Thelomma*.

Cyphelium	*Thelomma*
Apothecia	
Sessile or immersed, with a dark brown-black excipulum well developed also laterally, thus forming a distinct excipular margin	Immersed in verrucae, lateral part of excipulum very thin and hyaline. Basal part of excipulum brown-black, very thick and cushion-like
Spores	
1-septate or submuriform. Secondary wall usually with concentrically arranged layers	None-septate or 1-septate. Secondary wall (except for in *T. carolinianum*) with a distinct pattern of electron lucent and electron dense areas forming a ± distinct network
Secondary constituents	
Vulpinic acid	–
Atranorin	–
Chloroatranorin	–
Rhizocarpic acid	Rhizocarpic acid
Usnic acid	Usnic acid
Norstictic acid	Norstictic acid
–	Epanorin
–	Divaricatic acid
–	"446 Cl"
–	Salazinic acid

Among the lignum-inhabiting species *T. carolinianum* is odd in its geographical distribution and ecology. It occurs in Florida and South Carolina only, far away from the main distribution area of the genus in North America. The other two lignum-inhabiting species – *T. occidentale* and *T. ocellatum* – are closely related, but have different geographical as well as zonal distributions. *T. occidentale* occurs in North America, along the Pacific Coast, from California to Alaska. It seems to occur in rather humid areas at low elevations (Fig. 4 C). *T. ocellatum* is known from Europe only, occurring in the Upper to Lower Oroboreal Zone in the Alps and other mountainous areas in Central Europe, and also from the Middle to the Northern Boreal Zone in Scandinavia.

Thelomma Mass. emend. L. Tibell

Thelomma Mass. 1860: 268. – Originally monotypic: *T. mammosum* (Hepp in Hartung) Mass.

Holocyphis Clements 1909: 71, 174. – Originally monotypic: *H. bolanderi* (Tuck.) Clements

Carlosia Samp. 1923. – Originally monotypic: *C. lusitanica* Samp.

Cyphelium sect. *Cypheliopsis* Zahlbr. in Fünfstück & Zahlbruckner 1903: 84. – Originally monotypic: *C. bolanderi* (Tuck.) Zahlbr.

Thallus moderately to rather thick, crustaceous or placoid. Apothecia immersed in prominent verrucae, with mazaedium. Hypothecium dark brown to black, thick. Edge of excipulum proprium very thin, uncoloured. Spores dark brown-black, simple and spherical or one-septate and ellipsoidal.

Taxonomic remarks. Three species groups can be recognized on both morphological, chemical and ecological basis. The first one (*T. californicum, T. mammosum, T. santessonii* and *T. siliceum*) includes saxicolous species with a preference for coastal areas. In the hymenium and mazaedium they (except for *T. californicum*) contain norstictic and salazinic acid. In the thallus they have divaricatic acid or "446 Cl". *T. californicum* is aberrant in having a placoid thallus and one-septate spores; the other ones are very homogeneous. The second group includes *T. occidentale* and *T. ocellatum*. They are both lignicolous, produce epanorin and rhizocarpic acid in the hymenium and mazaedium and usnic acid in the thallus. Morphologically too they are very close, but *T. ocellatum* has isidia and apothecia are not often found. *T. ocellatum* is also unique in having a strong I + blue reaction in the medulla. Finally *T. carolinianum* has an isolated position in the genus. Occurring on lignum in Florida and South Carolina it is also geographically isolated. It has a discordant chemistry with norstictic acid in the thallus only. Morphology and spore ontogeny also differ considerably from the other species of *Thelomma*, but rather than erecting a monotypic genus I think it can be accepted in *Thelomma*.

A comparison of *Cyphelium* and *Thelomma* is given in Table 2.

Key to the species

1. Spores non-septate ... 2
   Spores 1-septate ... 4
2. Thallus greyish, KC + rose red ... 3
   Thallus with a yellow to olivaceous tinge, KC – ... 6. *T. santessonii*
3. Spores with a very coarse ornamentation (Fig. 15 D), fertile verrucae irregular in shape (Fig. 15 A, C) ... 7. *T. siliceum*
   Spores with a less coarse and irregular ornamentation (Fig. 7 E), fertile verrucae smooth and regular in shape ... 3. *T. mammosum*
4. Thallus verrucose or rimose, KC – ... 5
   Thallus placodiform, KC + rose red ... 1. *T. californicum*
5. Mature spores 22–28 × 14–15 µm, thallus thick, verrucose, PD – ... 6
   Mature spores 13–17 × 8–9 µm, thallus thin, smooth, rimose, PD + red ... 2. *T. carolinianum*
6. Thallus with black, well-delimited groups of minute isidia, medulla I + dark blue ... 5. *T. ocellatum*
   Thallus without isidia, medulla I – ... 4. *T. occidentale*

1. **T. californicum** (Tuck.) L. Tibell, comb. nov.

Trachylia californica Tuck. 1864: 263. – *Cyphelium californicum* (Tuck.) Zahlbr. in Fünfstück & Zahlbruckner 1903: 84. – Lectotype (selected here): "Acolium Californicum T. On metamorphic sandstone rocks, Oakland Hills, California, H. N. Bolander, 1864 ...", herb. Tuck. (FH).

Cyphelium farlowi Tuck. ex Herre 1910: 61. – Lectotype (selected here): "Acolium Farlowi Tuckerm. in litt. aug. 20, 1885 Monterey, Cal. Rocks near the sea", herb. Tuck. (FH).

Cyphelium andersoni Herre 1910: 62. – Lectotype (selected here): "Santa Cruz, on lignum, C. L. Anderson", herb. Herre (F, Field Herb. no. 1247525).

Thallus large, faintly yellowish-grey–grey, 0.3–0.4 mm thick, with distinct, radiating lobes in the periphery (Fig. 2 A, B). Cortex distinct, 30–40 µm thick, consisting of perpendicular hyphae densely interspersed with minute granular crystals. Surface of the thallus minutely granular (Fig. 2 B). Fertile verrucae conical, 2.0–2.5 mm in diam. *Apothecia*. Mazaedium 1.1–1.7 mm in diam., 0.5–0.7 mm high. Hymenium 80–110 µm high. Central part of excipulum 0.2–0.4 mm thick. Cortex of the verrucae consisting of three layers. The outermost, hyaline layer is 10–15 µm thick, paraplectenchymatous with very indistinct hyphae.

The next layer is densely interspersed with minutely granular crystals, 50–60 µm thick. The lowest layer is very irregular, prosoplectenchymatous, with strands of hyphae penetrating deep into the verrucae, giving the outer borderline of the phycobiont-containing layer a strongly folded appearence (Fig. 2 C). *Spores* 8/ascus, uniseriate. Semi-mature spores with a distinct striation pattern as seen in LM (Fig. 2 D). Mature spores 1-septate, slightly constriced at septum, 15–20 × 10–12 µm. Mature spores with an ornamentation of minute ridges interrupted by irregular fissures (Fig. 2 E, 3 B, C). In TEM the spore wall is seen to have a structure very similar to that of *T. mammosum* and *T. santessonii* (cf. Fig. 8 B and Fig. 3 A).

In TEM the spore wall consists of electron-dense, spot-like areas in a more electron-lucent matrix. The spore wall is thick (c. 2–2.5 µm), and in longitudinal section the dark spots are seen to be arranged slightly concentrically while the electron-lucent strands are slightly radiating (Fig. 3 A).

Chemistry. Thallus K –, C –, KC + rose red, PD –. The mazaedium of *T. californicum* is PD –. The vegetative thallus contains "446 Cl" as the major constituent. In addition three or four non-indentified minor substances forming a distinct pattern on the TLC plates were recorded (Fig. 1 B).

Ecology and distribution. *T. californicum* occurs on siliceous rocks, particularly on sandstone, and on lignum of old posts and fences. It grows in open situations. Collected from sea level to 800 m altitude.

T. californicum is known from a restricted area in California only (cf. Fig. 4 A).

Exsiccata examined: Krypt. Exs. Vind. 1952 (F, S, UPS). Rel. Tuck. 143 (FH, UAC, UC, UPS). Zahlbruckner, Lich. rar. 292 (S).

U.S.A.: *California*, Alameda Co., Oakland Hills, 1864 Bolander (lectotype of *Trachylia californica*), 1863 Bolander (Rel. Tuck. 143), Bolander (FH), 1910 Herre (F), 1911 Herre (F), Herre (Krypt. Exs. Vind. 1952). – Marin Co., San Francisco Bay, 1942 Brown (F); 1.6 km E of Stimons Beach, 1942 Brown

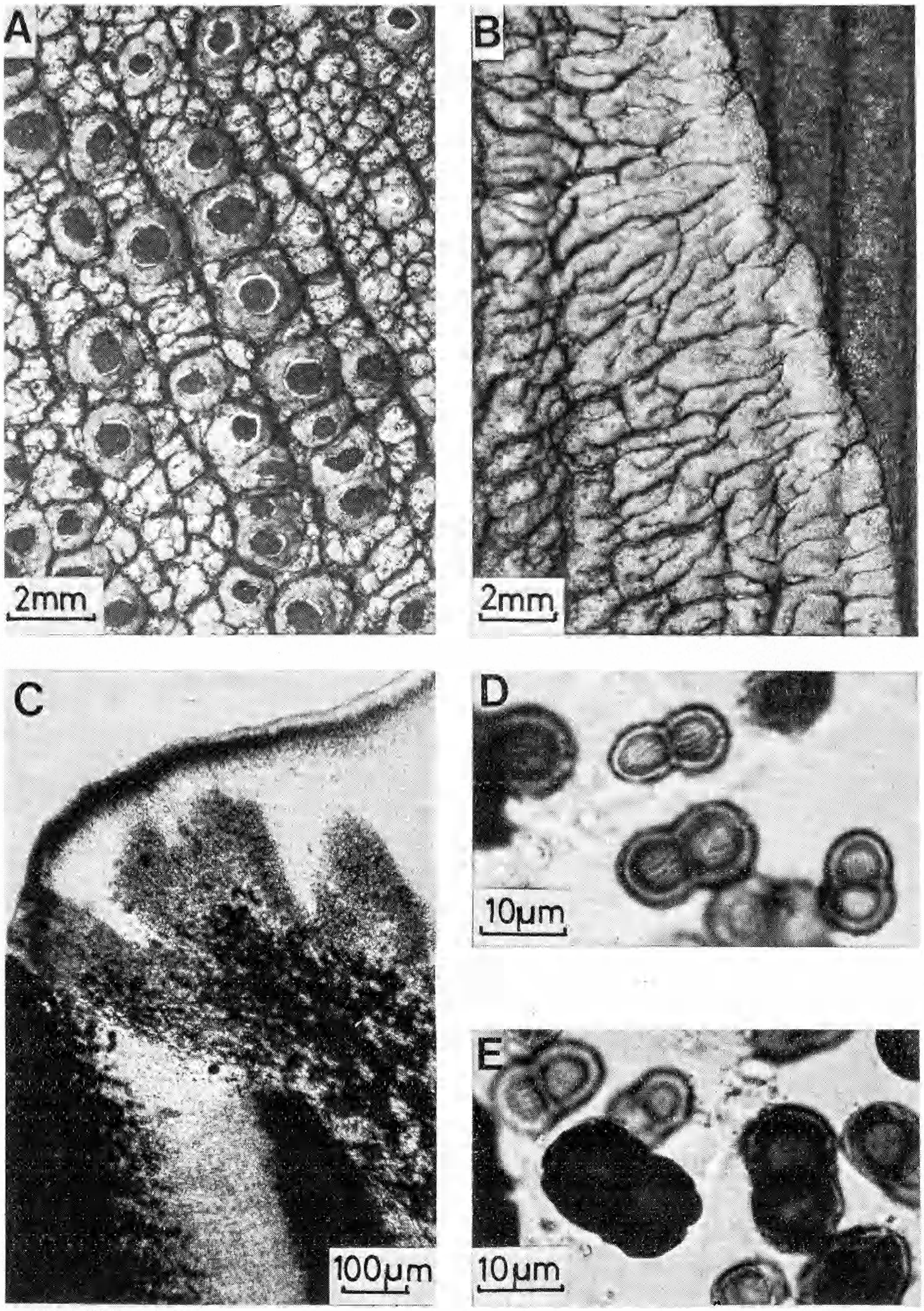

Fig. 2. *Thelomma californicum*. – A–B: Well developed thallus on lignum with mature apothecia and marginal lobes. California, San Mateo Co., near Point Año Nuevo, 1932 Herre (UPS). – C: Section of mature apothecium. Note the irregular outline of the phycobiont-containing layer. Zahlbruckner, Lich. Rar. exs. 292 (S). – D–E: Semi-mature and mature spores. Note the striated appearance of the spore wall of the semi-mature spores. Sushan 14672 (UPS).

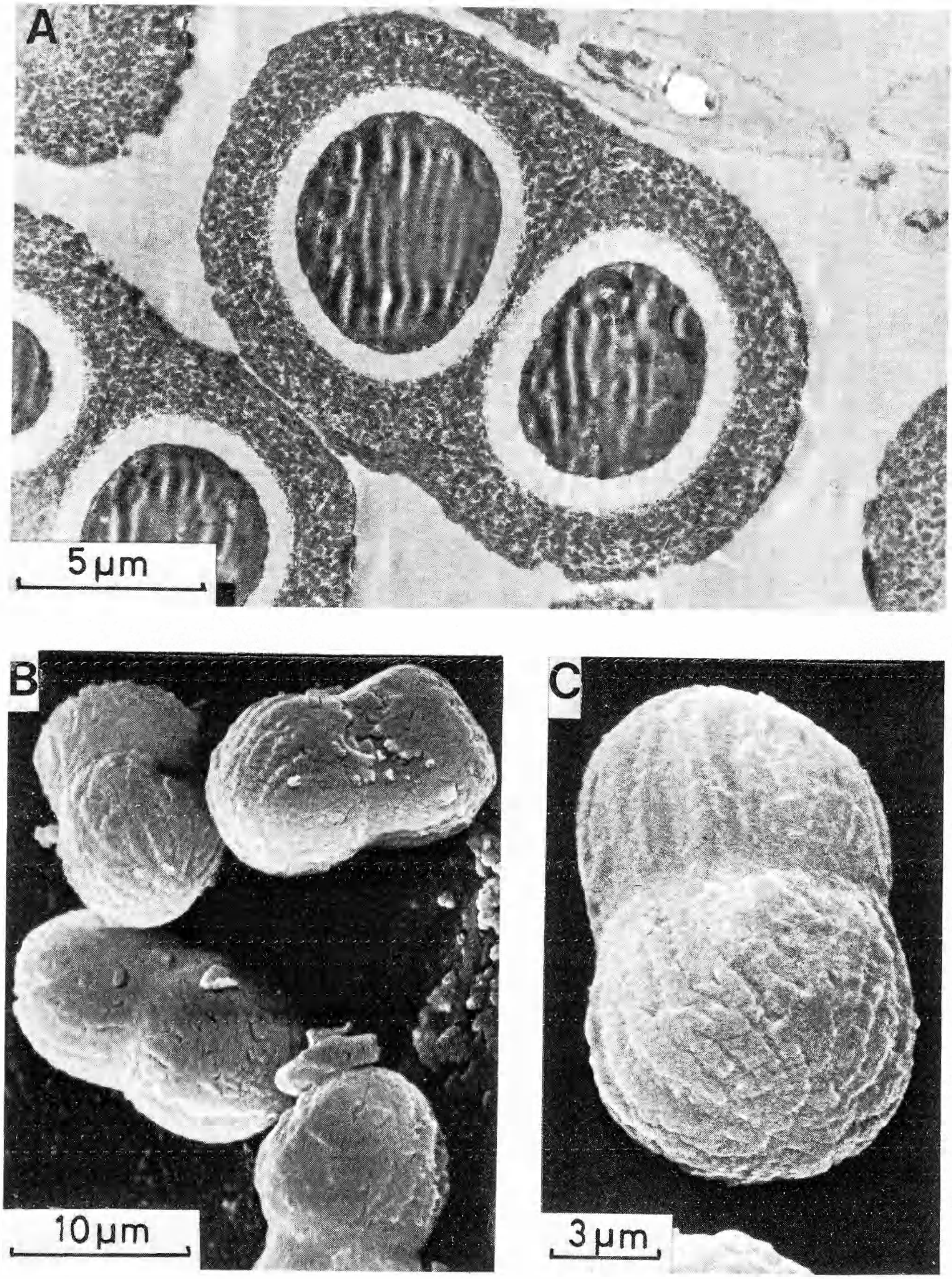

Fig. 3. *Thelomma californicum*. – A: Section of mature spore. – B–C: Mature spores. Note the longitudinally--spirally arranged ridge pattern. – A–C: California, San Mateo Co., near Point Año Nuevo, 1932 Herre (UPS).

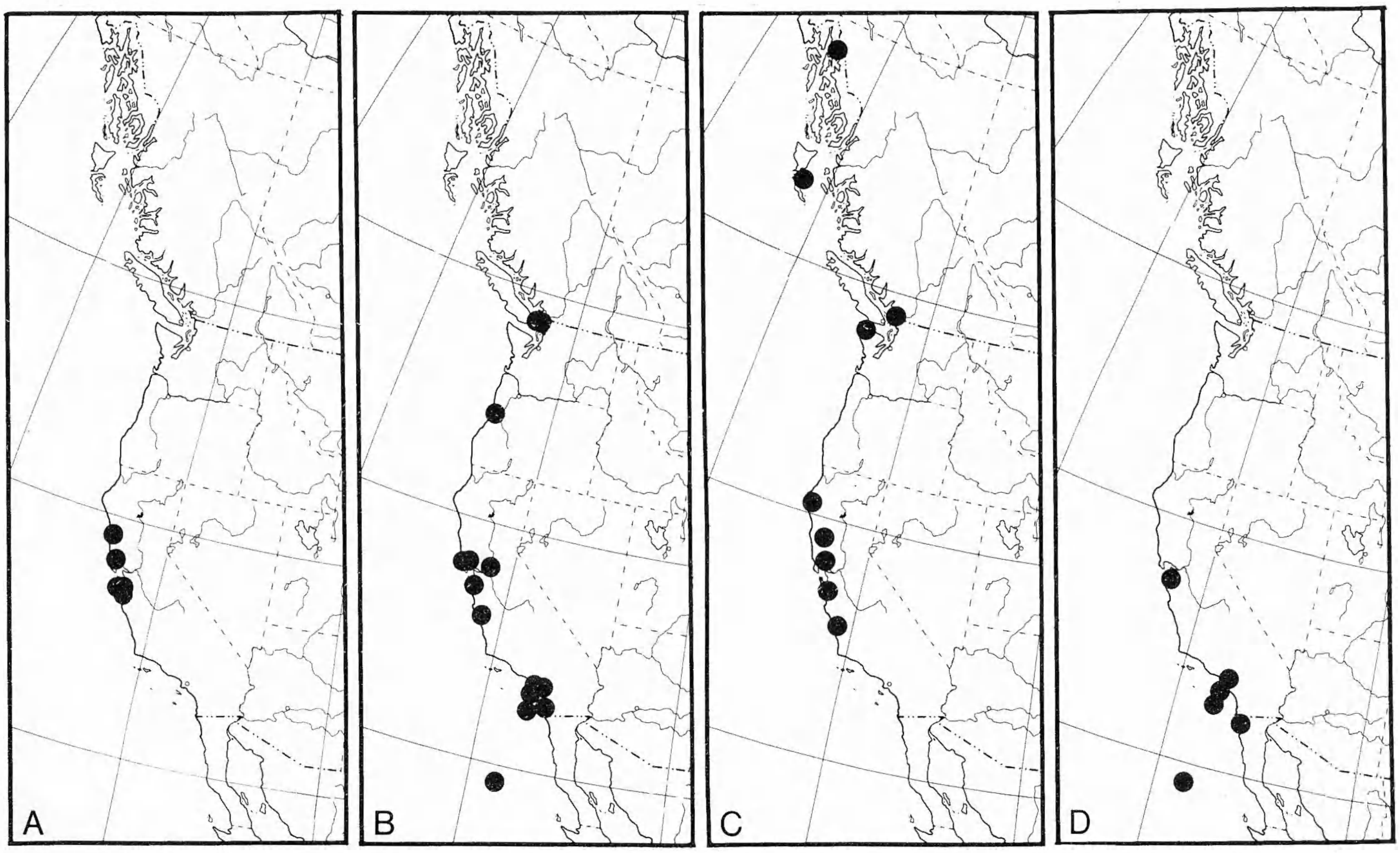

Fig. 4. Distribution of *Thelomma* species on the North American West Coast. – A: *T. californicum*. – B: *T. mammosum*. – C: *T. occidentale*. – D: *T. santessonii*.

(F); 5 km SE of Stimons Beach, 1942 Brown (F); Point Reyers Peninsula, Krakers Beach, 1962 Thiers 798 (SFSU); Rocky Tt., 1962 Volk 373 (SFSU); 1930 Kelley (F) – Mendocino Co., Cleone State Park, 1951 Kelley (UC) – Monterey Co., 1885 Farlow (lectotype of *Acolium farlowii*, cf. above) – San Francisco Co., Mission Hills, 1866 Bolander (FH); San Francisco, 1892 Blasdale (DS, F), 1892 Howe (DS, F); Skyline Bld., 1962 Largent 60 (SFSU) – San Mateo Co., San Bruno Mts., Bolander (F), 1906 Herre (DS, F, FH, UC); Near Pigeon Point, 1932 Herre (DS, F), 1943 Herre (F), 1957 Sushan 14672 (UPS); Point Año Nuevo, 1932 Herre (F, UPS); South end of Cahill Ridge Road, 1967 Jordan 835 (CANL), Jordan 836 (SFSU) – Santa Clara Co., Santa Cruz Mts., Herre (Zahlbruckner, Lich. rar. exs. 292) – Santa Cruz Co., Santa Cruz, 1886 (FH, with *T. occidentale*), 1910 Herre (lectotype of *Cyphelium andersonii*, cf. above); Corralitos, 1939 Herre (F); Santa Cruz Mts., Bonnie Don, 1939 Herre (F) – Sonoma Co., Petaluma, Madison Street, 1939 Koch (F) – County unknown, near San Francisco, 1892 Howe (F); Stengel Ranch, 1905 Herre (DS, F); Between Watsonville and Moss Landing, 1909 Herre (F); "California", 1865 Bolander (F, FH).

2. **T. carolinianum** (Tuck.) L. Tibell, comb. nov.

Acolium carolinianum Tuck. 1872: 237. – *Cyphelium carolinianum* (Tuck.) Zahlbr. in Fünfstück & Zahlbruckner 1903: 84. – Lectotype (selected here): "A. Carolinianum T. in litt., Gen. p. 237, 483 on old Cedar logs, Bluffton, S.C., legit Mellichamp" ex herb. Tuck. (FH).

Thallus crustaceous, continuous, smooth, rimose–areolate, rather thin (c. 0.2 mm thick), and with a faint, dull reddish-brown colour. Cortex 30–35 μm thick, densely interspersed by granular crystals. Medulla and strands of the medulla reaching the cortex are also richly interspersed by granular crystals. *Apothecia* developing in older verrucae. Fertile verrucae somewhat rugose, 1.0–1.5 mm in diam., slightly to moderately elevated. Mazaedium 0.6–1.0 mm in diam., black, non-pruinose, 0.15–0.22 mm high. Hymenium 55–75 μm high, I + dark blue. Central part of excipulum 0.16–0.35 mm thick, brownish-black. Cortex of fertile verrucae densely interspersed with crystals and with a uniform, 35–70 μm thick phycobiont-containing layer not interrupted by strands of hyphae (Fig. 5 B). *Asci* pyriform c. 35–40 × 14–16 μm (Fig. 5 C), with a long stalk. *Spores* 1-septate, 8/ascus, partly overlapping, 13–16 × 6–8 μm, slightly incised at septum and with a

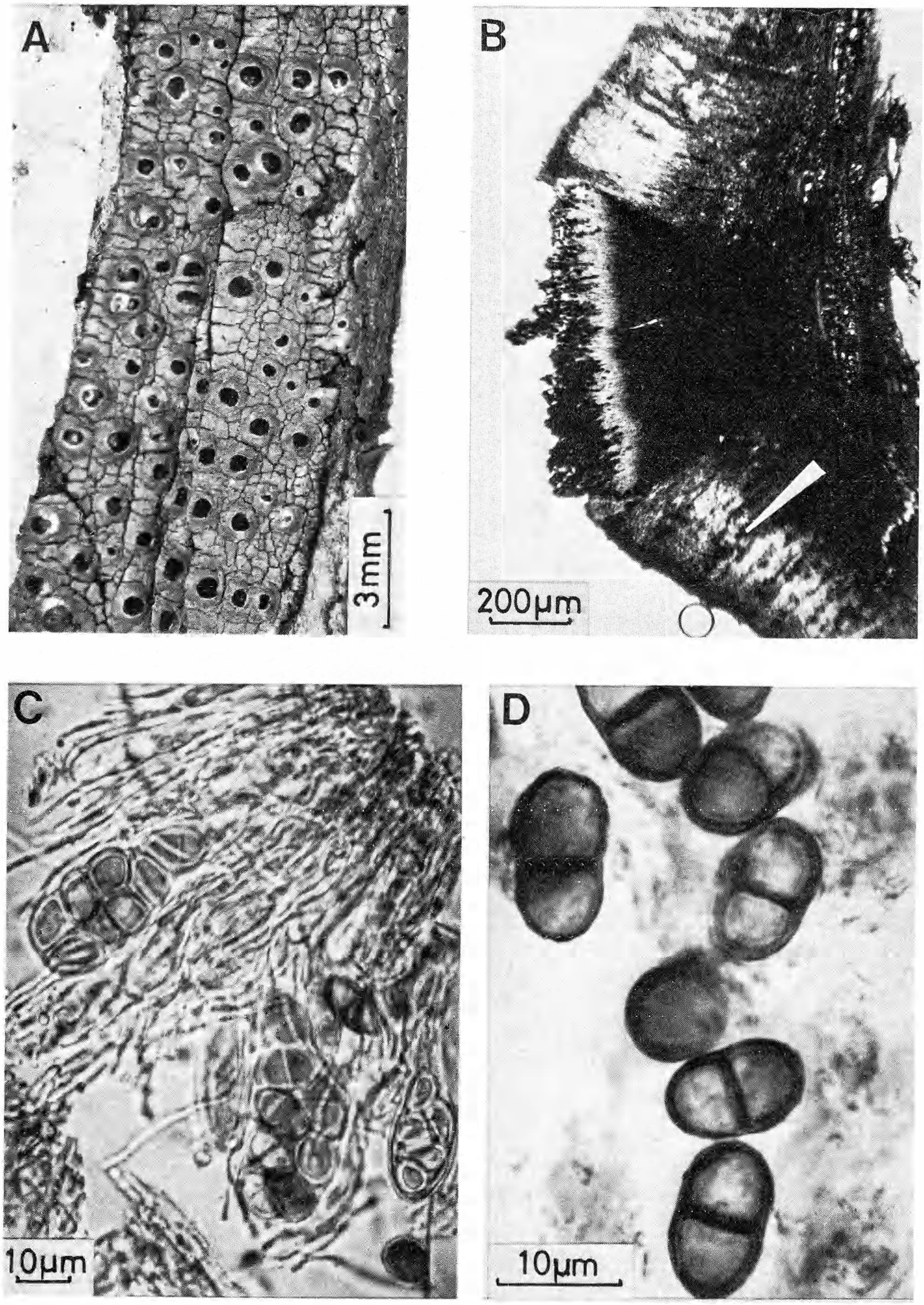

Fig. 5. *Thelomma carolinianum*. – A: Well developed thallus. – B: Section of mature apothecium. Note strands of crystals in the medulla (arrow). – C: Mature pyriform asci. – D: Mature spores. – A, C: Lectotype. – B, D: Calkins 207 (S).

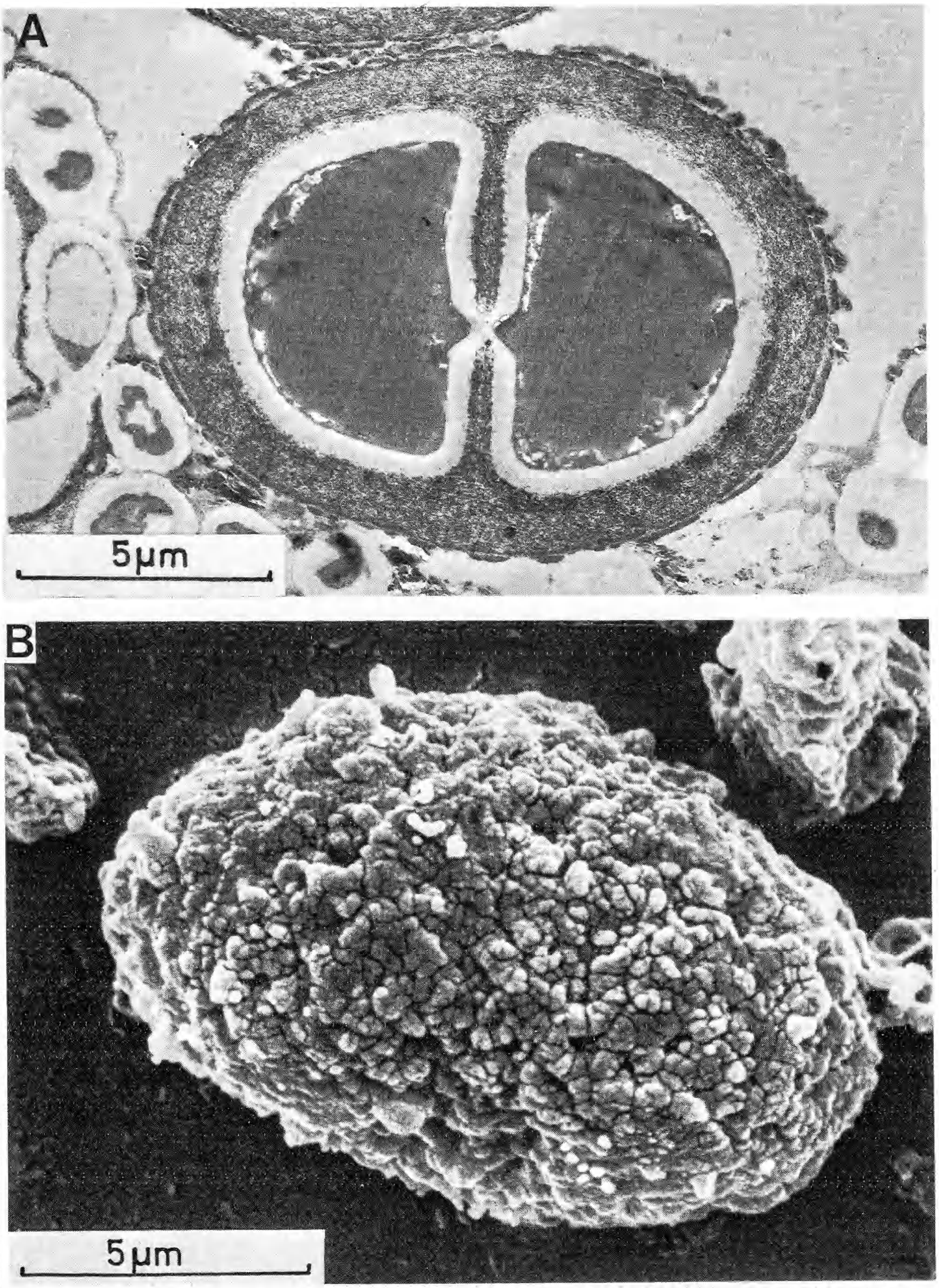

Fig. 6. *Thelomma carolinianum*. – A: Section of mature spore. Note the three wall-layers. Innermost layer very electron-lucent. Middle layer homogeneous and with a distinct outer limit. Outermost layer thin and uneven, giving rise to an ornamentation of the spore surface. Calkins 207 (S). – B: Mature spore with ornamentation of small verrucae and cracks. Florida, Gainesville, 1915 Nelson (FH).

slightly uneven surface (Fig. 5 D). In TEM the mature spores are seen to have a very thin and irregular primary wall (Fig. 6 A), and a thick secondary wall with very uniform structure. The ornamentation of the spores (Fig. 6 B) is due to the irregular surface of the primary wall.

Chemistry. Thallus K + deep red, PD + yellow, C –. All specimens in the list of localities were investigated by TLC and found to contain norstictic acid. There are two more PD + substances present, but they have not been identified. It should be noted that no PD + substance occurs in the mazaedium.

Taxonomic remarks. Although *T. carolinianum* has apothecia of *Thelomma*-type it differs in several respects from the other species in the genus, particularly in chemistry and ultrastructure of spores. Norstictic acid occurs as a minor substance in other species of *Thelomma* (cf. Table 1) but in these species it occurs in the mazaedium and not in the thallus. The very homogeneous structure of the secondary wall is also remarkable. As to geographical distribution *T. carolinianum* is also isolated from all other species. However, I think it is most convenient to include it in *Thelomma,* though it has a rather isolated position in the genus.

Ecology and distribution. T. carolinianum occurs on lignum or decorticated trunks. It has been recorded from "pine" stumps and lignum of *Juniperus* and *Taxodium*.

T. carolinianum is known from a restricted area in Florida and South Carolina only. I have seen no material collected later than 1915.

U.S.A.: Florida, Gainesville, 1915 Nelson (FH) – Jacksonville, Calkins (F, UC) – Lake City, 1900 collector unknown (F) – Sanford, 1911 Merrill & Rapp (FH). – *South Carolina,* Bluffton, Beaufort, 1868 Mellichamp, Herb. Tuck. (FH) – do., Mellichamp (lectotype, cf. above) – "S. Carolina, Sea Coast", Ravenal (F). – *Province unknown,* Calkins, North American Lichens 207 (S).

3. **T. mammosum** (Hepp in Hartung) Massal.

Massalongo 1860: 268. – *Cyphelium mammosum* Hepp in Hartung 1857: 147. – Coll. orig.: *"Cyphelium mammosum* Hepp, L. Taiche, no. 43" (UPS). Massalongo erroneously indicated that *C. mammosum* was described from Madeira, a misconception also met with in later publications (e.g. Hawksworth 1975).

Acolium bolanderi Tuck. 1866: 27. – Lectotype (selected here): *"Acolium bolanderi* in litt. ad Boland. Oakland Hills, grows with *Trachylia Calif.* but seems to me a different plant", ex Herb. Tuck. (FH).

? *Trachylia vouauxi* Harmand in Pitard & Harmand 1911: 8. – Coll. orig.: Canary Islands, Tenerife, Buenavista, Pitard 327 (microslide from PC kept in UPS) – Hierro, "troncs de Sabines de la Dehesa de los Reyes", 1906 Pitard (UPS).

Thallus light grey to slightly yellowish-grey or with a brownish tinge, areolate–verrucose. Areolae when still flat 0.5–0.8 mm in diam., fertile verrucae strongly convex, 1.1–1.6 mm in diam. (Fig. 7 A–B). Cortex smooth and slightly shining, coriaceous. *Apothecia* developing in older verrucae, with a thick thalline margin. Mazaedium black, epruinose, not or slightly protruding. Fertile verrucae often incised at the base, almost peltate. Mazaedium 0.20–0.35 mm high, hymenium 70–90 μm thick. Central part of excipulum 0.12–0.16 mm high, consisting of dark-coloured hyphae. Cortex of the verrucae consisting of three layers. The outermost layer is formed by a hyaline, paraplectenchymatous tissue, c. 8–13 μm thick. Next there is a 25–55 μm thick well-delimited layer filled by small, irregular crystals. The lowest layer is very irregular and consists of strands of a prosoplectenchymatous tissue penetrating deep into the verrucae giving the outer borderline of the phycobiont-containing layer a strongly folded appearance (Fig. 7 C).

Spores uniseriate, 8/ascus, but often only 6 or 7 mature. *Asci* cylindrical, 33–38 × 5–6 μm when mature. *Spores* 13–16 μm, non-septate, spherical, with a coarsely irregular ornamentation (Figs. 7 E, 8 C–E). In semi-mature spores a faint striation in the wall is sometimes seen in LM. In TEM the spore wall shows a very distinct pattern of electron-dense and electron-lucent parts forming a reticulate pattern. The dark spots are comparatively large in the middle part of the wall becoming much smaller towards the periphery. The electron-lucent strands in between are often slightly radiating while the dark spots have a tendency towards concentric arrangement, particularly in the outer part of the wall (Fig. 8 A–B).

Chemistry. Thallus K –, C –, KC + rose red, PD –. The mazaedium contains norstictic and salazinic acid. The cortex and/or medulla contains "446 Cl". Most specimens included in

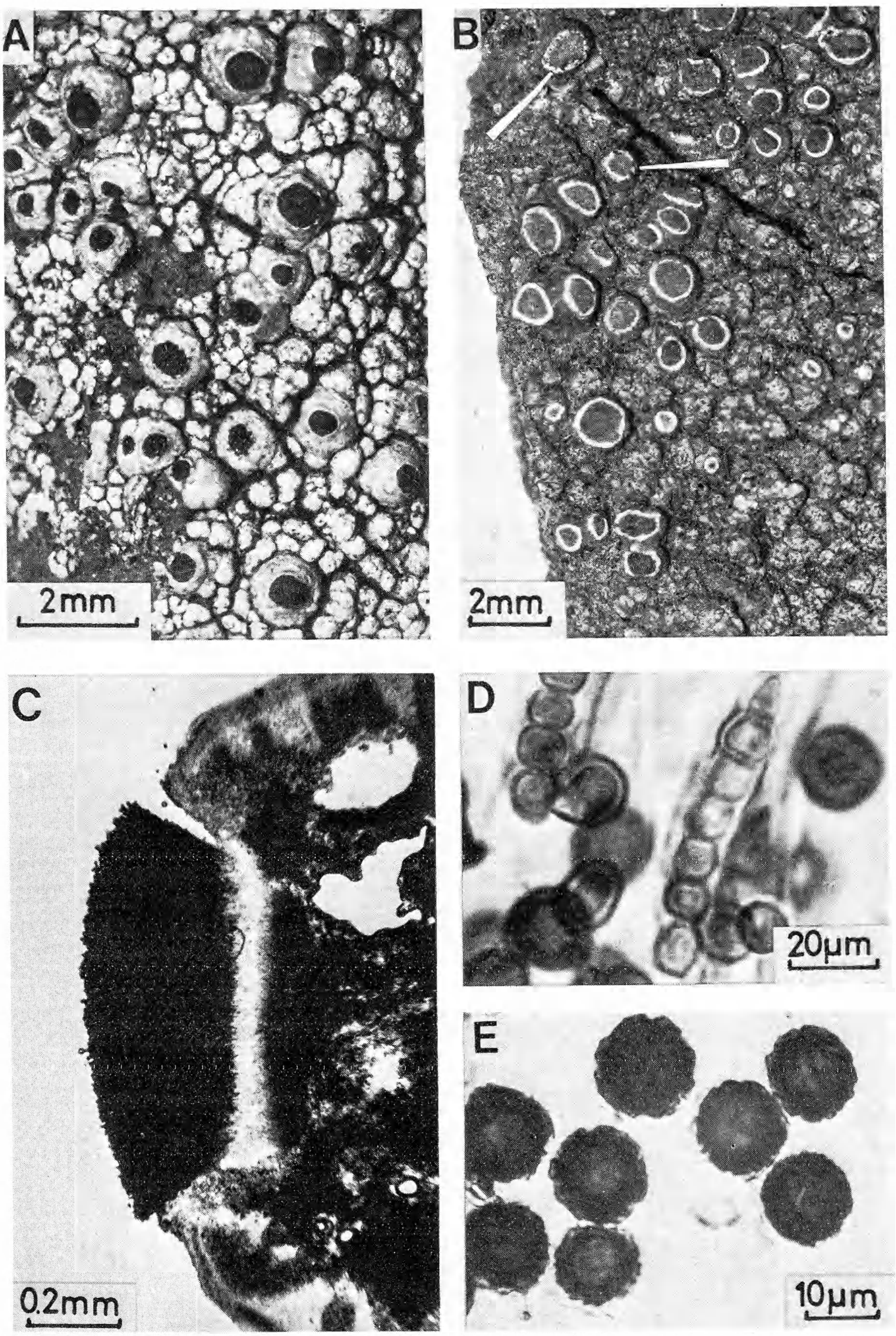

Fig. 7. *Thelomma mammosum*. – A: Well developed thallus. Coll. orig. (UPS). – B: Do., lectotype of *Acolium bolanderi*. Note the perithecia of *Discothecium gemmiferum* in the thalline margin of the apothecia (arrows). – C: Section of mature apothecium. R. Santesson 18004 (UPS). – D: Mature ascus and semi-mature spores with a faint striation pattern. – E: Mature spores with irregular ornamentation. – D–E: Sushan 14577 (S).

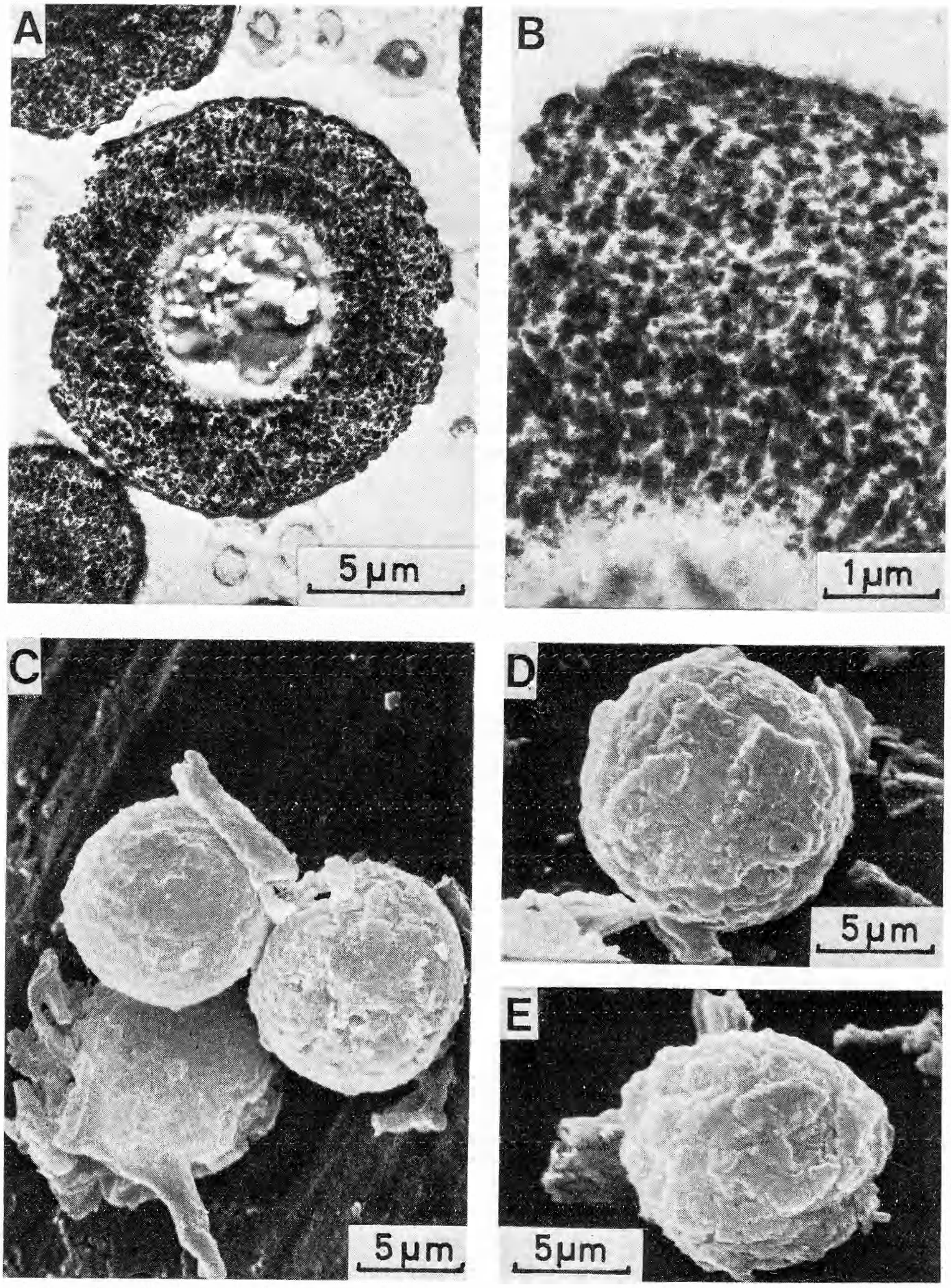

Fig. 8. *Thelomma mammosum*. – A: Tangential section of mature spore. Note the distinct electron-lucent and electron-dense areas. – B: Part of wall of mature spore. – C–E: Mature spores with irregular ornamentation. – A–C: Coll. orig. (UPS). – D–E: Bird 19199 (UPS).

Table 3. Comparison of diagnostic features of *Thelomma mammosum* and *T. santessonii*.

T. mammosum	*T. santessonii*
Thallus grey or only with a very faint yellowish-olivaceous tinge	Thallus distinctly yellowish-olivaceous
Thallus comparatively thin, fertile verrucae 1.1–1.6 mm	Thallus thick, fertile verrucae 1.4–2.1 mm
"446 Cl", thallus KC + rose red	Divaricatic acid, thallus KC –

the list of localities below were found to contain these substances by TLC but in a few instances norstictic acid was not found.

Taxonomic remarks. In many respects *T. mammosum* is similar to *T. santessonii,* and in some parts of California they often occur together. The differences between *T. mammosum* and *T. santessonii* are summarized in Table 3. *T. mammosum* and *T. santessonii* also have different total distributions (cf. Figs. 4 B and 4 D).

T. mammosum is frequently infected by the parasitic pyrenomycete *Discothecium gemmiferum* (T. Tayl. in Mackay) Vouaux. The determination of *D. gemmiferum* on the lectotype of *Acolium bolanderi* was kindly confirmed by Prof. R. Santesson. In Californian material kept in FH and UPS some 20% of the specimens are infected. The perithecia of the parasite preferably develop in the thalline margin of old apothecia (Fig. 7 B). It is interesting to note that so far I have seen no material of *T. santessonii* attacked by this parasite, though in some cases *T. santessonii* is found together with infected *T. mammosum.*

Trachylia vouauxi probably belongs to *Thelomma mammosum,* but the material I have seen so far (cf. above) is too scanty to allow a definite identification. *Trachylia vouauxi* was described from the Canary Islands (Tenerife and Hierro, one locality from each island). The chemistry is identical with that of *T. mammosum,* but the external morphology of the *Juniperus*-inhabiting specimen from Hierro is a little different. The occurrence on *Juniperus* is remarkable – I have seen no specimen of *T. mammosum* growing on other substrata than rocks. Until further material is available, particularly from the Hierro population, the systematic position of *Trachylia vouauxi* remains uncertain. The thallus of the Hierro material is, contrary to the statement in the description of *T. vouauxi,* KC + rose red.

Ecology and distribution. T. mammosum occurs in coastal areas, and seems to be abundant at low altitudes in some areas of California, particularly on islands such as the San Clemente and Sta Catalina islands. It occurs on siliceous rocks in open situations, and has been recorded from the spray zone up to c. 700 m (California) and 800 m (Canary Islands). As to the occurrence of one specimen of *Trachylia vouauxi* on *Juniperus sabina,* see Taxonomic remarks above.

T. mammosum has an interesting distribution. On the American West Coast it occurs from Baja California to British Columbia (Fig. 4 B). *T. santessonii* has a much more restricted, southern distribution (Fig. 4 D). It is particularly noteworthy that *T. mammosum* is also found on the Canary Islands and in Portugal. Although these areas and the Baja California–British Columbia part of the American W coast certainly have some similarity in maritime climate I know of no phytogeographical parallel, neither among higher plants nor among lichens.

New to Europe.

Exsiccata examined: Cummings, Decades of North American Lichens II: 141 (FH, S). Hasse, Lich. exs. 7 (FH: p.p. with *T. santessonii,* DS). Krypt. Exs. Vind. 1647 (FH, UPS: with *T. santessonii*). Rel. Tuck. 101 (FH, UC, UPS). Weber, Lich. Col. exs. 75 (S: with *T. santessonii,* DS).

Canada: British Columbia, Vancouver Island, Victoria, 1957 Eyerdam 2601 (CANL, UPS); do., Salt Spring Island, small island between Goat Island and Dead Man Island, E of Ganges, 1967 Bird 19199 (FH, UPS), Walter Hook, 1969 Bird 23856 (CANL).

U.S.A.: Washington, San Juan Co., San Juan Island, Lonesome Cove, 1961 Eyerdam (DS), do., 48°29′ N, 123°10′ W, James (CANL). – *Oregon,* Lincoln Co., 0.8 km S of Seal Rocks, 44°29′ N, 124°09′ W, 1972 Pike 2305 (UPS). – *California,* 60 localities from the following counties: Alameda, Contra Costa, Los Angeles, Marin, Monterey, Orange, San Diego, San Mateo, Santa Clara and Sonoma. A detailed list of localities is kept in S and UPS and copies are available on request.

Mexico: Baja California, Guadalupe Island, Islote Negro, 1963 Weber & McCoy Jr. (Weber, Lich. Col. exs. 75).

Canary Islands: Lanzarote, Teiche, coll. orig. (cf. above). – *Tenerife,* Anaga Peninsula, between Mt. Taborno and Paso, near Caseiro La Cumbre, along the highroad, 1974 Tibell 5651 (Tib., UPS).

Portugal: Estremadura, Berlenga, close to Carreiro do Mosterio, 1951 Tavares 4065 (LISU); do., southernmost part, 1951 Tavares 4257 (LISU).

4. **T. occidentale** (Herre) L. Tibell, comb. nov.

Cyphelium occidentale Herre 1910: 62. – Lectotype (selected here): California, Santa Clara County, foothills near Stanford University, Baker, Pacific Slope Lichens 436 (F).

Thallus crustaceous, verrucose–subareolate, grey (Fig. 9 A), without isidia. *Cortex* 11–24 μm thick, hyaline. No crystals in the cortex, nor in the medulla. Without strands of hyphae penetrating into the medulla from the cortex. The borderline of the medulla is even, parallel with the surface (Fig. 9 B). *Medulla* I –. Fertile verrucae 1.2–1.8 mm in diam., with uneven surface. *Apothecia* single in the fertile verrucae or rarely 2–3. Mazaedium 0.7–1.0 mm in diam., sometimes with a greenish-yellow pruina. Hymenium 55–80 μm high. Central part of excipulum 0.23–0.33 mm high, blackish-brown. *Asci* cylindrical. *Spores* 1-septate, 8/ascus, uniseriate, 22–28 × 12–15 μm, constricted at septum. In LM the surface of the spores is smooth or minutely uneven (Fig. 9 D). The spore wall as studied in TEM (Fig. 10 A) is very similar to that found in *T. ocellatum* and other *Thelomma* species except for *T. carolinianum.* In SEM (Fig. 10 B) the spore surface is seen to be minutely uneven, possibly a drying artifact, since no corresponding structure is found in the TEM pictures.

Chemistry. Thallus K–, C–, KC–, PD–. Medulla I –. The mazaedium often has a greenish-yellow pruina consisting of tetronic acid derivatives. Nine specimens were investigated by TLC, MS or both methods. As in *T. ocellatum* a rather confusing situation is encountered with considerable variation in number and amount of substances detected. Epanorin, rhizocarpic acid and usnic acid were found in the following specimens: California, no further locality indicated, Andersson, UPS; Santa Cruz, 1887 Farlow, FH; Santa Cruz Mts, Stengel Ranch, 1905 Herre, FH and Sushan 14818, UPS. Epanorin and rhizocarpic acid were detected in Koch 217, FH and Nash 8020, UPS. Usnic acid only was found in Baker, Pacific Slope Lichens 436, FH and UPS and no substance was detected in Brodo, Lich. Canad. exs. 32, UPS.

Taxonomic remarks. T. occidentale is morphologically and chemically very similar to *T. ocellatum,* and differs mainly in not being isidiate and having an I – medulla. The two species also have a different geographical and zonal distribution. *T. occidentale* occurs in coastal hemiboreal–temperate areas in North America, whereas *T. ocellatum* is found in boreal and oroboreal areas in Europe.

Ecology and distribution. T. occidentale occurs on lignum, preferably fencing posts. In some cases the substrate is indicated as lignum of redwood. It has been recorded from sea level to 600 m altitude, from southern Alaska to California, and is known from North America only (Fig. 4 C).

New to Alaska, British Columbia and Washington.

Exsiccata examined: Baker, Pacific Slope Lichens 436 (F, FH, UPS). Brodo, Lich. Canad. exs. 32 (UBC, UC, UPS).

Canada. British Columbia, Hastings, Burrard Inlet, 1889 Macoun (CANL) – Queen Charlotte Islands, Moresby Island, Alliford Bay, 53°12′ N, 131°59′ W, Brodo & Shchepanek, Brodo 11761 (UAC and Brodo, Lich. Canad. exs. 32).

U.S.A.: Alaska, Juneau, Mendenhall Valley, 1972 Wennekens (SFSU) – *California,* Humbolt Co., Cape Mendocino, 8 km S of Capetown, 1966 Ammirati 392 (SFSU) – Monterey Co., Hastings Natural Reservation E of Jamesburg, 1956 I. Tavares 58 e (UC) – San Diego Co., Santa Cruz, 1885 Farlow (F), 1886 Anderson (with *T. californicum,* FH); Santa Cruz, 1887 Farlow (FH); Santa Cruz Mts., Fatjo Ranch, 1908 Herre 1293 (F, FH) – San Luis Obispo Co., 23 km E of Cambria, along State Route 46, Nash 8020 (ASU, UPS) – San Mateo Co., Pilarcitos Creek Canyon, 1957 Sushan 14818 (UPS) – Santa Clara Co., foothills near Stanford University, 1902 Baker (Baker, Pacific Slope Lichens 436, lectotype, cf. above); do., 1902 Baker (FH); 6.5 km W of Gilroy, 1942 Brown (F) – Sonoma Co., Kenwood, 1887 Bioletti (F); Highway 128, 38 km past Cloverdale, 1968 Setzer 1581 (SFSU); Barbour Ranch Pasture, 6.5 km N of Santa Rosa, 1938 Koch (DS, F). – County unknown, Santa Cruz Mts., Stengel Ranch, 1905 Herre (DS, FH). – *Washington,* Clallam Co., Dungeness Bay, 48°09′ N. 123°08′ W, Brodo 15272 (CANL); do., Bird 23107 (UAC).

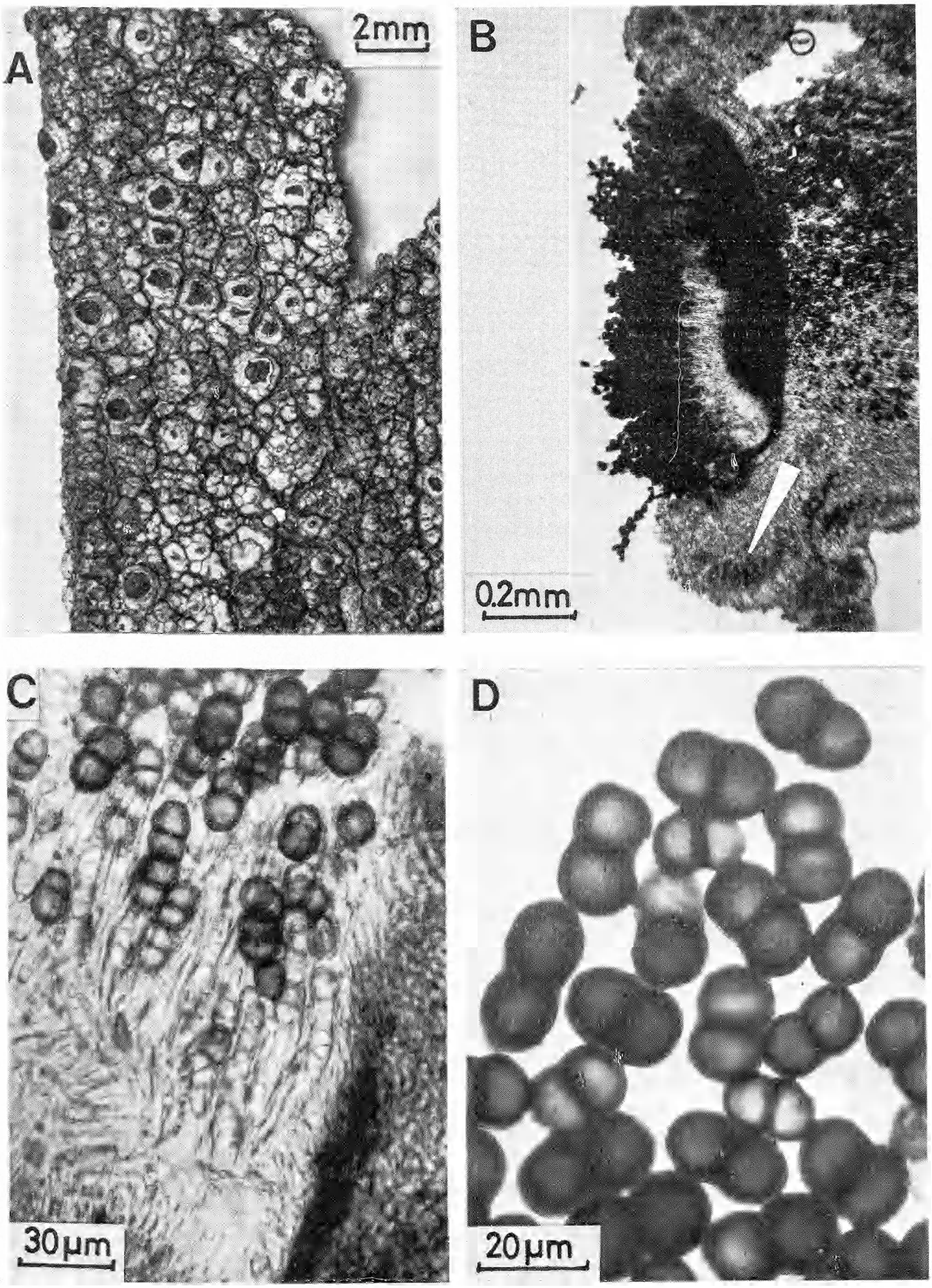

Fig. 9. *Thelomma occidentale*. – A: Thallus with fully developed apothecia. Note the irregular surface of the fertile verrucae. – B: Section of mature apothecium. Cortex comparatively thin and phycobiont-containing layer even (arrow). – C: Part of hymenium with asci, young and semi-mature spores and mature spores. – D: Mature spores. – A, D: Baker, Pacific Slope Lichens 436 (UPS). – B, C: Sushan 14818 (UPS).

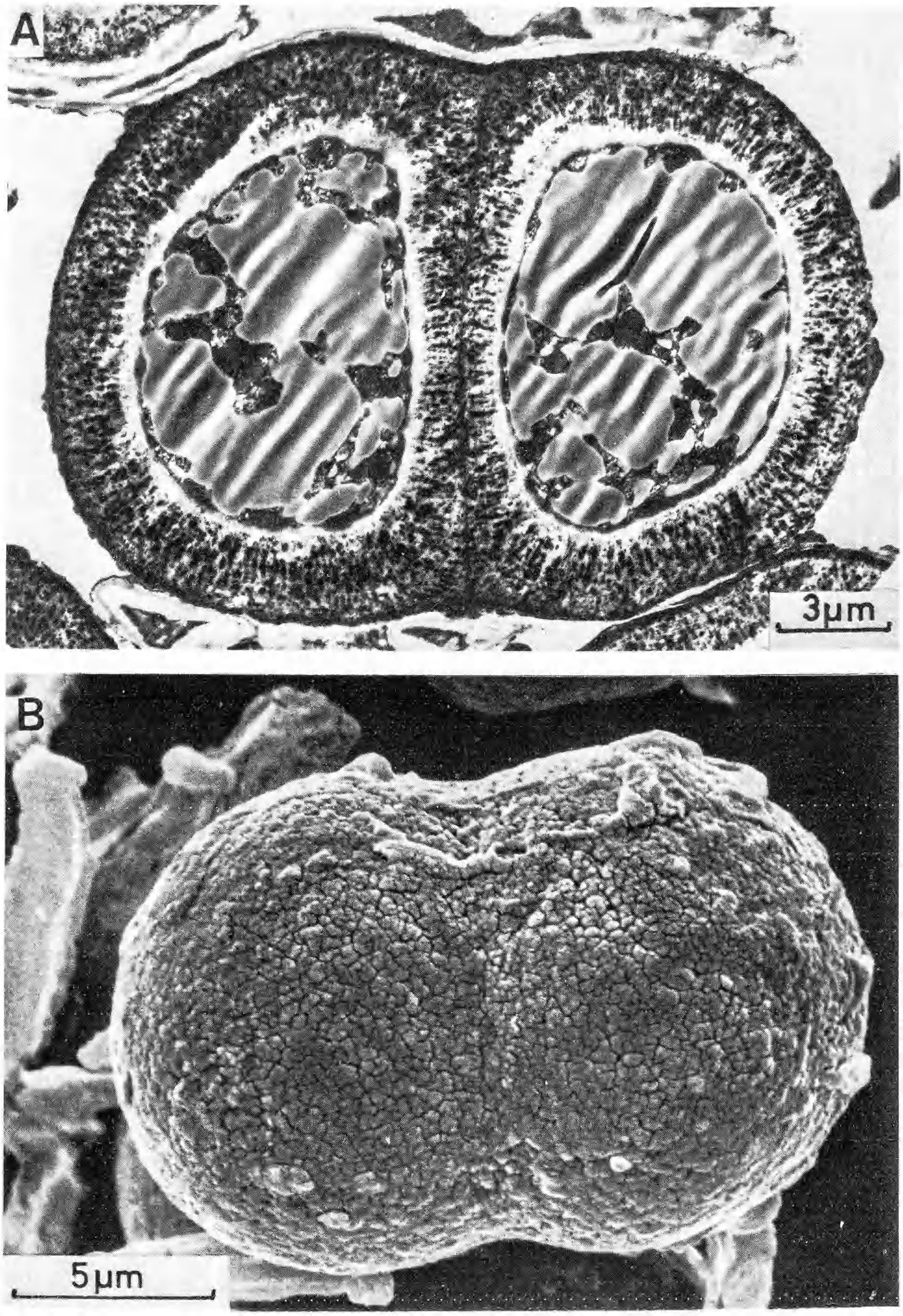

Fig. 10. *Thelomma occidentale*. – A: Mature spore. Sushan 14818 (UPS). – B: Mature spore with ornamentation of minute cracks. These cracks may at least partly be a drying artifact. Nash 8020 (UPS).

5. **T. ocellatum** (Koerb.) L. Tibell, comb. nov.

Acolium ocellatum Koerb. 1861: 285. – *Cyphelium ocellatum* (Koerb.) Trev. 1862: 4. – Lectotype (Tibell 1971): Switzerland, Hepp (Hepp, Flechten Eur. 331, ex Herb. Koerb., L).

Thallus crustaceous, well developed with flattened, subcrenulate verrucae or subareolate, grey. *Isidia* ± frequent, forming irregular, but well-delimited, black patches (Fig. 11 A). Isidia almost globose, 27–40 μm in diam., covered by a dark, dense plectenchyma (Fig. 11 C–D). Isidia particularly abundant when the thallus is sterile and in nutrient–enriched habitats. *Cortex* 22–32 μm thick, formed by hyphae perpendicular to the surface and sometimes with swollen and brownish apices. An outermost, completely hyaline layer, c. 10–13 μm thick is also usually present. No crystals in the cortex nor in the medulla. No strands of cortical hyphae penetrate down into the verrucae and the borderline of the phycobiont-containing layer is even. *Medulla* I + blackish-blue. *Apothecia* developing in old verrucae. Fertile verrucae 1.5–2.0(–2.5) mm in diam., with uneven surface. Mazaedium 0.5–1.0 mm in diam., sometimes with a greenish-yellow pruina. Edge of the excipulum ± distinctly greenish-yellow. Hymenium 80–110 μm high. Central part of excipulum 0.14–0.22 mm thick, brownish-black. Cortex of fertile verrucae without crystals, and with a uniform phycobiont-containing layer not interrupted by strands of hyphae (Fig. 11 B). *Asci* cylindrical, with a long stalk. *Spores* 1-septate, 8/ascus, uniseriate, 22–28 × 12–15 μm, slightly constricted at septum, and with a slightly uneven surface. In TEM mature spores are seen to have a wall with electron-dense and electron-lucent parts. The electron-lucent parts are sometimes slightly radiating (Tibell 1971). A weak pattern of electron-lucent strands in the outermost part of the wall is sometimes also seen, and this evidently gives rise to an indistinct striation pattern sometimes observed in LM (cf. Tibell 1971). In SEM the surface of the spores is seen to have a slight, irregular ornamentation (see Tibell 1971).

Chemistry. Thallus: K–, C–, KC–, PD–. Medulla I + dark blue. The mazaedium and the edge of the excipulum contain tetronic acid derivatives. Usnic acid is met with in some specimens (cf. Tibell 1971). In three specimens investigated by Dr J. Santesson epanorin and rhizocarpic acid were found (Tibell 1971). Reinvestigation by MS of other specimens cited afforded additional records. Thus in Tibell 4298 and Anzi, Lich. Lang. exs. 211 (UPS) were found to contain epanorin and rhizocarpic acid. Tibell 4246 and Hepp, Lich. Eur. 331 (UPS) were too scanty to be reinvestigated.

Taxonomic remarks. See *T. occidentale*.

Ecology and distribution. *T. ocellatum* occurs on lignum of conifers, often on wooden fences and posts in the vicinity of cultivated areas. These localities seem to be nutrient-enriched. In such localities sterile thalli of *T. ocellatum* often cover large areas. Specimens more richly provided with apothecia have been found on dry, decorticated twigs and trunks of *Pinus cembra* and *Larix decidua* at high altitudes in mountainous areas of C Europe.

T. ocellatum is known from Europe only, where in Scandinavia it occurs from the Hemiboreal to the Middle Boreal Zone, and in C Europe in the Upper and Middle Oroboreal Zones. It may also possibly occur in the Lower Oroboreal Zone in the Alps, the Carpathians and the Sudetes. A map of the distribution is given in Fig. 12. It should be noted that I have not had the opportunity to investigate material from Polish herbaria, and thus a number of Polish localities cited in Tobolewski & Kupczyk (1974 map 218, as *Cyphelium caliciforme*) are lacking in my map. Additional localities to those listed by Tibell (1971) are given below.

Weber (1967) reported *Cyphelium caliciforme* (nomen nudum = *Acolium ocellatum* Koerb. fide Weber) as new to North America, but this was probably based on misidentified material of *T. occidentale*. I have seen one of the three collections cited by Weber and it belongs to *T. occidentale*.

The species is new to Scandinavia, though so far only sterile material has been collected from this area.

Exsiccata examined: Vězda, Lich. Sel. exs. 1252 (Herb. Kalb, UPS).

Austria: Salzburg, Kitzbühler Alpen, Zell am See, Schmittenhöhe, 1973 Kalb (Vězda, Lich. Sel. exs. 1252); do., Zell am See, W of Schmittenhöhe, 1973 Santesson 24,822 (UPS). – *Vorarlberg*, Rätikon, Latschätz-Alm, 1975 Kalb (Herb. Kalb).

Italy: Trentino–Alto-Adige, Ortlergruppe, Martelltal, Mahder, c. 1 km NNW of Zutritt-See, 1971 Tibell

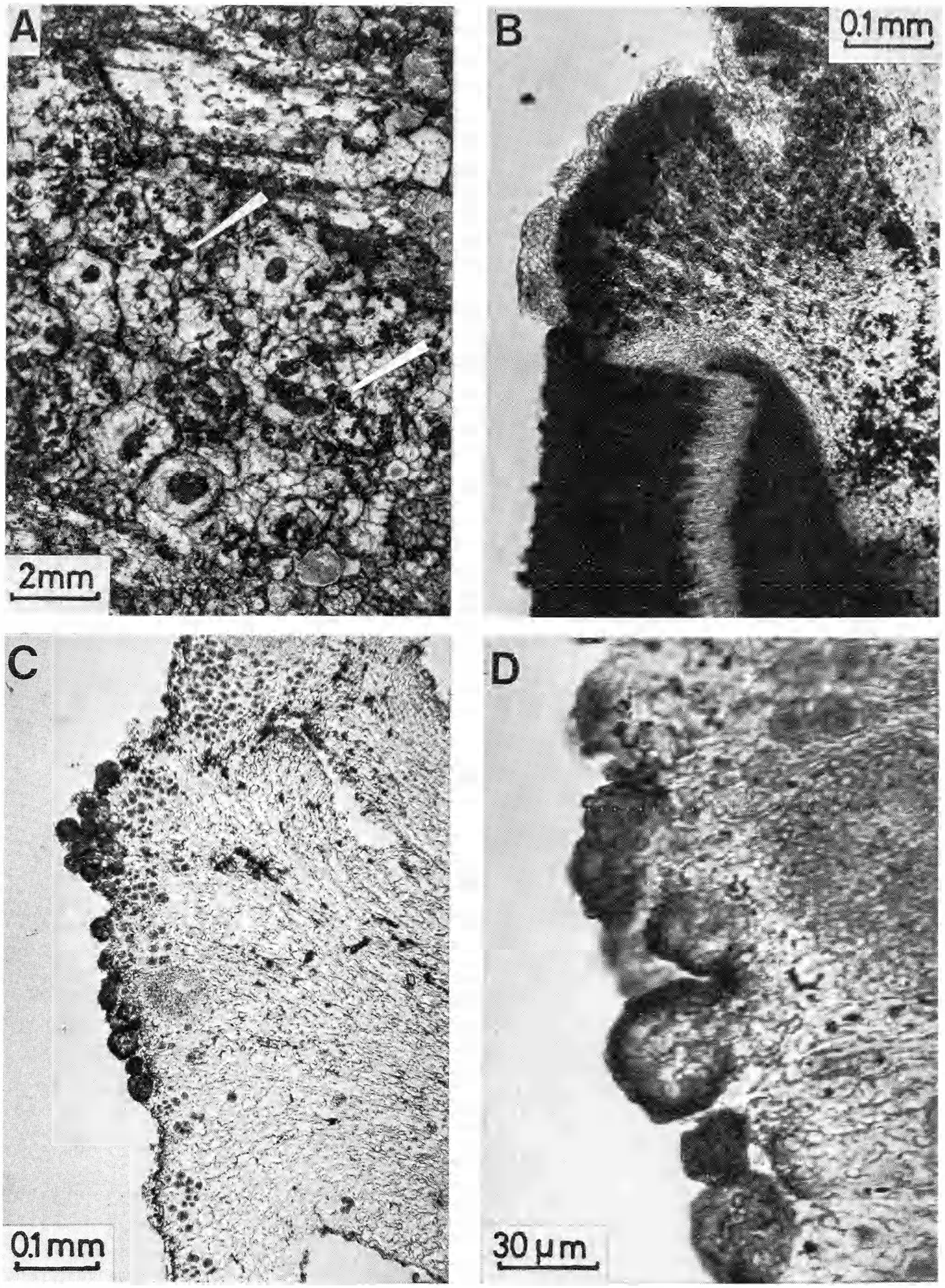

Fig. 11. *Thelomma ocellatum*. – A: Thallus with mature apothecia and well limited, black isidiate areas (arrows). Tibell 4433 (Tib.). – B: Section of mature apothecium. Switzerland, Zermatt, 1871 Th. M. Fries (UPS). – C: Section of isidiate part of thallus. – D: Isidia with well developed cortex. – C–D: Tibell 4315 (Tib.).

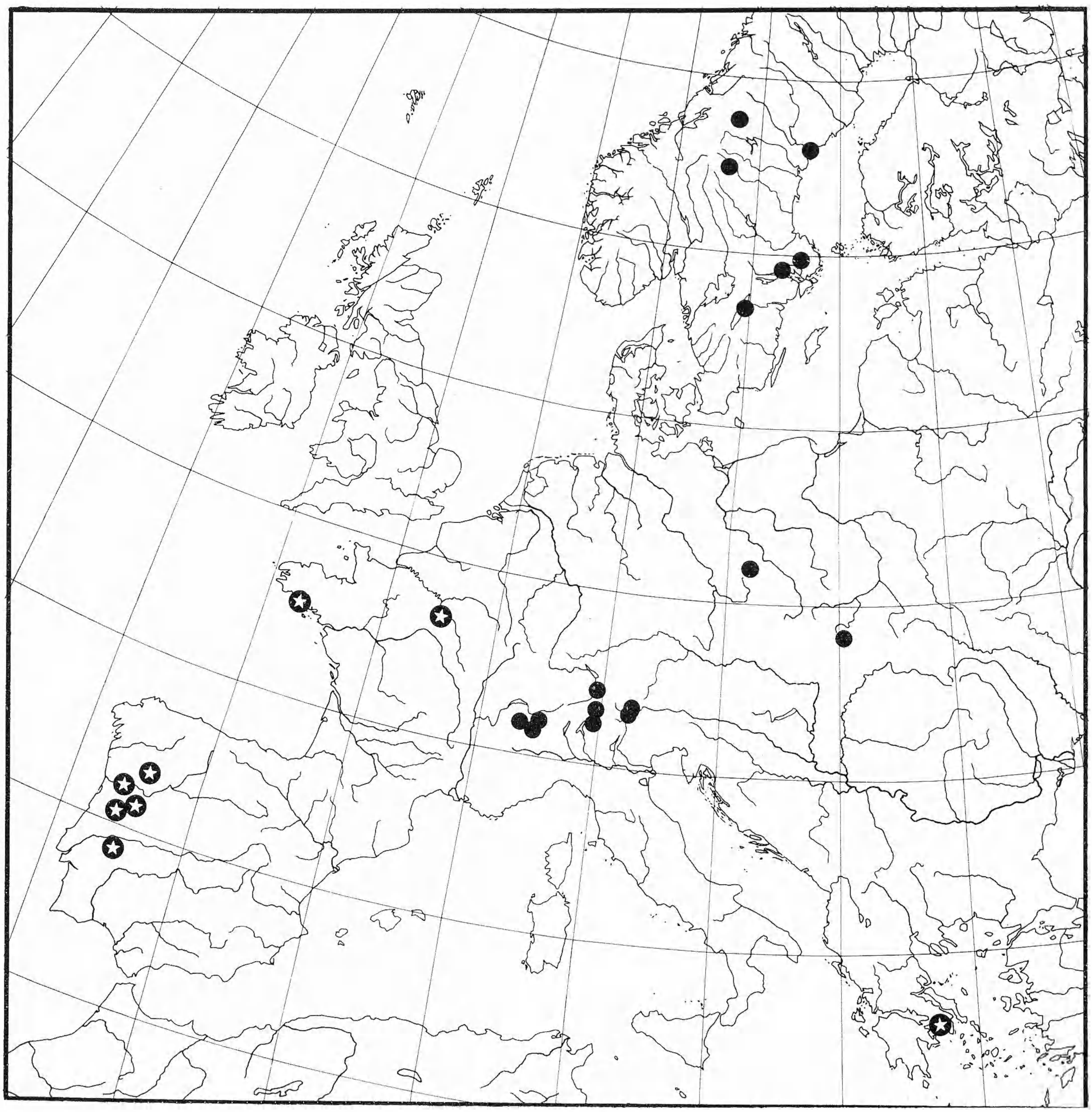

Fig. 12. Distribution of *Thelomma ocellatum* (dots) and *T. siliceum* (stars).

4479 (Tib.) – Sarntaler Alpen, N of Durnholz, Seebachtal, c. 3 km NNE of Durnholz, 1971 Tibell 4433 (Tib., UPS).

Sweden: Ångermanland, Ullånger par., c. 18 km NNE of Kramfors, Håll, 1975 Moberg 2832 (UPS). – *Härjedalen,* Hede par., 9 km S of Hede, Gammelvallen, 62°20′ N, 13°31′ E, 1973 Tibell 5463 (Tib.). – *Jämtland,* Offerdal par., Ytterolden, 1975 Tibell 6313 (Tib.). – *Östergötland,* Väversunda par., Omberg, Djurkälla, 1975 Tibell 6117 (Tib.). – *Uppland,* Alsike par., Fredrikslund, 1975 Tibell 5811 (Tib.) – Stavby par., Väsby, 1976 Tibell 6315 (Tib.). – *Västmanland,* Västerås-Barkarö par., c. 13 km SSE of Västerås, Ridön, Ormhäll, 1975 Moberg 3048 (UPS).

Switzerland: Wallis, Walliser Alpen, Zermatt, Gorner Schlucht, 1974 Kalb (herb. Kalb); do., Zermatt, Furri, 1974 Kalb (herb. Kalb); do., Zermatt, Fideln, 1974 Kalb (herb. Kalb).

6. **T. santessonii** L. Tibell, sp. nov.

Thallus pallide lutescens ex olivaceo brunneus, crustaceus, areolato–verrucosus. Verrucae fertiles fere peltatae 1.4–2.1 mm diam. Cortex laevigatus parum nitidus, coriaceus. Apothecia immersa, in verrucis vetustis protuberantia. Mazaedium nigrum, epruinosum. Excipulum basi valde incrassatum, brunneum vel nigricans. Asci cylindrici, 31–38 × 4–5 µm. Sporae globosae, non-septatae, 14–16 µm diam. ornamento scabro irregulari munitae. Thallus K −, C −, KC −, PD −. Mazaedium acidum norsticticum et salazinicum continens. Cortex vel medulla, vel ambo acidum divaricatum continentes.

Holotypus: U. S. A., *California,* Los Angeles Co., San Clemente Island, W shore, from Eel Point to Seal Cove, 1966 R. Santesson 17960 (UPS).

Thallus pale yellow, with an olivaceous–brownish tinge, crustaceous, areolate–verrucose. Areolae when still not fertile 1.0–1.5 mm in diam. Fertile verrucae incised at the base, almost peltate, strongly convex, 1.4–2.1 mm in diam. (Fig. 13 A). Cortex smooth, slightly shining, coriaceous. *Apothecia* developing in older verrucae, fully immersed. Mazaedium black, epruinose, not or slightly protruding. Mazaedium 0.31–0.42 mm high, hymenium 70–90 µm high. Central part of excipulum 0.23–0.36 mm high, consisting of dark brown hyphae. Cortex of the verrucae consisting of three distinct layers (Fig. 13 C). The outermost layer is formed by a hyaline, paraplectenchymatous tissue, c. 6–11 µm thick. Next there is a well-delimited 40–50 µm thick layer filled by small, irregular crystals. The lowest layer is very irregular and consists of strands of a prosoplectenchymatous tissue penetrating deep into the verrucae, giving the outer borderline of the phycobiont-containing layer a strongly folded appearance. *Spores* uniseriate, 8/ascus. *Asci* cylindrical, 31–38 × 4–5 µm when mature. Spores non-septate, spherical, 14–16 µm in diam., with a coarse, irregular ornamentation (Fig. 14 B). In semi-mature spores a faint striation pattern is sometimes visible. In TEM (Fig. 14 A) the spores are very similar to those of *T. mammosum.*

Chemistry. Thallus K −, C −, KC −, PD −. The mazaedium contains norstictic and salazinic acid. The cortex or medulla, or both, contain divaricatic acid. All specimens included in the list of localities below were found to contain these substances by TLC. The presence of divaricatic acid was also confirmed by MS in the holotype.

Taxonomic remarks. T. santessonii is closely related to *T. mammosum,* and remarks on the two species are given under the latter species.

Ecology and distribution. T. santessonii occurs on siliceous rocks in coastal areas of California and Baja California, alt. 20–500 m. In California it mainly occurs in the southern part. It thus has a much more restricted and more southerly distribution than *T. mammosum.* In southern California it often occurs together with *T. mammosum.*

Exsiccata examined: Hasse, Lich. exs. 7 (FH: p.p., with *T. mammosum*). Krypt. Exs. Vind. 1647 (p.p., with *T. mammosum*: UPS, S). Weber, Lich. Col. exs. 75 (p.p., with *T. mammosum*: FH, S, UAC, UPS).

U.S.A.: California, Los Angeles Co., San Clemente Island, R. Santesson 17960 (holotype, cf. above), 17967, 18069 (UPS), 1966 Weber L-42628 (UC); do., just N of Boulder, 1966 R. Santesson 18208 (UPS), 18209 (UPS: p.p., with *T. mammosum*); Santa Catalina Island, Arrow Point, 1966 R. Santesson 17600 a, b (UPS), 1966 Weber L-42119 (CANL); do., SW of Empire Landing, 1966 R. Santesson 17495 (UPS); Santa Monica Range, 1913 Hasse (Hasse, Lich. exs. 7) – Monterey Co., Carmel Valley, S slope of Pinyon Creek, 1949 Hassis (UC) – Riverside Co., near Riverside, 1911 Reed 3170 (FH) – Santa Clara Co., near Stanford University, Herre (Krypt. Exs. Vind. 1647. p.p., with *T. mammosum*) – Solano Co., SE of Vallejo, 2 km N of Blue Rock Springs Park, 1966 Tucker 6170 (UC) – No further locality indicated, 1874 Eisen (UPS).

Mexico: Baja California, c. 45 km S of the U.S. border, between Halfway House and El Burrito, 1966 R. Santesson 18259, 18264 (UPS) – c. 18 km SW of Ensenada, Punta Banda S of Bahía Todos Santos, 1966 R. Santesson 18296 e, 18297 f (UPS) – Punta Banda, 1973 Sigal 39 (SFSU) – Guadalupe Island, Islote Negro, 1963 Weber & McCoy, Jr. (Weber, Lich. Col. exs. 75, p.p. with *T. mammosum*).

7. T. **siliceum** (Fée) L. Tibell, comb. nov.

Gassicurtia silicea Fée in Mérat 1831: 252 (as *Gassicurtia silacea*). Fée material has been requested from G and STR, but no authentic material has been obtained. In 1837 Fée gave a very detailed description of *Gassicurtia silicea,* including notes on the ontogeny of the apothecia, the mazaedium and the asci. From this description it is evident that *G. silicea* is a *Thelomma* species. During some thirty years Nylander repeatedly collected a *Thelomma* species on sandstone in Fontainebleau, the type locality of *G. silicea.* Nylander consistently called it *G. silicea,* and in his herbarium (H-NYL) there are six specimens from Fontainebleau and one from Morbihan. Further material has also been distributed in Nylander's Herb. Lich. Paris no. 150. Thus there seems to be little doubt that Nylander's material really belongs to *G. silicea,* and it seems reasonable to select a neotype from his material. – Neotype: "*Gassicurtia silacea* Fée, Fontainebleau, W. Nylander", Herb. Nyl. p.m. 52 (H). A discussion of the nomenclature of this species is also given by Hawksworth (1975).

Carlosia lusitanica Samp. 1923: 1. – Coll. orig.:

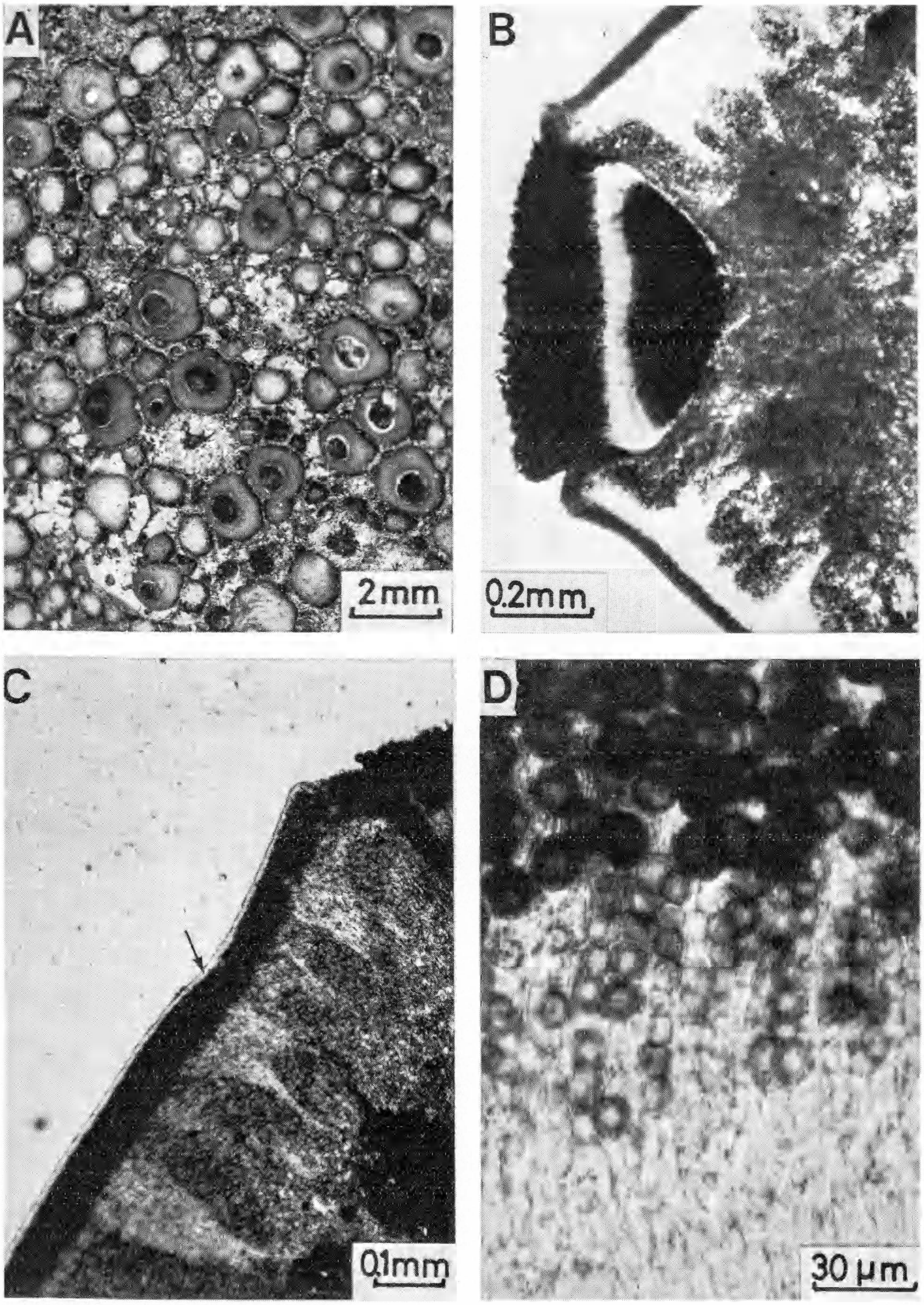

Fig. 13. *Thelomma santessonii*. – A: Thallus with mature apothecia. – B: Section of apothecium. – C: Cortex of fertile verrucae. The outermost layer (arrow) is very thin and below this an even layer filled with crystals is found. The thick innermost cortical layer is in some areas seen to reach far down into the phycobiont-containing layer. – D: Semi-mature and mature spores. – A–D: Holotype.

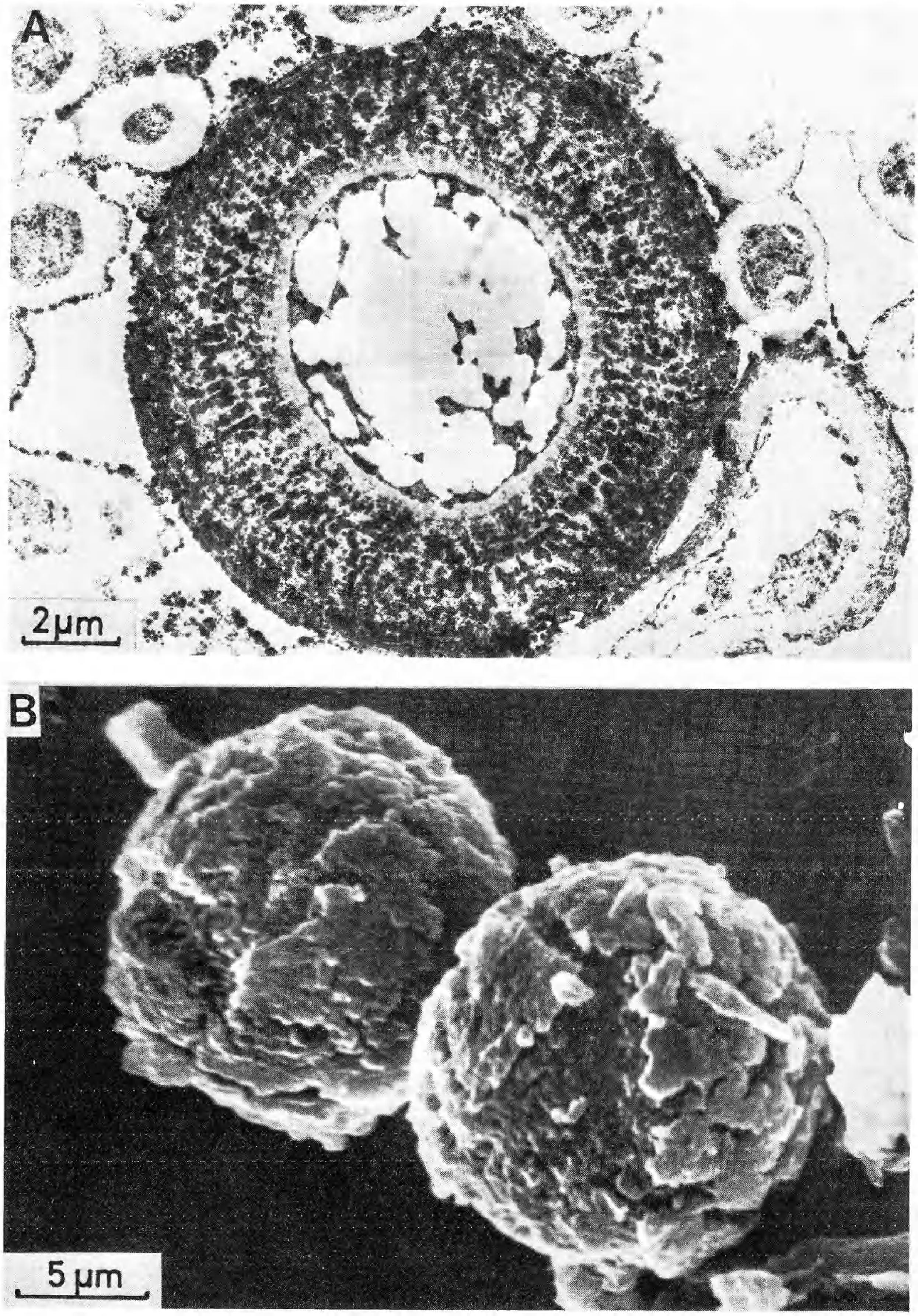

Fig. 14. *Thelomma santessonii*. – A: Section of almost mature spore. Holotype. – B: Mature spores with irregular ornamentation. R. Santesson 17600 a (UPS).

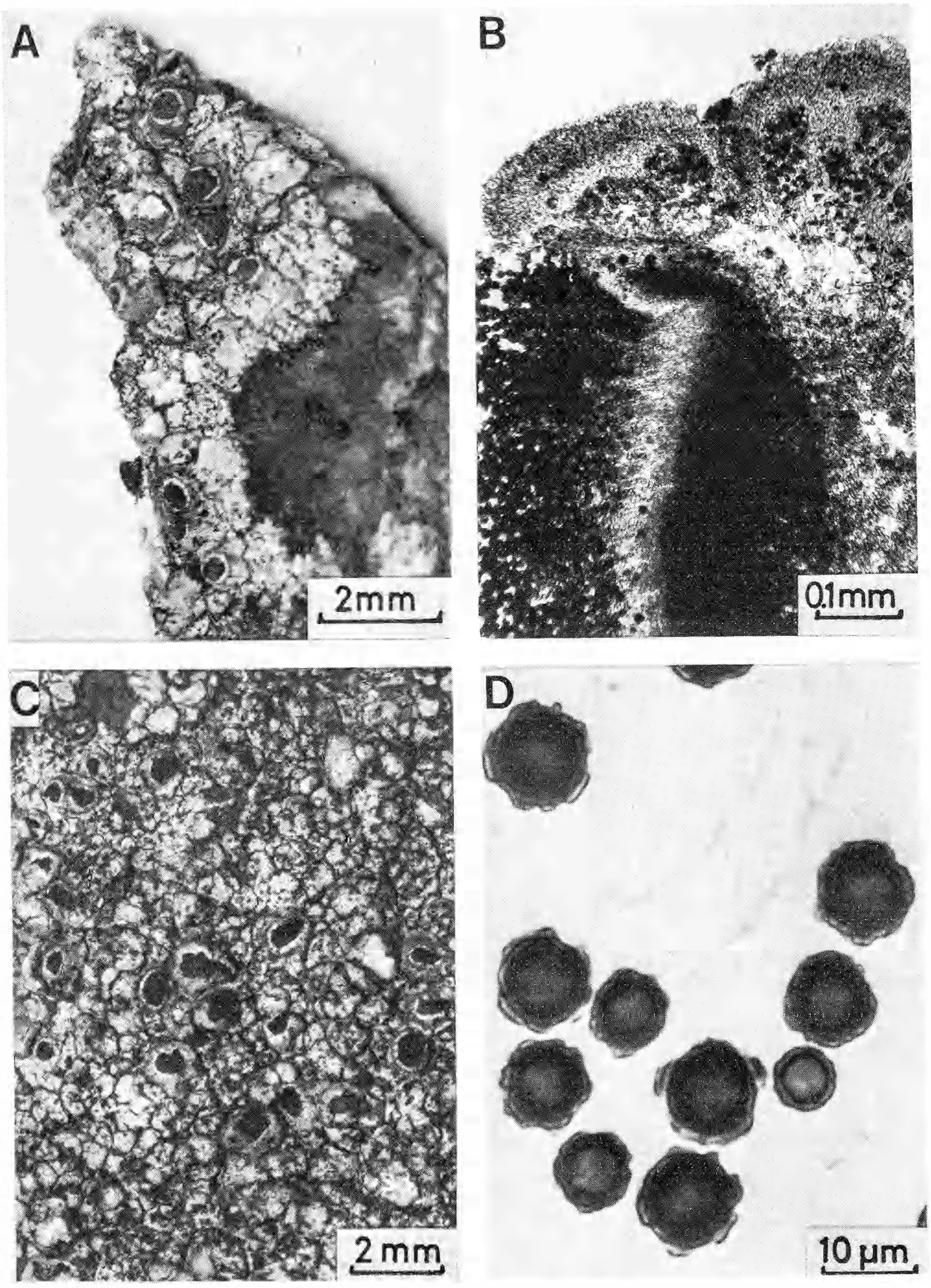

Fig. 15. *Thelomma siliceum*. – A, C: Thalli with mature apothecia. – B: Section of apothecium. The cortex is comparatively thin. – D: Mature spores with coarse and irregular ornamentation. – A, D: Tavares 2202 (UPS). – B, C: Poelt 10067 (Herb. Poelt).

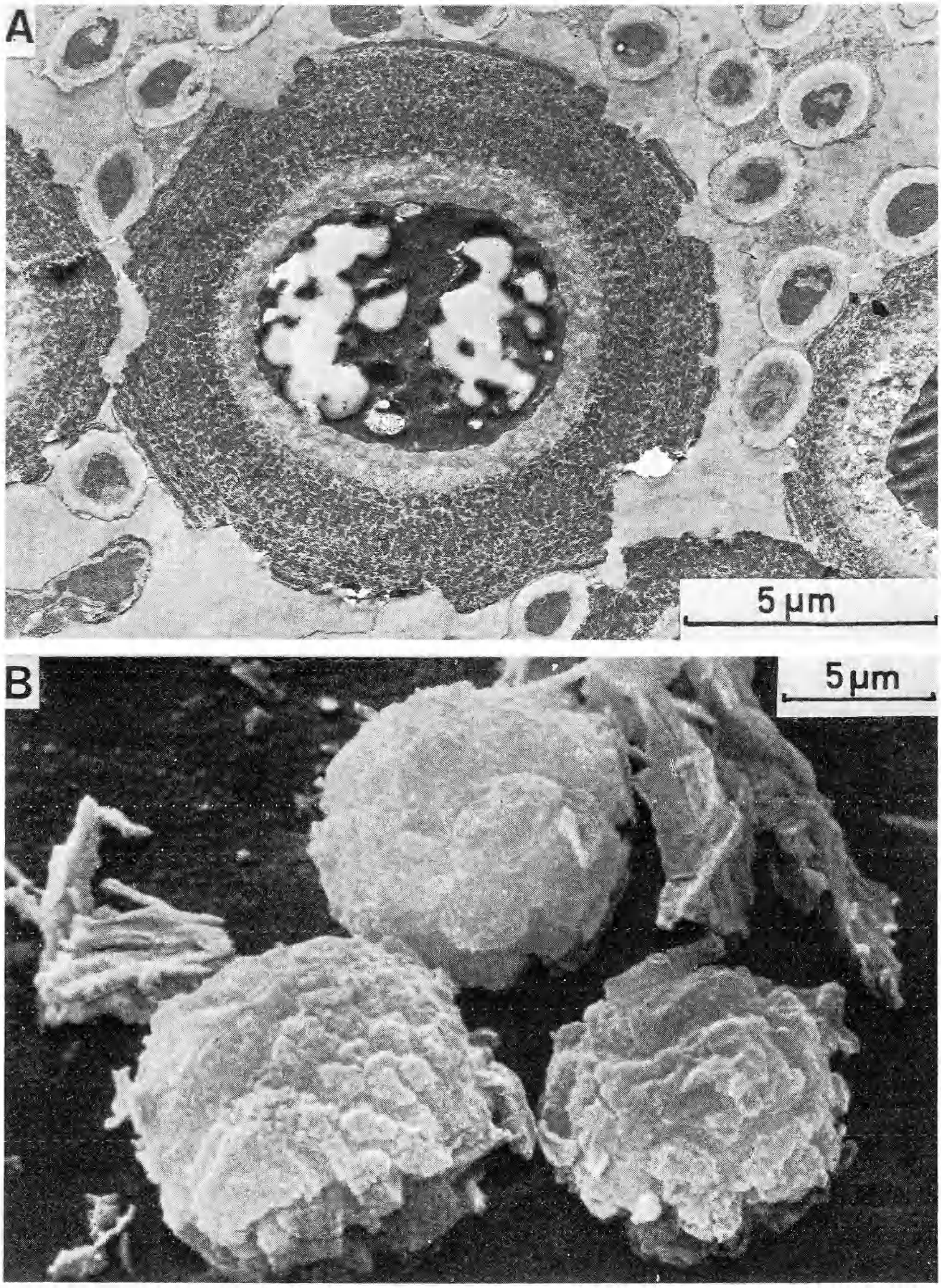

Fig. 16. *Thelomma siliceum*. – A: Section of mature spore. – B: Mature spore with irregular ornamentation. – A–B: Nylander, Herb. Lich. Paris 150 (UPS).

"*Carlosia lusitanica* Samp. Taboaço, sobre o granito, J. Sampaio, det. G. Sampaio" (LISU).

Thallus crustaceous, verrucose–areolate, when fully developed in part almost sublobate. Areolae 0.8–1.2 mm in diam. Thallus when well developed with a minutely granular surface similar to that found in *T. californicum*. Fertile verrucae 0.8–1.2 mm in diam., dull, often very irregular (Fig. 15 A, C). *Apothecia*. Mazaedium 0.6–0.8 mm in diam., black, often bent to one side or the other. Mazaedium 0.20–0.25 mm high, hymenium 70–110 μm high and central parts of excipulum 0.16–0.22 mm thick, dark brown. Edge of excipulum very thin, reaching to approximately one third of the height of the mazaedium. Cortex of fertile verrucae uniform, 30–50 μm thick and densely interspersed by minute, granular crystals. Dividing line to the phycobiont-containing layer fairly even (Fig. 15 B). Edge of thalline margins ± crenulate, whitish. *Spores* uniseriate. Mature spores 10–14 μm in diam., unicellular. Surface of the mature spores very irregular (Figs. 15 D, 16 B). In SEM it looks as if parts of the spore wall were torn away from the surface, leaving open scars. This irregularity of the spore surface is also seen in TEM (Fig. 16 A). In TEM another peculiarity is observed. The spore wall structure is rather similar to that one of for example *T. mammosum*, but the electron-dense elements are smaller and partly orientated in different directions in different parts of the wall (Fig. 16 A), while the spore wall of *T. mammosum* has a more uniform, reticulate structure formed by larger electron-dense and electron-lucent areas.

Chemistry. Thallus K –, C –, KC + rose red, PD –. The mazaedium contains norstictic and salazinic acid. Thallus containing "446 Cl" as major constituent.

Ecology and distribution. *T. siliceum* occurs on siliceous rocks. Many of the collections are from sandstone. It seems to be confined to coastal areas, though reaching high altitudes (800–900 m) on Attica, Greece and Serra da Estrêla, Portugal. The type locality – close to Paris – is puzzling. Here it was collected from 1824 to 1896. Perhaps this has to be considered as a relict locality. *T. siliceum* is so far known from a few, scattered localities only in Middle and South Europe (Fig. 12).

New to Greece.

Exsiccata examined: Nylander, Lich. Paris 150 (G, UPS). Tavares, Lich. Lus. exs. 27 (LISU, UPS).

France: Morbihan, Isle de Groix, collector unknown, Herb. Nyl. p.m. 50 (H). – *Seine-et-Marne,* Fontainbleau, neotype, cf. above; Fontainbleau, Rochers de Franchard, 1854 Nylander, Herb. Nyl. p.m. 51 (H); Fontainbleau, 1854 Nylander, Herb. Nyl. p.m. 53 (H), 1863 Nylander, Herb. Nyl. p.m. 49 (H), 1881 Nylander, Herb. Nyl. p.m. 48 (H), Nylander, Herb. Nyl. 43323 (H), 1896 Boistel (BM).

Greece: Attica, immediately W of the top of Imittos close to Athens, on N-facing side of siliceous boulder, 1971 Poelt 10067 (Herb. Poelt).

Portugal: Alto Alentejo, Fronteira de Marvão-Galegos, 1948 Tavares 2590 (LISU). – *Beira Alta,* Taboaço, coll. orig., cf. above – Serra da Estrêla, Caldas de Manteigas, 1944 Tavares 115 (LISU); do., Senhora do Destêrro, 1947 Tavares 2202 (LISU, UPS), 1946 Tavares (Tavares, Lich. Lus. exs. 27) – Between Ervas Tenras and Pinhel, 1962 Tavares 6823 (LISU) – *Trás-os-Montes,* between Vila Real and Murça, 1957 Tavares 5863, 5871, 5872 (LISU) – Ribeira de Sampaio, 1957 Tavares 5956 (LISU).

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Floristic notes from Mt Olympos and Mt Falakron (Boz Dagh), northern Greece

Arne Strid

Strid, A. 1976 10 22: Floristic notes from Mt Olympos and Mt Falakron (Boz Dagh), northern Greece. *Bot. Notiser 129:* 251–256. Stockholm. ISSN 0006-8195.

Notes are given on twenty-one species of angiosperms that are either new for Greece or have been very rarely recorded, or are otherwise of interest. The species are: *Silene tempskyana* Freyn & Sint., *Anemone nemorosa* L., *Hymenolobus pauciflorus* (Koch) Schinz & Thell., *Alchemilla flabellata* Buser, *Dryas octopetala* L., *Ononis repens* L., *Trifolium pallescens* Schreb., *Polygala supina* Schreb., *Malva alcea* L., *Aesculus hippocastanum* L., *Bupleurum affine* Sadler, *Gentianella crispata* (Vis.) J. Holub, *Mentha* × *verticillata* L., *Melampyrum cristatum* L., *Melampyrum arvense* L., *Melampyrum heracleoticum* Boiss. & Orph., *Euphrasia hirtella* Jord. ex Reut., *Lathraea squamaria* L., *Filago minima* (Sm.) Pers., *Alisma lanceolatum* With., and *Ruscus hypoglossum* L.

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This brief report adds a few species to the Greek flora and gives phytogeographical and taxonomic comments on an additional number that are rare or otherwise of interest.

Mt Olympos (2917 m), on the border between Thessaly and Macedonia, has been the subject of several publications (most important are those of Hayek 1928 and Stojanov & Jordanov 1938), but is far from being exhausted as a source of interesting botanical material. The present author is working on a comprehensive survey of the vascular flora and vegetation of the mountain and has so far registered some 1400 species.

Mt Falakron, also known as Boz Dagh (2229 m), is situated in eastern Macedonia north of the town of Drama. The most important paper on the mountain is that by Kitanov (1943), based on trips made in 1941 during which he collected 715 species. The mountain had previously been visited briefly by Mattfeld and by Rechinger; the total number of species known to the mountain was stated by Kitanov as 793. A few were added by Quézel & Contandriopoulos (1968) and there are undoubtedly many more to be found. The area is (or at least was in 1970) a military area and a special entry permit must be obtained from the military authorities in Drama and Kavalla. The mountainous area adjacent to the Bulgarian border (the southernmost extension of the Rhodope range) has never been explored botanically. Several boreal species that are known to stop short of the border are probably also to be found on Greek territory in this area.

This article is based on material collected on Mt Olympos in 1970, 1974 and 1975, and on Mt Falakron during a brief visit in July 1970. The abbreviation AKS in the list of collections indicates that the voucher is preserved in my own herbarium. Public herbaria are indicated by standard abbreviations.

Silene tempskyana Freyn & Sint.

Mt Olympos, southern foothills: 2.5 km from Kallithea along road to Olympias, 600 m. Meadow in agricultural area. ! 8306, 9.5. 1974 (AKS).

This is a member of the *Silene conica* group. In Flora Europaea (1: 180, 1964) it was included in ssp. *subconica* (Friv.) Gavioli. It is, however, so strikingly different from the common form of

Silene conica (which is widespread in the area) that it probably deserves at least subspecies rank. *S. tempskyana* is characterized by a robust habit, broad leaves, very large pink petals and a glandular-pubescent calyx.

The type of *Silene tempskyana* is Sintenis, iter thessal. no. 23 (Thessalia graeca, Pindus tymphaeus: in vineis ad Kalambaka. 4.5. 1896; G, LD), which closely matches the above collection. These are apparently the only two records so far.

The affinities of *S. tempskyana* were discussed by Freyn, following the type description (Bull. Herb. Boiss. 5: 584–585, 1897). He concluded that it might best be regarded as a subspecies of *S. juvenalis* Del. The question can probably only be solved by experimental studies. Unfortunately both the known collections are in early flowering stage and have no fruits.

Anemone nemorosa L.

Mt Olympos, S side: Xerolakkos valley, S of the road Leptokarya to Karya, 630 m. Moist, rocky ledge by the river in mixed forest. ! 8230, 7.5. 1974 (AKS, ATHU).

Very rare in Greece; there are old records from Mt Parnassos (Sibthorp, cf. Halácsy 1901 p. 6), Mt Athos (Grisebach, cf. Rechinger 1943 p. 182) and possibly a few more places.

On Mt Olympos it was found only in a very restricted area of some 100 square meters, together with *Ruscus hypoglossum,* for example.

Hymenolobus pauciflorus (Koch) Schinz & Thell.

Mt Olympos, E foothills: Ravine just N of Litochoron, 250 m. In shade on moist, rocky ledge under small overhang. ! 8060, 2.5. 1974 (AKS, ATHU).

This collection matches material from Corse determined (in LD) as *H. procumbens* (L.) Nutt. ex Torr. & Gray var. *revelieri* (Jord.) Pamp. It is probable that these plants are better placed in *H. pauciflorus,* however. They are characterized by their small size, very slender habit, entire or 3-lobed spathulate lower leaves, 4–12-flowered inflorescences and nearly orbicular siliculas. The habitat of the plants from Mt Olympos also agrees better with that of *H. pauciflorus* than with that of *H. procumbens* which is usually maritime or found on saline soils. *H. pauciflorus* has so far not been recorded from the Balkan Peninsula, but the species limits are in need of experimental study. The form of the silicula (elliptical-oblong to narrowly obovate in *H. procumbens,* nearly orbicular in *H. pauciflorus*) may prove to be the best distinguishing character.

Alchemilla flabellata Buser

Mt Falakron, summit area, 2150–2220 m. Rocky slopes facing N and E. ! 1111, 19.7. 1970 (AKS).

Alchemilla flabellata is a fairly distinct species characterized by truncate leaf lobes with long, narrow incisions and c. 4 teeth on either side. The collection closely matches the plant illustrated in the Bulgarian flora (5: 287, 1973) as well as material from the Alps. The species was not recorded for Greece in Flora Europaea (2: 54, 1968), but has in fact been collected once before on Mt Falakron at an altitude of 1980 m (Kitanov 1943 p. 239). Rechinger collected the species on the Boz-Dagh of Serrai some 40 km W of Mt Falakron at c. 1600 m (see Rechinger 1939 p. 471). These seem to be the only Greek records so far.

Another remarkable species growing together with *Alchemilla flabellata* near the summit of Mt Falakron is *Dryas octopetala* L. (! 1077, AKS). It is apparently the southernmost locality for this well-known arctic-alpine species. It was collected here by Kitanov and later by Goulimis, but is not noted for Gr in Flora Europaea (2: 34, 1968).

Ononis repens L.

Mt Olympos, NW foothills: Along road to Petra, at the point where the road crosses the river N of the village, off the road Katerini–Ag. Dimitrios, 250 m. Clearing in deciduous forest with scrub of *Paliurus spina-christi.* ! 9260, 13.8. 1975 (AKS).

Distinguished from *O. spinosa* L. ssp. *spinosa,* which is commoner in the area, by the partly subterranean stem, weak non-paired spines, obovate truncate leaflets (1.5–1.8 times as long as wide) and the legume clearly exceeded by the calyx.

Ononis repens was not reported from Greece in Flora Europaea (2: 147, 1968), but the map in Meusel, Jäger & Weinert (1965 map 232 b) shows it from the northernmost part of the country as well as from one station in central Greece. Hayek (1: 830, 1927) recorded it from Thracia and Macedonia.

Trifolium pallescens Schreb.

A common constituent of snowbed meadows on Mt Olympos between c. 2300 and 2800 m, occasionally down to c. 1500 m, e.g. W slopes of Ag. Antonios, 2500–2600 m (! 1300, 24.7. 1970; AKS), between Roudhi and Flambroro, 1900–2000 m (! 157, 20.6. 1970; AKS), between Skolio and Ag. Antonios, 2580–2650 m (! 9434, 18.8. 1975; AKS), and the saddle between Ag. Antonios and Bara, 2350–2470 m (! 9503, 21.8. 1975; AKS, ATHU). Stojanov & Jordanov (1938 p. 190) reported the species "in halboffenen Assoziation *Festucetum cyllenicae* in der Gegend Bara, auf cca. 2600 m Meereshöhe; auf grasigen Stellen zwischen den Gipfeln Skolion und Stavroitia sowie am Fusse von Skala, cca. 2500–2800 m."

Trifolium pallescens is very similar to alpine forms of *T. repens* L. They are distinguished on the following characters:

T. pallescens: Caespitose; old specimens with a massive, vertical tap-root up to 8 mm in diameter; branches numerous, short, prostrate to ascending, never rooting; stipules with a wide herbaceous field around the mid-vein and scarious margins, free part often entirely herbaceous, lanceolate, very gradually narrowed into an acuminate apex; flowers cream to pale pink; ovules 2. 2n = 16 (Favarger 1965).

T. repens: Massive tap-root lacking; stems creeping and often rooting at the nodes; stipules entirely membraneous or with a green mid-vein, free part abruptly contracted into a subulate apex; flowers white to pink; ovules 2–4. 2n = 32 (several counts); 2n = 16 reported in material from Afghanistan (Podlech & Dieterle 1969).

The type of *T. pallescens* is from the Alps (material in M) and shows the massive tap-root and lanceolate stipules characteristic of this species. Material from the Alps often has a less densely caespitose habit and larger leaves and flowers than plants from Olympos. The total distribution comprises the Alps, Pyrenees, Carpathians and mountains of the Balkan Peninsula (Meusel, Jäger & Weinert 1965 map 237 b). Olympos appears to be the southernmost locality; the similar plants found in snow-bed meadows at high altitudes in the Pindhos mountains all belong to *T. repens*. Handel-Mazzetti (in Hayek 1928 p. 288) reported *T. repens* var. *orphanideum* Boiss. from Mt Olympos as "häufig in Schneetälchen zwischen 2200 und 2400 m". This record may refer to *T. pallescens* which is a characteristic constituent of the *Alopecurus gerardii* association in such localities. The alpine form of *T. repens* does not seem to occur on Mt Olympos. The species is confined to lower altitudes, only occasionally reaching subalpine levels and then only in more or less disturbed habitats (e.g., around Refuge A at c. 2100 m).

T. parnassi Boiss. & Sprun., although sometimes confused with the superficially similar *T. pallescens* and often growing mixed with it on Mt Olympos (though less common), is in fact a very distinct species easily recognized by its large calyx with a straw-coloured tube and green, broady triangular teeth which are only half as long as the tube. It is endemic to high mountains of the Greek mainland (including Peloponnesos).

Polygala supina Schreb.

Mt Olympos, N side: Lowest part of the Papa Rema ravine, 400–500 m. Macchie. ! 8358, 11–12.5. 1974 (AKS, ATHU); Same place. ! 9029, 7.8. 1975 (AKS); Same ravine, 600–700 m. Mixture of macchie and deciduous forest. ! 9157, 8.8. 1975 (AKS).

Also collected by E. Sauer (Saarbrücken) on the eastern side of Mt Olympos between Litochoron and Stavros (Sauer, 19.5. 1970).

The species is rare in Greece and has only recently been reported (cf. Rechinger 1963 p. 253). The collections from the Papa Rema ravine have wings about half as wide as the capsule, a very short gynophore, and pseudolateral few-flowered racemes; they thus apparently belong to ssp. *rhodopaea* (Velen.) McNeill, previously believed to occur only in Bulgaria and the NE corner of Greece (cf. McNeill 1968 p. 31, Kitanov 1943 p. 248).

Malva alcea L.

Mt Olympos, NW side: 6 km from Kokkinoplos along road to Petra, 1050 m. Roadside in mixed forest. Erect herb, c. 1 m tall. ! 9650, 29.8. 1975 (AKS, ATHU).

The species is new for Greece. It belongs to a form with large (35–40 mm), rather shallowly emarginate petals.

After the preparation of this manuscript, *Malva alcea* was reported by Voliotis (1976 pp. 34–35) from Mt Lailias in the NE part of Greek Macedonia.

Aesculus hippocastanum L.

Mt Olympos, S side: Bottom of Xerolakkos valley, S of the road Leptokarya–Karya, 630 m. A few large trees by the stream. ! 8242, 7.5. 1974 (AKS, ATHU).

Mt Ossa, NE side: Above Karitsa, 650 m. Constituent of mixed forest. Several large trees in full flower. Obs. 26.5. 1974.

Also mentioned by Diapoulis (1935 p. 418) from Mt Olympos, without precise locality.

This species is generally believed to be indigenous in a small area only on the border between Greece, Albania and Yugoslavia (cf. map in Horvat, Glavač & Ellenberg 1974 p. 73) together with one station in E Bulgaria. The trees on Olympos and Ossa grow far from human habitation, however, and do not appear to have been introduced.

Bupleurum affine Sadler

Mt Olympos, NW side: 5 km from Petra along forest road to Kokkinoplos, 700 m. Dry deciduous oak scrub near the road. ! 9293, 14.8. 1975 (AKS, ATHU).

This species was previously known only from the Pannonian-Pontic area and from a single station in NW Turkey. It is related to *B. praealtum* L. which was collected on Mt Olympos by Sintenis (it. orient. a. 1889 no. 1844) and Sintenis & Bornmüller (it. truc. a. 1981 no. 1838), but differs in the shape and colour of the petals, size of fruits, etc. (cf. drawings in Flora of Turkey 4: 401, 1972). According to Snogerup, who revised the genus for the Flora of Turkey and kindly confirmed the identity of the above collection, it is generally found in deciduous oak forest, shibliak, etc., a rather unusual habitat for an annual *Bupleurum* species.

Gentianella crispata (Vis.) J. Holub

A species with scattered occurrences on Mt Olympos, reported from several places between c. 1900 and 2800 m (Diapoulis 1935 p. 422, Wagner 1935 p. 281, Stojanov & Jordanov 1938 p. 203, Quézel & Contandriopoulos 1965 p. 78). J. Persson (Göteborg) collected it near Refuge A at c. 2100 m in September 1974 and I observed it in a couple of localities in the same area in August 1975. The species was not recorded for Greece in Flora Europaea (3: 64, 1972) and Mt Olympos may well be the only Greek locality.

The total distribution of *Gentianella crispata* comprises part of the Balkan Peninsula and southern Italy, a disjunction that is not uncommon in the alpine flora of Mt Olympos (*Ranunculus brevifolius* is another example).

Mentha × verticillata L.

M. aquatica L. × *arvensis* L.

Mt Olympos, S side: Along the road Leptokarya–Karya, 22.8 km from intersection with the national road near Leptokarya, 770 m. Along a stream in mixed forest. ! 9532, 27.8. 1975 (AKS, ATHU).

The plants are completely sterile with small, empty anthers. This well-known hybrid has not previously been recorded with certainty for Greece (cf. Flora Europaea 3: 184, 1972).

Melampyrum cristatum L.

Mt Falakron, N side: Between the villages of Volakas and Mesovounion, 1100 m. Meadow and remnants of beech forest. ! 1010, 18.7. 1970 (AKS).

The collection apparently belongs to ssp. *cristatum* (cf. Hayek 2: 199, 1929). The species was not recorded for Greece in Flora Europaea (3: 254, 1972). In actual fact it has been collected by Kitanov (1943 p. 268) in the same area, but does not seem to have been found elsewhere in the country.

Melampyrum arvense L.

Mt Falakron: The valley of Prosotsani, just N turn-off to Nevrokopion, 620 m. ! 938, 17.7. 1970 (AKS, W).

The species was previously collected in the same area by Rechinger (1939 p. 496, no. 6259), Kitanov (1943 p. 268), and Quézel & Contandriopoulos (1968 p. 31). There are a few additional gatherings from Greek Macedonia, although the species was not recorded for Greece in Flora Europaea (3: 254, 1972). The collections apparently belong to ssp. *arvense*.

Melampyrum heracleoticum Boiss. & Orph.

Mt Olympos, N side: Papa Rema ravine, E side, 600–700 m. Deciduous mixed forest. Found only in a very restricted area but locally abundant. ! 9135, 8.8. 1975 (AKS, ATHU).

The species is new for Greece (previously recorded only from Albania and Yugoslavia). It is a distinct species characterized by pectinate bracts in which the teeth end in long, filiform aristas. The upper bracts are clearly bluish-violet as in *M. nemorosum,* not green as stated in Flora Europaea.

Euphrasia hirtella Jord. ex Reut.

Mt Falakron: N-facing, barren slope NW of the summit area, 1500–1600 m. ! 1034, 19.7. 1970 (AKS); det. Th. Karlsson.

The species is new for Greece. It has an arctic-alpine distribution extending to western Siberia and the Caucasus.

Lathraea squamaria L.

Mt Olympos, E side: Enipevs valley, Ag. Dionysios, between the monastery and the river, 750 m. Mixed forest. Apparently parasitic on the roots of *Corylus avellana.* ! 8136, 3.5. 1974 (AKS).

The species is new for Greece. The surroundings of the now ruined monastery of Ag. Dionysios are among the most frequently visited sites on Mt Olympos. Previously no botanist seems to have been there as early as the beginning of May, however, which is certainly the reason why such a conspicuous species as *Lathraea* has escaped notice.

The related *L. rhodopaea* Dingler is endemic to Bulgaria and NE Greece, including the island of Thasos (cf. Rechinger 1943 p. 486). It is taller, yellowish-brown, with a non-secund inflorescence, shorter pedicels and smaller flowers.

Filago minima (Sm.) Pers.

Macedonia, prov. & distr. Pierias: 4 km SSW Ag. Dimitrios along main road to Elasson (between Olympos and Titaros), 800 m. ! 219, 21.6. 1970 (AKS).

This species is apparently very rare in Greece. Wagenitz (1968 p. 64) recorded it only from two stations, one in E Macedonia near the Yugoslavian border (Rechinger no. 9063 a) and one on the island of Ikaria (Runemark & Nordenstam no. 16386). Later, Runemark et al. collected it 5 km NNW Elasson not far from Mt Olympos (no. 44930) and I have also collected it near Vlasti in prov. Kozanis (no. 1174). Being a fairly inconspicuous plant of trivial localities it may have been overlooked and therefore commoner in Thessaly and Macedonia than indicated by the four records so far.

Alisma lanceolatum With.

Mt Olympos, NW side: 5 km from Petra along forest road to Kokkinoplos, 670 m. By a small pool in a grazed meadow on the right hand side c. 400 m from the road. ! G-74-31-09, 14.5. 1974 (only living material collected).

The species is rare in the Balkan Peninsula. It does not appear in Hayek (1933), and Björkqvist (1967, 1968), who made a biosystematic study of the genus, recorded it only from two places in Greece (the islands of Crete and Samos) and a few in Bulgaria and Romania. Recently it has also been collected on the Greek mainland, however.

There are four sheets in the Goulandris Museum: (1) Regio Aegaea sept., penins. Sithonia: in collibus ad orientem porti Koufos, alt. 150 m. In depressione quâdam paludosa. Greuter no. 10466, 17.6. 1972; (2) Ipiros, prov. Ionnania, distr. Pogoni: Anatoli, amongst reeds. Jeavons no. 433, 4.9. 1971; (3) Thraki-Komotini: Xanthi, Kalisti to Porto Lago. Marshy area. Stamatiadou no. 4130, 16.8. 1968; (4) Ipiros, prov. Preveza, distr. Nikopolis-Parga: Between Louros and the bifurcation to Nea Sampous, place named Tsoumaneika, alt. 30 m. Marshland. Abundant. Stamatiadou no. 12459, 29.5. 1971.

In Conservatoire Botanique, Genève (G) there is also a sheet collected by Heldreich (prope Aetolico, in halipedo. 21.5. 1878), and Rechinger (1943 p. 706) recorded the species from Mytilene and Chios.

There are two chromosome races, $2n=26$ and $2n=28$ (see discussion in Björkqvist 1968 pp. 25–28). Plants with $2n=28$ have only been found in Scandinavia and Poland. The plants from Olympos have 26 chromosomes.

Ruscus hypoglossum L.

Mt Olympos, S side: Xerolakkos valley S of the road Leptokarya to Karya, 640 m. Rocky ledge in mixed forest near the river. ! 8255, 7.5. 1974 (AKS, ATHU, LTR). – N side: Papa Rema ravine, E side: 700–730 m, 0–30 m above the river. Beech forest. Obs. 12.8. 1975.

There is a single sheet in the Goulandris Museum (ATH): Mount Seloma W of Karitsa Ossa, alt. 1050 m. Fagetum. T. Rous no. 332, 28.6. 1972.

Rechinger (1943 p. 733) cited records from Mt Athos.

Ruscus hypoglossum is a species of rare occurrence in northern Greece. On Mt Olympos it is a constituent of beech forest, preferably in moist, rocky places near a stream. The vegetation in such places is largely composed of central European and subatlantic species. Among the shrubs are *Buxus sempervirens, Fraxinus ornus, Ilex aquifolium, Hedera helix, Clematis vitalba, Daphne laureola* and *Cotoneaster nebrodensis;* among the herbs and grasses are species such as *Arabis turrita, Sanicula europaea, Geranium robertianum, Lactuca muralis, Neottia nidus-avis, Polygonatum pruinosum, Bromus benekenii* and *Melica uniflora.*

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New species of Stephania and Rhaptonema (Menispermaceae)

B. C. Kundu and Suhita Guha

Kundu, B. C. & Guha, S. 1976 10 22: New species of Stephania and Rhaptonema (Menispermaceae). *Bot. Notiser 129:* 257–265. Stockholm. ISSN 0006-8195.

Three species are described: *Stephania neoguineensis* from the Eastern Highlands, District of Arau, New Guinea, *Stephania formanii* from Isuarava, Papua-New Guinea, and *Rhaptonema swinglei* from Madagascar. Anatomical structures of the stem and leaf of all species are described. Sclereids have been observed in all the species here described.

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Stephania neoguineensis Kundu & Guha, sp. nov.

Planta magna usque ad 6 m scandens (in ripa in silva *Castanopsis* ad altitudinem 1400 m perveniens). Caulis costatus, solidus, lignosus, non pubescens, aliquantum tortus, exasperatus, punctatus. Folia simplicia, alterna, petiolata, exstipulata; petioli costales, solidi, basi distincte pulvinati tortique, glabri, 5.5–6 cm longi, quam lamina breviores; lamina 8.3–11.7 cm longa et 6.9–9.6 cm lata, coriacea, utrinque glabra, pagina inferior grisea, superior pallidior, palmatim 10-nervia, interdum 9-nervia, nervi infra plus prominentes.

♂ inflorescentia in inferiore parte caulis exoriens, maxima, 45 cm longa, pedunculata, mixta umbelliformi-paniculata, axis primarius costatus, glaber, ca 39 cm longus, nonnullos ramos umbellatos ferens, axes secundarii ab axe primario alternatim orientes, 6.0–7.5 cm longi, costati, glabri, graciles. Unusquisque axis secundarius est umbella composita. Ad apicem axis secundarii est umbella ramorum gracilium tertiariorum (5–7 interdum 4), 3–3.5 cm longorum; rami tertiarii ad apicem plerumque 6–7 ramos gracilissimos glabros ferentes, qui denuo umbellae sunt, multos flores ferentes; cymulae ultimae laxae.

Flores masculi virello-albi, pedicellati; pedicelli 1.1–1.7 mm longi. Flores 1.2–1.75 mm longi. Sepala 6, libera, 2 serialia, 1.2–1.85 mm longa, 0.5–0.9 mm lata, obovata, ad marginem integra, apice acuta, basi truncata, tenuia, glabra, uninervia. Petala 3, libera, 0.4–0.9 mm longa, pariter lata, obdeltoidea, apice rotundata, basi obtusa, margine integra, nervo centrali ad circa medium furcato, non valde carnosa. Stamina 6, in synandrio peltato connata, stipite synandrii 0.7–0.9 mm longo, apice ca 0.5 mm lato; synandrium extrorsum, antherae transversaliter dehiscentes.

Flores ♀ et drupae adhuc ignotae.

Holotype: New Guinea, Eastern Highlands, Distr. Arau, c. 1500 m, 23.10. 1959, Brass 32246 (US).

Large climber, climbing up to 6 m in *Castanopsis*-oak forest on bank of stream. Stem ribbed, solid, woody, glabrous, somewhat twisted, surface rough, punctate (dotted). *Leaves* simple (Fig. 1 A), alternate, petiolate, exstipulate. *Petiole* ribbed, solid, distinctly pulvinar and twisted at base, glabrous, 5.5–6 cm long, shorter than the lamina. *Lamina* peltate, ovate, 8.3–11.7 cm long and 6.9–9.6 cm broad, coriaceous, palmately 10-nerved, sometimes 9-nerved, nerves more prominent on lower surface; both surfaces glabrous, lower surface grey and paler than upper surface, margin entire, base rounded, apex cuspidate.

Male inflorescence (Fig. 1 B) a mixed umbelliform panicle, borne on lower leafless part of stem, very large, 45 cm long, pedunculate, primary axis ribbed, glabrous, about 39 cm long, bearing a number of umbellate branches; secondary axes alternate on the primary axis, 6.0–7.5 cm long, ribbed, glabrous, slender, each being a compound umbel with (4–)5–7 tertiary axes 3–3.5 cm long; each of these at its tip usually bear 6–7 very slender, glabrous, umbelliferous branches, each bearing numerous flowers; ultimate cymules loose.

Male flowers (Fig. 1 C) 1.2–1.75 mm long,

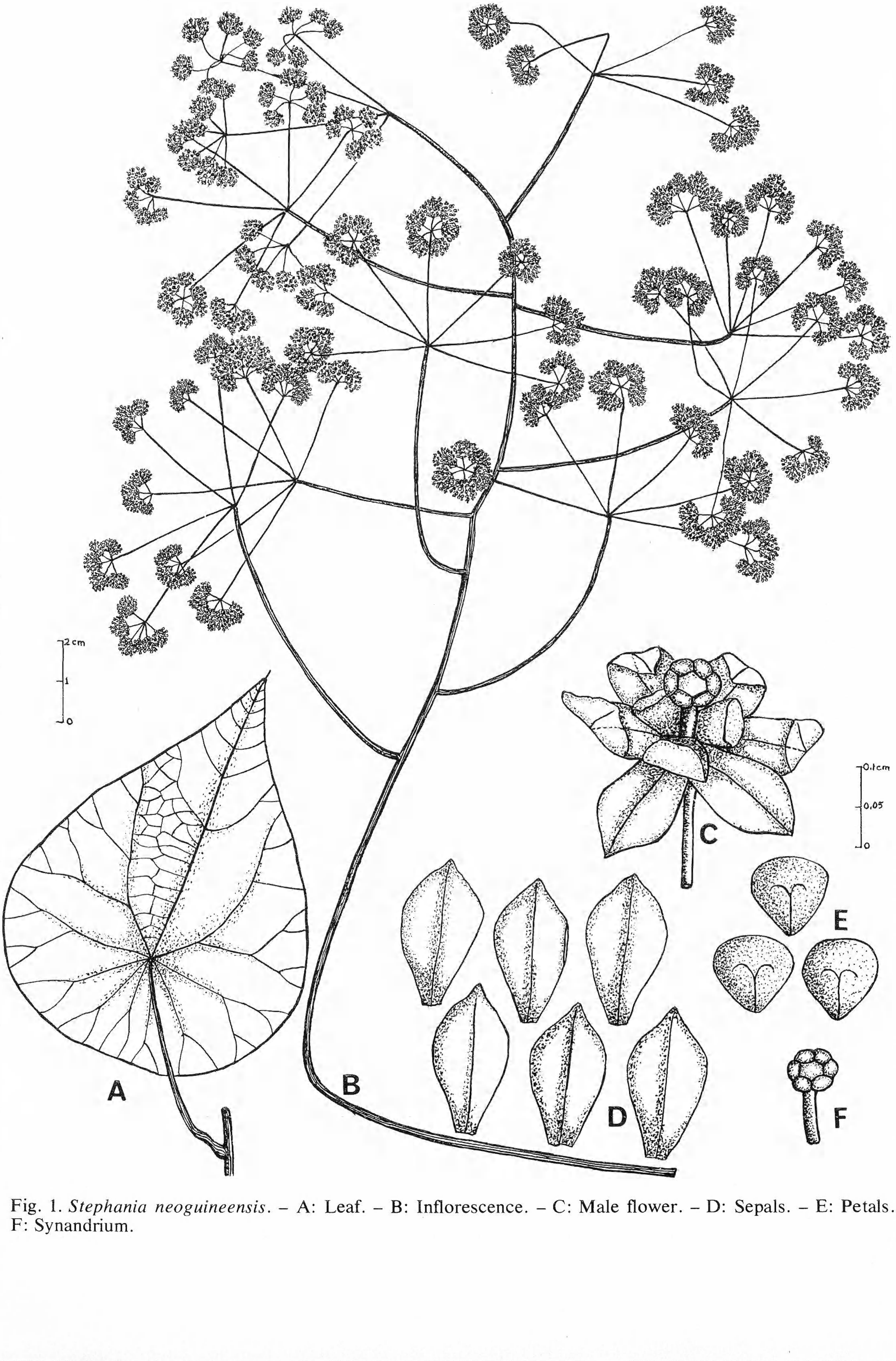

Fig. 1. *Stephania neoguineensis*. – A: Leaf. – B: Inflorescence. – C: Male flower. – D: Sepals. – E: Petals. F: Synandrium.

Table 1. Differences between *Stephania neoguineensis* and *S. montana*.

Organ	*S. neoguineensis*	*S. montana*
Lamina	broadly ovate coriaceous margin entire apex cuspidate base rounded	triangular or narrowly triangular chartaceous margin somewhat undulate apex apiculate base truncate to slightly rounded, basal corners sometimes apiculate
Petiole	inserted 2.4–3.2 cm from base of lamina	inserted 0.4–0.5 cm from base of lamina
Petal	obdeltoid	obovate

greenish-white, pedicellate, pedicel 1.1–1.7 mm long. *Sepals* (Fig. 1 D) 6, free in 2 rows, 1.2–1.85 mm long, 0.5–0.9 mm broad, obovate, thin, glabrous, with 1 unbranched central nerve, margin entire, apex acute, base truncate. *Petals* (Fig. 1 E) 3, free, 0.4–0.9 mm long and 0.4–0.9 mm broad, obdeltoid, with rounded apex, base obtuse, margin entire, 1 central nerve bifurcating at about the middle, not very fleshy. *Stamens* 6, connate in a peltate synandrium (Fig. 1 F), stalk of synandrium 0.7–0.9 mm long, top of synandrium about 0.5 mm broad, anthers extrorse, dehiscing transversely.

Female plant unknown.

Stephania neoguineensis belongs to the section *Thamnothyrsa* Diels and is related to *S. montana* Diels (Diels 1915). The two species differ in some respects (Table 1).

Anatomy

Stem. A transverse section of the stem (Fig. 2 A) shows the following structures. Periderm well developed. Cortex few-layered; inner cortex with brachysclereids (Fig. 2 B). Six to eight vascular bundles present each with a sclerenchymatous bundle cap. The caps are united in young stems, but when the stems increase in thickness the bundle caps become separated, but are united by the brachysclereids. Secondary growth of xylem almost crushes primary phloem. Pith very small.

Leaf. Vein islets and vein endings 6.94 and 7.84 per mm^2 respectively (Fig. 2 C). Sclereids abundant, associated with veins (Fig. 2 D) and with varying shape (Fig. 2 E). Rod-shaped crystals (Fig. 2 F) are also present in cells surrounding the veins. Cells of the spongy parenchyma contain large and small oil globules staining red with Sudan III. The ratio epidermal cells:palisade cells is 1:17.58. Stomata anomocytic. Papillae present on all epidermal cells on the lower surface.

Stephania formanii Kundu & Guha, sp. nov.

Planta scandens. Caulis costatus, solidus, glaber, lignosus, exasperatus. Folia simplicia, alterna, petio-

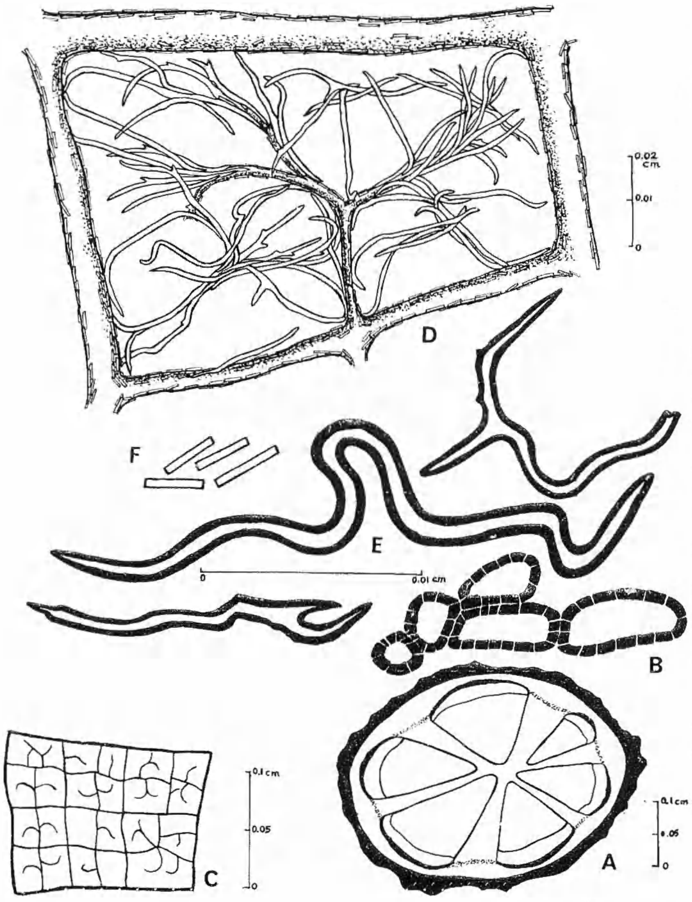

Fig. 2. *Stephania neoguineensis*. – A: T. S. of the stem. – B: Brachysclereids from the stem. – C: Venation. – D: Vein islet showing sclereids and crystals. – E: Sclereids. – F: Crystals.

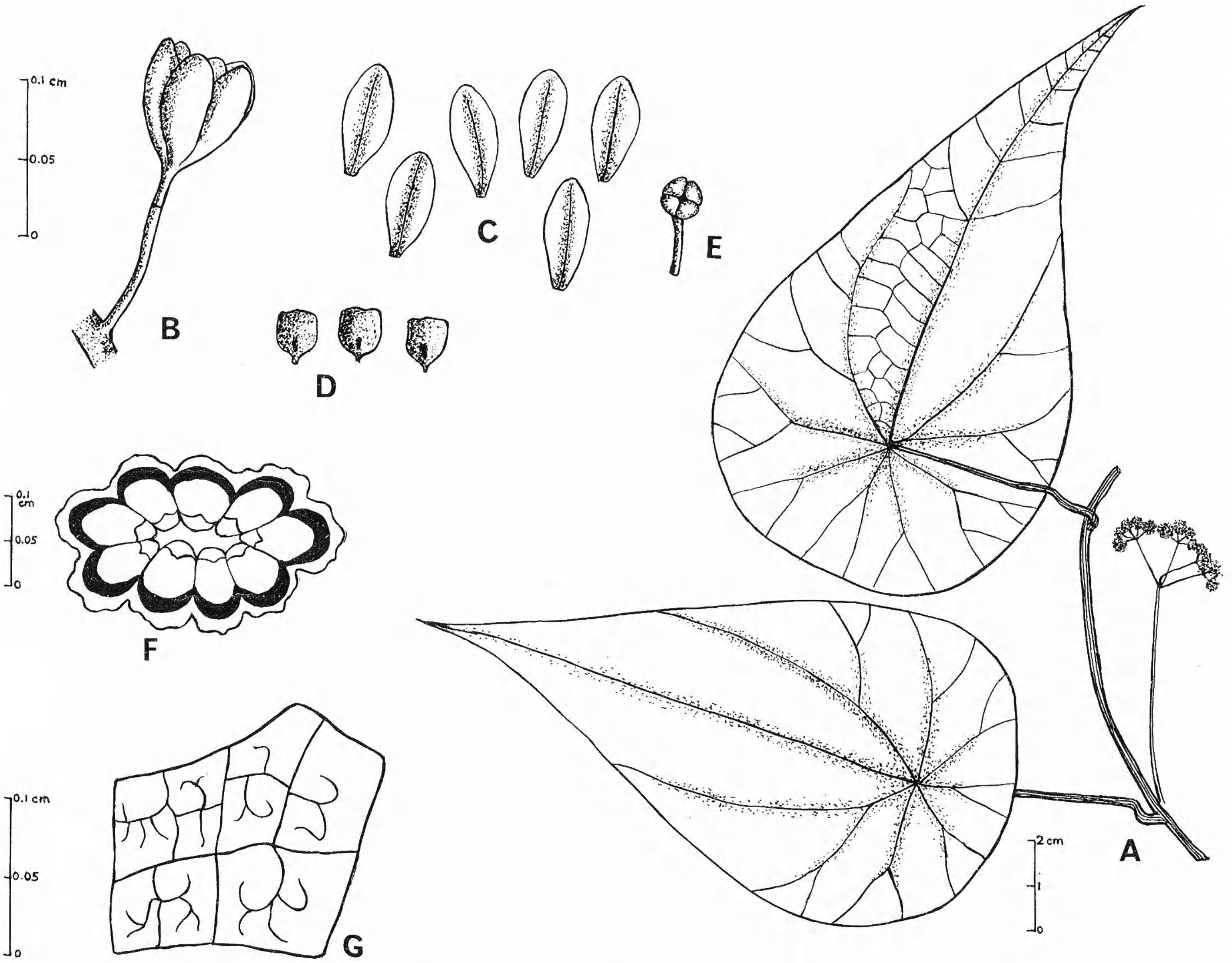

Fig. 3. *Stephania formanii*. – A: Part of a branch. – B: Male flower. – C: Sepals. – D: Petals. – E: Synandrium. – F: T. S. of the stem. – G: Venation.

lata, petioli validi, costati, glabri, asperi, laminis multo breviores, 5.0–6.5 cm longi, basi pulvinati distincte tortique, lamina peltata, petiolo affixo 2.4–2.35 cm a basi laminae, lanceolato-ovata, coriacea, utrinque glabra, pagina inferior superiore pallidior, palmatim 9-nervis (nervi 3 superiores magis prominentes) nervis paginarum inferiorum valde prominentibus, 12–16 cm longa, 6.6–7.9 cm lata, coriacea.

♂ inflorescentia umbellato-cymosa, pedunculata, 6–7.5 cm longa, pedunculus gracilis, costatus, c. 4.8 cm longus, radii primarii 3–4, 0.9–1.9 cm longi, graciles, costati, radii secundarii 2–2.25 mm longi, cymulae ultimae plusminusve laxae. Alabastra cremea, pedicellata, flores 0.75–0.8 mm longi, 0.5–0.7 mm lati. Sepala 6, interdum 5, libera, 2-serialia, obovata, margine integra, apice rotundata, basi obtusa, 0.75–0.85 mm longa et 0.25–0.35 mm lata, tenuia, uninervia, sepala utroque costae latere atro-colorata. Petala 3, libera, carnosa, parum unguiculata, margine integra, apice truncata, 0.35 mm longa et 0.2 mm lata, uninervia. Stamina 4, in synandrio peltato connata, stipite synandrii 0.6–0.75 mm longo, zona centralis sterilis synandrii valde reducta, apex synandrii 0.2–0.3 mm latus, synandrium introrsum.

Flores ♀ et drupae adhuc ignotae.

Holotype: Papua-New Guinea, Isuarava, 5000 ft, 13.2. 1936, Carr 15556 (BM).

Climber, stem woody, ribbed, solid, glabrous, surface rough. *Leaves* (Fig. 3 A) simple, alternate, petiolate. *Petiole* stout, ribbed, glabrous, much shorter than lamina, 5.0–6.5 cm long, pulvinar and distinctly twisted at the base, surface rough. *Lamina* peltate, petiole inserted 2.4–2.35 cm from base of lamina, lanceolate–ovate, 12–16 cm long and 6.6–7.9 cm broad, coriaceous, palmately 9-veined (upper 3 veins more prominent), veins more prominent on lower surface, both surfaces glabrous, lower

Table 2. Differences between *Stephania formanii* and *S. psilophylla*.

Organ	*S. formanii*	*S. psilophylla*
Lamina	ovate to lanceolate 12–16 cm long and 6.6–7.9 cm broad vein reticulations not raised on leaf surface apex attenuate	ovate to broadly ovate 5–9 cm long and 4–8 cm broad vein reticulations raised on both surfaces apex acuminate
Male inflorescence	6–7.5 cm long	1.4 cm long
Sepals	obovate	elliptic or broadly oblanceolate
Petals	rectangular with angustate base	obdeltoid
Synandrium	0.6–0.75 mm long	0.5 mm long
Distribution	Papua-New Guinea	Luzon, Philippines

surface paler than upper surface, margin entire, base rounded, apex attenuate.

Male inflorescence (Fig. 3 A) a pedunculate umbellate cyme, 6–7.5 cm long, peduncle slender, ribbed, 4.8 cm long, primary rays 3–4, 0.9–1.9 cm long, slender, ribbed; secondary rays 2–2.25 mm long; ultimate cymules more or less loose.

Male flower (Fig. 3 B): *Buds* cream-coloured, pedicellate, pedicel 1.05–1.3 mm long, articulate at a distance of about 1 mm from the base. *Sepals* (5–)6 (Fig. 3 C), free, in 2 rows, obovate, 0.75–0.85 mm long and 0.25–0.35 mm broad, thin, margin entire, apex rounded, base obtuse, 1 central vein, dark on both sides of the midrib. *Petals* 3 (Fig. 3 D), free, fleshy, 0.35 mm long, 0.2 mm broad, with short claws, margin entire, apex truncate, 1 central vein. *Stamens* 4, connate in a peltate synandrium (Fig. 3 E), stalk of synandrium 0.6–0.75 mm long, its central sterile top zone much reduced, synandrium top 0.2–0.3 mm broad, anthers introrse.

Female plant unknown.

Stephania formanii belongs to the section *Stephania* (sect. *Eustephania* Diels) and is related to *S. psilophylla* (Presl) Forman (Forman 1956) from which it differs in the characters given in Table 2.

The species has been named in honour of the eminent specialist in Menispermaceae, Dr L. L. Forman, Kew.

Anatomy

Stem. A transverse section (Fig. 3 F) shows the following regions. Epidermis single-layered, the cells highly suberized on the outer side. Cortex few-layered, collenchymatous. Eight vascular bundles present, each with a sclerenchymatous bundle cap. Pith small, parenchymatous.

Leaf. Sclereids and crystals (Fig. 4) similar in shape to those of *S. neoguineensis*, but fewer. Vein islets and vein endings (Fig. 3 G) 2.2 and 5.5 per mm^2 respectively. The ratio epidermal cells:palisade cells is 1:7.08. Stomata anomocytic. Papillae absent.

Sclereids

Sclereids are present in abundance in *S. neoguineensis* and *S. formanii* where they occur associated with the veins.

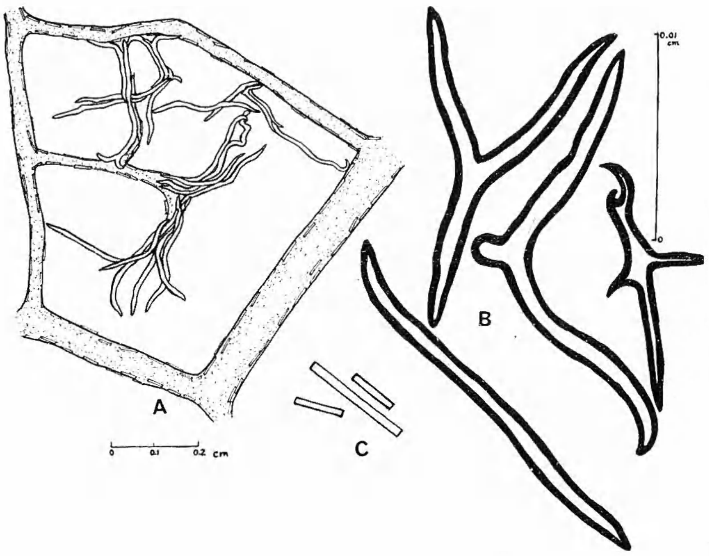

Fig. 4. *Stephania formanii*. – A: Vein islet showing sclereids and crystals. – B: Sclereids. – C: Crystals.

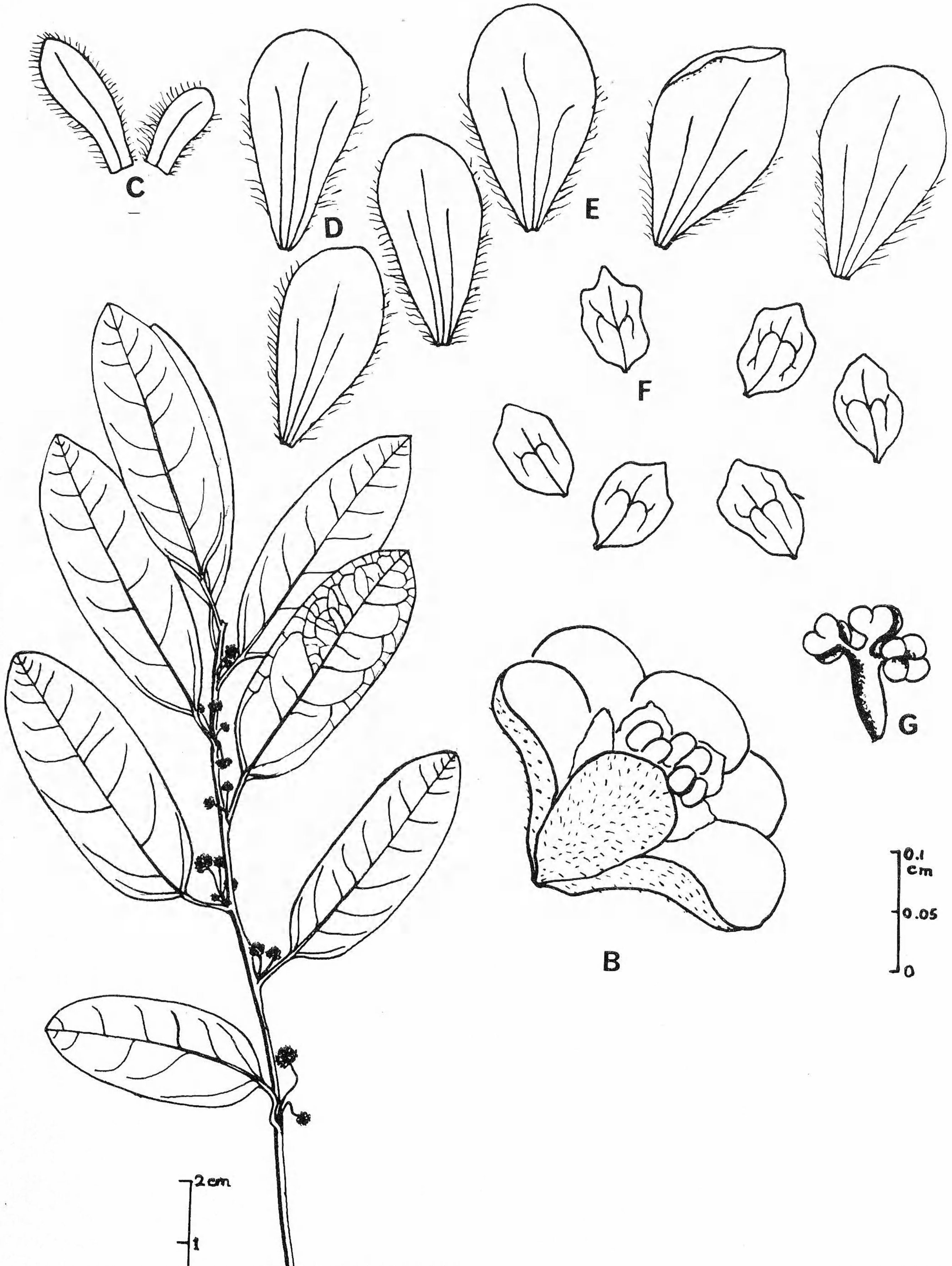

Fig. 5. *Rhaptonema swinglei*. – A: Branch of a male plant with leaves and inflorescences. – B: Male flower. – C: Bracteoles. – D: Outer sepals. – E: Inner sepals. – F: Petals. – G: Androecium.

Rhaptonema swinglei Kundu & Guha, sp. nov.

Frutex scandens, ligneus, villosus, pilis brunneolis dense tectus. Foliorum petiolus strictus, 0.7–0.9 cm longus, villosus, lamina coriacea, utrinque glabra, 3.2–5.4 cm longa, 1.2–2.0 cm lata. Inflorescentiae ♂ axillares, pedunculatae, villosae, 0.4–0.95 cm longae. Sepala 6, obovata, apice rotundata, petala 6, raro 8, angulari–elliptica, apice obtusa, vix acuta, 0.9–1.0 mm longa, 0.4–0.5 mm lata. Stamina 3, usque ad medium connata, apice libera. Flores ♀ et drupae adhuc ignotae.

Holotype: Madagascar, 200–300 m, 30.8–7.9. 1928, Humbert & Swingle 5546 (MO 1709189).

Stem climbing, terete, woody, surface densely covered with brownish villous hairs. *Leaves* (Fig. 5 A) simple, alternate, exstipulate, petiolate. *Petiole* much shorter than the lamina, 4–10 mm long, densely covered with brownish villous hairs, terete. *Lamina* coriaceous, oblong, apex usually rounded, margin slightly revolute, both surfaces glabrous, venation pinnately reticulate.

Male inflorescences 0.6–1.2 cm long, axillary, pedunculate capitate cymes; 2–5 inflorescences in each leaf axil on ordinary leafy branches; rachis 0.4–0.95 cm long, slender, villous.

Male flowers (Fig. 5 B) sesssile, bracteolate. *Bracteoles* (Fig. 5 C) 2, equal or unequal, oblong, margin entire, 0.8–1 mm long, 0.25–0.35 mm broad, villous on outer surface, rounded at apex, truncate at base, with 1 midvein. *Sepals* 6, free, in 2 rows, thin. Outer sepals (Fig. 5 D) obovate, 1.8 mm long, 0.85 mm broad, entire, rounded at apex, acute at base, veins 3, diverging. Inner sepals (Fig. 5 E) broadly obovate, 1.8 mm long, 0.9–1 mm broad, entire, rounded at apex, acute at base, veins 3, diverging, usually unbranched. *Petals* (Fig. 5 F) 6 or sometimes up to 8, free, membranous, somewhat angular elliptical, 0.9–1 mm long, 0.4–0.5 mm broad, base angustate, obtuse at apex, upper half of margin sometimes lobate, 1 midvein with 2 laterals dividing into a few branches. *Stamens* (Fig. 5 G) 3, 0.95–1 mm long, filaments united into a column, uppermost part of the filaments free, anthers dorsifixed, 4-lobate, 0.3 mm broad and 0.2 mm thick.

Female flowers and drupes not found.

The first species of *Rhaptonema,* a genus endemic to Madagascar, was established by Miers (1867, 1871) and bears the name *R. cancellata*. Five more species have subsequently been added by other workers (Baillon 1870, Baker 1887, Diels 1910, 1921). The new species differs clearly from the other species of *Rhaptonema* in the characters of the leaf laminae, type of inflorescence and shape of sepals and petals: From *R. cancellata* Miers in the non-papyraceous, brown-villous leaves and the male inflorescence which is not solitary. From *R. thouarsiana* (Baillon) Diels (=*Tripodandra thouarsiana* Baillon) in the much smaller leaves, the non-papyraceous laminae, the type of inflorescence and shape of laminae and the much longer sepals. From *R. latifolia* Diels in the much smaller leaves, the non-acuminate laminae and the hairy petioles. From *R. densiflora* Diels in the much smaller leaves which are not lanceolate or lanceolate-ovate, the much smaller male inflorescence and the shape of the sepals and petals. From *R. bakeriana* Diels in the smaller leaves, the non-emarginate base of the laminae and the outer sepals which are not linear–spathulate. From *R. glabrifolia* Diels in the much shorter petiole, the leaves which are not lanceolate or ovate-lanceolate, the non-acuminate apex and the non-subspathulate outer sepals.

The species has been named in honour of Professor C. F. Swingle.

Anatomy

Stem. T. S. (Fig. 6 A). Single-layered epidermis, outer walls strongly cutinized, hairs long, unicellular. Cortex narrow, sclerenchymatous; cells of inner cortex parenchymatous, containing tannin. 22 vascular bundles present, each with a sclerenchymatous bundle cap, caps united, a sclerenchymatous sheath on inner side of each bundle. Pith consisting of thick-walled parenchymatous cells.

Leaf. Sclereids (Fig. 6 B) abundant, associated with the veins. The ratio epidermal cells: palisade cells is 1:4.58. Stomata (Fig. 6 C) anomocytic, often sunken, usually surrounded by 9–10 cells. Epidermal cells without papillae. Vein islets 14.1 per mm^2, vein endings 41.1 per mm^2 (Fig. 6 D).

A transection of the leaf (Fig. 6 E) shows that both sides are covered with a thick cuticle. Below the upper epidermis there are usually two

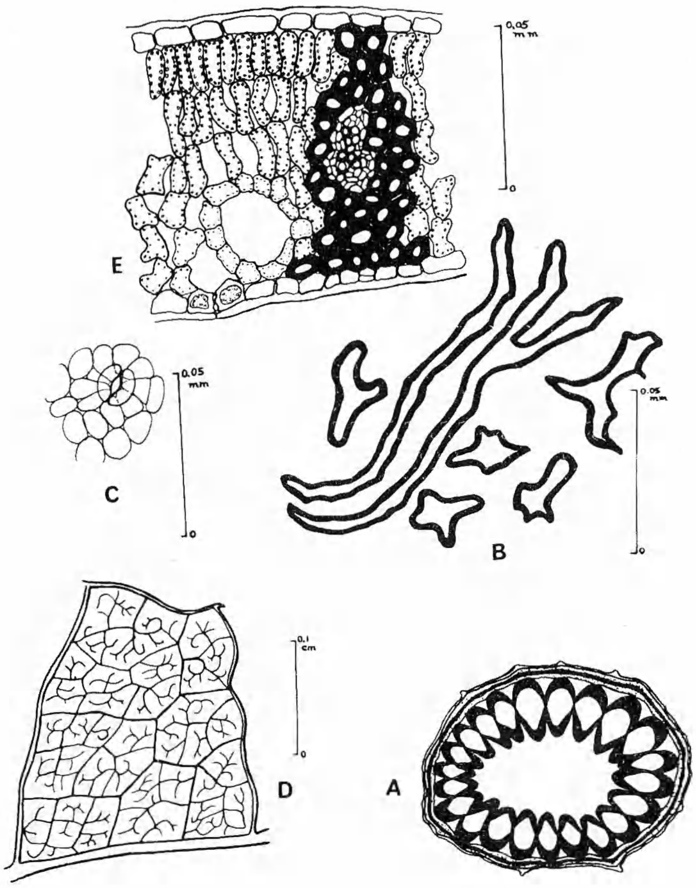

Fig. 6. *Rhaptonema swinglei*. – A: T. S. of stem. – B: Various types of sclereids from leaf. – C: Stoma. – D: Venation pattern. – E: T. S. of leaf.

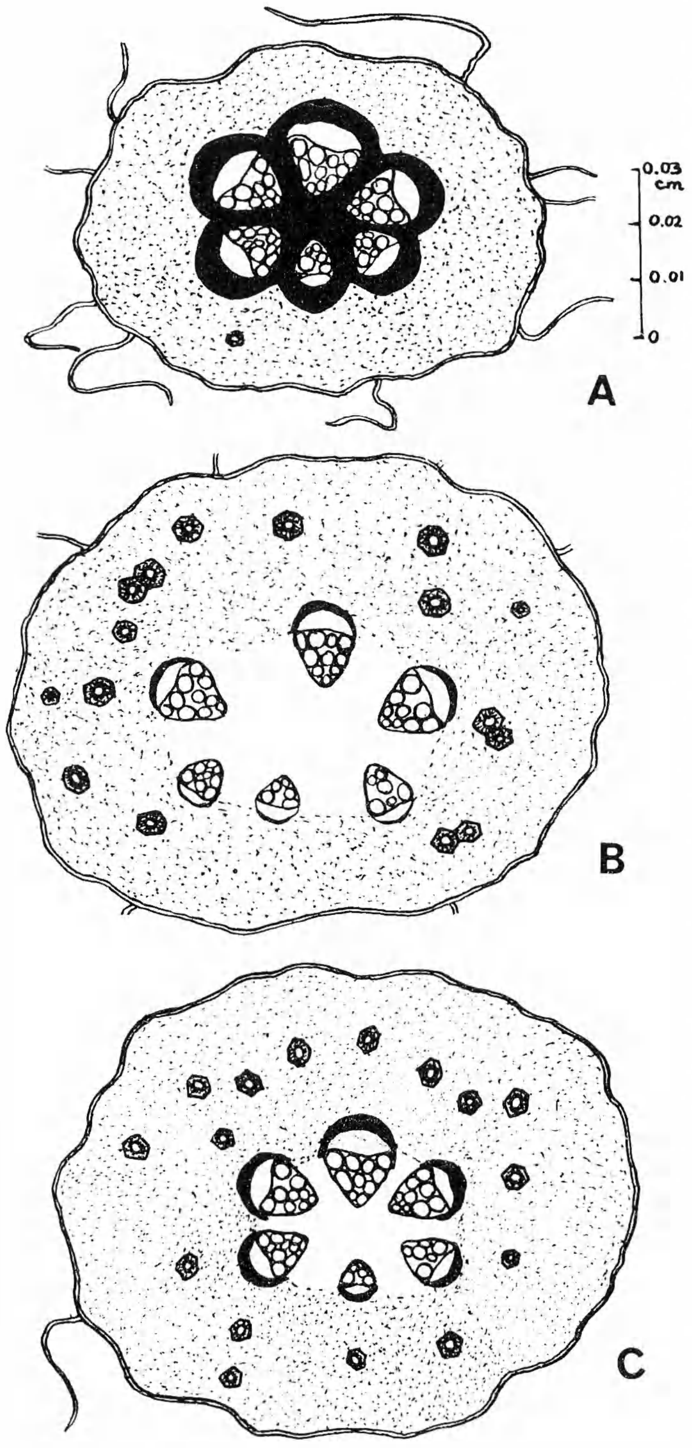

Fig. 7. *Rhaptonema swinglei*, T. S. of petiole. – A: Lower part. – B: Middle part. – C: Upper part.

layers of palisade cells. The spongy mesophyll consists of 3–4 layers of loosely arranged cells of which the upper one or two layers are elongated and resemble the palisade cells. In certain cells just below the upper epidermis stellate crystals are present. The spongy mesophyll contains irregularly shaped glands surrounded by thin-walled parenchyma cells much smaller than the spongy cells. Vascular bundles are surrounded by very thick-walled sclerenchyma cells extending from the upper to the lower epidermis.

Petiole. A transection of the lower part (Fig. 7 A) shows the following structures: single-layered epidermis, outer and radial walls of epidermal cells highly cutinized with a few very long unicellular epidermal hairs. Cortex collenchymatous with only a few irregularly distributed brachysclereids; vascular bundles 6, each with 3–4-layered sclerenchymatous bundle caps, the caps uniting to form a continuous sclerenchymatous ring. Pith and medullary rays thick-walled. T. S. of middle part of petiole (Fig. 7 B) shows more numerous brachysclereids in the cortex. Vascular bundles quite separate with poorly developed bundle caps. Pith and medullary rays thin-walled. A T. S. of the uppermost part of the petiole (Fig. 7 C) resembles that of the middle part but the bundle caps are fairly well developed and are not united.

Acknowledgements

The authors are grateful to Dr R. Ross, Keeper, British Museum, Dr Dan Nicolson, Curator, U.S. National Herbarium and Dr Thomas Croat, Curator of the Herbarium, Missouri Botanical Gardens for placing material at their disposal, to the authorities of the Botanical Survey of India for facilities in the Industrial Section, B.S.I. and to Dr N. C. Majumdar, Systematic Botanist, B.S.I., for the Latin descriptions.

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Wood-inhabiting fungi of alder forests in North-Central Scandinavia

3. Myxomycetes

Uno Eliasson and Åke Strid

Eliasson, U. & Strid, Å. 1976 10 22: Wood-inhabiting fungi of alder forests in North-Central Scandinavia. 3. Myxomycetes. *Bot. Notiser 129:* 267–272. Stockholm. ISSN 0006-8195.

More than 300 specimens, comprising 41 species, of wood-inhabiting Myxomycetes were collected from alder forests in North-Central Scandinavia. *Physarum serpula* Morgan is reported as new to Europe. *Didymium crustaceum* is cited from three localities. These appear to be the first definite records of this species from Sweden.

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In this investigation of the wood-inhabiting fungi of alder forests in North-Central Scandinavia (Fig. 1) by the second author interest has been concentrated on the group Aphyllophorales (Strid 1975), but other fungi such as agarics and Gasteromycetes (Strid 1976) were also collected. Even the Myxomycetes were included in so far as they grew on wood. Because the main aim of this investigation was to collect Aphyllophorales, the method used makes no claim to be particularly suitable for Myxomycetes, not even the wood-inhabiting species. Exceedingly minute species will have been overlooked in the field, but some were discovered by chance when examining pieces of wood which bore other fungi.

The alder woods investigated, 99 in number, represent areas in which little attention has previously been paid to Myxomycetes. Even if the field methods used were not well-adapted for making representative collections of this group of organisms, especially for a study of their ecology and distribution, it nevertheless seems justifiable to present this account of the Myxomycetes which were collected.

The first-mentioned author is responsible for the specific determinations and for the taxonomical comments. More than 300 specimens have been examined. Most of the material is deposited in herbarium UME and duplicate specimens of some collections are in GB.

Alder woods investigated

The alder woods of current interest are defined as *the type of vegetation where live alders dominate the tree layer* and *the type of vegetation where alders are replaced in the tree layer by other tree species but still exist as dying, dead and fallen trees*. Two species of alder are present within the investigated area. *Alnus glutinosa* occurs at a very few localities and is dominant at only two of the southernmost. At all other localities *A. incana* is the dominant tree. Furthermore, some other trees, both deciduous and coniferous species, are also intermixed. The alder woods were considered as forming a single vegetational unit and the collections of Myxomycetes were taken from all occurring tree species. The exact situation and the general vegetation of the individual localities can be found in an earlier paper (Strid 1975 Figs. 2, 3, pp. 20–46). Myxomycetes were collected at 78 of the 99 alder wood localities

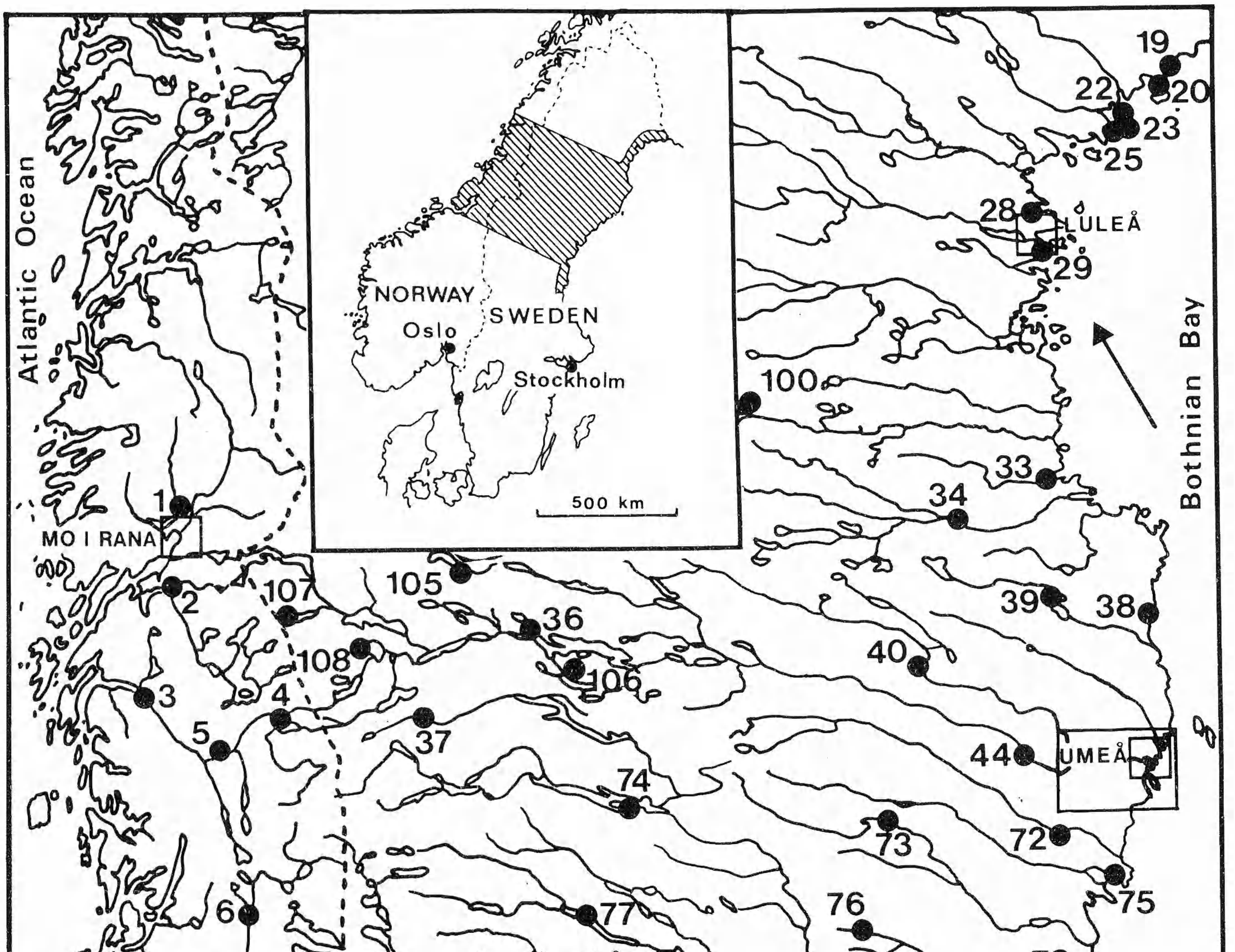

Fig. 1. Distribution of the investigated localities at which Myxomycetes were collected. The localities in the Umeå region, the framed area in the centre of the east coast, are excluded here but can be found in Fig. 2. – Insert: The Scandinavian peninsula with the investigated area marked.

investigated (Figs. 1, 2). The numbering of these localities is retained from Strid (1975). Furthermore, a number of specimens from some other localities, not included in Strid (1975), are presented, viz. nos. 100–109 below (see Figs. 1, 2).

100 Sweden, Pite lappmark, Arvidsjaur, Reivo forest reserve. 1975 09 17–19.

101 Sweden, Västerbotten, Umeå, Mariehem. 1972 05 10, 1973 05 25.

102 Sweden, Västerbotten, Umeå, Sörfors bridge. 1972 05 16.

103 Sweden, Jämtland, Stugun, S of Lake S Mörtsjön. 1972 09 13.

104 Sweden, Ångermanland, Vibyggerå, Skuleskogen. 1972 10 01.

105 Sweden, Lycksele lappmark, Sorsele, on the slope W of the S end of Lake Överstjuktan. 1974 06 24.

106 Sweden, Lycksele lappmark, Stensele, W of the hill Rönnberget. 1974 08 26.

107 Sweden, Lycksele lappmark, Tärna, Rödingsnäset. 1974 09 05.

108 Sweden, Lycksele lappmark, Tärna, W of Lake Björkvattnet. 1974 09 06.

109 Sweden, Västerbotten, Sävar, Skeppsvik. 1970 06 06.

List of species

The find localities are numbered according to Figs. 1 and 2 and to the list of localities in Strid (1975 pp. 20–46). Comments are given on the substrate and, in some cases, also on the taxonomy. Unless otherwise stated, the substrates (tree species) are abbreviated as follows.

Alnus – A. incana
Betula – B. pubescens
Picea – P. abies
Pinus – P. sylvestris
Populus – P. tremula
Prunus – P. padus
Salix – S. caprea
Sorbus – S. aucuparia

Ceratiomyxa fruticulosa (Müll.) Macbr. – 33, 47, 58, 72. *Alnus*, unspecified coniferous wood.

Licea castanea G. Lister – 89. *Salix.*

Licea minima Fries – 1–3, 30, 47, 51, 53, 62. *Alnus, Salix.*

Tubifera ferruginosa (Batsch) J. F. Gmel. – 17, 30, 100. *Alnus, Picea, Pinus.*

Lycogala epidendrum (L.) Fries – 1, 5, 7, 9, 10, 12, 14, 23, 29, 34, 38, 51, 75, 79, 82, 84, 88, 95, 96, 98. *Alnus, Betula, Pinus, Salix.*

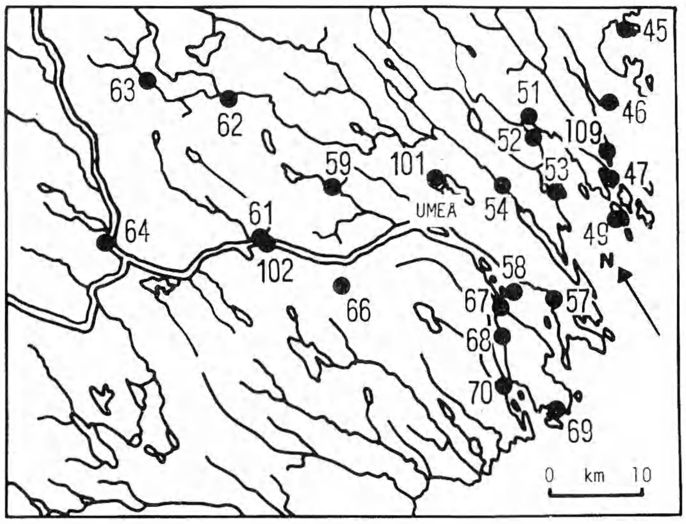

Fig. 2. Distribution of the investigated localities in the Umeå region. The town centre of Umeå is situated just SW of locality 101.

Reticularia jurana Meylan – 72, 101. *Picea* and *Alnus*, respectively.

As shown by Nannenga–Bremekamp (1958 a p. 776, 1974 p. 86), the structure of the pseudocapillitium is rather variable in this species. Like the specimens collected (Strid 13393) from the locality 101, it may consist of thread-like structures forming an irregular network, often with irregular membranous expansions at the junctions, or, as in the collection (Strid 13305) from locality 72, it may be formed of broader, membranous strands with rounded perforations. In the latter case it approaches that of *R. splendens* Morgan in appearance. Dr N. E. Nannenga-Bremekamp, who kindly examined a piece of the pseudocapillitium from Strid 13305, referred it to *R. jurana*. Obviously *R. jurana* and *R. splendens* are rather closely related. Kowalski (1975 p. 452) has relegated the former to a mere variety of the latter.

Reticularia lycoperdon Bull. – 9, 20, 23, 109. *Alnus, Betula.*

Reticularia olivacea (Ehrenb.) Fries var. *simulans* (Rost.) Nann.-Brem. – 2. *Alnus.*

Cribraria argillacea (Pers.) Pers. – 23. *Alnus.* An interesting substrate for a species normally found on coniferous wood.

Arcyria cinerea (Bull.) Pers. – 90. *Alnus.*

Arcyria incarnata (Pers.) Pers. – 5, 10, 12, 18–20, 28, 36–38, 51, 61, 69, 75, 77, 79, 86, 90, 96, 98. *Alnus, Betula, Salix,* unspecified coniferous wood, dead fruiting-body of *Phellinus igniarius.*

Arcyria nutans (Bull.) Grev. – 23, 25, 30, 47, 59, 62, 67, 82, 83, 88, 91, 97, 99, 102. *Alnus glutinosa, A. incana* (mainly), *Salix,* unspecified coniferous wood.

Arcyria oerstedii Rost. – 66. *Alnus.*

Arcyodes incarnata (Alb. & Schw.) O. F. Cook – 37, 54. *Alnus,* dead fruiting-body of *Phellinus igniarius.*

Trichia decipiens (Pers.) Macbr. – 3–5, 8, 10, 11, 18, 20, 30, 44, 68, 73, 82, 91, 95, 105. *Alnus, Picea, Salix, Sorbus.*

Trichia favoginea (Batsch) Pers. (sensu Martin & Alexopoulos 1969 p. 160) – 6, 17, 36, 95, 100. *Alnus, Betula, Salix.*

Trichia lutescens (A. Lister) A. Lister – 8. *Salix.*

Trichia scabra Rost. – 6, 44. *Alnus,* dead fruiting-body of *Phellinus igniarius.*

Trichia subfusca Rex – 36. Alnus.

Trichia varia (Pers.) Pers. – 2–4, 13, 15, 17, 18, 74, 77, 100, 104. *Alnus, Picea, Salix, Sorbus,* unspecified coniferous wood.

Enerthenema papillatum (Pers.) Rost. – 1, 2, 10, 37. *Alnus, Salix.*

Stemonitis axifera (Bull.) Macbr. – 13, 30. *Alnus, Salix.*

Stemonitis fusca Roth – 1, 9, 37, 44, 62, 74. *Alnus,* dead fruiting-body of *Phellinus igniarius.*

Stemonitis hyperopta Meylan – 67. *Alnus.*

Symphytocarpus amaurochaetoides Nann.-Brem. – 108. *Betula tortuosa.*

Comatricha elegans (Racib.) G. Lister – 47. *Alnus.*

Comatricha nigra (Pers.) Schroet. – 1–5, 10–12, 16, 20, 22, 23, 25, 28, 36–38, 73, 85, 91, 97, 99. *Alnus glutinosa, A. incana, Prunus, Salix,* unspecified coniferous wood, dead fruiting-body of *Antrodia serialis.*

Comatricha typhoides (Bull.) Rost. – 3, 7. *Alnus, Sorbus.*

Badhamia utricularis (Bull.) Berk. – 12, 49, 54, 63, 64, 66. *Alnus, Betula, Salix,* unspecified coniferous wood.

Fuligo muscorum Alb. & Schw. – 66. *Dicranum* sp.

Fuligo septica (L.) Wiggers – 39, 59, 66, 103, 106, 107. *Alnus, Betula, Picea, Populus.*

Craterium leucocephalum (Pers.) Ditmar – 84, 86, 90. *Alnus.*

The pseudocolumella and several of the capillitial calcareous nodules in the sporangia (Strid 10819) from locality 84 are distinctly yellow, but other characters, e.g. the greyish peridium in the upper half of the sporangium, agree better with those of this very variable species, than with those of *C. aureum* (Schum.) Rost.

Physarum cinereum (Batsch) Pers. – 49. *Alnus.*

The fructifications from this locality (Strid 7505) vary from rounded sporangia and short plasmodiocarps to strongly-netted plasmodiocarps (Fig. 3). A low (pseudo-)columella is present in at least some of the fructifications. The spores are 8.5–9 μm in diam., faintly warted, pale brown in transmitted light. This collection resembles *P. vernum* Somm. in some characters (well developed plasmodiocarpous fructifications, occurrence on bark), but the size and colour of the spores agree with *P. cinereum.* The two species are closely related, and intermediate specimens apparently occur (Alexopoulos & Sáenz R. 1975 pp. 248, 257). Characters delimiting the two taxa require further study.

Physarum contextum (Pers.) Pers. – 69, 106. *Alnus,* dead fruiting-body of *Phellinus nigrolimitatus.*

As diagnostic characters which separate *P. mucosum* Nann.-Brem. from *P. contextum,* Nannenga-Bremekamp (1974 pp. 312–314) mentions the three peridial layers, the outer of which becomes slimy when moistened, and the thin margin formed by the protruding peridium in sporangia with a flattened top, in *P. mucosum.* A peridial margin is present in some of the sporangia from locality 106 (Strid 14125), but is not visible in those from locality 69 (Strid 7954). In the sporangia with a protruding margin the peridium may be interpreted as being 3-layered, in sporangia without such a margin it

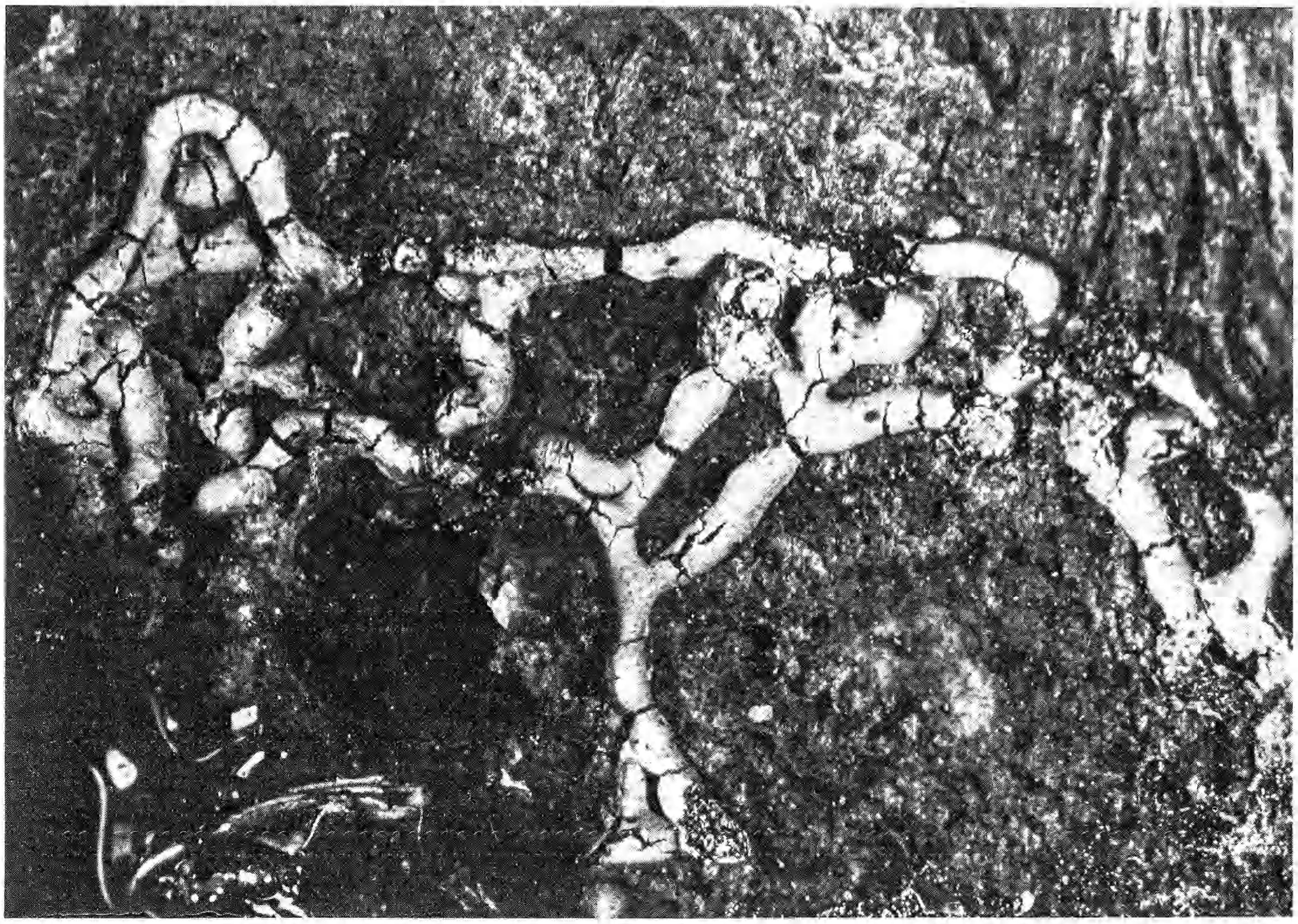

Fig. 3. Plasmodiocarpous fructification of *Physarum cinereum* (Batsch) Pers. – × 12.

appears 2-layered. Apparently the three peridial layers are not always distinct in *P. mucosum.* In the original description of the species (Nannenga-Bremekamp 1958 b p. 782) the peridium was described as 2-layered, later Nannenga-Bremekamp (1974 p. 314) described it as 3-layered at least in the upper half. Dr Nannenga-Bremekamp kindly sent material (N.-B. 1603) of *P. mucosum,* which I have compared with that collected by Strid and with specimens in Jaap's Myxomycetes Exsiccati, No. 5. Jaap's exsiccate is labelled "Physarum contextum Pers." and has been cited under that specific name by Martin & Alexopoulos (1969 p. 295). The spores from all the four different sources agree well in size, ornamentation and colour. The outer peridial layer becomes soft when moistened and takes on the same appearance in all cases. To me they all seem to represent one single taxon.

Physarum notabile Macbr. – 73. *Populus.*

Physarum nutans Pers. – 2–5, 8–10, 12, 14, 15, 17, 19, 28, 34, 36, 38, 40, 45–47, 52, 53, 57–59, 63, 66, 70, 72, 74, 75, 78, 79, 82–84, 86, 88, 90–92, 97–99. *Alnus glutinosa, A. incana, Betula, Picea, Salix, Sorbus.*

Physarum serpula Morgan – 97. *Alnus.*

This species is closely related to *P. auriscalpium* Cooke and *P. decipiens* Curtis. The differences and relationships between the three taxa have been discussed by Farr (1961, 1967). *P. serpula* has not been reported from Europe previously. The species is rare and there is still some doubt concerning the range of intraspecific variation. The actual collection (Strid 12100) keys to *P. serpula* in Martin & Alexopoulos (1969). Dr Marie Farr, who kindly examined the specimen, confirmed my determination: "It probably belongs in *Physarum serpula* despite its unusually bright colour, smooth peridium, and sparsely calcareous capillitium. The spores are typical for the species, but the presence of numerous 'giant' spores indicates some degree of abnormal maturation. However, it is not *P. auriscalpium*, nor *P. decipiens, P. superbum*, or *P. alpinum*, and I would tentatively place it in *P. serpula*, at least for the time being." (Farr in litt.)

Physarum viride (Bull.) Pers. – 91, 97. *Alnus*, unspecified deciduous tree.

Mucilago crustacea Wiggers – 36. On dead mosses on a live twig of *Salix*.

Didymium crustaceum Fries – 44, 76, 89. *Alnus, Salix*.

Probably the first definite Swedish records for this species. Santesson (1964 p. 119) includes the species in his list of Swedish Myxomycetes, but refers to R. Fries (1912 p. 757), who, in turn, refers to E. Fries (1849 p. 452). According to the latter the species had been found in the province of Västergötland, but no reference material has been found in Swedish herbaria.

Didymium melanospermum (Pers.) Macbr. – 64, 104. *Alnus, Sorbus*.

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New species of Anchusa and Arenaria from Sterea Ellas, Greece

Lars-Åke Gustavsson

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Anchusa phocidica L.-Å. Gustavsson, sp. nov. (Boraginaceae) and *Arenaria gionae* L.-Å. Gustavsson, sp. nov. (Caryophyllaceae) are described. Both are chasmophytes on limestone rocks. They are endemic to Mt Giona, Sterea Ellas, Greece. The differences between these species and their closest relatives are given.

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Anchusa phocidica L.-Å. Gustavsson, sp. nov. – Figs. 1, 2

Typus: Gustavsson 6945 (LD holotypus, G, W).

Planta perennis, caespitosa, suffruticosa, tota setosa. Caules 20–30 cm longi, ascendentes ad erecti. Folia basalia rosulata, 9–14 cm longa, 6–10 mm lata, lanceolata ad lineari-lanceolata, leviter sinuata ad integra, in petiolum 2–4 cm longum sensim attenuata. Folia caulina inferiora ad 6 cm longa et 7 mm lata, sessilia, lanceolata ad lineari-lanceolata. Folia superiora caulina minora, saepe ad basin latiora, ± amplexicaulia. Inflorescentia paniculata, pluricymosa, cymis 15–25-floris, bracteis 1–5 mm longis. Pedicelli florum inferiorum c. 5 mm longi, erectipatentes, florum superiorum 1–2 mm, erecti. Calyx in anthesi 3–4 mm, in statu fructescenti 4.5–7 mm longus, saltem ad 3/5 in lobos late obtusos ad subspathulatos divisus. Corolla laete caerulea, actinomorpha; tubus 1.8–1.9 mm longus, limbus 7–8 mm in diametro, squamae vix 1 mm longae. Stamina filamentis c. 0.5 mm longis praedita. Antherae 1.0–1.1 mm longae, c. 0.6 mm latae. Stylus 1.4–1.5 mm longus. Nuculae nigrae, 3.2–3.5 mm longae, 1.7–1.9 mm latae, irregulariter reticulatae, superficie tuberculata. Numerus chromosomatum (2n) 18.

Caespitose, suffruticose perennial. Whole plant setose with simple, stout as well as slender, patent to appressed, ± tubercle-based hairs. *Stems* 20–30 cm, ascending to erect, leafy throughout and branched above. Basal *leaves* in rosettes, 9–14 cm long (including petiole), 6–10 mm broad, lanceolate to linear lanceolate, slightly sinuate to entire at margin and gradually tapering towards the 2–4 cm long petiole. Lower cauline leaves up to 6 cm long and 7 mm broad, sessile, lanceolate to linear lanceolate. Upper cauline leaves smaller and often broadest near the base, somewhat amplexicaul. *Inflorescence* paniculate with some cymes, each usually with 15–25 flowers subtended by small bracts, 1–5 mm long. Cymes strongly condensed in early anthesis, later elongating to 2.5–6 cm. Pedicels, in fruit, of lower flowers c. 5 mm and erectopatent, those of upper flowers 1–2 mm and erect. *Calyx* 2–4 mm in anthesis, in fruit elongated to 4.5–7 mm and divided to at least 3/5 into broadly obtuse to subspathulate and ± unequal lobes. Lobes appressedly hairy outside, except for the glabrous and scarious apical part, light blue when young, later becoming brown, inside glabrous except for the extreme base. Margins of calyx lobes with fine hairs at apex and with tubercle-based, rigid hairs below. *Corolla* bright blue, actinomorphic; tube 1.8–1.9 mm long, limb 7–8 mm in diameter, scales less than 1 mm. Stamens with filaments c. 0.5 mm long. Anthers 1.0–1.1 mm long and c. 0.6 mm broad, dark brown. Style 1.4–1.5 mm long in fruit, stigma capitate and c. 0.2 mm broad. *Nutlets* black, 3.2–3.5 mm long and 1.7–1.9 mm broad, irregularly reticulate, surface tuberculate. *Chromosome number* 2n = 18.

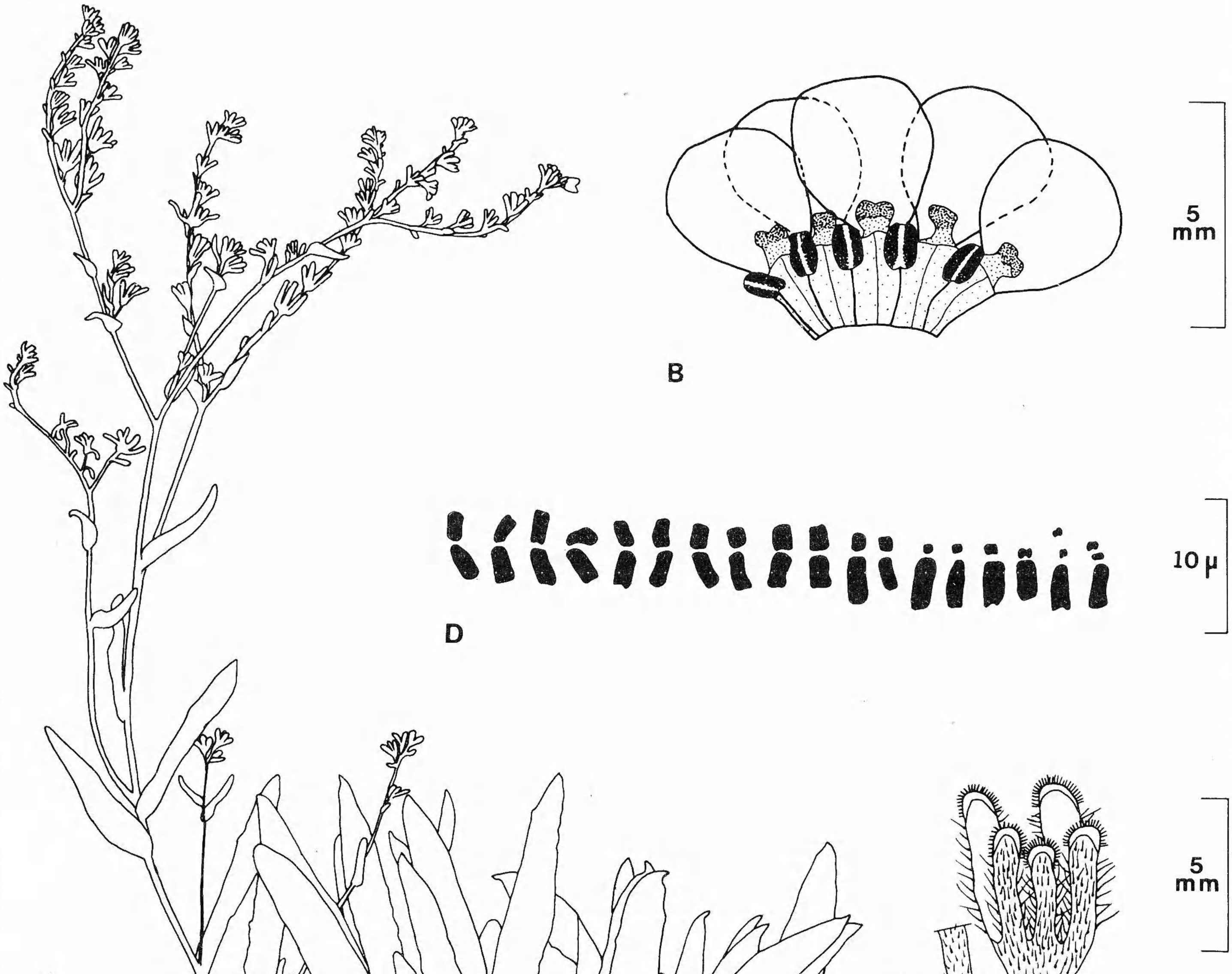

Fig. 1. *Anchusa phocidica,* type collection. – A: Habit. – B: Corolla, opened out. – C: Calyx. – D: Karyotype.

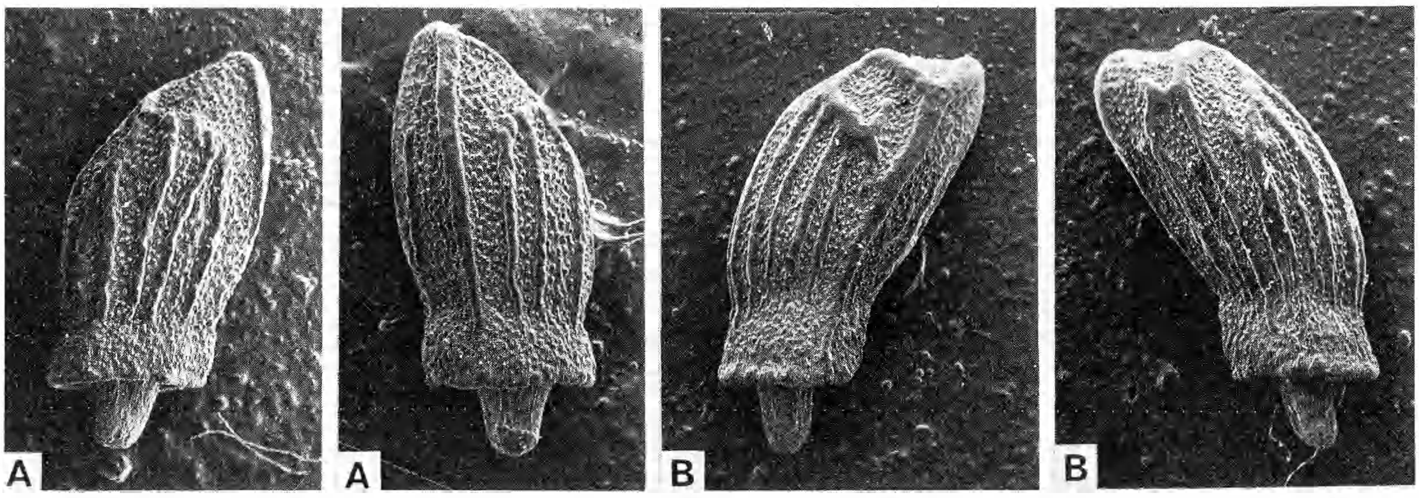

Fig. 2. A: Nutlets of *Anchusa phocidica,* type collection. – B: Nutlets of *A. serpentinicola* (Rech. fil. 17718). – × 10.

Material seen. Greece, nomos Phocis: Mt Giona, 3.5 km E of Sikea. E-facing limestone cliffs, c. 2000 m. 15.7. 1975. Gustavsson 6945.

Distribution and habitat. A. phocidica is known only from the type locality where it grows in crevices and on narrow ledges in a steep E-facing limestone cliff in the summit ridge at c. 2000 m. Only about 10 specimens have been observed, but as the habitat is situated in a vast rocky area, further finds are to be expected.

Taxonomic relationships. In his monographic treatment of *Anchusa* Gusuleac (1927) distinguishes only one species, *A. barrelieri* (All.) Vittman, under the new subgenus *Cynoglottis*. It is distributed in SE Europe from Italy eastwards to C Ukraine and in the western part of Asia Minor, but does not occur in Greece (Chater 1972). Rechinger (1960) described a second species of the same subgenus, *A. serpentinicola,* which inhabits serpentine rocks of Mt Vourinon in Nomos Kozani, N Greece. It has later also been reported from the southernmost part of Yugoslavia, where, however, it grows in crevices of limestone rocks.

Anchusa phocidica is most closely related to *A. serpentinicola* Rech. fil. These two species are distinguished from *A. barrelieri* (All.) Vittman mainly on their caespitose habit. *A. serpentinicola* differs from *A. phocidica* in having shorter and narrower leaves, up to 10 cm long and 4–7 mm broad, and more pronounced sinuate leaf margins. It also has smaller flowers: corolla limb c. 5 mm, tube 1.5–1.6 mm long and style c. 1.0 mm. Furthermore the nutlets of *A. serpentinicola* are brown, forming a pronounced angle between the collar-like ring and the rest of the nut and its surface is more weakly tuberculate (Fig. 2).

Cytology. Five plants cultivated in Lund were studied. After treatment overnight in 2 mM 8-hydroxiquinoline root tips were squashed and stained in acetoorcein.

The chromosome number was found to be $2n = 18$ (Fig. 1 D). The size varies between 3.9 and 6.3 μ. One subtelocentric pair has satellites on the short arm. There are 3 other pairs of subtelocentric and 5 pairs of metacentric–submetacentric chromosomes. Within each of these groups the individual pairs cannot be identified because of small differences in length and arm indices.

Previous cytological investigations of subgenus *Cynoglottis* have only been carried out for *A. barrelieri.* Strey (1931) counted the chromosome number for the first time and found it to be $2n = 16$, but he gives no further information on the chromosome morphology. Smith (1932) confirmed this count. The chromosome complement in his material seemed to consist of 1 subtelocentric pair with satellites on the short arm, 2 metacentric pairs and 5 submetacentric pairs. A deviating chromosome number was found by Lewitsky (1940). He found $2n = 18$, i.e. as in *Anchusa phocidica,* but no information on the chromosome structures was given.

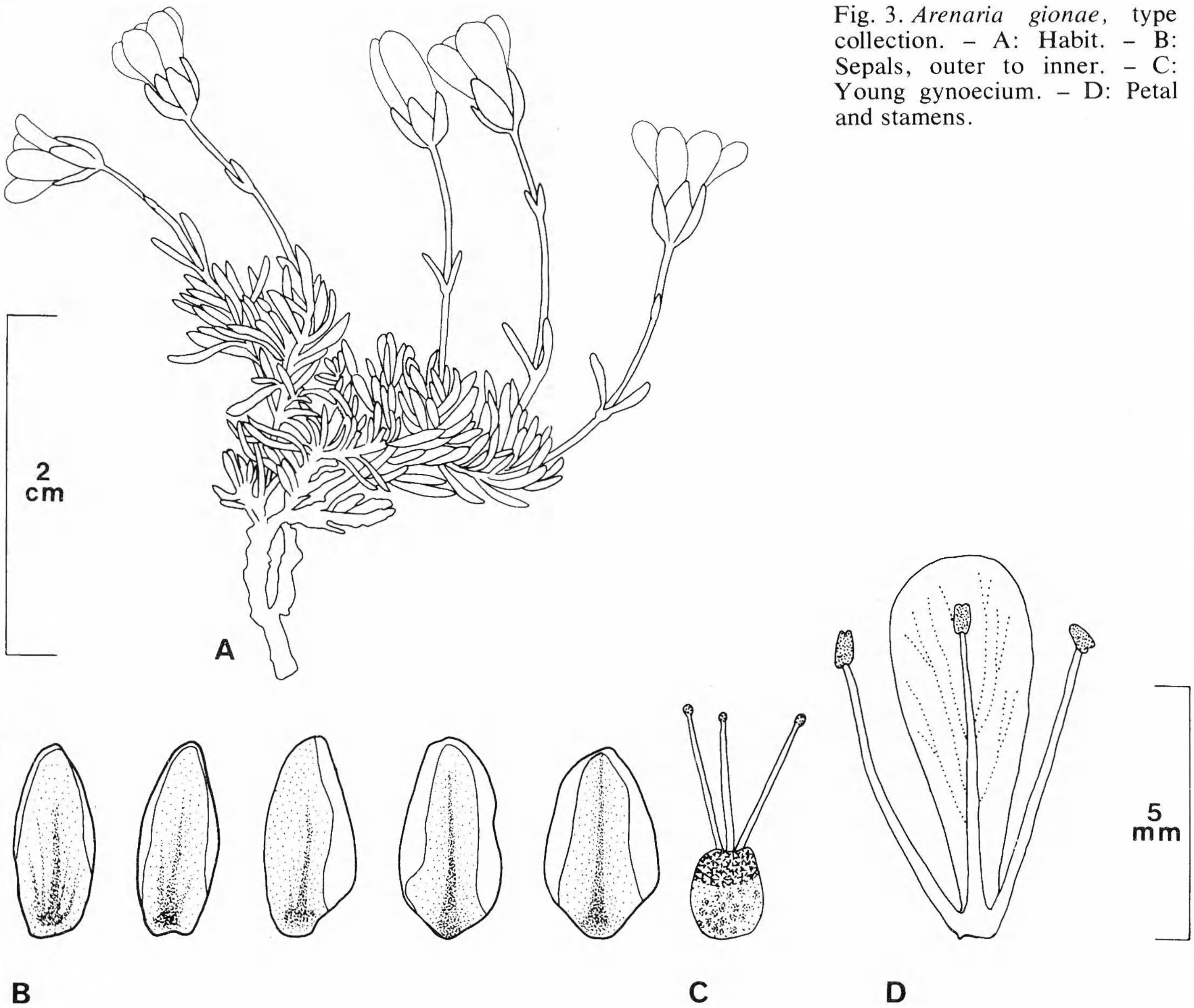

Fig. 3. *Arenaria gionae*, type collection. – A: Habit. – B: Sepals, outer to inner. – C: Young gynoecium. – D: Petal and stamens.

Arenaria gionae L.-Å. Gustavsson, sp. nov. – Fig. 3

Typus: Gustavsson 6811 (LD holotypus, G, K, UPA, W).

Herba perennis, caespitosa, glaberrima. Caules floriferi 1–2(–3) cm alti, foliis 2 oppositis, connatis. Folia 3.0–7.0 mm longa, 0.5–1.1 mm lata, 4- ad 8.5-plo longiora quam lata, anguste lanceolata ad linearia, uninervosa. Flores solitarii. Pedicelli 4–6 mm longi. Sepala ad basin carinata, 3.5–4.1 mm × 1.6–2.4 mm, exteriora lanceolata, interiora ovata. Petala 6.5–8.5 mm longa, 2.5–3.0 mm lata, obovata, ad basin leviter attenuata. Filamenta 5.0–5.5 mm longa. Antherae 0.7–0.8 mm longae, 0.5–0.6 mm latae. Styli 3. Capsula sepala paullo superans, regulariter dentibus 6 dehiscens.

Completely glabrous, caespitose to mat-forming perennial. Flowering *stems* slender, 1–2(–3) cm high, usually with 1 pair of opposite, connate leaves. *Leaves* 3.0–7.0 mm long and 0.5–1.1 mm broad, 4–8.5 times longer than broad, narrowly lanceolate to linear, crowded, 1-veined and with entire margins. *Flowers* solitary. Pedicels 4–6 mm, bracts narrowly triangular, 1.5–2 mm long. *Sepals* keeled at base, 3.5–4.1 mm × 1.6–2.4 mm, outer ones lanceolate with narrow scarious margin, inner ones ovate with a scarious margin up to 0.7 mm broad. *Petals* 6.5–8.5 mm × 2.5–3.0 mm, obovate, slightly attenuate at base. Filaments 5.0–5.5 mm, c. 0.2 mm broad at base. Anthers 0.7–0.8 mm × 0.5–0.6 mm, reddish. Styles 3, 2.3–3.2 mm long. *Capsule* slightly exceeding sepals, 3.2–3.6 mm long (when dry and with recurved teeth) and 1.9–2.4 mm broad, normally

Table 1. The most important characters separating *Arenaria gionae* from its closest relatives.

Arenaria species	Flowering stem length (cm)	Pedicel length (mm)	Number of flowers per stem	Leaves		Sepals length (mm) and shape	Hairiness
				length (mm)	length/ breadth		
bulica	<1	?	1	3–4.5	3.5–4	c. 3.5 acuminate	"asperulo-pubescens"
minutissima	1.5–3	?	1–2	1–3	2–3.5	4–4.5 shortly acuminate	stems and leaves "crispule puberulis" pedicels and sepals glandular-pubescent
antitaurica	2–4	5–15	1–2	6–10	5–7	3–5 acuminate to acute	densely glandular-pubescent
uninervia	≤4	3–10	(1–)2(–3)	5–11	3–4	3.5–4 acuminate to acute	densely glandular-pubescent
cretica	2–10	4–12	1–5	3–10	2–4.5	3–5 acute to obtuse	var. *cretica:* glandular-pubescent except for the leaves, var. *stygia:* whole plant glandular-pubescent
gracilis	2–8	7–18	(1–)2(–3)	3–8	3–5.5	3.5–5.5 acute to obtuse	stems papillose-scabrid, rest glabrous
gionae	1–2	4–6	1	3–7	4–8.5	3.5–4.1 acute to obtuse	completely glabrous

dehiscing with 6 teeth, teeth up to 1.5 mm long, acute. Seeds and chromosome number unknown.

Material seen. Greece, Nomos Phocis: Mt Giona, 6 km NW of Prosilion. Limestone outcrop on a S-facing slope at 1900–2000 m. 21.5. 1975. Gustavsson 4666. – Mt Giona, 7 km NW of Prosilion. Small limestone outcrops on E-, S-, and W-facing slopes at 2000–2150 m. 13.7. 1975. Gustavsson 6811. Typus.

Distribution and habitat. Arenaria gionae is only known from alpine habitats at altitudes of between 1800 and 2200 m on Mt Giona. It is an obligate chasmophyte occurring in minute limestone crevices on E-, S- and W-facing slopes in the NE part of the Giona massive, about 6–7 km N–NW of Prosilion. In addition to the collections *A. gionae* has been observed in several localities within this area.

Taxonomic relationships. Arenaria gionae belongs to section *Rariflorae* Williams (cf. McNeill 1962, 1963). Its closest relatives are in Iran, Turkey and on the Balkan Peninsula and Crete. In each of these three geographical areas two closely related species are endemic: *A. bulica* Stapf ex Williams and *A. minutissima* Rech. fil. & Esfandiari from Iran, *A. antitaurica* McNeill and *A. uninervia* McNeill from the Anti-Taurus Mt in southern Turkey (Davis 1967) and *A. cretica* Sprengel and *A. gracilis* Waldst. & Kit. from the Balkan Peninsula and Crete (Chater & Halliday 1968, Halácsy 1901). The most important differences between these species and *A. gionae* are given in Table 1. It is evident from the table that *Arenaria gionae* can be easily separated from the other species of section *Rariflorae* by its short flowering stems, short pedicels, solitary flowers, linear leaves (4–8.5 times longer than broad) and in being completely glabrous.

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Morphology of Ploiarium alternifolium and the taxonomic position of Ploiarium

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Prakash, N. & Lau, Y. Y. 1976 10 22: Morphology of Ploiarium alternifolium and the taxonomic position of Ploiarium. *Bot. Notiser 129:* 279–285. Stockholm. ISSN 0006-8195.

The morphology, anatomy and embryology of *Ploiarium alternifolium* (Vahl) Melchior is described. The stomata are paracytic and idioblasts containing druses and tannin are common in leaves. The young stem shows a spongy cortex, groups of pericyclic fibres and a heterogeneous pith. Pith cells with druses and starch are seen in the root. In the wood the pores are solitary and contain vessel deposits and tyloses. The parenchyma is mostly apotracheal diffuse. The rays are heterogeneous and are uni- or biseriate. Bordered pits are present on the lateral walls of vessels and fibres. The flowers are bisexual, regular and white. There are numerous stamens in five bundles. The anther wall is 4-layered – the innermost constituting the Secretory tapetum. Pollen is tricolporate and 2-celled. The ovules are numerous, anatropous, tenuinucellate, bitegmic and conspicuously elongated. Development of the embryo sac conforms to the Polygonum type. Fertilization is porogamous. The endosperm is nuclear. The mature embryo is straight and much elongated. The fruit is a capsule that dehisces from the base upwards. Available anatomical and embryological evidence justifies the inclusion of *Ploiarium* in the Bonnetiaceae rather than the Theaceae.

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Ploiarium, earlier known as *Archytaea* owing to confusion with that South American genus, contains three species occurring chiefly in South East Asia but extending to New Guinea. It has been variously included in the Theaceae and the Bonnetiaceae by different taxonomists. Airy Shaw (in Willis & Airy Shaw 1973) and Hutchinson (1973) have included the genus in the Bonnetiaceae which formed the tribe Bonnetieae in the Theaceae of Engler (see Melchior 1964). While the Bonnetiaceae of Airy Shaw has three genera, *Archytaea, Bonnetia* and *Ploiarium,* that of Hutchinson includes four additional genera from the Guttiferae – *Caraipa, Haploclathra, Kielmeyera* and *Mahurea*. The latter author spelled *Ploiarium* as *Ploiarum*. Based on anatomical differences Metcalfe & Chalk (1950) recognised Bonnetiaceae but left *Ploiarium* in the Theaceae.

This study on the vegetative anatomy and embryology of *Ploiarium alternifolium* (Vahl) Melchior seeks to clarify the systematic position of the genus in the light of data from internal morphology.

Material and methods

Plant specimens were collected along Rawang–Batu Arang Road about 20 miles North of Kuala Lumpur, Malaysia and also from the University of Malaya campus. Both vegetative and reproductive materials were fixed on the spot in FAA (in 70% alcohol) and placed in a vacuum chamber for 15 minutes to remove air bubbles from larger buds and flowers. After at least 48 hours in the fixative, young roots and stems were placed in a 1:1 mixture of glycerine and 70% alcohol overnight to bring about softening. The wood blocks were treated with 50% aqueous hydrofluoric acid for 48 hours. Following routine dehydration and embedding procedures (Sass 1958), sections were cut on a microtome at 10–15 microns. These were double stained with 1% alcoholic safranin '0' (1 hr) and 0.5% alcoholic fast green F.C.F.

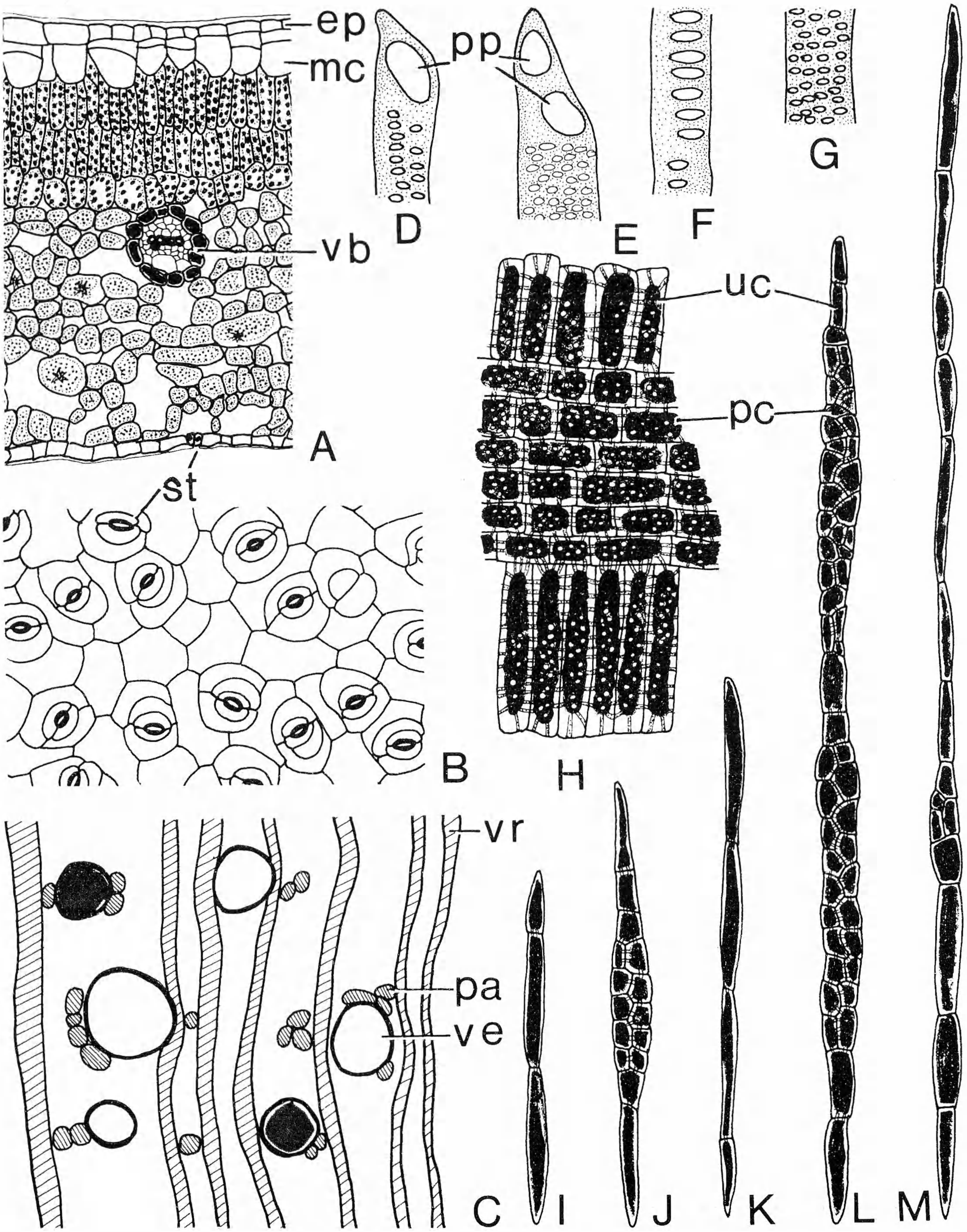

Fig. 1. Vegetative anatomy (ep epidermis, mc mucilage cell, pa parenchyma, pc procumbent ray cell, pp perforation plate, st stomata, uc upright ray cell, vb vascular bundle, ve vessel, vr vascular ray). – A: T.s. leaf. – B: Peel from lower epidermis. – C: T.s. wood from stem. – D–G: Portions of vessel members from macerated wood. – H: R.l.s. of ray. – I–M: T.l.s. of rays. – A, C, H–M × 110, B × 540, D–G × 220.

(15 seconds). A voucher specimen (accession no. KLU 21058) was deposited in the herbarium at the Department of Botany, University of Malaya.

Results

General morphology

The plant is an evergreen shrub reaching a height of about 6 meters in marshy acidic soil in association with *Nepenthes gracilis*. The leaves are oblong-lanceolate, shiny, green on the adaxial side but yellowish green on the abaxial side, up to 8 cm long and 2.5 cm broad, and with minutely toothed pink edges.

The flowers are solitary, bisexual, pentamerous, axillary, borne on pedicels 2–3 cm long. There are two bracts below the calyx. The sepals are green but with a pink margin while the petals are white. There are numerous stamens which are grouped into five bundles. The gynoecium is pentacarpellary, syncarpous and contains numerous greatly elongated ovules borne on axile placentae. There are five nectaries at the base of the ovary. The fruit is a septicidal capsule splitting from the base to the apex into five parts which are supported by a central column. The styles persist in the fruit.

Leaf anatomy

The leaf is thick and dorsiventral. The upper epidermis is devoid of stomata and is lined by a thick layer of cuticle. Underneath this is a layer of mucilaginous hypodermal cells (Fig. 1 A). The mesophyll consists of 2–4 layers of palisade tissue, the lowermost cells of which grade into the spongy tissue which forms up to two-thirds of the thickness of the lamina and shows numerous idioblasts containing druses and tannins. No sclereids are observed in the leaf. The leaf base is decurrent and therefore a distinct petiole is absent. The midrib contains a U-shaped vascular strand. This is accompanied by several smaller lateral veins. There are numerous stomata on the lower epidermis. Each guard cell is accompanied by a parallel subsidiary cell and the stomata are of the rubiaceous or paracytic type (Fig. 1 B).

Stem anatomy

The outline of the young stem is circular. The cortex is about 12 layers thick and is composed of an outer zone of compact parenchyma cells and an inner zone of spongy tissue containing prominent intercellular spaces. There are druses in some cortical cells and irregularly shaped sclereids in between. The endodermis is not distinct. The pericycle is heterogeneous and contains isolated groups of fibres. The vascular cambium is continuous and produces phloem towards the periphery and xylem towards the centre. The phloem fibres are thick-walled and elongated. There is a distinct parenchymatous pith containing numerous tanniniferous cells. The cork is subepidermal in origin and although the cells remain thin-walled they accumulate tannin.

Wood anatomy

Wood in roots and stems is essentially similar. Vessels are diffusely porous, predominantly solitary (Fig. 1 C) and often contain vessel deposits and balloon-shaped tyloses. Pores small (diameter 75–100 microns). Mean member length 0.7 to 1 mm. Perforation plate simple and oblique (Fig. 1 D). Occasionally two perforation plates on an end wall (Fig. 1 E). Intervascular pitting scalariform to opposite, large (Fig. 1 F, G). Wood parenchyma mostly apotracheal diffuse but a few paratracheal scanty. Rays uni- and biseriate, 3–30 cells high, mostly Krib's heterogeneous type II (Fig. 1 I–L) but some (Fig. 1 M), type I. Ray cells gorged with tannins and interconnected through numerous simple pits on their thickened radial walls (Fig. 1 H). Fibres with bordered pits on both radial and tangential walls which are moderately thick.

Root anatomy

In addition to normal roots, stilt roots are present at the base of the stem. The phellogen is initiated in the roots below the epidermis very early in development – even before the vascular cambium becomes active. The cork cells are suberised and accumulate tannin. The cortex is about 12 layers thick as in the stem but the intercellular spaces are more abundant in the root. The sclereids and crystals are also

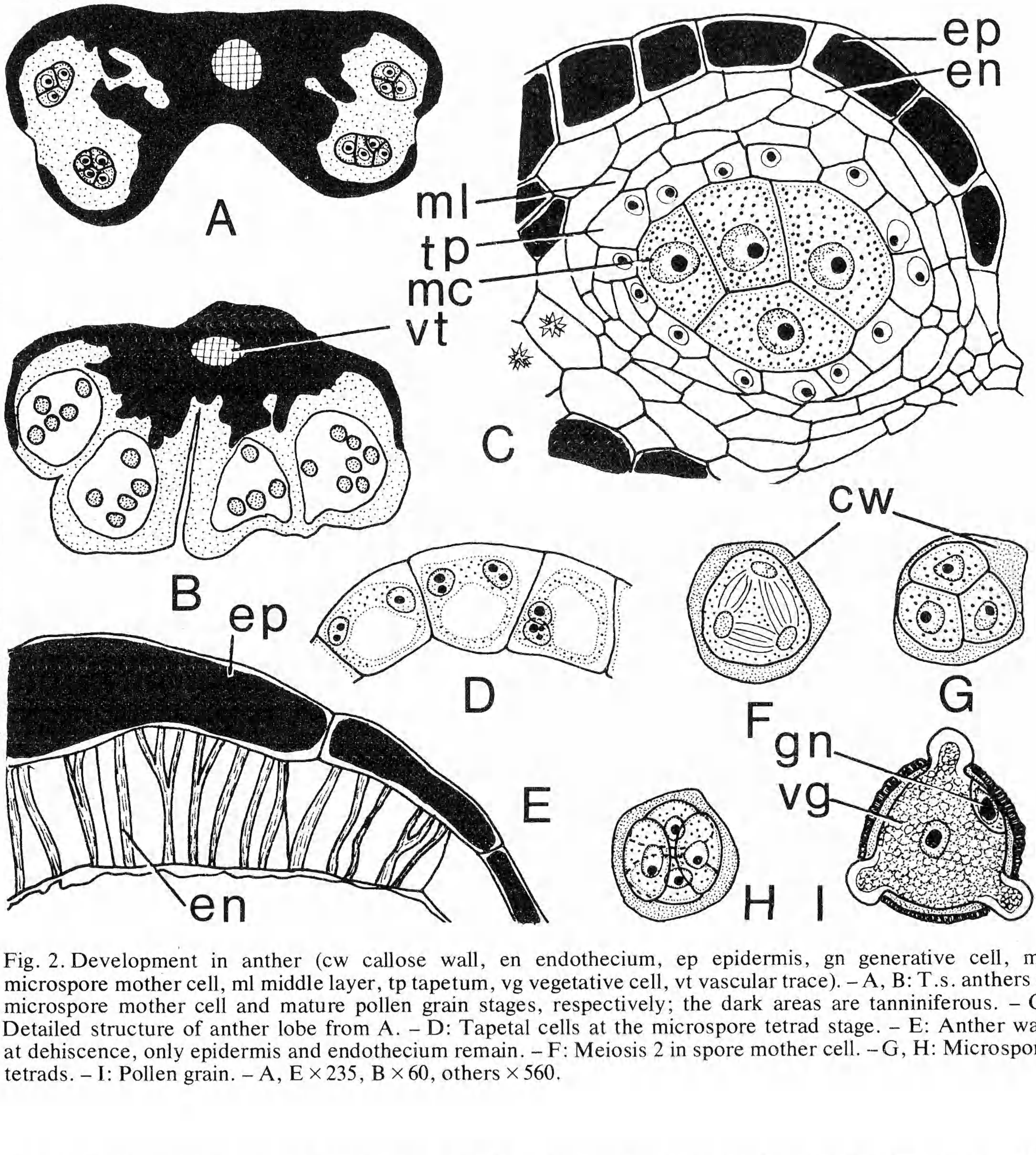

Fig. 2. Development in anther (cw callose wall, en endothecium, ep epidermis, gn generative cell, mc microspore mother cell, ml middle layer, tp tapetum, vg vegetative cell, vt vascular trace). – A, B: T.s. anthers at microspore mother cell and mature pollen grain stages, respectively; the dark areas are tanniniferous. – C: Detailed structure of anther lobe from A. – D: Tapetal cells at the microspore tetrad stage. – E: Anther wall at dehiscence, only epidermis and endothecium remain. – F: Meiosis 2 in spore mother cell. – G, H: Microspore tetrads. – I: Pollen grain. – A, E × 235, B × 60, others × 560.

more abundant as compared with the stem. The endodermis is not very distinct from the inner cortical layers. The xylem is diarch with two alternating phloem strands. The pith cells usually have tannin, crystals or starch grains.

Anther development

The anthers are tetrasporangiate (Fig. 2 A, B) and are supplied with a single vascular trace. Tannin deposition takes place very early in anther development in the cells of the connective and the epidermis. Crystals in the form of druses are common in the connective.

The anther wall at the microspore mother cell stage (Fig. 2 C) consists of four layers of cells lying below the epidermis. These are endothecium, two middle layers and the secretory tapetum. The endothecium develops fibrous bands before the dehiscence of the anther (Fig. 2 E). The epidermis is persistent. The middle layers are ephemeral. The tapetal cells

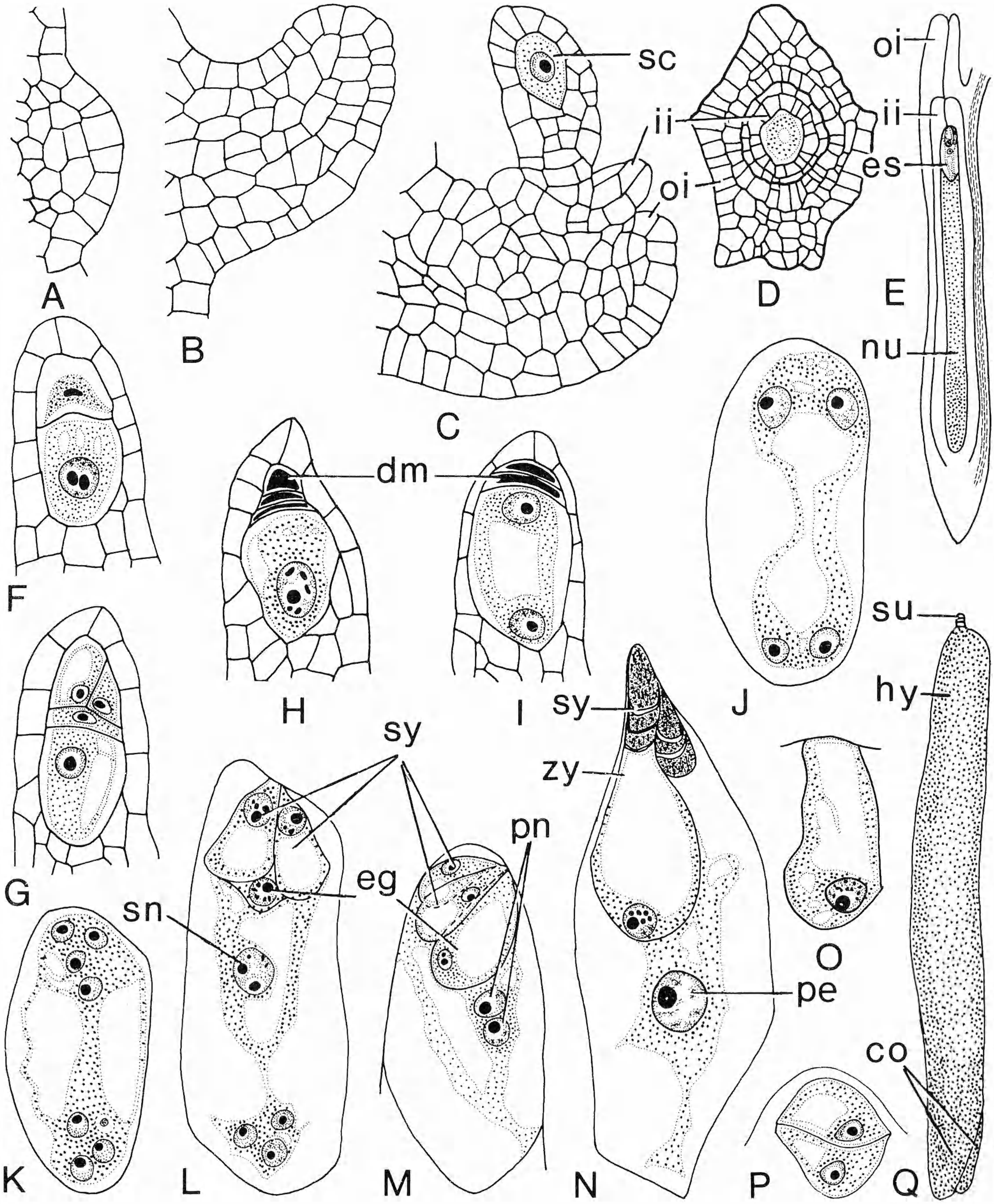

Fig. 3. Development in ovule and seed (co cotyledon, dm degenerating megaspores, eg egg, es embryo sac, hy hypostase, ii inner integument, nu nucellus, oi outer integument, pe primary endosperm nucleus, pn polar nuclei, sc sporogeneous cell, sn secondary nucleus, su suspensor, sy synergid, zy zygote). – A, B: L.s. ovular primordia. – C: L.s. young ovule, the integuments are just initiated. – D: T.s. ovule. – E: L.s. ovule. – F: L.s. nucellus showing a dyad, the upper cell is degenerating. – G, H: Megaspore tetrads. – I: Two-nucleate embryo sac with remnants of a dyad cell and a megaspore. – J, K: Four- and eight-nucleate embryo sacs. – L, M: Organised embryo sacs, antipodals still seen in L. – N: Fertilized embryo sac. – O: Zygote. – P: Two-celled proembryo. – Q: Mature embryo. – E, Q × 45, D × 190, others × 470.

(Fig. 2 D) become binucleate at the time of meiosis in the microspore mother cells. In the transverse section of an anther there are three or four sporocytes in each sporangium. Meiosis in these followed by simultaneous cytokinesis results in tetrahedral and decussate microspore tetrads (Fig. 2 F–H). The callose wall of the microspore mother cells becomes gelatinous in appearance as meiosis proceeds and disintegrates soon after the microspores are formed, thus releasing them in the sporangial cavity. The mature pollen grains are tricolporate, have a thick ornamented exine, and are two-celled (Fig. 2 I). Rarely 4-colporate grains are found.

Megasporangium

Numerous ovules are borne on axile placentae. Each ovule arises as a protuberance which gradually undergoes curvature and differentiates into an ovule (Fig. 3 A–C). The ovules are anatropous, bitegminal and tenuinucellar. The ovules are conspicuously elongated; the width to length ratio being 1 to 10 or more (Fig. 3 E). There is a very long and massive nucellar tissue present below the oblong embryo sac which at maturity occupies only the terminal eighth of the length of the nucellus. Much of it therefore persists into the seed and is gradually but completely consumed by the developing endosperm. The classification of the ovule as tenuinucellar despite the presence of massive chalazal nucellar tissue is because in the formation of the megaspore mother cell the archesporial cell does not cut off a parietal cell (see Davis 1966). Both the integuments form the micropyle. The outer integument consists of three layers of cells and the inner two layers (Fig. 3 D) before fertilization of the ovule. There is a slight increase in the number of layers in each integument in the seed in which the cells become generally enlarged and accumulate tannin but otherwise remain unmodified.

Megasporogenesis and development of the female gametophyte

There is a single subepidermal archesporial cell which enlarges and directly becomes the sporogenous cell (Fig. 3 C). With further enlargement and onset of meiosis it becomes the megaspore mother cell. A parietal cell is not cut off prior to its formation. Meiosis in the megaspore mother cell usually results in four megaspores arranged in either linear or T-shaped manner (Fig. 3 G, H). The micropylar megaspores degenerate while the chalazal is functional. However, sometimes the upper dyad cell fails to divide and degenerates as such (Fig. 3 F, I). The nucleus of the single functional megaspore divides and a vacuole separates the daughter nuclei (Fig. 3 I). Two successive mitoses in this embryo sac give rise to four and eight-nucleate gametophytes (Fig. 3 J, K). The eight nuclei then organise into a pattern characteristic of the Polygonum type of embryo sac (Fig. 3 L). The antipodal nuclei are not seen to form cells and degenerate either before (Fig. 3 M) or after the fusion of the two polar nuclei (Fig. 3 L).

Seed

Both the synergids degenerate after the porogamous double fertilization. The zygote and the primary endosperm nucleus are the only constituents of the embryo sac in the seed for a long time after fertilization. Seeds collected at regular intervals for four weeks from enlarging fruits always showed this stage. The zygote divides transversely (Fig. 3 O, P). In the material collected by us we could not observe further development of the embryo except in the seeds at the time of dispersal which contained a strikingly elongated, straight, narrow, cylindrical embryo with two terminal equal cotyledons and a short uniseriate suspensor (Fig. 3 Q).

Discussion

Metcalfe & Chalk (1950) described in the leaves of *Ploiarium* idioblasts which are almost circular or rectangular, slightly thickened and mostly solitary, and they included a figure depicting the structure of a vascular ray and transverse section of the wood. While including the genus in the Theaceae, they suggested that its possible exclusion from the family along with certain others would leave Theaceae with genera which are much more uniform in structure. We confirm the presence of circular idioblasts containing either tannin or druses in the leaf and the points of wood anatomy illustrated by them for the genus.

We further find that like *Archytaea, Ploiarium* also shows decurrent leaf bases, paracytic stomata and subepidermal thin-walled cork which are characters common to *Bonnetia* as well. The two former genera, however, differ in the nature of the pericycle which is entirely sclerified in *Archytaea* but is heterogeneous in *Ploiarium*. Like *Bonnetia* (Metcalfe & Chalk 1950), *Ploiarium* also has vessels with simple perforations, heterogeneous rays which are 1–3 cells wide, stem cortex with sclereids and phloem with fibres.

There is no embryological work on any other genus of the Bonnetiaceae of either Airy Shaw (Willis & Airy Shaw 1973) or Hutchinson (1973). In the Theaceae itself detailed embryology of only *Camellia* is known (Kapil & Sethi 1963, Sethi 1965). There are some important differences in the embryological characters of *Camellia* and *Ploiarium*. *Ploiarium* shows a monosporic Polygonum type of embryo sac development, whereas *Camellia* (Bawa 1970) shows a bisporic Allium type of development. The shape of the ovule and the structure of the mature embryo are also markedly different in the two taxa. A hypostase is present in *Camellia* but not in *Ploiarium*. There are none the less significant similarities between them in the structure of and development within the anthers. In both taxa the ovules are anatropous, bitegmic and tenuinucellar. Both show a nuclear endosperm.

Taking into account characters from both vegetative anatomy and embryology, we support the removal of *Ploiarium* from the Theaceae and, based on evidence so far available, its placement in the Bonnetiaceae.

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The distribution of characters within an angiosperm system

2. Sieve-element plastids

H.-Dietmar Behnke and Rolf Dahlgren

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In plastids of sieve elements are usually found ergastic accumulations of starch (S) and/or protein (P). The P-type of accumulations are restricted to certain groups of angiosperms and are of different subtypes, which prove characteristic to particular groups of plants. One subtype, with more or less cuneate protein bodies, is found in all the monocotyledonous taxa so far investigated, which are scattered over most orders distinguished. A similar shape of protein bodies is found only in *Asarum* of Aristolochiaceae among the dicotyledons. A second P-subtype, where protein filaments form a ring-shaped structure around a light matrix, is characteristic of all taxa of Caryophyllales studied. Other subtypes of P-plastids are found in families of Magnoliales, Aristolochiales and Laurales in the superorder Magnolianae, in all three families of Fabales (Rosanae), in Vitaceae and Leeaceae within Rhamnales (Celastranae), and in some other more scattered genera: *Eucryphia, Ulmus, Rhabdodendron* and (probably) in *Brassica* and *Capparis*. Both starch and protein accumulations occur in the sieve elements of gymnosperms, however, the P-type is restricted to Pinaceae. The possible relationships of groups with P-type plastids in sieve elements are discussed.

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During the last decade the ultrastructure of the sieve-element plastids has been extensively investigated by one of us (H.-D. B.). The following account is based primarily on published reports (e.g. status reviews by Behnke 1972, 1975 c, 1976) but also contains unpublished results on various taxa (investigated by Behnke or other authors).

In plastids of sieve elements there are two major kinds of ergastic accumulations, viz. starch or protein. The micromorphology of these accumulations which is used to define different types and subtypes of sieve-element plastids has proved to be characteristic of larger groups of taxa, and therefore gives interesting and useful information to be used in further considerations on interrelations among angiosperms.

The investigations on occurrence of the different types of sieve-element plastids have not been completed, but some patterns of the distribution are taking shape and contribute interesting possibilities.

Types of sieve-element plastids

A primary distinction can be made between sieve elements with accumulations consisting of proteins (*P-type plastids*) and those lacking protein, which is usually combined with presence of starch (*S-type plastids*). P-type sieve-element plastids may also contain starch grains in addition to the protein accumulations.

The presence of protein-accumulating plastids is restricted to certain groups in the angiosperm system (Fig. 1). They are found in: (A) all monocotyledons so far investigated; (B) the

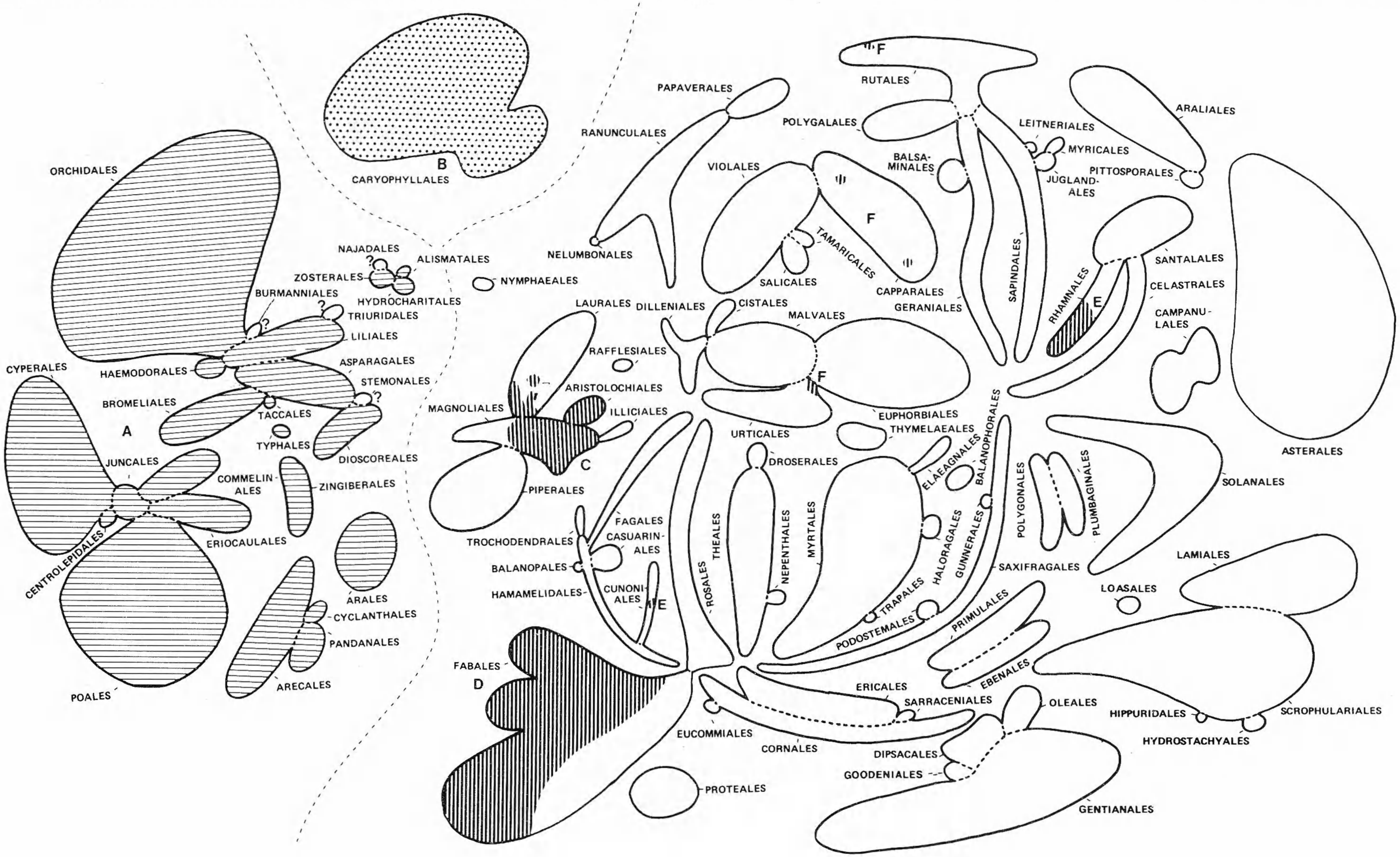


Fig. 1. Distribution of sieve-element plastids with protein accumulations (shaded groups). The different types of shading denote largely different kinds of protein inclusions. The letters refer to the grouping in the text. – A: Monocotyledons. – B: Caryophyllanae. – C: Magnolianae. – D: Fabanae. – E: Vitaceae and Rhamnaceae (Rhamnales) in Celastranae and Eucryphiaceae (Cunoniales) in Hamamelidanae. – F: *Ulmus* (Ulmaceae, Urticales) in Dillenianae, *Rhabdodendron* (preliminarily in Rutaceae, Rutales) in Rutanae, and *Capparis* (Capparidaceae) and *Brassica* (Brassicaceae) in Capparales, Violanae. – White areas among dicotyledons represent groups having sieve elements with starch inclusions only or groups not yet investigated. The orders among monocotyledons where no representative has yet been studied are white but supplied with a question-mark.

superorder Caryophyllanae; (C) a number of families in superorder Magnolianae, viz. the orders Magnoliales, Aristolochiales and Laurales: Annonaceae, Canellaceae, Eupomatiaceae, Monimiaceae (incl. Atherospermataceae), some Lauraceae and Magnoliaceae, Hernandiaceae, Calycanthaceae and Aristolochiaceae; (D) the families of Fabales: a few genera studied in Mimosaceae and Caesalpiniaceae and a considerable number of genera in Fabaceae (though P-type plastids are lacking in several other genera in the last-mentioned family); (E) the families Vitaceae and Leeaceae of Rhamnales and the family Eucryphiaceae of Cunoniales (Saxifragales?); and finally, (F) a few interesting genera, viz. *Ulmus* (but not in other genera of Ulmaceae), *Rhabdodendron* (but not in other Rutaceae), and *Brassica* as well as *Capparis* (Capparales).

The S-type plastids are presumed to occur in virtually all groups of dicotyledons except those mentioned and are therefore of subordinate interest in this context. However, it is of crucial importance to note, for example, the absence of P-type plastids and the presence of S-type plastids, in some families now excluded from, for example, Caryophyllanae.

The P-type plastids can be divided into a number of subtypes and forms as shown by electron microscopy (Behnke 1975 a, b, 1976). The subtypes to a reasonable degree are characteristic of some of the groups of plants mentioned above.

Protein may be present in the sieve tubes in the form of crystalloids, digested by 0.5% pepsin and mostly by 0.3% trypsin, and/or in the form of protein filaments which under the experimental conditions used were not attacked by these enzymes. The ultrastructural morphology of the protein inclusions, i.e. the size, shape and arrangement of crystalloids and/or filaments, can be used for characterizing some subtypes.

The monocotyledonous subtype – Fig. 3 A–B

In the monocotyledons, the protein inclusions are variably large, cuneate crystalloids normally found in considerable numbers. Protein filaments are lacking. P-type plastids have been demonstrated for a great variety of genera (distributed among orders according to Dahlgren 1975):

Alismatales: *Hydrocleis, Echinodorus.* – Hydrocharitales: *Butomus, Elodea.* – Zosterales: *Potamogeton.* – Dioscoreales: *Dioscorea, Tamus.* – Asparagales: *Smilax, Ruscus, Asparagus, Dracaena, Sansevieria, Yucca, Anthericum, Agave, Muscari, Allium, Sprekelia.* – Taccales: *Schizocapsa, Tacca.* – Haemodorales: *Xiphidium, Eichhornia, Philydrum.* – Liliales: *Gloriosa, Liriope, Iris, Alstroemeria.* – Orchidales: *Anoectochilus, Vanda.* – Bromeliales: *Billbergia, Tillandsia, Orthophytum, Vriesea, Vellozia.* – Typhales: *Sparganium, Typha.* – Zingiberales: *Musa, Hedychium, Costus, Canna, Calathea.* – Commelinales: *Dichorisandra, Spironema, Tinantia, Tradescantia.* – Eriocaulales: *Eriocaulon.* – Juncales: *Juncus, Luzula.* – Cyperales: *Scirpus.* – Centrolepidales: *Centrolepis.* – Poales: *Restio, Flagellaria, Avena, Hordeum, Oryza, Phleum, Saccharum, Secale, Setaria, Sorghum, Triticum, Zea.* – Arecales: *Arenga, Caryota, Chamaedorea, Chamaerops, Cocos, Elaeis, Livistona, Nypa, Phoenix, Prestoea, Rhapis, Roystonea, Washingtonia.* – Pandanales: *Pandanus.* – Cyclanthales: *Carludovica.* – Arales: *Arum, Dieffenbachia, Typhonodorum, Lemna.*

This is a representative list and indicates that the monocotyledons exhibit a high degree of homogeneity as regards this character. One significant fact is that *Butomus, Hydrocleis* and *Echinodorus* have the typical monocotyledon P-type plastids whereas in the similar *Cabomba, Nuphar* and *Nymphaea,* all in Nymphaeales, the plastids are S-type. In some species of *Piper* and *Peperomia* and in *Houttuynia* and *Saururus,* all in Piperales, there are also S-type plastids, but there are P-type plastids in Arales (which agrees with Piperales in a number of features). Finally, *Dioscorea* (Dioscoreales) has the monocotyledon P-type plastids although this genus exhibits many dicotyledonous traits. All this indicates that the monocotyledons are perhaps a more homogeneous group than is sometimes considered.

The Caryophyllanae subtype – Fig. 3 C–D

In the superorder Caryophyllanae, which consists of the single order Caryophyllales, the sieve-element plastids are of a subtype not found in any other angiosperms. Protein filaments are always present and are organized into a peripheral ring-shaped structure around a light matrix. Crystalloids are also often present as globular or polygonal bodies. The absence of crystalloids or their specific micromorphology

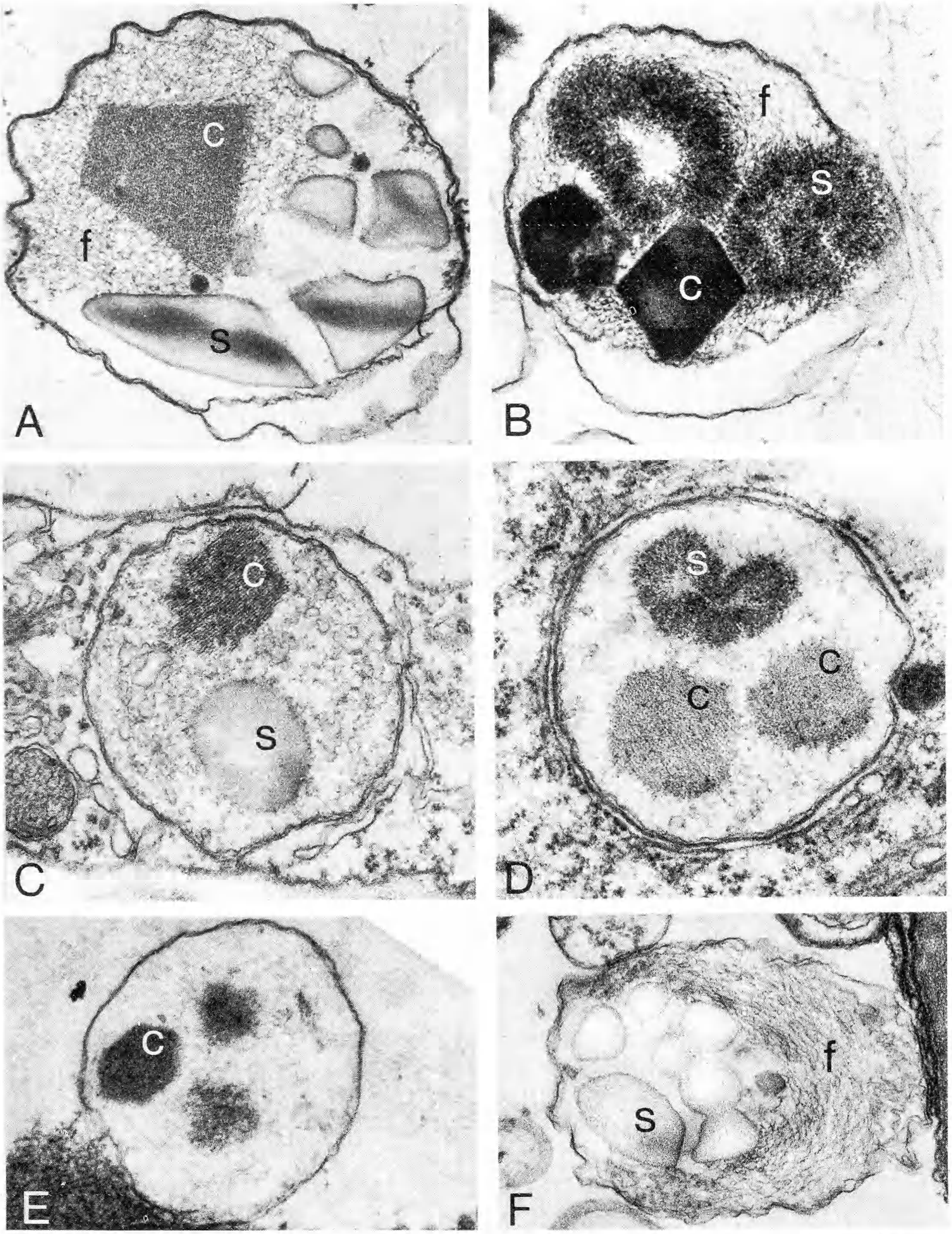


Fig. 2. Sieve-element plastids in families of Magnolianae (A–C, F), Vitaceae (D) and Eucryphiaceae (E). Polygonal protein crystalloids (c) are present in A–E and protein filaments (f) in A, B and F. Starch inclusions: s.

are used to distinguish between three different forms of this subtype (Behnke 1976). Starch is only rarely present. Though present in three forms this subtype seems to characterize a homogeneous group, the Caryophyllanae (Dahlgren 1975), comprising the following families (of which a considerable number of genera have been shown to have this specific subtype): Phytolaccaceae (incl. *Lophiocarpus*), Agdestidaceae, Stegnospermataceae, Achatocarpaceae, Nyctaginaceae, Aizoaceae, Molluginaceae, Didiereaceae, Cactaceae, Portulacaceae, Hectorellaceae, Basellaceae, Chenopodiaceae (incl. Dysphaniaceae), Halophytaceae, Amaranthaceae and Caryophyllaceae.

This very characteristic subtype of protein-accumulating plastids contributes to making Caryophyllanae a very distinct group. Other characteristic features are the starch-rich perisperm usually surrounded by a curved embryo, the common presence of betalains, the mainly campylotropous or amphitropous ovules, the almost constantly bitegmic, crassinucellate ovules, the nuclear endosperm formation, the 3-nucleate pollen grains, etc. In these features alone Caryophyllanae stands out as entirely distinctive, probably meriting of being placed on a level with the mono- and dicotyledons (cf. Dahlgren 1975 Fig. 2).

The exclusion from Caryophyllanae of Bat(id)aceae, Gyrostemonaceae, Theligonaceae, Polygonaceae and Plumbaginaceae, which all lack P-type plastids, is supported by other features. Thus, for example, all of them lack perisperm with starch; the starch in Plumbaginaceae and Polygonaceae being formed in the endosperm.

The subtype in Magnolianae – Fig. 2 A–C, F

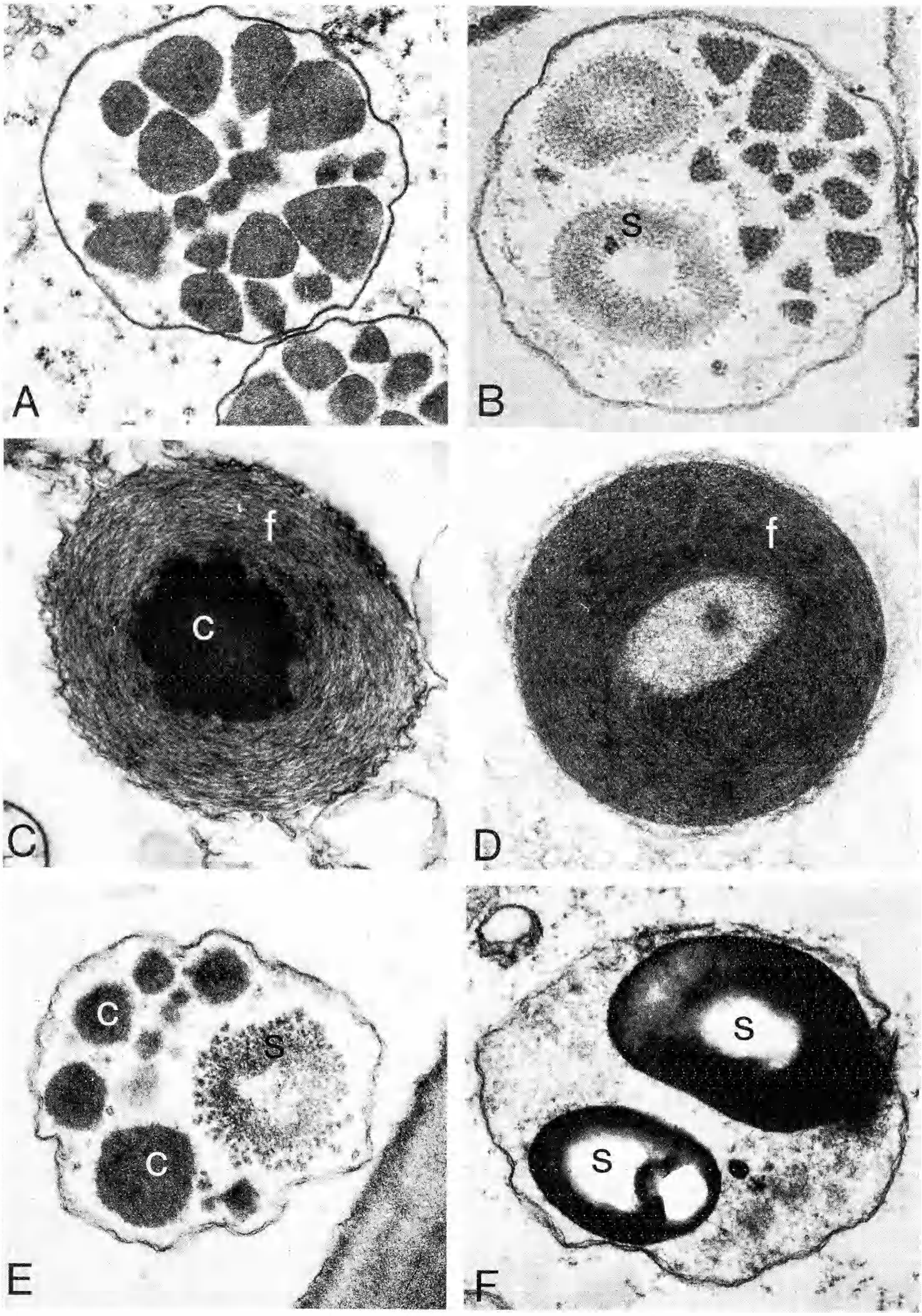
In the superorder Magnolianae, conditions differ markedly from the monocotyledons and Caryophyllanae. For example, P-type sieve-element plastids are found only in certain families: Annonaceae, Canellaceae, Eupomatiaceae, Aristolochiaceae (Fig. 2 A), Calycanthaceae, Monimiaceae (Fig. 2 B), Hernandiaceae (Fig. 2 C), and some Lauraceae and Magnoliaceae. Secondly, their micromorphology is so variable that at least three different forms can be defined in this subtype. The protein is usually found in the form of a single, polygonal crystalloid in these families, but in *Asarum* (of Aristolochiaceae) there are several cuneate bodies (as in monocotyledons). The size of the protein bodies may be large, small or variable in Magnolianae. Separate, irregularly to regularly arranged protein filaments are sometimes present in Annonaceae, Canellaceae, Calycanthaceae, Monimiaceae, and Aristolochiaceae. Occasionally, viz. in *Canella* (Fig. 2 F), crystalline bodies are not formed at all, protein filaments prevailing instead.

The great variation in the shape of P-type plastids in Magnolianae probably indicates primitiveness. Like other characters, such as the presence and types of benzylisoquinoline alkaloids and the presence of cells with essential oils, the P-type plastids denote relationships within Magnolianae.

Starch inclusions are usually present in the sieve-element plastids in Magnolianae. Thus lack of protein and presence of starch (i.e. S-type plastids) only would be expected as the result of reduction in the course of evolution in the group. This is found in several families, such as Austrobaileyaceae, Winteraceae, Myristicaceae, Chloranthaceae and some Lauraceae and Magnoliaceae.

The Fabales subtype – Fig. 3 E

In the order Fabales (of superorder Rosanae in Dahlgren 1975), conditions are variable and still incompletely known, though the results so far are somewhat unexpected. The protein inclusions in Fabales usually consist of few to many, irregularly shaped crystalloids of variable size. This subtype of protein-accumulating sieve-element plastids has been found in genera of all three families in Fabales, viz. in Mimosaceae: *Acacia* and *Mimosa*, Caesalpiniaceae: *Bauhinia*, *Cassia*, *Cercis* and *Gleditsia*, and in Fabaceae: *Astragalus*, *Coronilla*, *Dalea*, *Lotus*, *Lupinus*, *Medicago*, *Melilotus*, *Ononis*, *Petalostemum*, *Pisum*, *Trifolium* and *Wisteria*. Apart from the protein deposits starch inclusions are also usually present in the sieve-element plastids of these genera. Protein was found to be absent in some genera of Fabaceae, however, the plastids thus being classified as S-type (Fig. 3 F). These genera are: *Baptisia*, *Desmodium*, *Dolichos*, *Galega*, *Glycine*, *Hippocrepis*, *Phaseolus*, *Robinia*, *Vicia* and *Voandzeia* (several of


A
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which are characterized by the presence of stipels).

P-type plastids in Vitaceae, Leeaceae and Eucryphiaceae – Fig. 2 D, E

The Rhamnales (of superorder Celastranae in Dahlgren 1975) represent another order containing S-type and P-type sieve-element plastids. While S-type plastids have been found in Rhamnaceae, e.g. its genera: *Ceanothus, Colletia, Noltea* and *Rhamnus,* the families Vitaceae and Leeaceae exclusively contain P-type plastids with polygonal protein crystalloids (Fig. 2 D), e.g. in the following genera investigated: *Ampelopsis, Cissus, Parthenocissus, Tetrastigma, Vitis* and *Leea.*

In a critical appraisal of the order Rhamnales Johnston (1974), unaware of the plastid data, proposed to separate its two suborders, placing the Rhamnineae (and its only family Rhamnaceae) next to the Rosales and the Vitineae (Vitaceae and Leeaceae) near the Saxifragales s.l. and/or Sapindales, probably as a separate order Vitales. The sieve-element plastid data tend to support this treatment in that Rosales and Rhamnineae are purely S-type taxa and as in or near Saxifragales s.l. there is one family with P-type plastids, the Eucryphiaceae (of the order Cunoniales in Dahlgren 1975). The P-subtype of *Eucryphia* (single polygonal crystalloid; Fig. 2 E) not only comes close to those in Vitineae but could also be used as a link with the P-type of Magnolianae.

Vitaceae also shows resemblance to Rutaceae and Dilleniaceae in the endo- or exotestal seed walls with tracheidal cells (Corner 1976 p. 47).

Other genera with P-type plastids

In addition to the taxa mentioned above, P-type plastids are found in *Ulmus* (Ulmaceae, Urticales), in *Rhabdodendron* (uncertain affinity, sometimes referred to Rutaceae, Rutales), and in *Brassica* and *Capparis* (placed in Capparales).

Among numerous representatives of Urticales and other orders (often referred to the Hamamelidae sensu Takhtajan) investigated for plastids only one genus proved to have P-type plastids, viz. *Ulmus.* Starch was frequently found to be absent in Urticales. The protein inclusions in *Ulmus* consist of crystalline, rectangular to rhomboid bodies. P-type plastids are lacking, however, in the material studied of *Celtis* and *Aphananthe* in the same family, and in all material studied of Urticaceae, Cannabaceae and Moraceae and, for example, in the orders Casuarinales, Fagales, Myricales, Juglandales, Leitneriales and Hammamelidales, which are sometimes associated with Urticales. The aberrant condition in *Ulmus* is noteworthy as *Ulmus* is also unique within the family in having tetrasporic embryo sacs, 3-nuclear pollen grains and samaras. So far its systematic position has however not been questioned.

The presence of P-type plastids (with small, single protein inclusions) in *Brassica* (results taken from micrographs in Favali & Gerola 1968) and *Capparis* is contrary to reports on S-type plastids in the same order. In view of the repeatedly observed difficulty in critically distinguishing the small, sometimes amorphous protein from other contents of the plastids, further investigation of a greater number of species, initiated by one of us (H.-D. B.), would probably clarify this discrepancy.

The description of P-type plastids with small polygonal inclusions in *Rhabdodendron* renders the alignment of this genus both with the S-type order Rutales (as proposed by Takhtajan 1969, Puff & Weber 1976) and the P-type Caryophyllales (as treated by Prance 1968) unsatisfactory. The specific P-type plastids of *Rhabdodendron* agrees best with some forms in the subtype of Magnolianae.

Discussion and conclusions

In the gymnosperms, P-type plastids in sieve elements are known only in the Pinaceae, whereas in all other families (Araucariaceae, Taxodiaceae, Cupressaceae, Podocarpaceae, Cephalotaxaceae) of Pinidae as well as in

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Fig. 3. Sieve-element plastids of the monocotyledon subtype (A–B), of the Caryophyllanae subtype (C–D) and of the Fabales subtype (E–F). – A–B with cuneate protein crystalloids, C–D with ring-like bundle of filaments (f) and crystalloids (c), E with polygonal crystalloids (c), and F with starch inclusions (s) only.

Taxidae there are only S-type plastids. S-type plastids are also found in the cycads and in *Ginkgo, Ephedra, Welwitschia* and *Gnetum*. The protein inclusions in the sieve elements of Pinaceae agree perhaps most closely with those of Caryophyllales, both consisting of a ring-shaped structure of filaments.

As the gymnospermous ancestors of the angiosperms are probably very distantly related to present-day gymnosperms, the conditions in the latter groups may be of little relevance in connection with the angiosperms. Still, it is of great interest that both P- and S-types are represented in the gymnosperms. This may also have been the case in the (extinct) ancestors of the angiosperms.

Behnke (1972 p. 180) discussed the possible significance of P-type plastids in angiosperms. He concludes: "If traced back along a dendrogram proposed by Takhtajan (1969) from top to base, we are led to the striking fact that there are continuously connecting lines to the Magnoliales", and ... "only the line to Caryophyllales has a gap in the Ranunculales". From this Behnke further concluded that "both P- and S-type plastids (or a combined P/S-type) were probably present in the ancestors of angiosperms" and that either P-type or S-type features have been lost in the course of phylogeny.

Provided that P-type plastids have a common origin we would presume that they were present in the ancestral angiosperms or at least in some of the earliest evolutionary branches of them. As mentioned above, they are present and quite variable within Magnolianae. Thus again we find that this group has a key position among present-day angiosperms, which has previously been supported by monosulcate pollen grains, 3-merous flowers, successive type of microsporogenesis, apocarpy, cellular endosperm formation, lack of vessels, etc. Several of these features are often regarded as primitive in angiosperms. P-type plastids would have been conserved in some plant groups, in each branch of which they have undergone divergent evolution. Thus, if P-type plastids were ever present in the common ancestors, the enzymes for the protein accumulations have been lost in most evolutionary branches, starch accumulating S-type plastids being the only ones left.

The absence of P-type plastids in Ranunculanae (Ranunculales, Nelumbonales, Papaverales) is not inconsistent with this assumption; there is no or weak direct evidence that these orders are transitional between pre-Magnolianae and Caryophyllanae.

P-type plastids may also have originated polyphyletically, i.e. along different lines of evolution. The fact that the P-type plastids differ from one another in some of the different main taxonomic groups may support this alternative. Meeuse (1970 p. 67) regarded the uniform sieve-element plastids in the monocotyledons as "another cogent argument in favour of a heterogeneity, i.e. of an independent origin of Monocots and Dicots, ...". In Magnolianae, however, sieve-element plastids have developed a considerable variation in forms. The shape of the protein bodies in *Asarum*, as one example, falls within the pattern of the monocotyledons and does not support Meeuse's argument. In this connection may be mentioned the great importance attached by El-Gazzar & Hamza (1975 p. 24) to other morphological similarities between Dioscoreaceae and Aristolochiaceae. Thus, on sieve element plastid data, a common ancestry of monocots and the Magnolianae is possible. Other features contribute to connect the two groups.

The sieve-element plastids contribute interesting information that supports previous indications of relationships. The key position of Magnolianae, in this as well as in other characters, is conspicuous, like the possible connection with the in this feature very distinctive group of monocotyledons. Like the monocotyledons, the Caryophyllanae form as a distinct group. Fabales has another subtype of P-type plastids which, although on first consideration less consistent, could represent a side branch (characterized by multiplication of protein crystalloids) of the line leading to Eucryphiaceae and Vitaceae-Leeaceae. This fact that the latter families have the same subtype of P-plastids might warrant reconsidering their affinities and discussing a closer relationship than that hitherto accepted. For the moment, the presence of P-type plastids in other groups, such as *Ulmus* and *Rhabdodendron,* gives no definite indication of other affinities of these groups than those previously suggested, while for Capparales further results should be awaited.

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Note added in proof. Gunnera (Gunneraceae, Gunnerales) has recently been investigated and found to contain P-type sieve-element plastids (Behnke, unpubl.).

Floristic reports from the high mountains of Pindhos, Greece

Björn Aldén

Aldén, B. 1976 10 22: Floristic reports from the high mountains of Pindhos, Greece. *Bot. Notiser 129:* 297–321. Stockholm. ISSN 0006-8195.

Some 50 species and subspecies are discussed. 4 new taxa are described from C and S Pindhos, viz. *Campanula pindicola, Centaurea triamularia, Lithospermum goulandriorum* ssp. *thessalicum* and *Solenanthus pindicus.* 16 species are reported as new for Pindhos, 5 new to Greece and 1 (*Thesium brachyphyllum* Boiss.) new to the Balkan Peninsula. The new hybrid *Achillea fraasii* Schultz ×*A. holosericea* Sibth. & Sm. is described. New chromosome numbers for 10 taxa are given.

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This report presents new or noteworthy high-mountain plants from the S and C parts of the Pindhos mountains on the Greek mainland. The area investigated is shown in Fig. 1. Two serpentine mountains, Mt Mavrovouni and Mt Milia (the area also known as Lingos), c. 10 km N of Mt Zygos were also visited. Field-work was carried out during the summers of 1971 to 1974. More than 5,000 collections were made, most of them from above 1800 m. Circumstances prevented the author from investigating an area S and SE of Mt Karava. These parts are still unknown botanically.

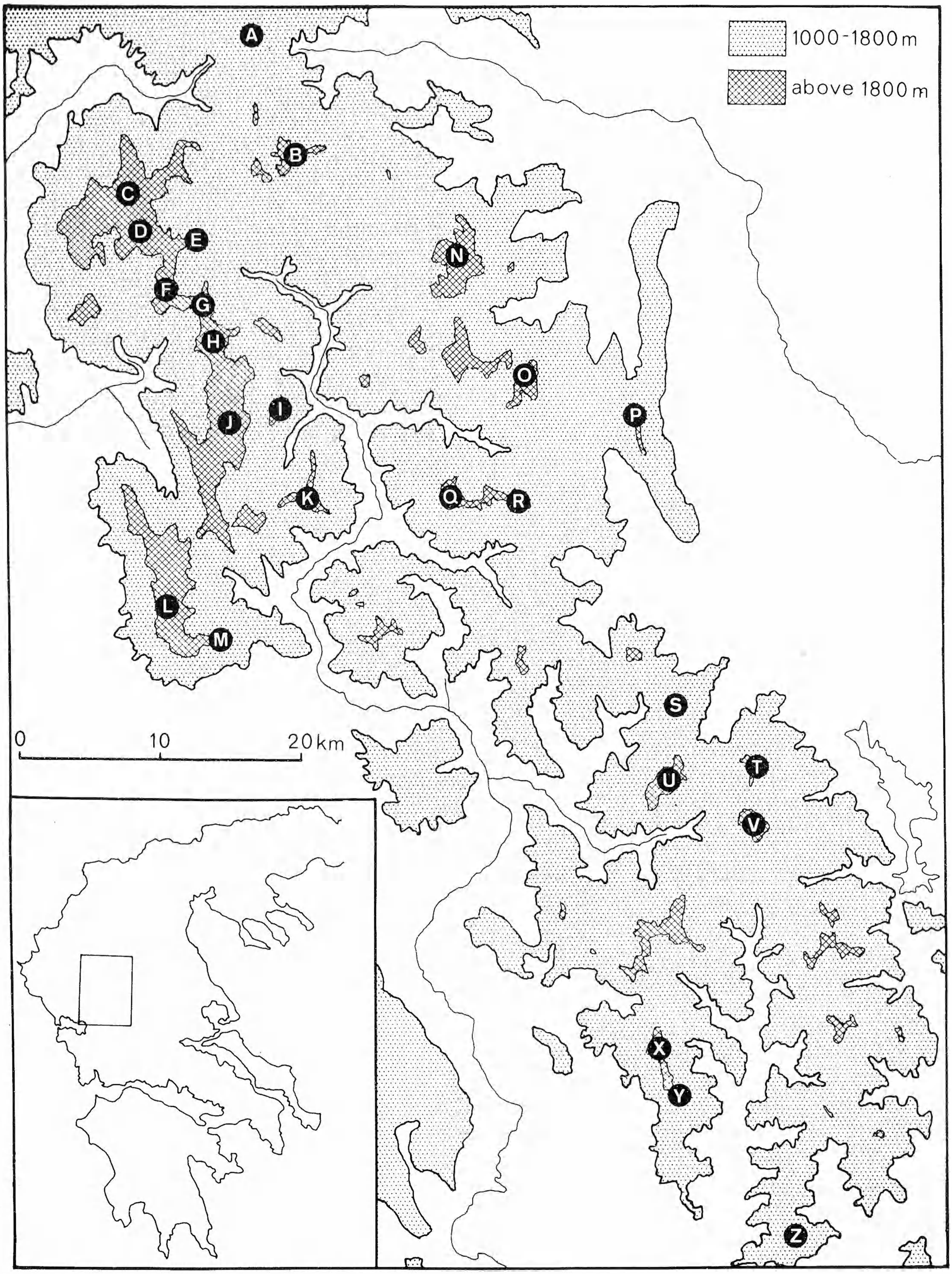
Unless otherwise stated the nomenclature follows Flora Europaea 1–3 (Tutin et al. 1964–1972) and Prodromus Flora peninsulae Balcanicae 2 and 3 (Hayek 1931, 1933). The main works consulted for information on general distribution are Vergleichende Chorologie der zentraleuropäischen Flora (Meusel et al. 1965), Flora der Schweiz (Hess et al. 1967–1972), Flora of Turkey 1–5 (Davis 1965–1976) and Flora Europaea 1–3 (Tutin et al. 1964–1972).

Two mountains previously unexplored botanically will be briefly discussed below.

Mt Koziakas

Mt Koziakas is one of the mountains bordering the plains of Thessaly, 20 km W of Trikkala. It consists of hard limestone exhibiting karst formation with a series of steep-sided cliffs running N and S. In the summit area, with peaks between 1750 and 1901 m, are also some occurrences of younger and softer limestone. The timber-line, formed by *Abies borisii-regis,* is between 1700 and 1800 m according to the aspect. The boulder-rich rocky parts have an extremely rich mixed flora. Depressions in the hard limestone form rather isolated niches each with one or a few dominant species that are virtually restricted to the depression (Fig. 2). Most of the species on Mt Koziakas are non-alpine, mostly nemoral plants such as *Actaea spicata, Fraxinus excelsior, Lilium martagon, Lonicera alpigena, Malva moschata, Polygonatum officinale, Rubus idaeus, Senecio nemorensis, Solidago virgaurea* and *Thalictrum aquilegiifolium.* Species more typical to alpine regions in Greece are *Asplenium fissum, Geranium macrorrhizum, Heracleum sphondylium* ssp. *pyrenaicum, Saxifraga paniculata* and *S. sempervivum.*

Classification into montane, subalpine or


1000-1800 m
above 1800 m
A
B
C
D
E
F
G
H
I
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K
L
M
N
O
P
Q
R
S
T
U
V
X
Y
Z
0
10
20 km

Fig. 2. Mt Koziakas. Part of a depression in hard limestone at c. 1800 m.

alpine species is often problematic. The altitudinal phytozonation is not well defined because of climatic conditions, grazing and tree felling. Only a limited number of species can be regarded as being restricted to given altitudinal levels. There are at least three very rare species on Mt Koziakas that add to its interest, viz. *Allium heldreichii, Geranium aristatum* and *Lithospermum goulandriorum* ssp. *thessalicum* Aldén, ssp. nov. The richness of the flora and the relative accessibility of the area make Mt Koziakas well worth protecting.

Mt Pachtourion

Mt Pachtourion consists of three ridges with peaks between 1800 and 2000 m, the chief ones being Soufli and Katafili. (The most westerly parts are also known as Neraidha – not marked in Fig. 1). It lies roughly 7 km SE of the village of Ghardikion in the valley of Aspropotamos and SE of Mt Kakarditsa, the highest peak in C Pindhos. Between the peaks Soufli and Katafili, which are very steep, are a series of lower peaks. On the N slopes *Fagus*

Fig. 1. C and S Pindhos. Mountains visited:

Augo (Q)
Baros (F)
Boutai (E)
Dhokimi (B)
Kakarditsa (J)
Karava (U)
Katarrachias (H)
Kauki (Z)
Kazarma (T)
Kourouna (I)
Koziakas (P)
Liakoura (Y)
Loupata (R)
Mazur-Ailas (S)
Neraidha (O)
Pachtourion (K)
Peristeri (C)
Perivoulion (G)
Pteri (X)
Spilea (M)
Trapos (D)
Tringia (N)
Tzoumerka (L)
Voutsikaki (V)
Zygós (A)

Fig. 3. Mt Pachtourion. A NW slope with *Fagus sylvatica* reaching 1800 m.

sylvatica ascends to 1800 m (Fig. 3) and to about 1600 m on the S slopes. An interesting feature of Mt Pachtourion is the abundance of base-poor metamorphic rocks, viz. iron silicates and the mineral pyrolusite. Here *Euphorbia glabriflora, Achillea absinthoides* and *Senecio viscosus* were found. On the S slopes at about 1700 m in screes and other stony places, *Asyneuma canescens, Centaurea triamularia* Aldén, sp. nov. and *Euphorbia deflexa* occur. The aromatic species *Nepeta spruneri, Satureja parnassica* and *Artemisia absinthium* dominate. On some of the very steep NE slopes of the peak Katafili *Acantholimon androsaceum* covers the rocks in parts. In the boulder-rich areas of hard limestone on the peak Soufli *Sideritis perfoliata* was found, and in moist rock meadows on the N side *Alchemilla plicatula* and *Coeloglossum viride*. Many of the cliff systems and peaks in this fascinating area remain to be investigated.

Chromosome counts – material and methods

Plants have been raised from seed and bulbs collected in nature and kept in cultivation in the experimental greenhouses of the Lund Botanical Gardens. Chromosome counts were made from root tips of young plants that had been kept overnight at a temperature of c. 3°C. The root tips were then fixed in the Svalöf modification of Navashin-Karpechenko fixative and later sectioned with a microtome and stained with crystal violet.

Apiaceae

Peucedanum longifolium Waldst. & Kit.

Collections. Mt Augo, 6 km SW of Pirra, 1850–1950 m, A 2401 – Mt Boutai, 4 km SW of Chalikion, 1800–1900 m, A 3194 – Mt Pachtourion, 5.5 km SSE of Athamania, c. 1900 m, A 4706 – Mt Koziakas, 5 km NE of Pertoulion, c. 1900 m, A 1517 – Mt Trapos, 5 km SW of Chalikion, 1800–1850 m, A 4208 – Mt Tzoumerka, 4 km W of Theodhoriana, c. 2000 m, A 2740.

Previously only recorded from Mt Phalakron in NE Greece (Quézel & Contandriopoulos 1968).

The specimens collected are not in the fruiting stage. The leaf lobes are very narrow (0.5–1 mm, rarely up to 2 mm) the material thus being referable to *P. longifolium*.

P. longifolium occurs on dry rocky ground between 1800 and 2000 m, often associated with *Jurinea mollis* ssp. *glycacantha, Salvia argentea, Laserpitium siler* ssp. *garganicum* and in W Pindhos also with *Alkanna nonneiformis*.

General distribution. Balkan Peninsula.

Aspleniaceae

Asplenium fissum Kit. ex Willd.

Collections. Mt Kakarditsa, 3.5 km W of Athamania, 2050–2250 m, A 3531 – Mt Katarrachias, 6 km ENE of Kalarrites, 2100–2160 m, A 5308 – Mt Koziakas, 6 km E of Pertoulion, c. 1850 m, A 4841 – Mt Pachtourion, 6 km SSE of Athamania, c. 1800 m, A 4653 – Mt Perivoulion, 7.5 km S of Chalikion, c. 2100 m, A 3336 – Mt Spilea, 4 km SSW of Theodhoriana, 1850–1930 m, A 2899 – Mt Trapos, 5 km WSW of Chalikion, 1980–2080 m, A 3815 – Mt Tzoumerka, 4.5 km W of Theodhoriana, 2000–2050 m, A 2753.

Previously recorded from Mt Peristeri in Pindhos (Quézel & Contandriopoulos 1965).

Most plants from Pindhos have 2–3-pinnate, rather short and broad leaves. In habit they are thus closer to *A. lepidum*, but in other respects (glabrous leaf lamina, spore size and sculpture) the specimens agree with *A. fissum*.

A. fissum grows in crevices of cliffs and boulders of hard limestone from 1800 to 2200 m but is not common.

General distribution. Mountains of SC and SE Europe.

Asplenium viride Huds.

Collections. Mt Kakarditsa, 4 km W of Athamania, 2250–2350 m, A 3692 – Mt Katarrachias, 6 km ENE of Kalarrites, 2150–2250 m, A 5193 – Mt Mavrovouni, 5 km WNW of Milea, 1900–2000 m, A 5139 – Mt Milia, 5 km NW of Milea, 2050–2100 m, A 4937 – Mt Perivoulion, 7.5 km S of Chalikion, c. 2100 m, A 3186 – Mt Trapos, 6 km SW of Chalikion, c. 2200 m, A 4142 – Mt Tzoumerka, 5.5 km WSW of Theodhoriana, c. 2250 m, A 2754.

Reported from Mt Trapos (=Mt Plaka) by Quézel & Contandriopoulos (1965). Rare in Pindhos. Occurs in moist places among rocks and on rock ledges in the W parts. On Mt Kakarditsa up to 2300 m.

General distribution. N temperate regions.

Asteraceae

Achillea absinthoides Hal.

Collections. Mt Kakarditsa, 3 km W of Athamania, c. 2000 m, A 3650 – Mt Loupata, 6 km SSW of Pertoulion, 1850–2000 m, A 1724 – Mt Pachtourion, 5.5 km SSE of Athamania, c. 1830 m, A 4681; do, c. 1800 m, A 4695 – Mt Tzoumerka, 4.5 km WSW of Theodhoriana, 1800–1900 m, A 2657; do, 1900–1950 m, A 2699.

Previously recorded only from Mt Tzoumerka (locus classicus) and Mt Smolika above the village of Samarina (Zaganiaris 1938–40). No specimens have been seen from the last locality (left out in Fig. 8 A).

A. absinthoides grows on dry rock ledges or stony slopes from 1800 to 2000 m, mainly on base-poor metamorphic rock and associated with *Senecio viscosus*.

Chromosome number 2n = 18 (A 3650). No previous counts.

General distribution. Endemic to Pindhos (Fig. 8 A).

Achillea fraasii Schultz × **A. holosericea** Sibth. & Sm.

Collection. Mt Trapos, 5 km SW of Chalikion, 1800–1850 m, A 4215.

A new hybrid with the basal and lower cauline leaves 3-pinnate, as in *A. fraasii*, but with broader segments. Indumentum of leaves on both surfaces dense with villous-sericeous hairs as in *A. holosericea*. Bracts as in *A. fraasii*, with sparse covering of long hairs. Ligules cream-coloured. Pollen stainability 12.5% (in cotton blue).

The hybrid was found on a dry rock ledge growing together with the parental species.

Centaurea phrygia L.

Collections. Mt Baros, 8 km SSW of Chalikion, 1850–1950 m, A 3069 – Mt Peristeri, 6 km W of Chalikion, c. 2150 m, A 4190 – Between Mt Peristeri and Mt Trapos, 5.5 km WSW of Chalikion, c. 2000 m, A 4239.

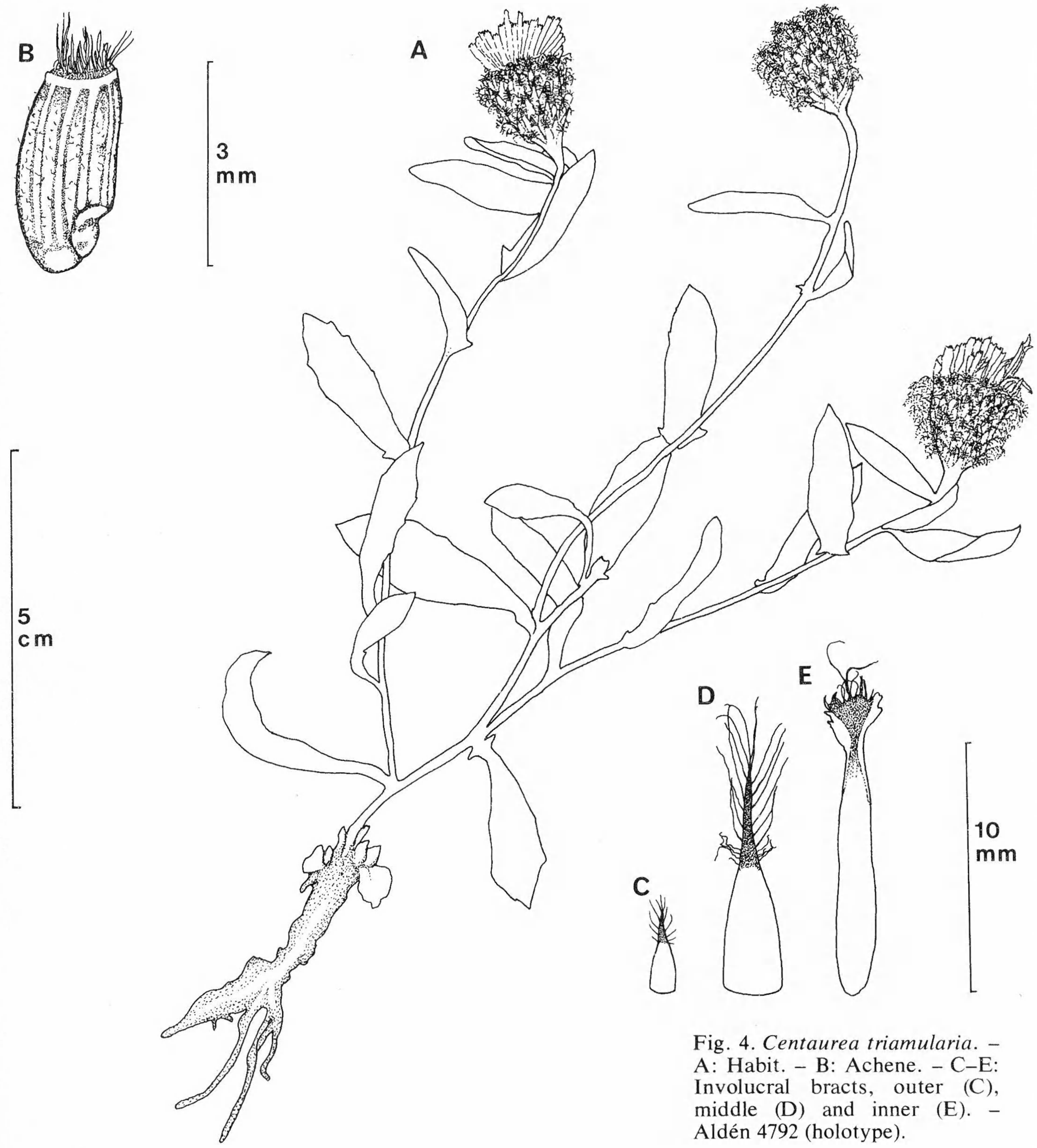

Fig. 4. *Centaurea triamularia*. – A: Habit. – B: Achene. – C–E: Involucral bracts, outer (C), middle (D) and inner (E). – Aldén 4792 (holotype).

On a few mountains in WC Pindhos some plants belonging to the *C. phrygia* group were found. The same taxon has been reported by Formanek (1897) from Mt Dhokimi under *C. nigrescens* Willd. From the Balkan Peninsula where the degree of variability of the *C. phrygia* group is high a number of local taxa have been given species rank (cf. Săvulescu 1964). Characters such as branching, indumentum, shape of leaves and capitula, shape and colour of bract appendages, some of these partly modificative, have been used for diagnosis. The nomenclature used below is according to Dostál (1975).

Of the subspecies recognized within *C.*

phrygia the plants from Pindhos approach ssp. *melanocalathia,* endemic to the Carpathian Mountains. They differ in some characters, viz. stems simple (rarely branched once or twice), 10–30 cm, leaves narrowly lanceolate to ovate-lanceolate, sparsely puberulent to greyish arachnoid-tomentose, involucre mostly with arachnoid-tomentose bracts. Characters such as indumentum and shape of leaves vary according to habitat. The same characters also distinguish them from ssp. *phrygia* which also differs slightly in shape of appendage.

Ssp. *rarauensis,* a local taxon in Romania, has simple stems and arachnoid-tomentose leaves, but differs in having broader leaves and a dark brown, not black, bract appendage. The Greek plants thus show new vegetative character combinations, but as the group is in need of revision I prefer to place them under *C. phrygia* s.l., in the vicinity of ssp. *melanocalathia,* with no other epithet.

The plants were found on dry ground that had been previously wet and in meadows up to 2150 m.

General distribution (*C. phrygia* s.l.). N, C and SE Europe to W Asia.

Centaurea triamularia Aldén, sp. nov. – Fig. 4

Typus: Graecia, Thessalia: Mons Pachtourion, supra pagum Athamania in Aspropotamos, in rupestribus, aridis, subalpinis, c. 1700 m, 31.7. 1974, Aldén 4792 (LD holotypus).

Perennis. Caulis humilis, procumbens vel ascendens, 9–20 cm altus, arcuato-recurvatus, basi et ad medium ramosus. Folia integra vel sparsim serrata, utrinque breviter hirta et ± arachnoidea, 5–13 × 20–50 mm, inferiora obovato-lanceolata, in petiolum attenuata, media et superiora obovato-lanceolata vel lanceolata, saepe subhastata. Capitula solitaria, subsessilia. Pedunculi mox incrassati. Involucrum cylindricum, 6–9(–10) × 12–15 mm, phyllis appendicibus non obtectis, sparse lanatis vel subglabris. Appendices interiores orbiculatae, ad apicem fimbriatae, obscure fuscae, mediae, 6–8 mm, lanceolatae, ad apicem filiformes, plumoso-ciliatae c. 8–12-fimbriatae, obscure fuscae, arcuato-recurvae attenuatae. Flores dilute purpurei. Achaenia c. 3 mm longa, papposa, pappo ad 1 mm longo. Numero chromosomatum 2n = 22.

Procumbent to ascending perennial. *Stems* from a rhizome, 9–20 cm, arcuate, branched at or below middle. *Leaves* entire to remotely serrate, arachnoid-puberulent, 5–13 × 20–50 mm, lowest attenuate into a petiole, obovate-lanceolate, middle and upper subhastate, obovate-lanceolate to lanceolate. *Capitulum* single on short, slightly thickened peduncles. Involucre cylindrical, 6–9 × 12–15 mm. *Bracts* sparsely lanate to subglabrous, not completely covering each other. Appendage of inner bracts orbiculate with a fimbriate apex, dark brown, middle 6–8 mm, attenuate into a subulate-filiform acumen, arcuate-recurved, pectinate-fimbriate with 8–12 fimbriae on each side, blackish-brown. *Florets* pale purple. Achenes c. 3 mm, reddish-brown, finely puberulent. Pappus up to 1 mm long.

In size of involucre and type of bract appendage *C. triamularia* resembles *C. indurata,* but differs markedly in habit, size of achenes and length of pappus. *C. triamularia* is best placed near *C. stenolepis* and perhaps also *C. phrygia* ssp. *pseudophrygia,* which it approaches in achene and pappus characters, but not in habit, shape of leaves and shape and size of involucre.

C. triamularia grows on dry and stony slopes of base-poor rock at c. 1700 m. Chromosome number 2n = 22.

Gnaphalium hoppeanum Koch

Collections. Mt Kakarditsa, 4 km W of Athamania, 2250–2350 m, A 3696 – Mt Karava, 3 km ESE of Vlasion, c. 2100 m, A 995 – Mt Katarrachias, 5.5 km ENE of Kalarrites, 2150–2250 m, A 5256 – Mt Peristeri, 6 km W of Chalikion, c. 2150 m, A 3965; do, 2200 m, A 4161; do, 2200–2290 m, A 4179 – Mt Perivoulion, 7.5 km S of Chalikion, 2100–2180 m, A 3320 – Mt Trapos, 5 km WSW of Chalikion, 1980–2080 m, A 3809 – Mt Tzoumerka, 4.5 km WSW of Theodhoriana, 1900–2000 m, A 2514.

G. hoppeanum, in some cases confused with *G. supinum,* has previously been collected on Mt Peristeri (Maire & Petitmengin 1908, as *G. supinum,* Quézel & Contandriopoulos 1965) and on Mt Tzoumerka (Baldacci in Halácsy 1902, as *G. supinum*). No *G. supinum* has been found in the material from C and S Pindhos. Specimens of *G. hoppeanum* from Pindhos have one to many capitula, when few they are rather distant, when many they are crowded at anthesis. After anthesis, however, growth continues so that the capitula become more distant.

G. hoppeanum grows in a variety of alpine habitats.

General distribution. Abruzzia in Italy and the S Balkan Peninsula.

Scorzonera hispanica L.

Collections. Mt Baros, 8 km SSW of Chalikion, 1850–1950 m, A 3080 – Mt Boutai, 4 km SW of Chalikion, 1800–1900 m, A 3200 – Mt Kakarditsa, 3 km W of Athamania, 1820–1920 m, A 3712 – Mt Kourouna, 2 km SSW of Aghio Paraskevi, 1900–1970 m, A 2015.

New to C and S Pindhos.

Plants erect, stems 20–50 cm, usually branched above the middle, leaves 10–25 × 0.2–1.0 cm. Morphologically the material is referable to var. *glastifolia* (Willd.) Wallr. (cf. Hayek 1931).

S. hispanica grows in dry meadows from 1800 to 1950 m.

General distribution. C and S Europe, S Russia, Caucasus, Turkey and Siberia.

Scorzonera mollis Bieb.

Collections. Mt Augo, 6 km SW of Pirra, 1850–2000 m, A 2346; do, 1700–1800 m, A 2359; do, 1800–1850 m, A 2375; do, 1850–1900 m, A 2402 – Mt Boutai, 4 km SW of Chalikion, 1800–1900 m, A 3210 – Mt Spilea, 3.5 km SSW of Theodhoriana, c. 1800 m, A 2854 – Mt Trapos, 5 km SW of Chalikion, 1800–1850 m, A 4207.

In Pindhos previously known only from Mt Smolika (Baldacci 1899) and Mt Grammos (Zaganiaris 1938–40).

S. mollis grows in dry stony places up to 1900 m.

Chromosome number 2n = 14 (A 3210). No previous counts.

General distribution. SE Europe, Asia to Iran.

Scorzonera purpurea L. ssp. **rosea** (Waldst. & Kit.) Nyman

Collections. Mt Baros, 8 km SSW of Chalikion, 1800–1900 m, A 2933; do, 1850–1950 m, A 3105 – Mt Pachtourion, 5 km SSE of Athamania, c. 1800 m, A 4575.

The taxon is here treated as a subspecies of *S. purpurea* (Nyman 1879).

Ssp. *rosea* is rare in Greece collected on Mt Kaimaktsalan (Rechinger 1936) and near the village of Siatista (Zaganiaris 1938–40) in Greek Macedonia and in Pindhos on Mt Said Pascha (near Mt Zygos) by Sintenis (in Halácsy 1901). Only one typical specimen was collected on Mt Baros. Intermediates between ssp. *rosea* and ssp. *peristerica* with densely fibrous stock apex but with rather short recurved leaves occur on Mt Pachtourion and Mt Baros.

Compared with ssp. *peristerica* ssp. *rosea* seems to be more sensitive to grazing and was found in richer ungrazed meadows at about 1850 m.

General distribution. EC Europe, from C Italy to C Greece.

Boraginaceae

Alkanna nonneiformis Griseb.

Collections. Mt Boutai, 4 km SW of Chalikion, 1800–1900 m, A 3221 – Mt Kakarditsa, 4 km W of Athamania, 2250–2350 m, A 3570 – Mt Loupata, 6 km SSW of Pertoulion, 1850–2000 m, A 1728 – Mt Peristeri, 5 km W of Chalikion, c. 2100 m, A 4113 – Mt Perivoulion, 7.5 km S of Chalikion, 2100–2150 m, A 3138 – Mt Trapos, 5 km SW of Chalikion, 1800–1850 m, A 4209 – Mt Tzoumerka, 4.5 km WSW of Theodhoriana, 1800–1900 m, A 2652; do, 1900–1950 m, A 2682.

New to Greece. *A. nonneiformis*, previously regarded as endemic to Yugoslavian Macedonia, was found mainly in the W parts of C Pindhos (Fig. 8 B). It is rather variable, especially in shape of leaves and in indumentum. The relation between eglandular and glandular hairs on the calyx and pedicels is not as distinct as previously described (cf. Rechinger 1964), i.e. the glandular hairs do not always dominate. In some specimens from Pindhos the corolla is almost glabrous externally and the middle cauline leaves lanceolate to ovate-lanceolate. The nutlets are 2.5–3 mm (in the Yugoslavian Macedonian specimens up to 2.5) with only a moderate downward curvature of the apices. The foeniculi are larger than in plants from Yugoslavian Macedonia.

A. nonneiformis grows on rock ledges and in dry stable screes, often below S- to E-facing cliffs, from 1800 to 2300 m.

General distribution. S Yugoslavia and Pindhos in Greece.

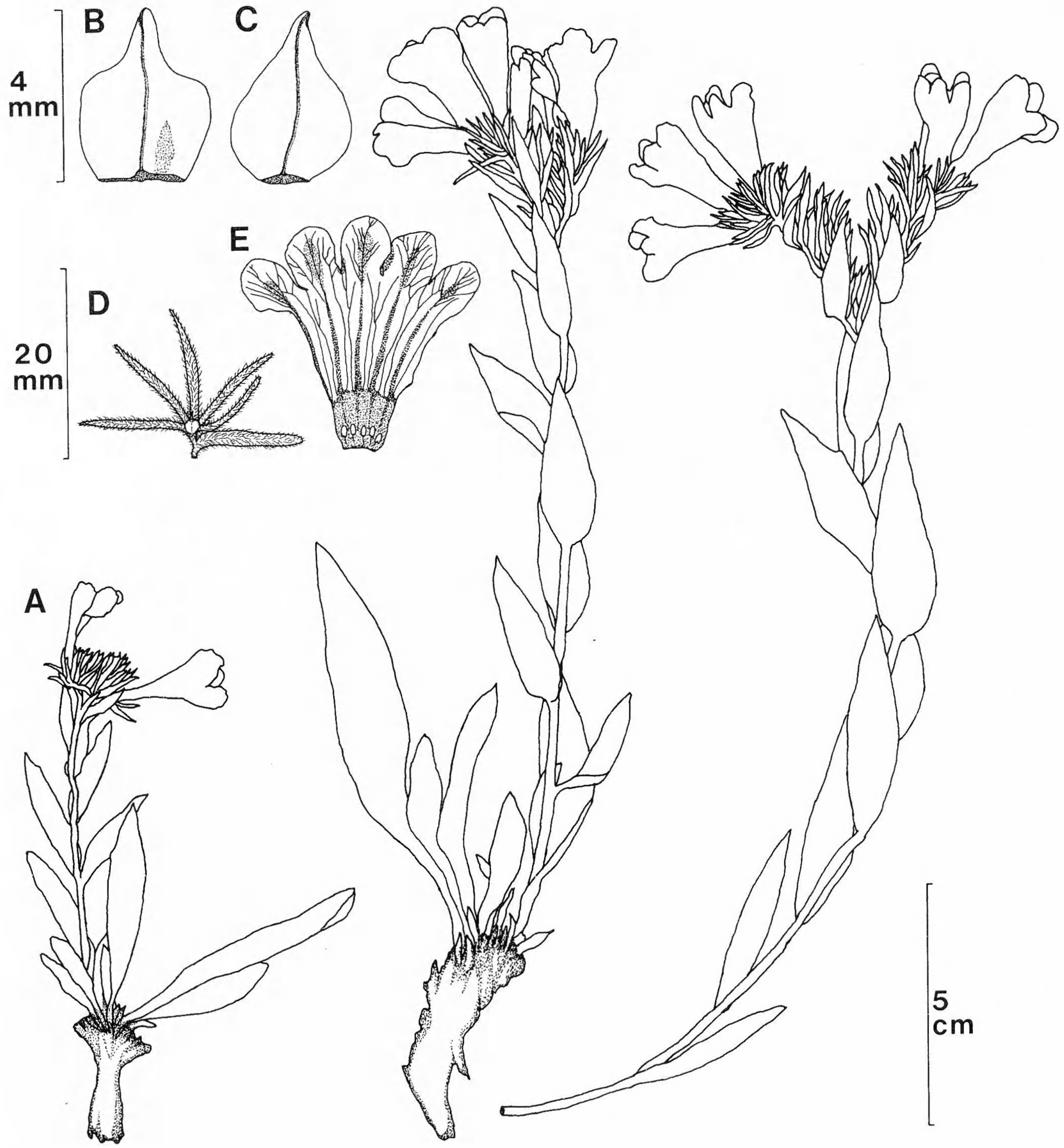

Fig. 5. *Lithospermum goulandriorum.* – A, B, D, E: ssp. *thessalicum.* – C: ssp. *goulandriorum.* – A: Habit. – B–C: Nutlets from the ventral side. – D: Calyx and bract after anthesis. – E: Corolla (opened). – A, E: Aldén 1515 (holotype). – B, D: Aldén 1202. – C: Stamatiadou 7244 (holotype).

Lithospermum goulandriorum Rech. f. ssp. **thessalicum** Aldén, ssp. nov. – Fig. 5

Collections. Graecia, Thessalia: Mons Koziakas, supra pagum Elati, in praeruptis calcareis, 1900 m. 7.7. 1972 Aldén 1515 (LD holotypus); Mt Koziakas, 11 km NW of Pili (near Elati), c. 1800 m, A 1202; 5 km NE of Pertoulion, 1750–1900 m, A 1505.

Ssp. *goulandriorum* similis, sed calyx 9–11 mm (post anthesin ad 15 mm), corolla major, (22–)25–30 mm, 12–15 mm diametro, in vivo et in sicco azurea, antherae 1.3–1.5 mm longae, fructus 4 × 2.8 mm, compresso-ovoideus, latere interno carinatus, apice abrupte attenuatus, basi c. 2 mm latus. Numero chromosomatum 2n = 28.

Shortly villous to strigose perennial with a stout, black, vertical rhizome. *Stems* simple, ascending to erect, (7–)10–20(–25) cm. Basal *leaves* in a rosette, attenuate into petioles, laminas lanceolate, up to 15 cm long, 5–20 mm broad, acute. Cauline leaves lanceolate to ovate-lanceolate (rarely ovate), 2–6 × 7–15(–20) mm. Indumentum of leaves and bracts strigulose to strigose. *Inflorescence* in dense cincinnate cymes or subcapitate with 10–15(–18) flowers. Pedicels 1–4 mm. *Calyx* 9–11 (after anthesis up to 15 mm), strigose, with lobes linear to linear-lanceolate. *Corolla* funnel-shaped, very slightly oblique, 12–15 × (22–)25–30 mm, with lobes 5–6 mm long, externally sparsely pilose, azure blue. *Stamens* inserted 1.5 mm above the insertion of the corolla. Anthers 1.3–1.5 mm long. *Style* short, c. 0.6 mm and erect. *Nutlets* 4 × 2.8 mm, smooth and shining, ovoid, compressed dorsi-ventrally, with a ventral carina, abruptly narrowed at apex and with a broad base (2 mm).

The genus *Lithospermum* is maintained according to Riedl (1967).

Ssp. *goulandriorum* was found by Stamatiadou on Mt Timphi in Epiros in 1969 and later described by Rechinger (1971).

Ssp. *thessalicum* is clearly separable from ssp. *goulandriorum* in having very large azure blue corollas. The inflorescence is denser and the indumentum consists of hairs at least 1 mm long, giving a greyer appearance. The nutlets are greyish-white and shining as in ssp. *goulandriorum*, but differ in having a well-marked, not subattenuate apex and a broad base.

Ssp. *thessalicum* is a chasmophyte growing on hard limestone from 1800 to 1900 m.

Chromosome number 2n = 28 (A 1202). In the section *Margarospermum* Reichenb., which comprises 6 taxa most of which are evidently old relicts, no chromosome counts are yet available of *L. gastonii* Benth., from the French Pyrenees, and *L. goulandriorum* ssp. *goulandriorum*. The more widespread *L. purpureo-coeruleum* and *L. zollingeri* A. DC., from E Asia, both have 2n = 16 (Reese 1952, Britton 1951, Matsuura & Suto 1935, Grau 1966). *L. calabrum* Ten., endemic to S Italy has 2n = 20 (Grau 1968).

Solenanthus pindicus Aldén, sp. nov. – Fig. 6

Typus. Graecia, Thessalia: Mons Kakarditsa, supra pagum Athamania in Aspropotamos, in rupestribus, aridis, superioribus, 2050–2250 m. 20.7. 1973. Aldén 3507 (LD holotypus).

Perennis. Caulis simplex, crassus, ad 60 cm longus. Folia basalia longe petiolata, ad 35 cm longa, 2–4 cm lata, inferiora et media sessilia lanceolata vel ovato-lanceolata, superiora ovato-lanceolata vel ovata. Folia et caules breviter tomentosi. Inflorescentia sat longe paniculata, ramis non vel paulo crassis, fructiferis sat laxis. Pedicelli calyce breviores vel subaequantes. Calyx (post anthesin) 4–5 mm longus, laciniis linearibus vel lineari-lanceolatis, obtusis. Corolla tubulosa, 5–6 mm longa, stamina valde exserta, 8–10 mm longa. Nucula magna, compressa, plana vel paullo convexa, interne et lateribus ± dense aculeolata vel sub-glochidiata, glochidia 1–2-unguiculata, externa non vel parce aculeolata. Aculei semiaequales. Areolae non aculeatae glabrae, nitidae.

Robust perennial up to 60 cm. *Stems* simple, rather thick, striate-sulcate. Basal *leaves* long-petiolate, up to 35 cm, with lamina lanceolate, 2–4 cm broad, lower and middle cauline leaves sessile, acute, attenuate-rotundate, lanceolate to ovate-lanceolate, upper cauline leaves ovate-lanceolate to ovate. Leaves and stem shortly tomentose. *Inflorescence* rather lax, branches not or slightly thickened, elongating until fruiting stage. Pedicels 2–4 mm, mostly shorter than calyx. *Calyx* (after anthesis) 4–5 mm, tomentose, with lobes linear to linear-lanceolate. *Corolla* tubular, 5–6 mm long, glabrous or with a few hairs externally. *Stamens* long-exserted (3–4 mm above apex of corolla), filaments 8–10 mm long. *Style* long-exserted. *Nutles* 5–6 mm long, outer surface with a few circular glochidia up to 1 mm long, hooks of glochidia (0–)1(–2), lateral and inner surfaces rather densely glochidiate-aculeolate.

S. pindicus is related to the likewise very local *S. albanicus*, known from NW Greece and S Albania. The most useful characters are the number and shape of the glochidia. *S. pindicus* has much fewer and shorter (up to 1 mm) glochidia on the outer surface of the nutlet and the glochidia or aculei are subequal mostly with one (rarely 0 or 2) apical hook (in *S. albanicus* (2–)4–6 hooks; Fig. 6 B). The upper cauline leaves are ovate-lanceolate to ovate, not ovate-rhombic as in *S. albanicus*. *S. stamineus*, a mainly SW Asiatic species, occurs on Mt Chelmos on Peloponnesos. It differs from

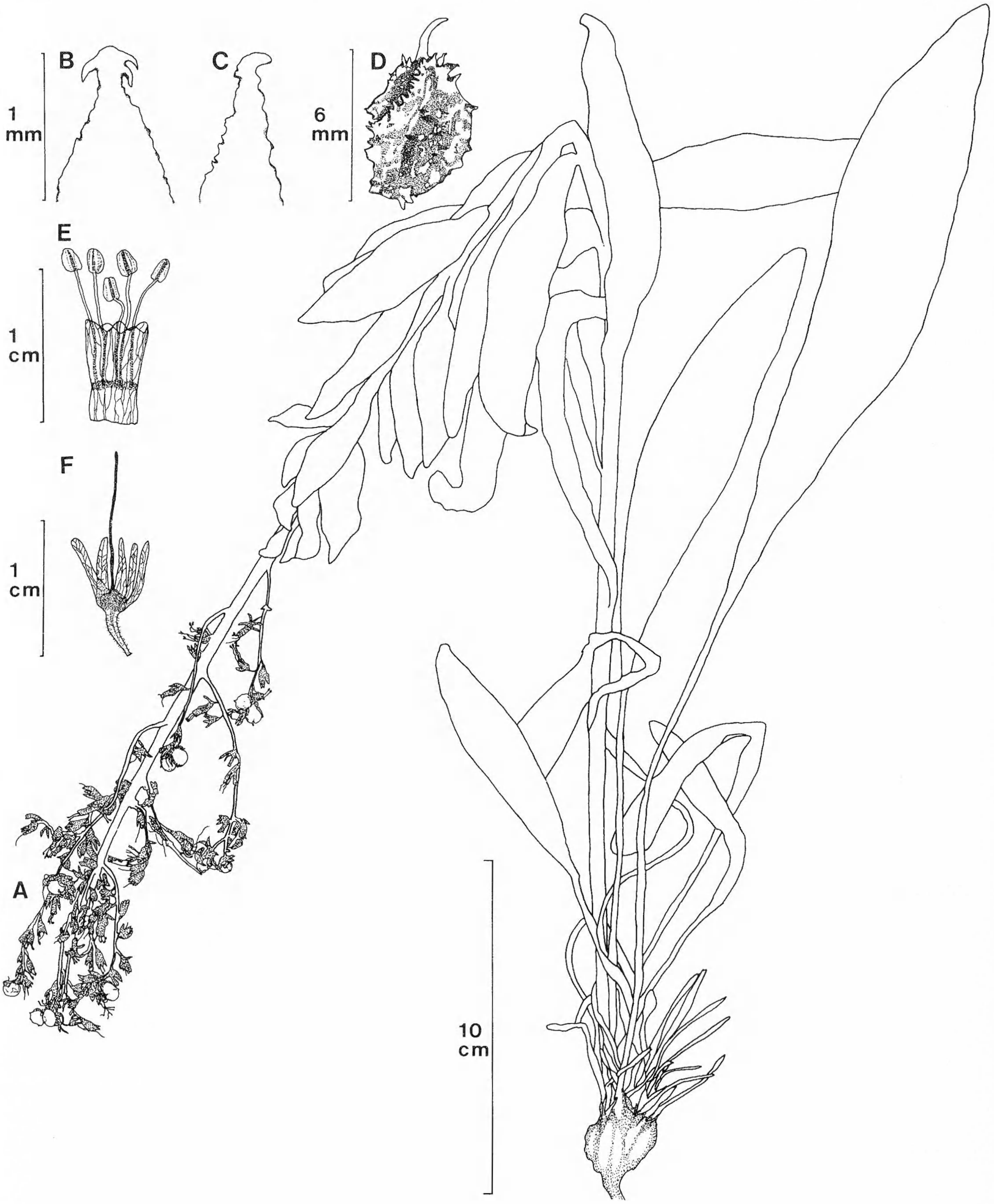

Fig. 6. A, C–F: *Solenanthus pindicus*. – B: *S. albanicus*. – A: Habit. – B–C: Glochidia from nutlets. – D: Nutlet. – E: Corolla and stamens. – F: Calyx and style. – A, C–F: Aldén 3507 (holotype). – B: Baldacci 188 (holotype).

both *S. pindicus* and *S. albanicus* in its grey indumentum of leaves and stem and the flattened glochidia. A fourth species in Greece, *S. scardicus*, was reported from Mt Kaimaktsalan by Zaganiaris (1938–40). It is best distinguished from the others on larger and winged nutlets.

S. pindicus grows on dry stony rock ledges at about 2150 m.

Campanulaceae

Asyneuma canescens (Waldst. & Kit.) Griseb. & Schenk ssp. **canescens**

Collections. Mt Karava, 3 km ESE of Vlasion, c. 2150 m, A 974 – Mt Kazarma, 4 km NE of Vlasion, c. 1800 m, A 720; 5.5 km NE of Vlasion, c. 1900 m, A 4378 – Mt Mazur-Ailas, 3 km ESE of Argidhea, 1750–1800 m, A 882 – Mt Pachtourion, 5 km SSE of Athamania, c. 1880 m, A 4576.

A. canescens ssp. *canescens* (cf. Damboldt 1970) is new to Pindhos, but known both N and S of the area. It is a rare plant in Pindhos, found mainly in the SE parts. The plants from Pindhos are usually smaller than normal, have ascending, often flexuose to erect stems, 10–20 cm, leaves 1–3 cm long, flowers mostly single in the panicle.

It grows in dry stony places from 1750 to 2100 m.

General distribution. SE Europe.

Campanula pindicola Aldén, sp. nov. – Fig. 7

Typus. Graecia, Thessalia: Mons Kakarditsa, supra pagum Athamania in Aspropotamos, in rupestribus calcareis superioribus, c. 2100 m. 21.7. 1973. Aldén no. 3669 (LD holotypus).

Perennis. Caules plures, tenues, nudi, teretes, ascendentes, 15–20 cm alti. Rhizoma tenue repens. Folia basalia ignota (per anthesin deficientia), caulina inferiora lanceolato-spathulata, integerrima vel rarius sparsim crenulata, 1–2 × 5–10 mm, media et superiora linearia vel lineari-lanceolata, stricta vel paullo reflexa, media longiora ± dense obsita, basi et apice breviora, 0.4–2.0 × 10–30(–37) mm, plerumque canaliculata, obtusa et breviter mucronata. Flores (1–)2–6, subnutantes, racemum laxum formantes. Bractea 6–10 mm longa. Pedunculi et pedicelli ± crassi, plerumque ante anthesin nutantes, 3.5–12 mm. Calyx glaber, 6–9 mm laciniis 3–6(–7) mm tenuibus triangularibus vel linearibus, apice reflexis. Corolla cyanea, breviter campanulata, apice parum expanda demum subangustata, 9–11 mm longa, interne papillosa et sparse pilosa, laciniis 3–4 mm longis, triangularibus. Stamina c. 5 mm longa. Stigma corollam subaequans. Receptaculum papillosum, 3-loculare.

Glabrous perennial. *Stems* several, terete, somewhat ribbed, slender, ascending, 15–20 cm, from a slender more or less horizontal rhizome. Basal *leaves* unknown, absent at anthesis, lower cauline leaves lanceolate-spathulate, entire or very rarely remotely crenulate, 1–2 × 5–10 mm, middle and upper cauline leaves linear to linear-lanceolate, straight or slightly recurved, 0.4–2.0 × 10–30(–37) mm, usually canaliculate, obtuse and shortly mucronate. Middle cauline leaves longest and more abundant. *Inflorescence* (1–)2–6-flowered, lax, with 1–4 undeveloped flower primordia. Peduncles and pedicels rather stout, usually recurved, 3.5–12 mm long. Bracts 6–10 mm long. *Calyx* 6–9 mm with lobes 3–6(–7) mm, narrowly triangular to linear, apex recurved. *Corolla* dark blue, shortly campanulate, scarcely expanded, 9–11 mm long, lobes (2–)3–4 mm long, triangular. Inner surface of corolla with papillae and very fine dendroid hairs. *Stamens* c. 5 mm long. *Stigma* almost equalling corolla. *Ovary* papillose, 3-locular.

C. pindicola is clearly referable to the taxonomically very difficult subsect. *Heterophylla* (Witas) Fed. The nomenclature below according to Podlech (1965). Of the four series recognized within this subsection *C. pindicola* comes close to species in *Saxicolae* Witas. The main difference is the slender rhizome which it has in common with *C. gentilis* Kovanda (Kovanda 1968) that was placed in *Saxicolae* by Kovanda (1970). *C. gentilis* differs from *C. pindicola* in shape and size of corolla, the more abundant lower cauline leaves, leaves increasing abruptly in length upwards and in being densely caespitose. An intermediate between *Saxicolae* and *Vulgares* Witas is *C. velebitica* from N Balkan. It differs from *C. pindicola* in having much larger, broadly campanulate corollas and narrower calyx teeth. *C. romanica,* a typical *Saxicolae,* differs (apart from the thickened rhizome) in having the middle cauline leaves remotely serrulate and a narrowly campanulate corolla. The only *Campanula* species with a papillose receptacle (as in all *Saxicolae*) known from Pindhos is *C. albanica* ssp. *albanica*. It is commonly 1-flowered with corollas 14–18(–22) mm long. In the shape of the corolla *C. pindicola* comes close to species in the series

Fig. 7. *Campanula pindicola*. – A: Habit. – B: Flower (opened). – Aldén 3669 (holotype).

Pusillae. As *C. caespitosa,* for example, they have, however, persistent leaf rosettes, nodding flower buds and smooth receptacles.

C. pindicola grows together with *C. albanica* ssp. *albanica* in limestone crevices at about 2100 m.

Caprifoliaceae

Viburnum lantana L.

Collections. Mt Baros, 8 km SSW of Chalikion, 1900–2000 m, A 3293 – Mt Koziakas, 6 km E of Pertoulion, 1800–1840 m, A 4826 – Mt Trapos, 5 km SW of Chalikion, c. 1900 m, A 4205 – Between Mt Trapos and Mt Peristeri, 5 km WSW of Chalikion, c. 1950 m, A 4134 – Below Mt Zygos, 2 km NE of Metsovon, c. 1250 m, A 122.

New to Pindhos. Only a few records from Greece, viz. Macedonia and W Thrace (cf. Rechinger 1939, Ganiatsas 1939), Mt Parnassos in Sterea Hellas and Peloponnesos.

V. lantana is a predominantly woodland species, but grows in limestone crevices and on rock ledges from 1800 to 1950 m in a few places in Pindhos. Also found on serpentine rock at 1250 m near the village of Metsovon.

General distribution. S and C Europe to C Ukraine and N Africa.

Caryophyllaceae

Paronychia polygonifolia (Vill.) DC. in Lam. & DC.

Collections. Mt Karava, 4 km NNW of Vlasion, 1950–2000 m, A 4338 – Mt Voutsikaki, c. 4 km ESE of Vlasion, c. 2020 m, A 4438.

In Greece previously only known from a few mountains in Sterea Hellas, i.e. the region S of Pindhos.

It was found growing together with *Herniaria parnassica* in dry meadows at about 2000 m in SE Pindhos.

General distribution. S Europe to Turkey.

Crassulaceae

Sedum atratum L.

Collections. Mt Kakarditsa, 4 km W of Athamania, c. 2300 m, A 3605 – Mt Katarrachias, 5.5 km ENE of Kalarrites, 2150–2250 m, A 5237; 6 km ENE of Kalarrites, c. 2100 m, A 5272 – Mt Peristeri, 6 km W of Chalikion, c. 2200 m, A 4182 – Mt Perivoulion, 7.5 km S of Chalikion, 2050–2150 m, A 3324 – Mt Trapos, 5 km WSW of Chalikion, 1980–2080 m, A 3843; 6 km SW of Chalikion, c. 2220 m, A 4156.

S. atratum is new to C Pindhos and not common in Greece though localities are known from most mountain areas except from Peloponnesos.

Plants from Pindhos have stems 1.5–7 cm, unbranched or branched with erect branches, leaves green to red, petals greenish-yellow to almost pink, up to twice as long as sepals. According to Webb (1961) ssp. *carinthiacum* occurs in the Austrian alps, Slovenia, the Dolomites, N Albania and Epiros in NW Greece. It appears to be the dominant form on the Balkan Peninsula, though plants corresponding to ssp. *atratum* occur here and there in the region. The variation, even within small populations, is, however, too wide to justify the maintenance of the two subspecies recognized by Webb (1964).

Material from Austria and Switzerland shows the same morphological variation.

S. atratum grows on moist ground, on rock ledges, etc. up to 2300 m.

General distribution. Mountains of C and S Europe.

Cyperaceae

Carex diandra Schrank

Collections. Below Mt Baros, 7 km SSW of Chalikion, 1600–1650 m, A 4256; do, A 4260 – Between Mt Peristeri and Mt Trapos, 6 km WSW of Chalikion, c. 2000 m, A 4020.

New to Greece.

C. diandra shows a high degree of variability in the area, partly as the result of hybridization with *C. paniculata*. Plants from Pindhos have stems 20–40 cm, leaves 1–5 mm broad, spikes up to 1 cm long, not or very shortly stalked, lowest bracts sometimes very long. Some of the plants are also more robust than normal and correspond to var. *major* (Koch) A. & G. (cf. Hylander 1966).

On Mt Zygos, near the road between Trikkala and Ioannina, are some tussocks of the hybrid *C. diandra* × *C. paniculata*. They are predominantly sterile, have short-stalked spikes, long lower bracts and intermediate utriculi characters.

C. diandra grows in poor-fens above the timber-line in the W and more humid parts of Pindhos.

General distribution. Europe, Canary Islands, Caucasus, N Asia, N America and New Zealand.

Carex silvatica Huds.

Collections. Mt Augo, 4.5 km SW of Pirra, 1650–1750 m, A 2160 – Mt Neraidha, 4 km NW of Pertoulion, c. 1900 m, A 1607.

New to Pindhos. Previously reported from NE Greece (Hayek 1933), Mt Bela Voda E of Lake Prespa (Zaganiaris 1938–40) and Euboea (Rechinger 1936).

The Pindhos localities of a woodland species such as *C. silvatica* are interesting in that they are 100 to 200 m above the present timber-line, and may indicate previous altitudes of timber-lines in the area. On many of the mountains the woods have been destroyed and recovery is very slow and counteracted by grazing. Other typical woodland species can also be found far above the present timber-line.

General distribution. Europe, N Africa, temperate Asia, introduced and naturalized in eastern N America.

Euphorbiaceae

Euphorbia brittingeri Opiz ex Samp.

Collections. Mt Baros, 8 km SSW of Chalikion, 1900–2000 m, A 3010 – Below Mt Zygos, 4 km NNW of Metsovon, c. 1400 m, A 125.

E. brittingeri is recorded for Greece in Smith & Tutin (1968) but I have seen no reports of localities.

It belongs to the critical *E. epithymoides* group and resembles *E. montenegrina* in having leaves serrate or serrulate to half or more than half of the leaf margin. The length of the tubercles on the fruits (often used as a key character) is not constant within *E. brittingeri* as tubercles 2–3 times as long as wide, can sometimes be found.

The morphology of the plants collected in Pindhos is as follows: Perennial with rather short stems, 20–30 cm, woody below. Sterile shoots present. Leaves 10–30 mm long, obovate to ovate-lanceolate, mostly serrulate to more than half of their length, with sparse long hairs below and on margins. Ray leaves yellowish at anthesis, rhomboid-elliptical. Raylet leaves suborbicular. Capsule densely covered with yellow, slender tubercles. Seeds yellowish-brown, smooth, c. 2 mm.

E. brittingeri was found in meadows and on moist rock ledges from 1400 to 1950 m.

General distribution. W and C Europe, N and C Italy and N and C Balkan Peninsula.

Euphorbia deflexa Sibth. & Sm.

Collections. Mt Pachtourion, 7 km SSE of Athamania, 1680–1720 m, A 4782; 5 km SSW of Athamania, c. 1700 m, A 4787.

New to Pindhos. *E. deflexa* is a plant with a wide altitudinal amplitude known from the coastal lowlands but also from several mountain areas, for example, Mt Parnassos, Mt Olympos (in Halácsy 1904) and Mt Vermion (Rechinger 1939).

Chromosome number 2n = 16 (A 4787). No previous counts known.

In the single locality on Mt Pachtourion it was growing in scree of non-calcareous rock at c. 1700 m.

General distribution. Endemic to Greece and Crete.

Euphorbia glabriflora Vis.

Collections. Mt Pachtourion, 5.5 km SSE of Athamania, c. 1830 m, A 4675; do, c. 1800 m, A 4696 – Mt Zygos, 4 km NE of Metsovon, c. 1750 m, A 1297.

A rare species in Pindhos collected on Mt Zygos (Haussknecht 1897, as *E. pindicola* sp. nov.) and above the village of Malakasi, near Mt Zygos, by Sintenis (in Halácsy 1904).

E. glabriflora grows in open woods or above the timber-line up to 1850 m in areas with non-calcareous rock, especially on serpentine.

Chromosome number 2n = 16 (A 1297). No previous counts known.

General distribution. C Balkan Peninsula.

Fabaceae

Astragalus purpureus Lam.

Collections. Mt Augo, 6 km SW of Pirra, 1800 m, A 2367; do, 1850–1900 m, A 2429.

New to Greece. Nearest localities in Albania.

The plants from Mt Augo differ somewhat from the SC European plants in being smaller in most of their parts, stems up to 10 cm, leaves up to 4 cm, peduncles shorter than or as long as leaves.

There were c. 100 individuals growing in crevices of a limestone rock at 1800 m and also a few individuals on a rock ledge somewhat higher up.

General distribution. S and W Europe from W France and E Spain to C Balkan Peninsula.

Lathyrus pallescens (Bieb.) Koch

Collections. Mt Baros, 8 km SSW of Chalikion, 1850–1950 m, A 3085 – Mt Neraidha, 3 km N of Chatsipetrion, 1950–2000 m, A 1105 – Mt Peristeri, 5.5 km W of Chalikion, 2100–2200 m, A 3936; 6 km W of Chalikion, 2050–2150 m, A 4010; 5 km W of Chalikion, c. 2100 m, A 4119 – Mt Perivoulion, 7.5 km S of Chalikion, 1950–2050 m, A 3124; do, 2100–

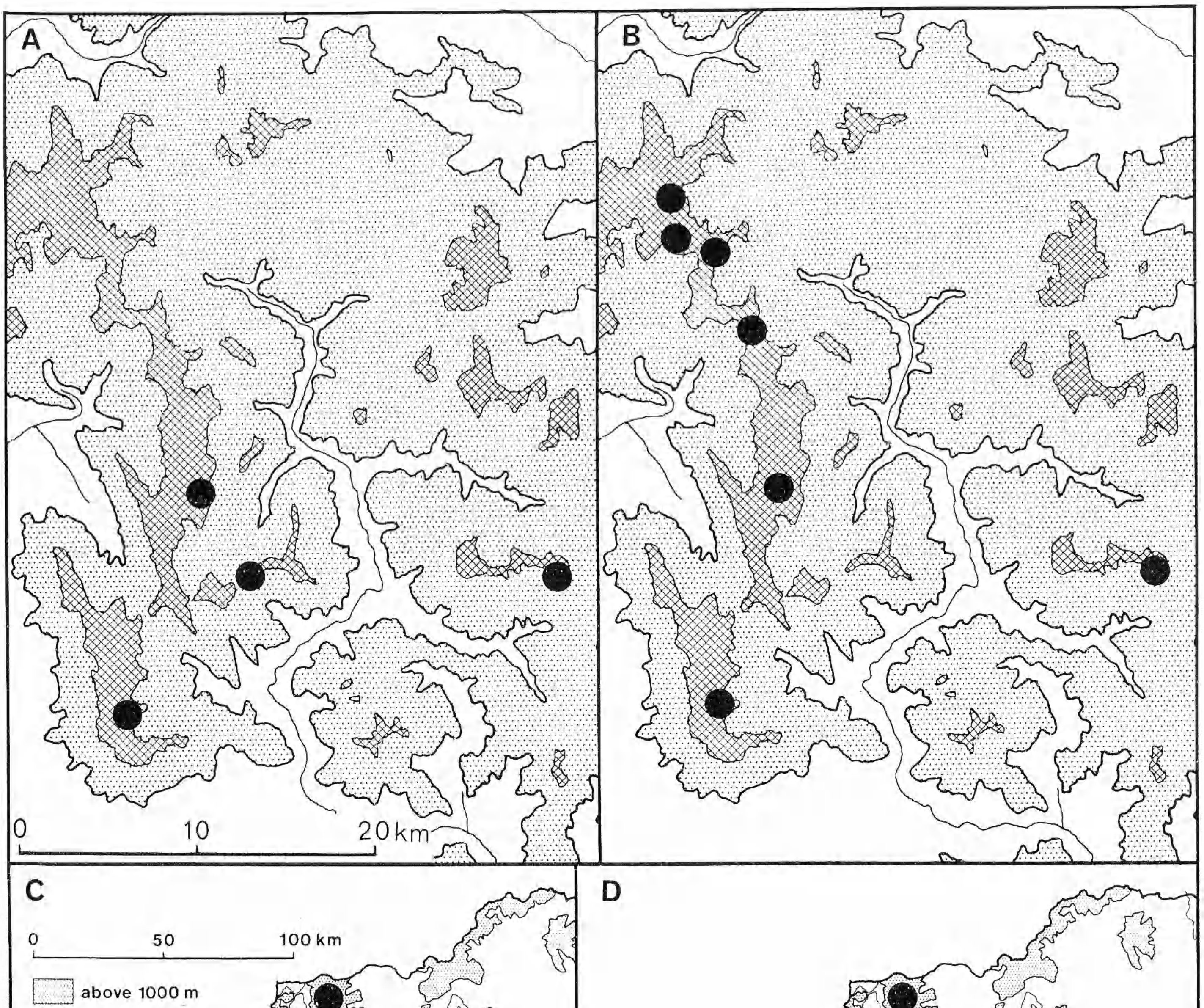

Fig. 8. Known localities in Greece for 4 species. – A: *Achillea absinthoides*. – B: *Alkanna nonneiformis*. – C: *Geranium aristatum*. – D: *Asphodelus albus*.

2180 m, A 3319 – Mt Tringia, 2.5 km N of Paleochorion, 1850–1950 m, A 339; 6 km S of Kastanea, 1800–1900 m, A 473.

New to Greece.

L. pallescens is a glabrous or sparsely hairy perennial. According to Ball (1968) *L. pallescens* is a pubescent plant with a pubescent or villous calyx. This is not so. Specimens from Pindhos and several other specimens seen from outside Greece are glabrous or sparsely hairy with a glabrous calyx, but with the margins of the calyx teeth mostly ciliate. The closely related *L. pannonicus* is distinguished from *L. pallescens* in having the style filiform, not dilated, at the apex. The colour of the corolla in plants from Pindhos is cream-sulphur, sometimes with a violet tinge.

L. pallescens grows on rather dry rocky but grass-rich slopes from 1850 to 2150 m.

General distribution. SE Europe, Transcaucasia and E Turkey.

Geraniaceae

Geranium aristatum Freyn & Sint.

Collections. Mt Baros, 8 km SSW of Chalikion, 1850–1900 m, A 3273 – Mt Boutai, 3 km SSW of Chalikion, c. 2000 m, A 3448 – Mt Koziakas, 6 km E of Pertoulion, c. 1850 m, A 4851 – Between Mt Peristeri and Mt Trapos, 5 km WSW of Chalikion, 1860–1930 m, A 4053; do, c. 1950 m, A 4127.

A rare plant in Greece (localities in Fig. 8 C) with the locus classicus on Mt Trapos (Freyn 1897). Also reported from Mt Phlambouro above the village of Katafigion (Zaganiaris 1938–40), Mt Timphi (Goulimy 1955, Quézel & Contandriopoulos 1965) and on Mt Bela Voda (Quézel & Contandriopoulos 1968). In Hayek (1927) Macedonia refers to localities in Yugoslavia just N of the Greek border and E of Lake Doiran (Bornmüller 1925).

G. aristatum grows among boulders and on ledges of hard limestone from 1800 to 2000 m.

General distribution. S Albania, S Yugoslavia and NW to NC Greece.

Geranium sylvaticum L. ssp. **sylvaticum**

Collections. Below Mt Baros, 7 km SSW of Chalikion, 1600–1650 m, A 4264 – Mt Katarrachias, 6 km ENE of Kalarrites, 2150–2250 m, A 5195 – Mt Trapos, 6 km WSW of Chalikion, 2150–2250 m, A 3896.

New to Pindhos. The nearest localities of *G. sylvaticum* are in NE Greece and in Albania, though some of these belong to ssp. *caeruleatum*.

Ssp. *sylvaticum* occurs in moist rock meadows up to 2200 m.

General distribution. Temperate Eurasia, introduced in N America.

Iridaceae

Iris germanica L.

Collections. Mt Trapos, 5 km SW of Chalikion, c. 1950 m, A 4229; do, 1950–2000 m, A 4232.

I. germanica is now a widely cultivated species and naturalized in most parts of S and C Europe. Previous collections in Pindhos are from Mt Timphi (Goulimy 1955: probably *I. germanica;* Phitos 1962: *Iris* sp.; Quézel & Contandriopoulos 1965: *Iris* spec., magnifique espèce sans doute nouvelle).

The plants from Pindhos differ somewhat from the description in Hayek (1933) in having stout simple stems, 30–50 cm with about 3 flowers and slightly recurved leaves, 10–40 × 1.0–3.5 cm. Plants cultivated in the greenhouses in Lund were up to 70 cm high and branched.

I. germanica is probably indigenous in Pindhos. It was found on a few rock ledges from 1950 to 2000 m.

Chromosome numbers $2n = 46$ (A 4229) and 48 (A 4232). Previous reports are $2n = 24$, 34, 36, 44, 48 and 60 (Fedorov 1969).

General distribution. S and C Europe, N Africa and Israel.

Lamiaceae

Salvia argentea L.

Collections. Mt Augo, 6 km SW of Pirra, 1850–1900 m, A 2406 – Mt Boutai, 4 km SW of Chalikion, 1800–1900 m, A 3195 – Mt Kazarma, 6 km NE of Vlasion, 1900–2000 m, A 4406 – Mt Kauki, c. 2 km N of Kerasochorion, 1600–1750 m, A 113 – Mt Neraidha, 2.5 km W of Pertoulion, c. 1500 m, A 1663 – Mt Peristeri, 5 km W of Chalikion, c. 2100 m, A 4115 – Mt Trapos, 5 km SW of Chalikion, 1800–1850 m, A 4217 – Mt Voutsikaki, 4 km E of Vlasion, 1600–

1700 m, A 621 – Mt Tzoumerka, 4.5 km WSW of Theodhoriana, 1900–1950 m, A 2680.

Not previously reported from the area though known from NW Pindhos (Halácsy 1902).

S. argentea is represented by two altitudinal forms, one tall, amply branched, lowland to montane form and one rather short, shortly branched form, found at higher altitudes. The latter form, which is called var. *alpina* Heldr. (cf. Halácsy 1902), is not uncommon in C and S Pindhos and occurs on dry stony E or S slopes from 1500 to 2100 m.

General distribution. S Europe.

Sideritis perfoliata L.

Collection. Mt Pachtourion, 5 km SE of Athamania, 1900–1940 m, A 4707.

Very rare in Greece, and outside Pindhos only reported from Mt Athos (by several authors) and Mt Phengari on Samothrace (Turrill 1935, as var. *lanata*, Ade & Rechinger 1938).

The plants from NE Greece differ from those in Pindhos in being densely lanate. In Pindhos it is reported from Mt Agrapha (Heldreich in Halácsy 1902), Mt Neraidha (Maire & Petitmengin 1908) and Mt Grammos (Zaganiaris 1938–40). Mt Neraidha (not the one shown in Fig. 1) is rather close to and W of the peak Soufli, Mt Pachtourion, where *S. perfoliata* was found in 1974. A glabrous form (not seen by me and perhaps wrongly determined) was reported from Mt Augo in Epiros (Regel 1942). The plants on Mt Pachtourion are 20–35 cm, sparsely hirsute and glandular and have 4–10 verticillasters. Young leaves sublanate.

As *S. perfoliata* is a mainly Anatolian species the localities in Pindhos are of great interest.

It grows in crevices of hard limestone.

General distribution. Greece, Anatolia.

Stachys recta L. s.l.

Collection. Mt Loupata, 6 km SSW of Pertoulion, c. 1850 m, A 1676.

I have seen no previous reports of *S. recta* from Pindhos except that of Baldacci (1898). A fairly distinct morphological form of *S. recta* was found on Mt Loupata. Plants collected on Mt Kakarditsa by Baldacci (as *S. recta*) though in poor condition belong to this form.

The morphology of the plants from Mt Loupata shows some new combinations of characters (habit and flower in Fig. 9): Ascending to erect, shortly hispid, almost eglandular perennial, 10–15 cm. Leaves 10–20 × ×4–10 mm, crenate-dentate, the lower ones petiolate, ovate to obovate, rounded to cuneate at base, the upper ones sessile to subsessile, oblong to lanceolate. Indumentum of leaves, stem and calyx of crispate to ± straight hairs up to 1 mm long. Flowers in 1–2 verticillasters, each with 1–6 flowers. Calyx campanulate, 7–9 mm, with a few short glandular hairs. Calyx teeth subequal, margins covered with subsessile glands, acuminate, broadly triangular, c. 1/3 as long as the tube. Corolla 12–15 mm, yellow with or without purple spots, pubescent-glandular, upper lip 4–5 mm, lower lip 7–9 mm. The number of verticillasters, flowers and habit is clearly influenced by habitat and altitude. In habitat, habit and leaf shape, but not shape of calyx teeth and degree of hairiness, it is close to *S. beckeana*. This taxon, which is restricted to SW Yugoslavia and N Albania, is nothing but an altitudinal form of *S. recta* with long hairs perhaps meriting recognition as a subspecies. Another high-mountain taxon, described from N Albania, is *S. recta* L. ssp. *dörfleri* (Hayek) Hayek. Though in habit close to the plants from Pindhos it differs in having narrowly triangular calyx teeth. As the whole group shows a reticulate variational pattern and no experimental studies have yet been carried out, no new specific or infraspecific epithet is given to this C Pindhos taxon.

It was found in mobile scree at c. 1850 m.

General distribution (*S. recta* s.l.). S Europe to W Asia.

Liliaceae

Allium guicciardii (Boiss.) Heldr.

Collections. Mt Kakarditsa, 3 km W of Athamania, 1820–1920 m, A 3725 – Mt Koziakas, 5 km NE of Pertoulion, c. 1750 m, A 1478; 6 km E of Pertoulion, c. 1600 m, A 4861 – Mt Milia, 5 km NW of Milea, 2050–2100 m, A 4966 – Mt Pachtourion, 5 km SSE of Athamania, c. 1700 m, A 4790.

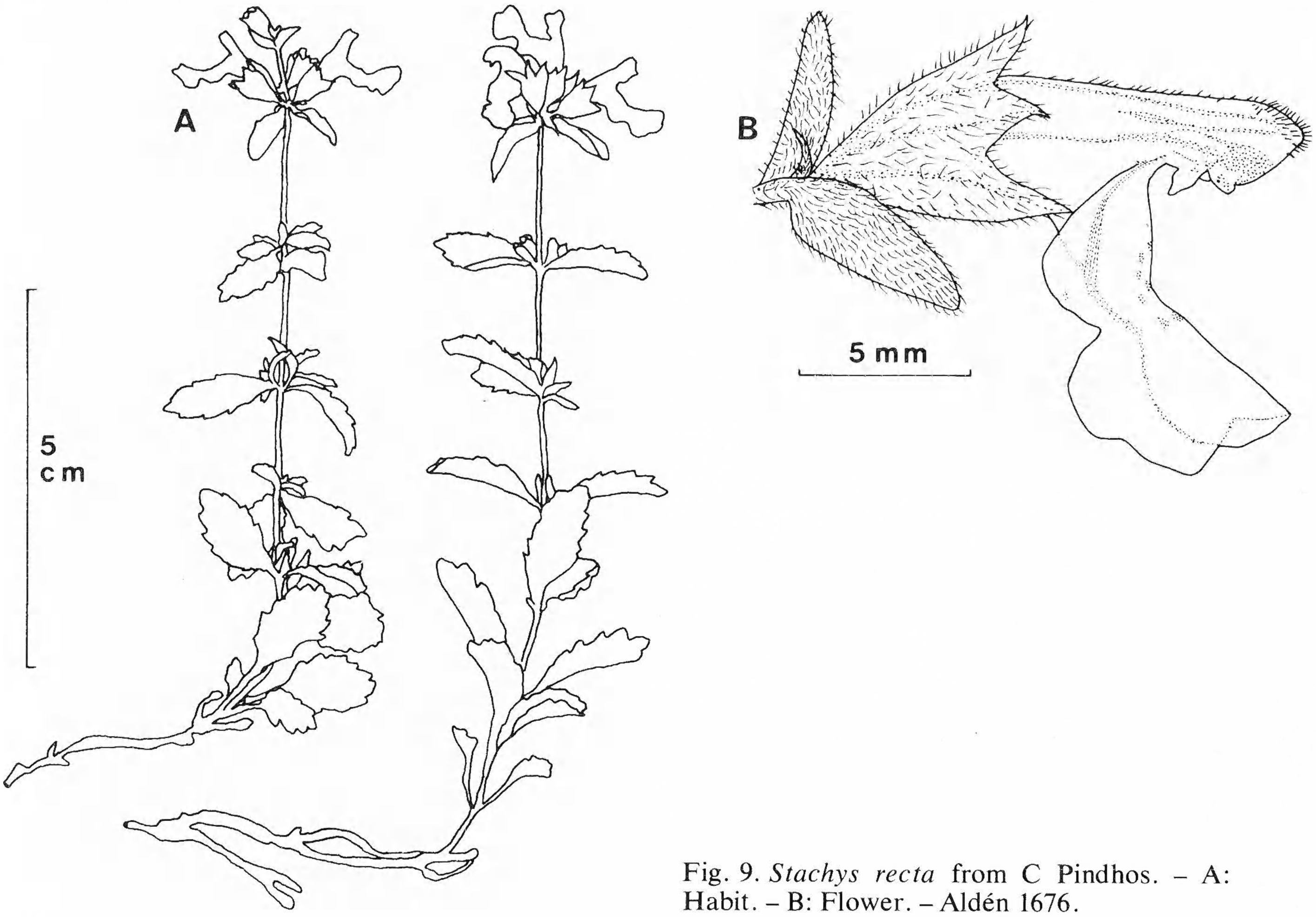

Fig. 9. *Stachys recta* from C Pindhos. – A: Habit. – B: Flower. – Aldén 1676.

In Pindhos known only from the lower slopes of Mt Peristeri (Haussknecht 1899).

It grows on dry stony slopes from 1600 to 2100 m and was also found on serpentine in the mountains N of Mt Zygos.

Chromosome numbers 2n = 16 (A 4966) and 32 (A 3725, 4790). No previous counts known. The closely related *A. flavum* has 2n = 16 (Fedorov 1969).

General distribution. C and S Balkan Peninsula.

Allium heldreichii Boiss.

Collections. Mt Koziakas, 11 km NW of Pili, c. 1800 m, A 1231; 5 km NE of Pertoulion, c. 1900 m, A 1518; 6 km E of Pertoulion, c. 1850 m, A 4849.

A. heldreichii, previously regarded as endemic to Mt Olympos, was first found outside Mt Olympos by Rechinger (1939) and Ganiatsas (1939) on Mt Vermion.

It belongs to the section *Allium* and is very closely related to *A. aucheri* Boiss., in E Anatolia, Iran and Caucasus (cf. Wendelbo 1971). The newly discovered plants on Mt Koziakas are even closer to *A. aucheri* than the previously known ones in having tepals 7–10 mm long. In fact when the characters of plants from Mt Olympos and Mt Koziakas are considered together, the difference between *A. heldreichii* and *A. aucheri* is very slight being mainly a question of plant height and shape of perigonium, and *A. heldreichii* could perhaps better be classified as a subspecies of *A. aucheri*.

A. heldreichii is thus a taxon which again shows the connection between NC Greece and more easterly elements.

It is a predominantly woodland species. It grows in rocky places on Mt Koziakas up to 1900 m.

Chromosome number 2n = 14 (A 4849). No previous counts.

General distribution. Endemic to NC and N Greece.

Allium parnassicum (Boiss.) Hal.

Collections. Mt Katarrachias, 5.5 km ENE of Kalarrites, c. 2050 m, A 5339 – Mt Koziakas, 6 km E of Pertoulion, 1750–1850 m, A 4815.

A Greek endemic species. Some localities in Sterea Hellas, one on Mt Peristeri in Pindhos (Maire & Petitmengin 1908) and one on Mt Smolika (Zaganiaris 1938–40).

Grows on dry grassy slopes from 1750 to 2050 m.

General distribution. SC, C and NW Greece.

Allium suaveolens Jacq.

Collection. Mt Kakarditsa, 3.5 km W of Athamania, 2050–2250 m, A 3506.

New to Greece. The nearest localities are in Albania.

The plants from Pindhos have smaller umbels, 20–25 mm and slightly longer stamens than specimens seen from outside Greece.

A. suaveolens was found on rock ledges on the NE side of Mt Kakarditsa.

Chromosome number 2n = 16 (A 3506) which agrees with previous reports (Fedorov 1969).

General distribution. C and S Europe.

Asphodelus albus Mill.

Collections. Mt Augo, 4.5 km SW of Pirra, c. 1650 m, A 2327 – Between Mt Trapos and Mt Peristeri, 5 km WSW of Chalikion, c. 1950 m, A 4135 – Below Mt Zygos, 4 km NNW of Metsovon, c. 1400 m, A 128.

A mainly W Mediterranean species, in Pindhos collected previously on Mt Tragopetra (near Mt Dhokimi) by Sintenis (cf. Halácsy 1902) and on Mt Timphi (Phitos 1962). Outside Pindhos reported from Mt Vermion (Rechinger 1939, Ganiatsas 1939) and Mt Bela Voda (Zaganiaris 1938–40). The known localities in Greece are shown in Fig. 8 D.

On Mt Augo, at about 1600 m, it was growing in abundance, almost covering some of the slopes. Seen but not collected on Mt Boutai.

Chromosome number 2n = 28 (A 2327). Previous counts 2n = 26 and 56 (Fedorov 1969, Lovka et al. 1972).

General distribution. S Europe, from Bretagne to C Balkan.

Ophioglossaceae

Botrychium lunaria (L.) Swartz in Schrad.

Collections. Mt Baros, 8 km SSW of Chalikion, 1800–1900 m, A 2975; do, 1900–2000 m, A 3023 – Mt Kakarditsa, 3.5 km W of Athamania, 2050–2100 m, A 3664; 4 km W of Athamania, c. 2350 m, A 3750 – Mt Karava, 3 km NNW of Vlasion, 2050–2150 m, A 4290; 3 km NW of Vlasion, c. 2150 m, A 4306 – Mt Katarrachias, 5.5 km ENE of Kalarrites, 2150–2250 m, A 5241 – Mt Mazur–Ailas, 3 km ESE of Arghidhea, c. 1800 m, A 932 – Mt Peristeri, 6 km W of Chalikion, 2200–2295 m, A 3945; do, 2200–2290 m, A 4165 – Mt Perivoulion, 7.5 km S of Chalikion, 2100–2180 m, A 3318; do, 2050–2188 m, A 3133 – Mt Trapos, 5 km WSW of Chalikion, 1980–2080 m, A 3829; 5.5 km WSW of Chalikion, c. 2100 m, A 3865 – Mt Tringia, 6 km S of Kastanea, 1950–2000 m, A 1935 – Mt Tzoumerka, 4.5 km WSW of Theodhoriana, 1750–1850 m, A 2487; do, 1900–2000 m, A 2507 – Below Mt Zygos, 4 km NNW of Metsovon, c. 1400 m, A 126.

No published localities seen from C and S Pindhos.

Somewhat variable according to habitat. Plant height varies from 1–15 cm.

B. lunaria is a common species in the area and can be found in a variety of habitats from rich and moist rock meadows to dry places of heathland character up to 2300 m.

General distribution. Between 35° and 65° in the N Hemisphere, Patagonia, S Australia and Tasmania.

Ophioglossum vulgatum L.

Collections. Mt Kakarditsa, 3 km W of Athamania, c. 1800 m, A 3773 – Mt Koziakas, 5 km NE of Pertoulion, 1740 m, A 1561.

New to Pindhos, but collected in 1965 by Rechinger (Rechinger 18641, unpublished) near Mt Zygos at 1500 m. Apart from Pindhos known from Mt Athos (n.v.), the islands of Naxos and Ikaria (Runemark et al. 1960), the islands of Andros (Snogerup & Bothmer 31699, 31962 and 32575, unpublished) and Kephallinia (Snogerup 23729, unpublished).

Grows in wet places up to 1800 m.

General distribution. Europe, Asia and N America.

Orchidaceae

Coeloglossum viride (L.) Hartm.

Collections. Mt Baros, 8 km SSW of Chalikion, 1850–1900 m, A 3274 – Mt Katarrachias, 6 km ENE of Kalarrites, 2150–2250 m, A 5206; do, c. 2100 m, A 5275 – Mt Pachtourion, 5 km SE of Athamania, 1900–1940 m, A 4737 – Mt Perivoulion, 7.5 km S of Chalikion, c. 2100 m, A 3177 – Mt Trapos, 6 km WSW of Chalikion, 2150–2250 m, A 3888.

New to Pindhos, but known from Mt Olympos. *C. viride* is the only orchid species, with the exception of *Orchis pallens,* that can be found at higher altitudes in Pindhos.

It grows in moist rock meadows from 1900 to 2250 m.

General distribution. Europe to Siberia and N America.

Poaceae

Agropyron sanctum (Janka) Hackl.

Collections. Mt Liakoura, 4 km ENE of Granitsa, 1400–1500 m, A 755 – Mt Pteri, 5 km NNE of Granitsa, c. 1700 m, A 1883.

Apart from localities in NE Greece (cf. Rechinger 1939) only known from Mt Voutsikaki (Mt Ghavellu) (Formanek 1897, Haussknecht 1899) in SE Pindhos.

A. sanctum grows on dry stony slopes just above the timber-line.

General distribution. Endemic to Greece.

Festuca paniculata (L.) Schinz & Thell.

Collections. Mt Baros, 8 km SSW of Chalikion, 1850–1950 m, A 3056; do, c. 1900 m, A 4244.

First recorded from Greece by Ganiatsas (1939) on Mt Vermion. Later reported by Quézel & Contandriopoulos from Mt Smolika (1965) and Mt Bela Voda (1968). The nearest localities outside Greece are in Albania and Yugoslavian Macedonia.

A few tufts of *F. paniculata* were found on a dry grassy slope of heathland character.

General distribution. C and S Europe, NW Africa.

Ranunculaceae

Actaea spicata L.

Collections. Mt Koziakas, 6 km E of Pertoulion, 1800–1840 m, A 4833 – Mt Pachtourion, 6 km SSE of Athamania, c. 1800 m, A 4656 – Between Mt Peristeri and Mt Trapos, 5 km WSW of Chalikion, 1860–1930 m, A 4062; do, c. 1950 m, A 4128.

Except for an early report from Peloponnesos by Sibthorp (in Halácsy 1901), recorded from Mt Cholomon (on Chalkidhiki; Zaganiaris 1938–40), Mt Vermion (Quézel & Contandriopoulos 1968), Mt Timphi (Goulimy 1955, Quézel & Contandriopoulos 1965) and Mt Peristeri (Quézel & Contandriopoulos 1965).

A. spicata is a predominantly woodland species but occurs at higher altitudes in S Europe.

In Pindhos it was found in crevices and among boulders of hard limestone from 1800 to 2000 m. It is probably spread by rock partridges (*Alectoris graeca*) which nest among the boulders and eat the berries.

General distribution. Temperate Eurasia.

Ranunculus platanifolius L.

Collection. Mt Baros, 8 km SSW of Chalikion, 1850–1900 m, A 3275.

Very rare in Greece and only known from Mt Grammos (Zaganiaris 1938–40) and two localities in C Pindhos, in and near the valley of Aspropotamos, viz. on Mt Mikrogura above the village of Chalikion (Sintenis in Halácsy 1901) and near the village of Kastanea at 1700 m (Quézel & Contandriopoulos 1965). All localities are in forest.

On Mt Baros *R. platanifolius* was found in a moist rock crevice far above the timber-line.

General distribution. C and S Europe, Belgium and W Fennoscandia.

Rosaceae

Amelanchier ovalis Med.

Collections. Mt Trapos, 5 km SW of Chalikion, c. 1900 m, A 4206 – Mt Tzoumerka, 4.5 km WNW of Theodhoriana, c. 2100 m, A 2761.

New to Pindhos. The nearest locality is on Mt Parnassos in Sterea Hellas.

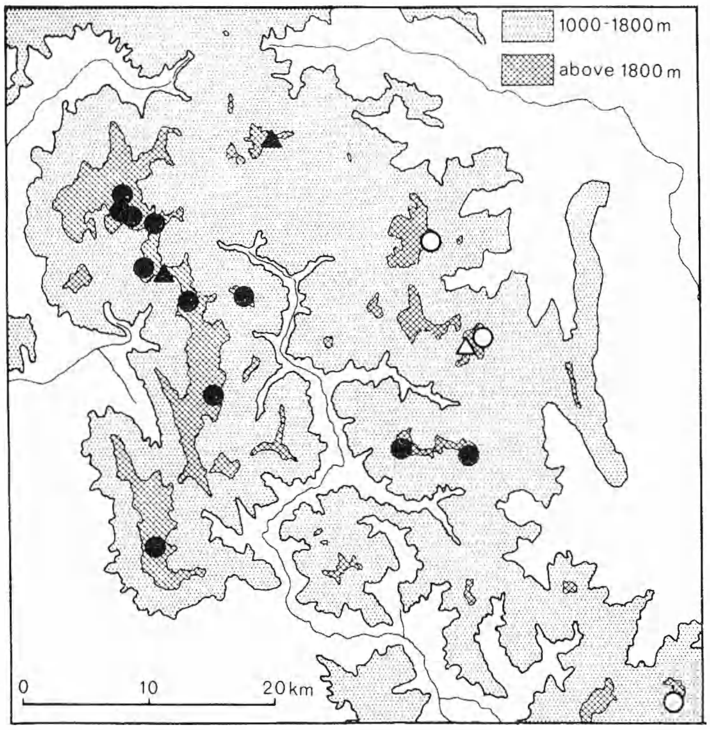

Fig. 10. Known localities of 4 *Thesium* species in C and S Pindhos. *Thesium linophyllon* ssp. *linophyllon* (dots), *T. brachyphyllum* (circles), *T. arvense* (unfilled triangle) and *T. parnassi* (filled triangles).

Differs from *A. ovalis* var. *cretica,* known from Crete, Peloponnesos and the island of Youra, N Sporades (Snogerup & Phitos 43312, unpublished), in the leaves lacking persistent indumentum.

In Pindhos *A. ovalis* grows in vertical limestone cliffs.

General distribution. C and S Europe, Caucasus, Lebanon and NW Africa.

Santalaceae

Thesium arvense Horvatovszky

Collections. Mt Neraidha, 3 km N of Chatsipetrion, 1950–2000 m, A 1108; do, 1900–1950 m, A 1114.

T. arvense was reported from Mt Peristeri and Mt Karava by Quézel & Contandriopoulos (1965), but the plants were incorrectly determined and probably belong to *T. linophyllon* ssp. *linophyllon* (Greuter, pers. comm.). Thus the locality on Mt Neraidha seems so far to be the only in Pindhos (Fig. 10).

It is an extremely variable species and when not in flower is sometimes hard to distinguish from *T. divaricatum*. The latter, collected at lower altitudes in Pindhos, Sterea Hellas and on Peloponnesos differs, however, in having less dense longitudinal venation on fruits, longer pedicels and a slenderer habit. Length of bracts and bracteoles is very variable and of less diagnostic value. *T. arvense* on Mt Neraidha is smaller than normal, has more condensed panicles and rather short bracts as long as to twice as long as the fruit.

It was found on dry grazed grassy slopes from 1950 to 2000 m.

General distribution. SE to E Europe to C Asia (Hendrych 1968).

Thesium brachyphyllum Boiss.

Collections. Mt Kazarma, 4 km NE of Vlasion, c. 1850 m, A 662 – Mt Neraidha, 4 km NW of Pertoulion, c. 1900 m, A 1590 – Mt Tringia, 3 km NNW of Paleochorion, c. 1900 m, A 219.

New to the Balkan Peninsula (localities in Fig. 10). The localities given in Boissier (1879) and later cited in Hayek (1924) refer to specimens collected by Pichler in "montis Balkan Thraciae" and by Balansa in "Tauri Cilicici supra Bulghar Maaden". The latter locality was evidently misinterpreted by Hayek as being in Bulgaria, not in SC Turkey as it is. However, both specimens are said to be stoloniferous and thus cannot be *T. brachyphyllum*.

The plants from Pindhos have the following morphology (Fig. 11): Procumbent to ascending, estoloniferous perennial up to 5 cm with a stout and woody stock. Leaves crowded, up to 13 mm long but usually much shorter. Nut c. 2.5 mm, with a few prominent longitudinal veins and lateral anastomosing veins. Bracts 2–5 times as long as nut. Inflorescence beginning below middle. The stoloniferous *T. parnassi* has nuts at least 3 mm long, usually with several prominent longitudinal veins or sometimes quite smooth with scarcely noticeable lateral veins. Leaves on stem not crowded. Bracts equalling or twice as long as nut. Inflorescence shorter, beginning at or above the middle of the stem.

T. brachyphyllum grows on dry grassy slopes.

General distribution. Greece, Crimea, Anatolia and Caucasus (Hendrych 1966).

Thesium linophyllon L. ssp. **linophyllon**

Collections. Mt Augo, 6 km SW of Pirra, 1850–1900 m, A 2427; do, 2000–2050 m, A 2237 – Mt Baros,

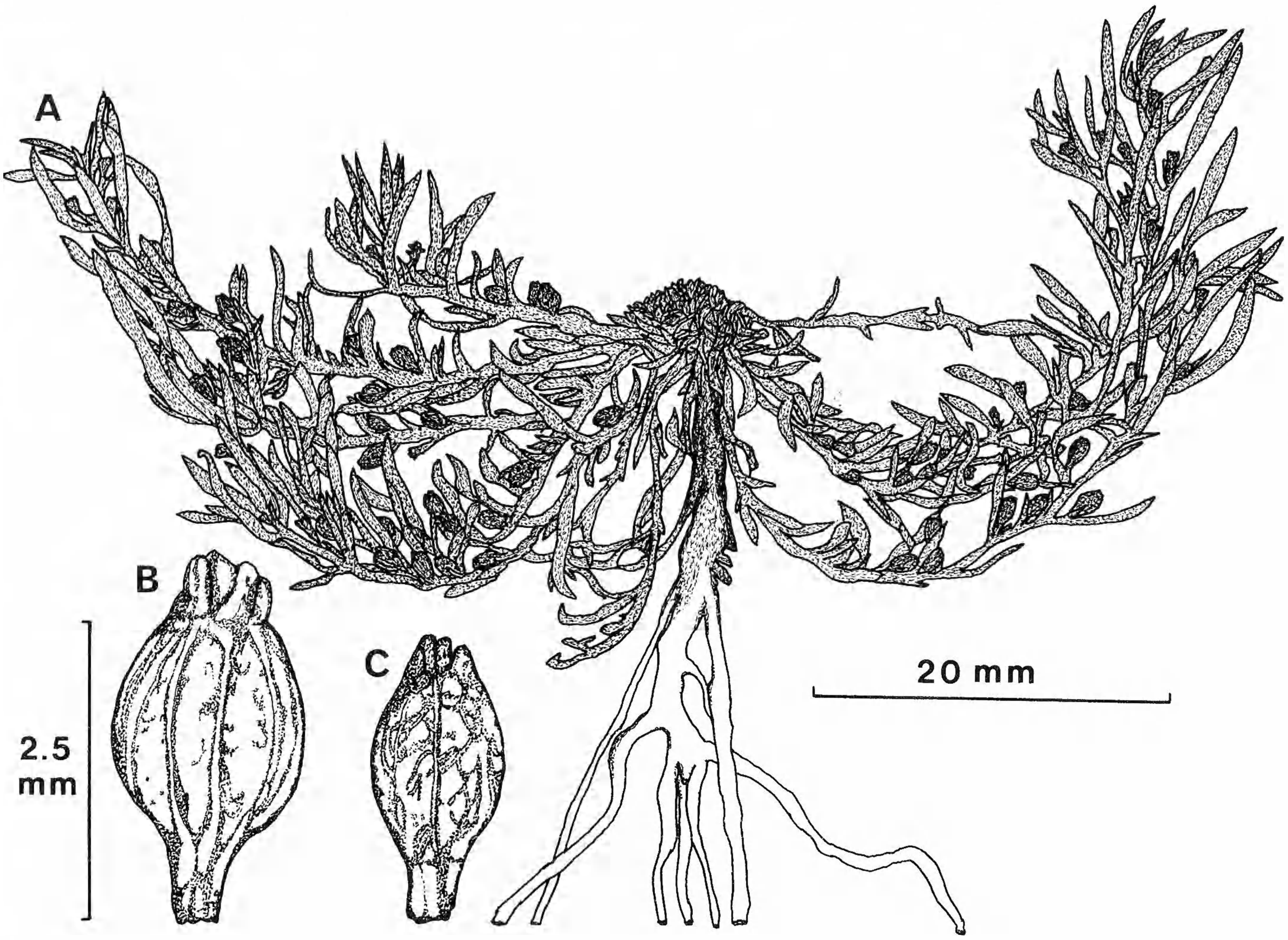

Fig. 11. A, C: *Thesium brachyphyllum*. – B: *T. parnassi*. – A: Habit. – B–C: Nuts. – A, C: Aldén 219. – B: Aldén 2942.

8 km SSW of Chalikion, 1850–1950 m, A 3092 – Mt Boutai, 4 km SW of Chalikion, 1800–1900 m, A 3196; 3 km SSW of Chalikion, 1950–2000 m, A 3436 – Mt Kakarditsa, 3 km W of Athamania, c. 2000 m, A 3472; 3.5 km W of Athamania, 2050–2100 m, A 3670 – Mt Katarrachias, 5.5 km ENE of Kalarrites, 2000–2050 m, A 5317 – Mt Kourouna, 2 km SSW of Aghio Paraskevi, 1800–1900 m, A 1977; do, 1900–1970 m, A 2023 – Mt Loupata, 6 km SSW of Pertoulion, 1850–2000 m, A 1718 – Between Mt Peristeri and Mt Trapos, 5 km WSW of Chalikion, 1860–1930 m, A 4054; do, c. 1950 m, A 4130 – Mt Trapos, 5.5 km WSW of Chalikion, c. 2200 m, A 4137; 5 km SW of Chalikion, 1800–1850 m, A 4216 – Mt Tzoumerka, 5.5 km WSW of Theodhoriana, 2100–2250 m, A 2577.

New to Pindhos. Previously reported from Mt Athos (cf. Hendrych 1969). The localities in Pindhos are given in Fig. 10.

The nomenclature is according to Hendrych (1969).

Ssp. *linophyllon* is extremely variable in vegetative characters but always stoloniferous.

It grows in dry meadows from 1850 to 2200 m on calcareous ground.

General distribution. C, SE and E Europe extending to the Ukraine (Hendrych 1969).

Thesium parnassi A. DC.

Collections. Mt Baros, 8 km SSW of Chalikion, 1800–1900 m, A 2942 – Mt Dhokimi, 9.5 km W of Kastanea, 1850–1900 m, A 4886; do, c. 1850 m, A 4916 – Mt Mavrovouni, 5 km WNW of Milea, 1900–2000 m, A 5118 – Mt Milia, 5 km NW of Milea, c. 2150 m, A 4988.

Not previously collected in S and C Pindhos. Localities in Fig. 10.

T. parnassi grows on dry or moist grassy slopes up to 2150 m on non-calcareous ground and was also found in the serpentine mountains N of Mt Zygos.

General distribution. Albania, Greece, Italy, Sicily and Yugoslavia.

Scrophulariaceae

Limosella aquatica L.

Collection. Mt Karava, 3 km NNW of Vlasion, c. 1950 m, A 4323.

Only one previous locality known in Greece, viz. Mt Timphi (Quézel & Contandriopoulos 1965).

L. aquatica is a rather polymorphic species a number of forms of which have been described. Plants with linear to linear-setaceous leaves have been called f. *borealis* Less. (cf. Neuman 1901). Dwarf plants can often be found growing together with normal-sized individuals. Plants with pedicels up to as long as leaves occur in the two known localities in Greece. These plants agree with plants I have seen in Scandinavia. Normally the flowers are 5-merous but plants with 4-merous flowers have been seen in material from Scandinavia and Greece. The collection described as *L. tenella* (Quézel & Contandriopoulos 1965) is thus a form of *L. aquatica*. The plants from Mt Karava are only 6–20 mm tall, with linear to linear-setaceous leaves. The pedicels are shorter than to almost equalling the leaves and the flowers are 4–5-merous.

It was found in a doline where snow had previously lain.

General distribution. Eurasia, Greenland and N America.

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Micropeziza Fuck. and Scutomollisia Nannf. nov. gen. (Discomycetes Inoperculati)

J. A. Nannfeldt

Nannfeldt, J. A. 1976 10 22: Micropeziza Fuck. and Scutomollisia Nannf. nov. gen. (Discomycetes Inoperculati). *Bot. Notiser 129:* 323–340. Stockholm. ISSN 0006-8195.

Micropeziza Fuck. is the correct name for the genus previously known as *Actinoscypha* Karst. and *Niesslella* Höhn. *Peziza cornea* B. & Br. is shown to belong here, and *M. scirpicola* Fuck., *Trochila ignobilis* Karst., *Mollisia sylvatica* Karst., and *Belonidium aurantiacum* Rehm to be conspecific with it. The correct name becomes *M. cornea* (B. & Br.) Nannf. *Actinoscypha graminis* Karst. is given a new epithet, viz., *karstenii* Nannf., when transferred to *Micropeziza,* because of the earlier *M. graminis* (Desm.) Rehm. *M. verrucosa* (E. Müll.) Nannf. is a new combination. *M. punctum* Rehm is shown to deviate so strongly in the structure of the excipulum that it is made the type of a new genus, *Scutomollisia,* to which also three new species are referred, viz., *S. leptoderma, S. operculata,* and *S. stenospora.* Both genera are considered to belong to the Mollisioideae. The various positions of the fruitbodies in relation to the matrix within this group are discussed and so is the taxonomic position of *Nannfeldtia* Petr. *Actinoscypha muelleri* Graddon must be removed from the genus, but no better position can be assigned to it.

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In 1919 Höhnel (cf. 1923 p. 112) combined into his new genus *Niesslella* three inconspicuous Ascomycetes which grow saprophytically on grasses and sedges and whose superficial ascocarps develop beneath a shield of radiating hyphae, which shield irregularly tears open to expose the flat hymenium. These were *Micropeziza scirpicola* Fuck., *M. punctum* Rehm, and *Belonidium aurantiacum* Rehm. He considered *Niesslella* and his monotypical tropical genus *Discomycella* (Höhnel 1912 p. 400) as Microthyriaceae that imitate Discomycetes ("Discomyceten vortäuschende Microthyriaceen"). I found later (Nannfeldt 1932 p. 319) that the much older monotypical *Actinoscypha* Karsten (1888 p. 5; *A. graminis* Karst.) is most probably congeneric with *Niesslella*. Ten years ago Müller (1966) confirmed this, revised the genus (without mentioning *B. aurantiacum*) and described a new species (*A. verrucosa*). He found Höhnel's (and my) interpretation erroneous and recognized in *Actinoscypha* typical inoperculate Discomycetes that could unrestrainedly be referred to Dermateaceae sensu meo. After that one more species has been described, viz., *A. muelleri* Graddon (1972 p. 158).

The "Grundart" of *Niesslella* is *Micropeziza scirpicola,* which Fuckel (1870 p. 291) placed as the second in its two-species genus. According to his principles Höhnel regarded the first species, *M. poae* Fuck., as the "Grundart" of Fuckel's genus. Unfortunately, he made no serious attempt to settle its identity. He did not see the type collection (F. rhen. 1174) and trusting on Rehm's general reliability he satisfied himself by finding that the fungus distributed by Rehm (Ascom. exs. 1221) as *M. poae* is " eine echte Mollisiee". Saccardo (1889 p. 343) had earlier referred *Micropeziza poae* to *Mollisia* and listed "*Micropeziza* Fuck. ex p." as a synonym of that genus. Strangely enough, the correctness of this synonymy has never been questioned. Fortunate, but still stranger, is the fact that nobody has observed that *Micropeziza* Fuck. (1870) as a generic name antedates *Mollisia* (Fr.) Karst. (1871) and uncritically drawn the nomenclatorial consequences.

M. poae is represented in Herb. Rehm (S) by two samples of the type collection. Some more samples determined by Rehm as *Niptera poae* (Fuck.) Rehm show the same species, and his description (Rehm 1891 p. 558) refers also to it. This fungus agrees in all essential respects with *M. scirpicola,* and so *Micropeziza* becomes the correct name for our genus. But there are in Rehm's herbarium under the name of *M. poae* also samples of *M. karstenii* (=*A. graminis*) and *M. punctum* as well as species of *Mollisia* s. lat., e.g. Rehm, Ascom. 1321, i.e. the collection which had misled Höhnel.

Peziza cornea Berkeley & Broome (1851 p. 183) as redescribed and depicted by Dennis (1960 p. 117, Pl. XX L = 1968 p. 185, Pl. XXIII L) shows so many features suggestive of *Micropeziza* that it too had to be examined in this connection. When Dennis remarks that "although this species was most thoroughly redescribed by Massee from the type collection at Kew it has been strangely misinterpreted by continental authors", he had evidently Höhnel and myself in mind. The former (1918 p. 366) had not seen the type specimen but only part of a later collection (Rbh., F. eur. 1119), collected by Broome himself on the same matrix (*Carex paniculata*), "von dem anzunehmen ist, dass es denselben Pilz enthält", an assumption that proved to be erroneous. Höhnel found his fungus to be a minute *Mollisia.* This (or a closely related species?) was illustrated by me (Nannfeldt 1932 p. 126), and going from bad to worse I stated later (Nannfeldt 1936 p. 193; repeated by Ramsbottom & Balfour-Browne 1951 p. 72) that the type specimen is identical. That statement must have been due to a misunderstanding of which was the true type material.

The label of the Rabenhorst exsiccatum gives June 1867 as the collecting date but no locality whatsoever. Besides two copies of this exsiccatum there are five more samples in K collected by Broome in the same month (all on leaves of *C. paniculata*), viz. two "Batheaston, June 1867" (Herb. Phillips and Herb. Plowright; a sample with the same labelling is in S from Herb. Sydow), two "Oakford Valley, 1 June 1867" (Herb. Broome) and one "Oakford Valley, St. Catherine's, 3 June 1867" (Herb. Broome). They show all Höhnel's fungus, except the sample from Herb. Plowright, which is now devoid of any fungus. All these samples emanate certainly from one and the same locality, viz. Oakford Valley.

It should furthermore be observed that a small piece of paper is attached to the Phillips sample with sketches of asci and spores and with the words "Sp. Herb. C.E.B. – .007 × .001 mm", for this makes the treatment in his Manual (Phillips 1887 p. 332; copied in Saccardo 1889 p. 640) a complete mystery: Batheaston is given as the sole locality and, nevertheless, the apothecia are said to be 300–500 μm broad and the spores "fusiform, slightly curved, biguttulate, at length pseudo-uniseptate, 15 × 2 μm", for these details point unequivocally to the true *P. cornea,* and this is otherwise not known from the Batheaston area.

There are in K five more samples of *P. cornea* collected by Broome on *C. paniculata,* but rather on sheaths than on leaf blades, which makes the phrase 'on dead stalks' of the original description more intelligible. They all seem to be from Spye Park (Wiltshire). The diagnosis gives "March 1850" as the collecting date, and so a sample (n. 109) dated "3/18 – 1850" must be the holotype. Another sample (also from Herb. Broome) was collected "Febr. 1850" and one (with a duplicate in Herb. Fries, UPS) "March

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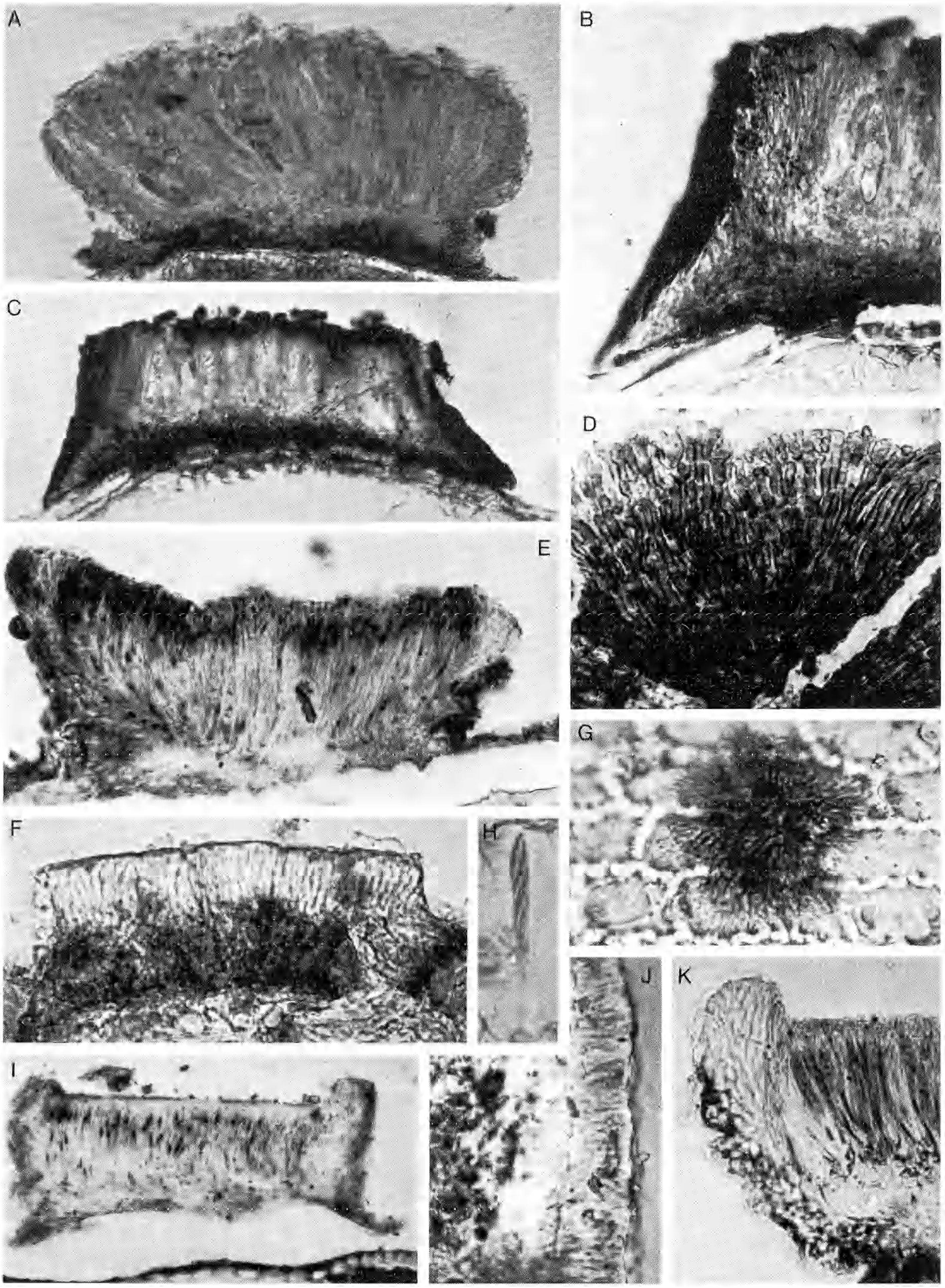
Fig. 1. A: "*Actinoscypha*" *muelleri* (isotype ZT). Median section; the cuticle clothing excipulum seen to the right; intraepidermal mycelium also discernible (c. 240 ×). – B–D: *Nannfeldtia atra* (Müller UPS). – B–C: Median sections (c. 370 × and c. 180 ×). – D: Part of shield (c. 370 ×). – E–G: *Micropeziza cornea.* – E (type of *Belonidium aurantiacum*): Median section (c. 370 ×). – F (type of *M. scirpicola*): Excipulum from outside (c. 370 ×). – G (III. 1859 Broome): Young, still semitranslucent shield (c. 370 ×). – H–K: *M. poae.* – H–I (type): Ascus with 1-septate spores and median section of apothecium (c. 1000 × and c. 240 ×). – J (J. A. N. 23966): Part of excipulum from outside (c. 370 ×). – K (J. A. N. 4115): Part of median section showing the thick walls of the excipular cells (c. 370 ×).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1859". One sample (from Herb. Ravenel) is marked "Wiltshire – Febr. 1851". These show all the same fungus, which proves to be a typical *Micropeziza*. The fifth sample, dated "1/29 – 51" shows – at least now – only a few apothecia of a *Mollisia* (s. lat.) with dark excipulum and a narrow fringe of dark radiating hyphae surrounding the base of each fruitbody.

The description of *Belonidium rufum* Schroeter (1893 p. 109) led Rehm (1896 p. 1228) to suppose a close relationship to *M. scirpicola*. According to information from Dr W. Stojanowska (in litt. 29.XI. 1975) no material is now to be found in his herbarium (WROC).

Critical perusal of descriptions of small sessile Discomycetes on grasses and grass-like monocotyledons brought to light two more candidates for inclusion into *Micropeziza*, viz., *Trochila ignobilis* Karsten (1871 p. 248) and *Mollisia sylvatica* Karsten (1888 p. 4). More species may still be hidden under insufficient or misleading descriptions, and intensified field studies will certainly add new species and widen the host-ranges and distributions of the old ones.

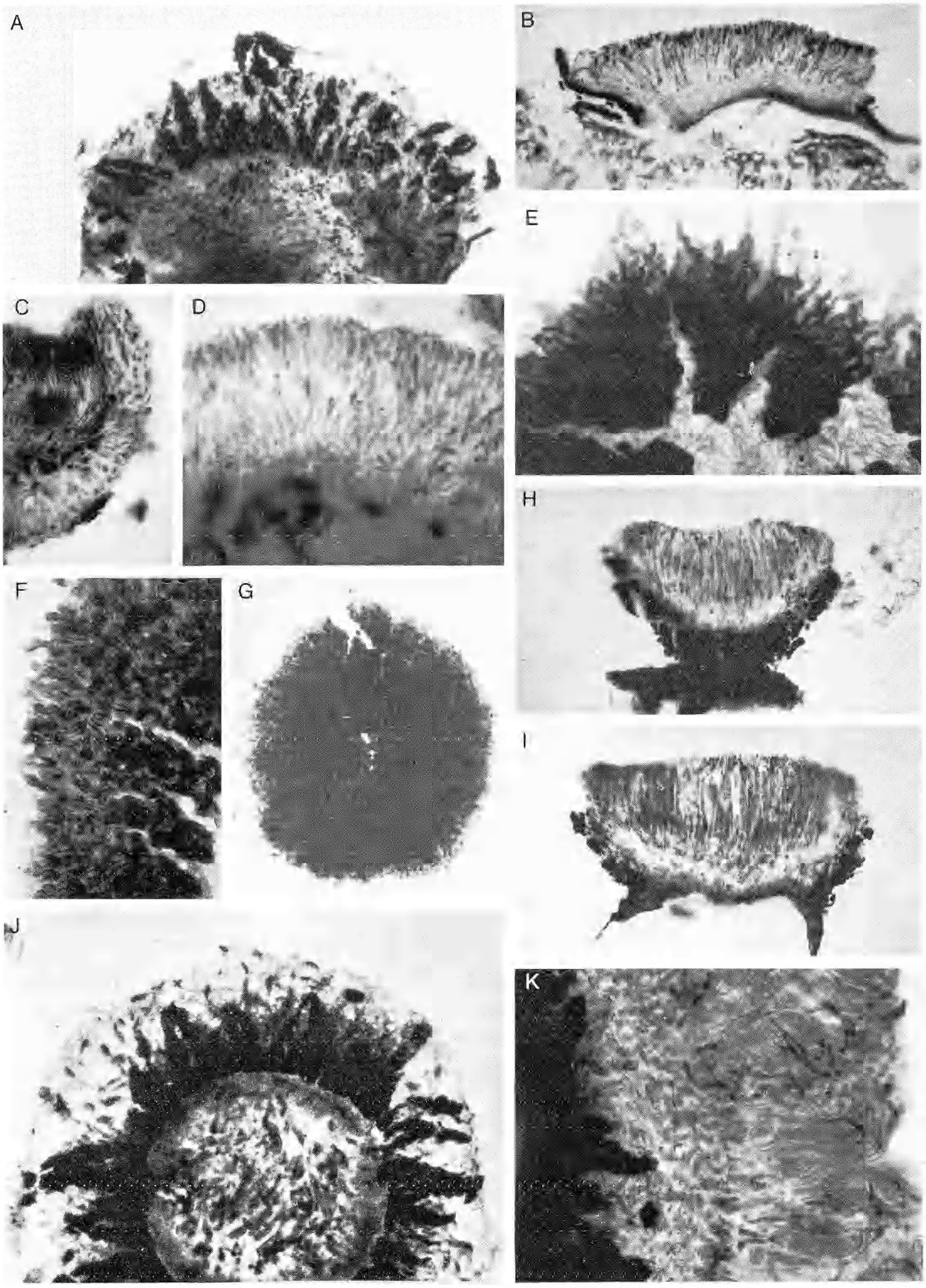
No other host families were included in my search, for experience has convinced me that "mollisioid" fungi growing on grasses and similar plants to a considerable extent constitute special genera restricted to such plants. It should not be forgotten, however, that Höhnel (1919) thought *Discomycella* (with *D. tjibodensis* on dead leaves of *Amomum* sp.) to be closely related to *Niesslella*. On the other hand, our increased knowledge of *Micropeziza* makes my suggestion (Nannfeldt 1932 p. 199) untenable that also *Pezolepis* H. Sydow (1925 p. 408) might be of this kinship.

Actinoscypha muelleri Graddon (1972), the latest acquisition to our genus, is a most distinctive fungus, well illustrating the highly neglected wealth of small "mollisioid" Discomycetes which grow on grasses and similar plants and for which only too often no satisfactory generic names can be found. The above species is such a case. It is no *Micropeziza* and does not fit into any other genus known to me. My examination of it (isotype, ZT) failed to show shields or remnants of such. The shape of a median section (Fig. 1 A; also well shown in Graddon's drawing) differs markedly from that of a true *Micropeziza*. The tissues of the matrix beneath the apothecia are filled by hyphae (not shown in his drawing but in my photograph), and in one section the excipulum was seen to be covered by a strongly refractive, yellowish membrane, c. 1 μm thick, smooth except for shallow grooves at intervals of c. 10 μm. This membrane is clearly a flap of the matrical cuticle and the grooves mark the limits between the cells of the epidermis and indicate that the apothecia form subcuticularly, just as they do, e.g., in *"Mollisia" advena* Karst. and *"Dibeloniella" eriophori* (Kirchn.) Müll. & Défago (= *"Mollisia" cymbispora* Rostr.) according to information from Mrs Berta Andersson. *A. muelleri* resembles also in some respects *Coronellaria* Karst.

Up to now, nine nominal species have thus been found to belong to *Micropeziza*, but are they all specifically distinct? Certainly not, but the answer given below is only tentative, for the material available at present is hardly sufficient to show the full variability and host range of these rare and little collected fungi.

M. punctum, *M. karstenii* (= *A. graminis*), and *M. verrucosa* (= *A. verrucosa*) each possess characters (vide infra) that make their distinctness obvious, but the other six agree closely with each other in all essential points. They differ from the first three in the shield (Fig. 1 G), whose cell walls are thin and rather pale (instead of thick and dark; Fig. 2 G) but share with *M. karstenii* and *M. verrucosa* the peculiar excipulum formed by conglutinated rows of

Fig. 2. A–E: *Micropeziza karstenii*. – A–B (Syd., Myc. germ. 2156): Apothecium from below with remnants of the shield and median section (both c. 150 ×). – C (Starbäck): Part of the same showing excipular structure (c. 370 ×). – D (Lohammar): Excipulum from outside (c. 150 ×). – E (J. A. N. 11522 a): Shield splitting up and exposing hymenium (c. 370 ×). – F–K: *M. verrucosa*. – F (type): Fissured shield (c. 370 ×). – G (Dutoit): Shield (c. 150 ×). – H–I (Kretschmer): Eccentric and median sections of apothecium (c. 150 ×). – J (Dutoit): Apothecium from below with remnants of the shield; asci with pigmented spores visible in the centre (c. 150 ×). – K (type): Margin of apothecium from below; to the left remnants of the shield; to the right squeezed-out hymenial elements showing pigmented tips of paraphyses (c. 370 ×).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elongated cells with hyaline, thick and strongly refractive walls (Figs. 1E, F, I–K; 2 A–D, H–K).

Micropeziza scirpicola and *Mollisia sylvatica,* known only from their type collections, agree in general appearance, all microscopic details, and matrix (leaves of *Scirpus silvaticus*), and so they can safely be declared synonymous. It should be observed that Höhnel (1919) totally overlooked the excipulum in *M. scirpicola* taking its alleged absence as a distinguishing mark from *B. aurantiacum* and that Müller (1966) did not notice its peculiar structure.

Peziza cornea and *Belonidium aurantiacum* are both described from *Carex;* the former (on *C. paniculata*) is known from several finds in the type locality and from one more English collection (Dennis 1960, 1968), the latter (on *C. acutiformis*) from the type collection from Germany only. The apothecia of *B. aurantiacum* are slightly paler but otherwise the agreement between all specimens is so full that they cannot be kept apart. They agree further in almost every respect with *M. scirpicola.* Besides in hosts they differ in apothecial size, the *Scirpus* fungus having slightly smaller apothecia. The asci of *M. scirpicola* are also on the average somewhat shorter and the hymenium accordingly a little lower.

Trochila ignobilis is based on two simultaneous finds, one (lectotype) on *Eriophorum vaginatum* and the other (paratype) on *Carex* sp. The material is very poor, especially the duplicates of the lectotype in S (from Herb. Rehm) and UPS, but there cannot be any doubt which fungus Karsten had in mind, for no other fungus is to be seen in the "maculis albicantibus". This is a *Micropeziza,* which in all details agrees with those treated above. The diagnosis is thus so far misleading as it gives the apothecia as "erumpenti-superficialia", and so is the comment "aeqvo fere jure ducitur ad *Trochilam* vel *Mollisiam*".

As far as I understand, all later records of this species are erroneous.

Rehm (1888 p. 142) reported as *Naevia ignobilis* (Karst.) Rehm an immersed-erumpent fungus on *Carex curvula,* collected by G. Winter and distributed as *Micropeziza subvelata* Rehm in J. Kze, F. sel. 585 and Rbh., F. eur. 2648. He had compared Winter's fungus with "Originalen Karsten's" (i.e., the sample now in S) and found them to agree so well as to be conspecific. This conclusion is incomprehensible, for Winter's fungus belongs clearly to the *Hysteropezizella diminuens* complex, but from that date on Karsten's species has invariably been regarded as an immersed-erumpent species. The name has, in fact, only rarely been actually used (e.g., by Rostrup 1888 p. 539, 1891 p. 612, 1894 p. 18, 1904 p. 119 and Schroeter 1893 p. 151) but has now and then been referred to as doubtfully distinct from two other Karsten species, viz., *T. fuscella* and *T. diminuens.* When I (Nannfeldt 1932 p. 114) had found that the latter species and *Hysteropezizella caricis* (Peck) H. Syd. are synonymous, Lind (1934 p. 89) transferred *N. ignobilis* to *Hysteropezizella* and used it "ad interim" as a collective name for various species of *Hysteropezizella* (and *Merostictis*) on Cyperaceae and grasses.

A second collection on *Eriophorum vaginatum* of a fungus in every detail agreeing with Karsten's species has been seen from Germany.

A recent Swedish collection (Holm 727 c) of a morphologically indistinguishable fungus on *Juncus effusus* turned up when this paper was almost completed. This find makes it even more probable that we are dealing with a single species possessing a rather wide host range. As *cornea* is the oldest of the epithets, the correct name of the species becomes *Micropeziza cornea.*

M. poae, finally, is described from leaves of *Poa sudetica* (=*P. chaixii*), and fungi of the same morphology have become known from culms and leaves of various grasses. They are certainly all conspecific and agree on the whole rather well with the preceding fungus on Cyperaceae and Juncaceae.

In Fuckel's diagnoses the only tangible differences between *M. poae* and *M. scirpicola* are "ascis subclavatis, stipitatis" in the former and "ascis sessilibus oblongis" in the latter and spores 12 × 2 μm and 12–14 × 3 μm, respectively. Rehm found differences in the size of the apothecia (0.2–1 mm against 0.1–0.15 mm) and in the spores, viz., 0(–1)-septate 10–12 × 2–2.5 μm against 1(–3)-septate 15–17 × 2.5 μm, but described the asci with about the same words in both. The hymenial elements are very difficult to see clearly because of their agglutination. They change also considerably with increasing age, the agglutination becoming stronger, the swellings of the paraphysal tips more pronounced and their walls pigmented. The slow development of the asci with only few ripening at each time makes it almost impossible to find free mature spores. All descriptions of the hymenial elements must thus be taken *cum grano salis*.

The samples on Cyperaceae have spores that differ very little from those of graminicolous specimens. (The recent collection on *Juncus* is rather young without mature spores.) In both groups the spore size lies as a rule within 12–16 × 2–3 μm. The broadest spores observed emanate from graminicolous specimens and the few 3-septated from such on Cyperaceae.

A difference in the shape of the ascus may seem a futile character and one difficult to define as the shape changes with the age, but in the present case it is easy to see that asci of comparable age are thicker and stouter (especially basally) in specimens from Cyperaceae and *Juncus* than in such from grasses (Fig. 1 H), just as Fuckel noticed.

There are, however, additional differences. The shields are in both groups formed by radiating hyphae with so thin and pale walls that they are transparent under the microscope (Fig. 1 G). In specimens from Cyperaceae the walls are bright yellowish brown and the young shields *in situ* show the same colour under a hand lens. The diameter of the hyphae is 2–3 μm. In the graminicolous specimens the walls are still thinner and their colour under the microscope is a pale and dirty yellowish brown with a tinge towards olive. The hyphae reach a diameter of only 1–1.5 μm.

The structure of the excipulum is also markedly different in the two groups, the radiating thick-walled hyphae being straighter and less closely septated in the graminicolous specimens, especially their terminal cells are distinctly longer.

Moreover, the fungi on Cyperaceae and *Juncus* seem to grow in very wet habitats, as indicated by the microscopical algae that as a rule accompany them on the matrix, whereas those on grasses grow in drier, wholly terrestrial localities.

M. poae will thus be kept as a separate species.

The number of acceptable species has thus been reduced to five: *M. cornea, M. karstenii, M. poae, M. punctum*, and *M. verrucosa*. Three additional, new species (one on *Carex* and two on *Juncus*) will be described below. Their affinities are with *M. punctum*.

More species certainly remain to be detected and described. Thus, a North American sample (U. S. A.: Washington, Mt Baker; ZT!) on *Carex* sp. collected by Prof. E. Müller shows a fungus close to *M. verrucosa* but probably distinct. The sample is too poor for description but, nevertheless, most interesting as being the first find of a *Micropeziza* outside Europe. Further, Dr O. Eriksson has given me some Swedish and Norwegian samples of *Elymus* bearing shields similar to those of *Micropeziza* but too young to show the details of excipulum and hymenium necessary for identification. Another case for intensified field studies!

Ascomycetes with ascocarps developing beneath a superficial or subcuticular covering shield have as a rule been placed in a special group (Hemisphaeriales) with numerous members, especially in the tropics. It has become evident (cf., e.g., Luttrell 1951, 1973, Arx & Müller 1954, Müller & Arx 1962) that this is no true (monophyletic) taxon but rather an ecologic and physiognomic assemblage of fungi that by convergent evolution have reached the same "life form" in response to their superficial habitat. The concerned fungi are mostly bitunicate but some few inoperculate Discomycetes have been detected amongst them (and more may remain unobserved). Thus, *Diplocarpon rosae* Wolf (1912) with subepidermal apothecia formed beneath a subcuticular radiating shield was described as a new genus of Microthyriaceae. However, when a closely related species without shield was discovered, it became clear that they were Discomycetes, and the presence or absence of a shield was not even considered as sufficient for generic distinction (Wolf 1924; cf. Nannfeldt 1932 p. 171–172). *Schizothyrioma* Höhn. with wholly subcuticular fruitbodies should also be remembered (Holm 1971).

Wholly superficial are the fruitbodies in *Micropeziza* (and *Discomycella?*) as well as in *Nannfeldtia* Petrak (1947).

Prof. E. Müller (in litt.) has drawn my attention to the last-mentioned genus (sole species *N. atra* Petr. on leaves of *Carex firma*) and generously supplied material (Switzerland: K^{t} Graubünden: Davos Ducantal b. Sertig

2.IX. 1971 E. Müller) for study. Clearly it does not belong to the Phacidiaceae as suggested by its author (and repeated by Korf 1973 p. 280). Prof. Müller suggests a close affinity to *Micropeziza,* but I cannot follow him in this. In my opinion it affords rather an additional example of convergent evolution leading to "hemisphaerioid" fruitbodies (Fig. 1 B–C). The following are the principal deviating features: (1) The structure of the shield whose radiating hyphae from the very beginning are firmly coalesced into a plate similar to that of many Microthyriaceae (Fig. 1 D); (2) the breaking up of the central suprahymenial part of the shield into polygonal cells or small groups of cells, simulating an epithecium; (3) the presence of a rich subcuticular and intraepidermal mycelium beneath the fruitbodies and of numerous hyphae perforating the wall of the matrix and connecting the mycelium with the fruitbodies. Further deviating features are the shape and non-septation of the spores. To Petrak's very full description can be added that the spore wall eventually becomes smoky grey and that the ascus tips show a small, flat, directly I + ring with a wide opening.

A very homogeneous and certainly monophyletic group is formed by *M. cornea, M. karstenii,* and *M. poae,* each of which happens to be the type of one of the three genera we are concerned with. The crucial feature is the peculiar texture of the marginal excipulum (*vide supra*). Other important traits are the structure of the shield, the tendency to agglutination of the hymenial elements (which may become almost as firm as in *Orbilia*), the general shape and size of the spores, and the intense direct reactivity to iodine in the perforated apical ascus plug (becoming almost black). The perforation is relatively wide and easily seen from above. In *M. cornea,* where the apical part of the plug reaches c. 3 µm in diameter, it can be seen that the plug consists of a wider apical cylinder and a narrower proximal one separated by a low uncolourable ring.

As the iodine reactions have been found to offer several previously neglected complications with bearing upon the use of this character in taxonomy (cf. Kohn & Korf 1975; Nannfeldt 1976) and affecting also species treated in this paper I have found it advisable to describe the reactions in detail.

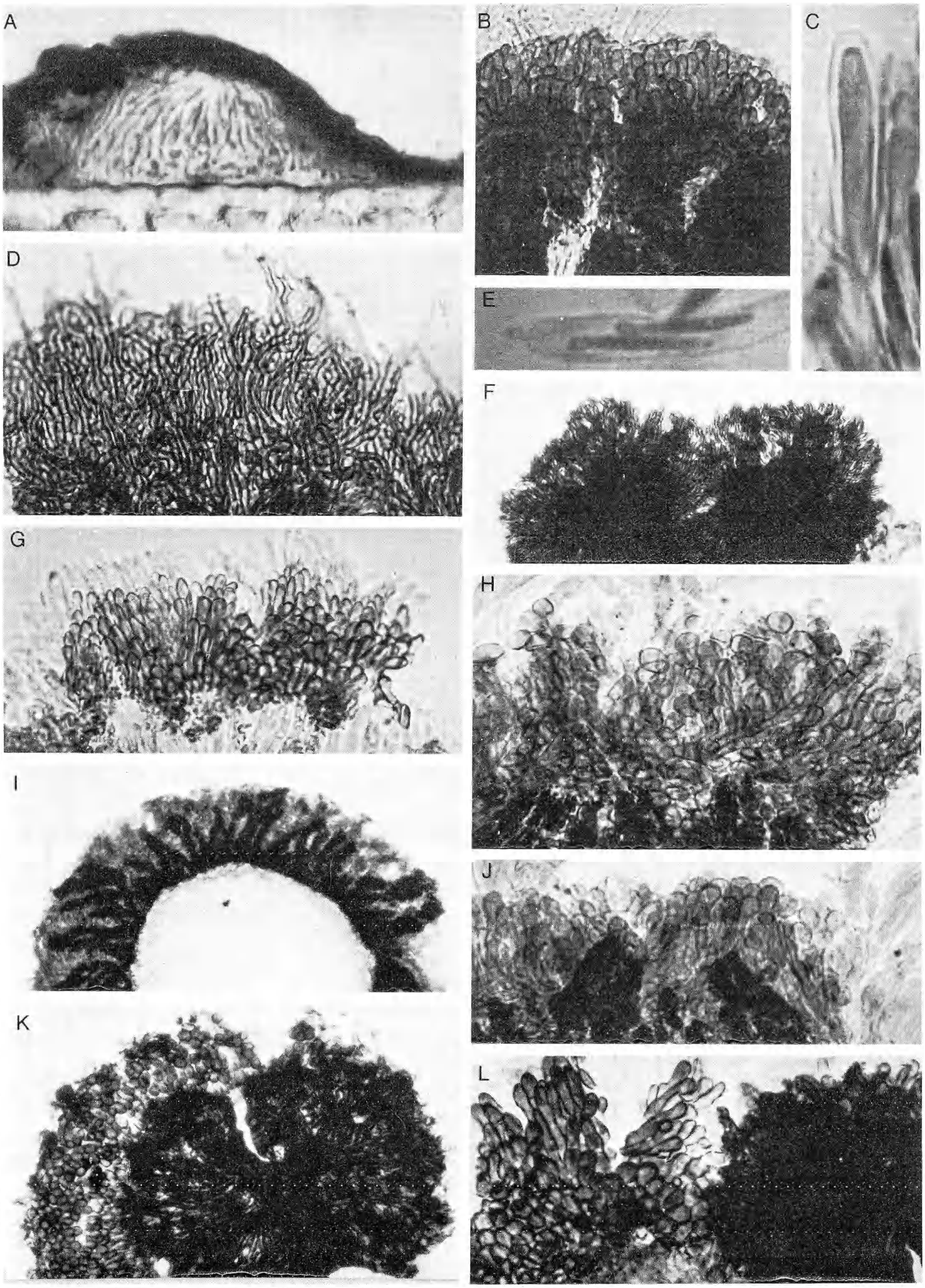
In *M. cornea* and *M. poae* the shields are formed by hyphae whose walls are thin and pale. The remnants of the shields contrast thus only slightly in colour from the excipulum when attached to it (Fig. 1 F, J). In *M. karstenii,* on the contrary, the hyphae (especially those in the central part of the shield) possess thicker and much darker walls, and their remnants consequently stand out as dark crusts or scurves on the pale excipulum (Fig. 2 A).

M. verrucosa agrees exactly with the preceding group with regard to the excipulum and has also shields of the same type (Fig. 2 F, G, J, K) but the conglutination of the hyphae is stronger (approaching the conditions in *Nannfeldtia*). The walls of the hyphae are more undulate, and their free ends are short and rounded with pigmented walls. The shields of the North American sample referred to above are of about the same character.

The eventually rough and pigmented spore wall in *M. verrucosa* is unique within the genus, but two more alleged unique characters do not hold true, for the cup-shaped base of the apothecium and the presence of a dark thick "subiculum" between it and the matrix are fictions due to the study of eccentric sections. Median sections show apothecia of exactly the same shape and position as in the other species (Fig. 2 H, I).

Pigmentation of the spore wall is no common feature within the Mollisioideae and, when it

Fig. 3. A–D: *Scutomollisia punctum* (J. A. N. 14611). – A: Median section of young fruitbody; apothecium still covered by the shield (c. 600 ×). – B: Margin of excipulum from outside (c. 370 ×). – C: Young ascus with maximal wall thickening (c. 1000 ×). – D: Margin of shield (c. 370 ×). – E–G: *S. stenospora* (type). – E: Part of mature ascus with two spores left; the large drop in the distal end of the spores visible (c. 1000 ×). – F: Two confluent shields (c. 150 ×). – G: Margin of excipulum from outside (c. 370 ×). – H–J: *S. leptoderma* (type). – H: Margin of excipulum from outside (c. 370 ×). – I: Apothecium from below with remnants of the shield (c. 150 ×). – J: Margin of excipulum from outside (c. 370 ×). – K–L: *S. operculata* (type). – K: Shield on top of apothecium (c. 240 ×). – L: Apothecium from below; to the right operculum adhering to the excipulum (c. 370 ×).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occurs, it appears as a rule rather late. It is to be found, e.g., in "*Niptera*" *arctica* Rehm as well as in several members of the *Hysteropezizella* complex (cf. Défago 1968). The situation resembles thus that in Hemiphacidiaceae and Sclerotiniaceae discussed by Korf (1962 p. 16–18).

The spore wall is almost without exception smooth in the whole Helotiales. A roughness comparable to that in *M. verrucosa* seems to occur occasionally in "*Niptera*" *arctica* and to consist of minute (occasionally confluent) amorphous granules attached to the wall and can hardly be designated as a true ornamentation.

M. punctum and the three novelties differ strikingly from the preceding in the structure of the excipulum (Fig. 3B, G, H, J, L), which agrees with that typical of the *Mollisia-Pyrenopeziza* complex. Their excipulum is formed by radially arranged, diverging rows of ± isodiametric cells of which the outer are subglobose and have strongly pigmented walls except towards the margin, where the terminal cells of the rows are elongated and ± clavate with paler walls. Because of the deviating excipulum these species will be placed in a new genus, *Scutomollisia,* with *M. punctum* as the type species.

It could be expected that the excipulum should tend to be reduced or transformed when the apothecia develop beneath a shield, since its protecting function has been taken over by the shield, just as is the case in most members of the *Hysteropezizella* complex where the matrix affords protection to the ± immersed apothecia (cf. Défago 1968). Such is evidently also the case with the species of *Micropeziza sensu restrictiore* and in one of the new species of *Scutomollisia,* viz., *S. leptoderma,* in which the excipulum is thin, externally dissolved into long (up to 70 µm), flaccid, free, hypha-like rows of subcylindrical cells (c. 2–4 µm in diam. and up to 20 µm long) terminating in a large subglobose or broadly pyriform cell (ca. 8–12 × 8–12 µm) (Fig. 3 H, J). All cells remain long so thin-walled and pale that the whole excipulum is easily overlooked. In the three other species it is as strong, coherent and dark as normally in the *Mollisia–Pyrenopeziza* complex.

The shield (Fig. 3 D, F, K) has the same structure in *Scutomollisia* as in *Micropeziza.* The normal way for the hymenium to become exposed is by ± radial, centrifugal fissures in the shield, resulting in a number of triangular flaps, ± firmly adhering to the excipulum. The number of such flaps and, consequently, their breadths vary from species to species. *S. leptoderma* has the most numerous and narrowest flaps (Fig. 3 H–J). One of the new species of *Scutomollisia,* viz., *S. operculata,* forms an interesting exception. The centre of its shield is firmer and does not rupture from the pressure of the growing apothecium. The entire shield is instead lifted from the matrix. Sometimes it becomes lying on the apothecium as a free operculum (Fig. 3 K) until it falls off, but usually it remains attached to the matrix on one side and adheres on that side to the excipulum (Fig. 3 L). The material of *S. stenospora* is too young to show with certainty how the shield behaves.

In *S. punctum* the asci are rather plump, ± cylindrical, almost sessile and, when young, hardly narrowed upwards and broadly rounded, thus similar to those of *M. cornea* but still more extreme. Their wall is firm, thick and strongly refractive. Before spore formation the wall can apically reach a thickness of well 2 µm (Fig. 3 C). Also the wall (and the median septum) of the young spores is unusually thick and highly refractive. In one otherwise typical apothecium (J.A.N. 14611) still unseptated spores had smoky grey walls that got a distinct violet tinge by iodine. The asci are I– as observed by Rehm (1881, 1891), and not even pretreatment with KOH and H_2SO_4 provokes a positive reaction. No apical plug is to be seen. In its place there is a thin, almost flat cushion. Müller (1966) reports a positive reaction and draws an ascus of the same shape and with the same apical plug as in his other species. Now, however, he finds (in litt. 22.XII. 1975) that he must have been the victim of some mistake.

The new *S. leptoderma* has also plump and unconditionally I– asci as well as spores that rather early show a very distinct median septum.

The two remaining species, *S. operculata* and *S. stenospora,* possess on the contrary gracile asci with subconical tips, including minute apical plugs (c. 1 µm in diameter) that with iodine directly acquire a pure, but not very dark blue. No fully mature spores have been seen and only few that have escaped from the asci. They are hyaline-walled, subcylindrically clavuliform with the upper end slightly thicker and more rounded than the lower, show no sign of septation, and contain a row of usually four rather large drops (vacuoles?), of which the uppermost as a rule is the largest and situated very close to the end (Fig. 3 E).

The agreement in excipular structure of the four species of *Scutomollisia* with the *Mollisia–Pyrenopeziza* complex is so close that it cannot be doubted that they are derived from it. On the other hand, the differences in the same respect from the true *Micropezizae* are so profound that the two genera must represent different evolutionary lines. In view of our present knowledge (cf. Nannfeldt 1976) there is no hindrance for keeping both I− and I+ species in *Scutomollisia*.

More detailed comparisons with the *Mollisia–Pyrenopeziza* complex are out of the question as long as its taxonomy is in its present chaotic state, but some remarks on the position of the apothecium in relation to the matrix may be useful here. In the floristic literature *Mollisia* (incl. *Tapesia* Fuck.) is regularly described as having superficial apothecia but this is not correct. Korf's formulation (1973 p. 291) is not accurate either: "Apothecia entirely superficial, rarely with a tiny base inserted in the host tissue". The "inserted base" is the primordium, which forms within the matrix just below its surface and from which the apothecium grows out. Höhnel (e.g., 1918 p. 577–578) calls such a base a "hypostroma", and Le Gal & Mangenot (e.g., 1958 p. 31, 1961 p. 316) designate such apothecia as "suberumpent". The presence of such an intramatrical primordium is rather the rule than an exception. But, for example, Graddon (1972) was misled to consider this feature so unusual that he named his new *M. stromatica* after it. The type species of *Mollisia* (*M. cinerea* (Pers. ex Fr.) Karst.), *Tapesia* (*T. fusca* (Pers. ex Fr.) Fuck.) and *Haglundia* Nannf. (*H. perelegans* Nannf.) possess such primordia (cf., e.g., Nannfeldt 1932 figs. 13a, 23a and 11a, tab. IV fig. 3, tab. VI figs. 1 and 2). More examples are illustrated by, e.g., Le Gal & Mangenot (1958, 1960, 1961, 1966), Bellemère (1968), and Aebi (1972).

On the other hand, Hütter (1958) goes too far in the opposite direction when ascribing all the "Mollisieae" (i.e., *Belonopsis* (Sacc.) Rehm, *Mollisia, Tapesia,* and *Trichobelonium* (Sacc.) Rehm) a stipe-like apothecial base. He overlooks the existence of closely allied species with ± broad-based, truly superficial apothecia. However, rather few species can with full confidence be placed in this latter category, for a tiny intramatrical base is easily missed, if not specially sought for.

Le Gal was evidently well aware of this distinction, and amongst her detailed and exact descriptions and drawings we find two wholly superficial lignicolous species, viz., *Mollisia cinereo-olivascens* Le Gal & Mangenot (1958 p. 52–53 as *Niptera cinerea* var. *olivacea;* 1961 p. 304–308) and *M. undulato-depressula* (Feltg.) Le Gal & Mangenot (1960 p. 152–160). Otherwise the few reliable examples known to me are on substrates with smooth, firm and persistent surfaces. One such species, *M. millegrana* (Boud.) Nannf. on *Filipendula ulmaria,* is illustrated by me (Nannfeldt 1932, figs. 14c and d), but this is far from being a typical *Mollisia*. More typical species seem to occur on grasses, Cyperaceae and Juncaceae, but for lack of adequate studies they cannot be mentioned by reliable names. At least part of *Niptera* Fr. sensu Dennis (1972) belongs here, e.g., *Peziza junciseda* Karst. ssp. *juncinella* Karst. as shown by the type specimen. In some cases there is a dense intramatrical mycelium beneath the apothecia (just as in *Nannfeldtia,* see above), in other cases there is no or only a sparse inconspicuous mycelium.

If we further remember that the bases of ± superficial "mollisioid" apothecia are often surrounded by a fringe of radiating brown-walled hyphae adpressed to the matrix, it is easy to imagine how species with superficial apothecia beneath a shield can have evolved. The assumption that *Scutomollisia* has arisen this way from the *Mollisia-Pyrenopeziza* complex seems unavoidable.

For the species of *Micropeziza* a corresponding evolution is probable, but their "roots" are less obvious. Shields and hymenia are so similar to those in *Scutomollisia* as to suggest a close affinity, but the excipulum is so deviating that on first sight the affinity with the Mollisioideae (and even with the Dermateaceae on the whole) might be questioned. However, the formation of "sclerenchymatic" tissues can evidently be realized in most groups of fungi, probably as a response to edaphic conditions.

The pigmentation of spore walls and paraphysal tips (as in *M. verrucosa*) is an unusual feature in the Mollisioideae though far from unknown, and also the roughness of the spore wall has at least one counterpart (see above). It seems thus possible that also *Micropeziza* is derived from the Mollisioideae and that its peculiar excipulum has arisen by reduction of the normal external layer accompanied by a strong "sclerenchymatization" of an inner layer.

Le Gal & Mangenot (1958 p. 52–54, 1961 p. 301–308) describe and depict a lignicolous typical *Mollisia* (*M. cinereo-olivascens* Le Gal & Mangenot), in which the perihymenial excipulum has "une zone interne de filaments incolores et redressés, à disposition radiale, à parois réfringentes plutôt épaisses; ces parois ne se colorent pas au bleu coton, alors que le contenu des hyphes bleuit intensément" (1958 p. 52). This is word for word applicable to the *Micropeziza* excipulum. On several occasions I have seen similar tissues in superficial culmicolous species of *Mollisia* s. lat. (which I must leave anonymous).

Evolutionary lines in the opposite direction, i.e., towards immersed and at the most ± erumpent apothecia lead evidently to the *Hysteropezizella* complex, where likewise reduced and/or transformed excipula can be found. An inner "sclerenchymatic" layer of *Micropeziza* type is thus very conspicuous in *Merostictis circinata* (Lib.) Défago. It becomes thus still more likely that *Micropeziza* too has its phylogenetic "roots" in the *Mollisia-Pyrenopeziza* complex, representing an independent line and a more "advanced" stage than *Scutomollisia*.

Key to Discomycetes with superficial apothecia formed beneath a shield of radiating hyphae

1. Hymenium in mature apothecia with an "epithecium" of crumbled remnants of the shield. On *Carex firma* ..... *Nannfeldtia atra* (see p. 329–330)
   Hymenium naked in mature apothecia 2
2. Perihymenial ectal excipulum of "textura oblita"; its hyphae with thick, hyaline, strongly refractive walls (*Micropeziza*) 3
   Ectal excipulum "mollisioid", i.e., "textura globulosa"–"textura angularis"; cells brown-walled, towards the margin elongated and claviform, paler (*Scutomollisia*) 6
3. Shield of rather pale, thin-walled hyphae; its torn flakes almost concolorous with the excipulum when attached to the apothecium 4
   Shield hyphae with strongly pigmented walls; the torn flakes of the shield much darker than the excipulum 5
4. Shield hyphae 2–3 µm in diam.; their walls bright yellowish brown. Asci plump, <55 µm long. On Cyperaceae and Juncaceae ..... *M. cornea*
   Shield hyphae 1–1.5 µm in diam.; their walls pale and dirty yellowish brown with a tinge of olive. Asci gracile, mostly 55–75 µm long. On grasses ..... *M. poae*
5. Spores hyaline, smooth. On grasses ..... *M. karstenii*
   Spore wall early greyish brown, rough. On *Carex sempervirens* ..... *M. verrucosa*
6. Asci plump with broad rounded tips, unconditionally I –. Spores 15–22 × 3.5–4.5 µm, early with a distinct median septum 7
   Asci gracile, acuminate with minute apical plugs, directly I + (pure blue). Spores narrower (c. 2 µm broad), long (permanently?) unseptate 8
7. Excipulum conspicuous with distinctly pigmented cell walls. On grasses, esp. *Nardus* ..... *S. punctum*
   Excipulum thin and long translucent, dissolved into free cell rows; cell walls thin and rather pale. On *Juncus* ..... *S. leptoderma*
8. Spores 16–22 × 2 µm. On *Juncus* ..... *S. stenospora*
   Spores 8–11 × 2 µm. On *Carex binervis* ..... *S. operculata*

Micropeziza Fuck.

Fuckel, Jb. Nassau. Ver. Naturk. 23–24 (=Symb. myc.): 291 (1870). – Lectotypus (sel. by Höhnel 1919): *M. poae* Fuck.

Actinoscypha Karst., Medd. Soc. F. Fl. Fenn. 16: 5 (1888). – Typus (only species): *A. graminis* Karst.

Niesslella Höhn., Ber. Deutsch. Bot. Ges. 36: 468 (1919). – Typus (by designation): *Micropeziza scirpicola* Fuck.

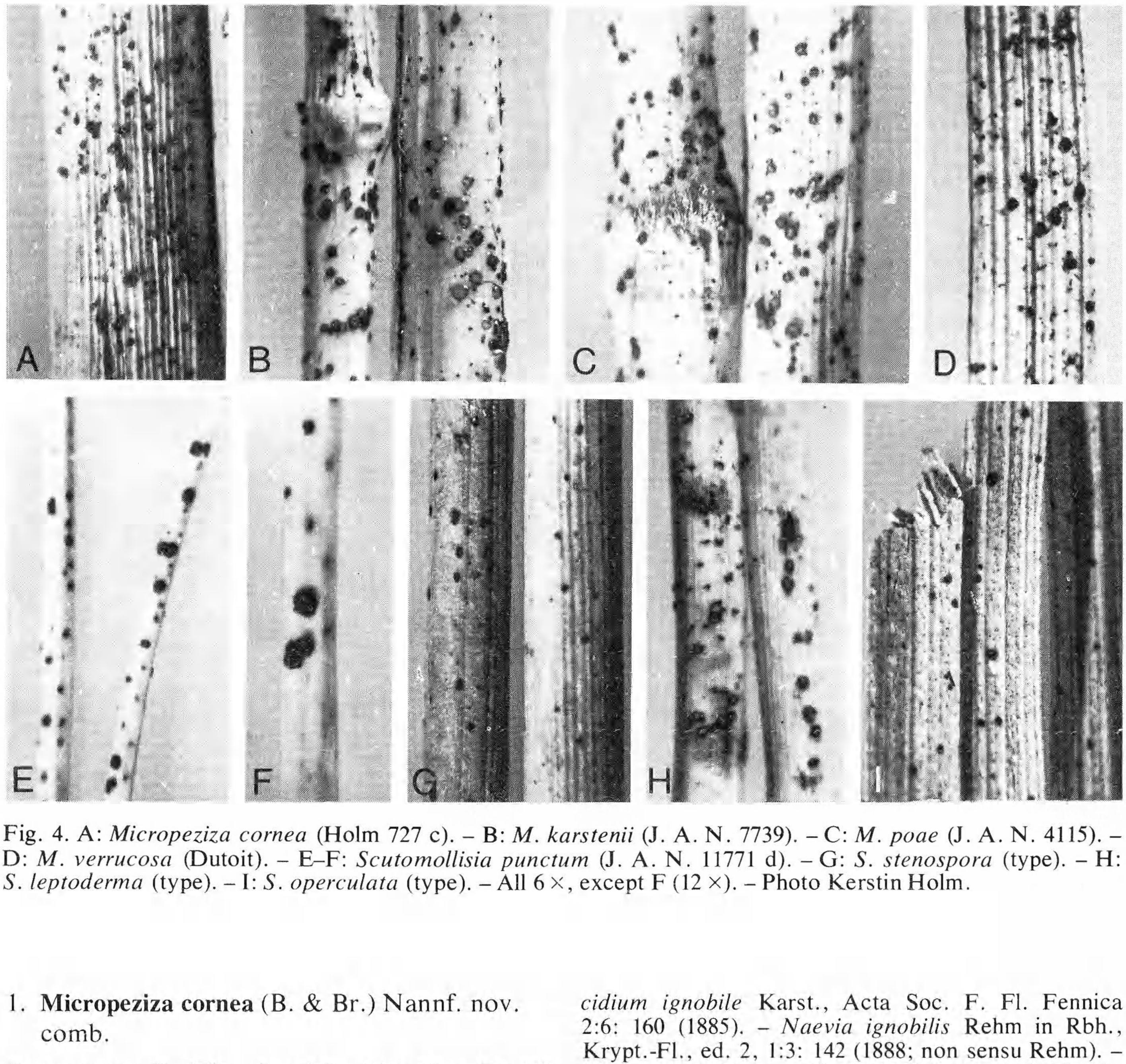

Fig. 4. A: *Micropeziza cornea* (Holm 727 c). – B: *M. karstenii* (J. A. N. 7739). – C: *M. poae* (J. A. N. 4115). – D: *M. verrucosa* (Dutoit). – E–F: *Scutomollisia punctum* (J. A. N. 11771 d). – G: *S. stenospora* (type). – H: *S. leptoderma* (type). – I: *S. operculata* (type). – All 6 ×, except F (12 ×). – Photo Kerstin Holm.

1. **Micropeziza cornea** (B. & Br.) Nannf. nov. comb.

Peziza cornea B. & Br., Ann. Mag. Nat. Hist. 2:7: 183 (1851). – *Calloria cornea* Phill., Man. Brit. Discom. p. 332 (1887). – *Mollisia cornea* Höhn., Sitz.ber. Akad. Wiss. Wien, Math.-nat. Kl. 1, 127: 367 (1918; non sensu Höhn.). – Typus (only coll.): England (*Carex paniculata*) 18.III. 1850 C. E. Broome (K!).

[*Peziza scirpicola* Fuck., F. rhen. 1870 (1866; nom. nud.).] – *Micropeziza scirpicola* Fuck., Jb. Nassau. Ver. Naturk. 23–24 (=Symb. myc.): 292 (1870). – *Mollisia scirpicola* Sacc., Syll. fung. 8: 384 (1889). – *Belonidium scirpicola* (*"scirpicolum"*) Rehm in Rbh., Krypt.Fl., ed. 2, 1:3: 567 (1891). – *Urceolella scirpicola* Boud., Hist. Class. Discom. d'Eur. p. 130 (1907). – *Niesslella scirpicola* Höhn., Ber. Deutsch. Bot. Ges. 36: 468 (1919). – *Actinoscypha scirpicola* E. Müll., Ber. Schweiz. Bot. Ges. 76: 234 (1966). – Typus (only coll.): Fuck., F. rhen. 1870 (*Scirpus silvaticus*).

Trochila ignobilis Karst., Bidr. känned. Finlands nat. folk 19 (=Myc. Fenn. 1): 248 (1871). – *Phacidium ignobile* Karst., Acta Soc. F. Fl. Fennica 2:6: 160 (1885). – *Naevia ignobilis* Rehm in Rbh., Krypt.-Fl., ed. 2, 1:3: 142 (1888; non sensu Rehm). – *Hysteropezizella ignobilis* Lind, Kgl. Danske Vidensk. Selsk., Biol. Medd. 11 (2): 89 (1934; non sensu Lind). – Lectotypus (sel. here): Finland (*Eriophorum vaginatum*) P. A. Karsten (Herb. Karsten 1535 H!; isolectotypi: S! UPS!)

Mollisia sylvatica Karst., Medd. Soc. F. Fl. Fenn. 16: 4 (1888). – Typus (only coll.): Finland (*Sc. silv.*) P. A. Karsten (holotypus: Herb. Karsten 1495 H!; isotypus: S!).

Belonidium aurantiacum Rehm in Rbh. l.c. p. 564 (1891). – *Niesslella aurantiaca* Höhn. l.c. p. 468 (1919). – Typus (only coll.): Syd., Myc. march. 1582 (*Carex acutiformis*).

Matr.: various Cyperaceae, e.g. *Carex acutiformis* and *C. paniculata*, *Eriophorum vaginatum*, and *Scirpus silvaticus*, as well as *Juncus effusus*.

Exs.: Fuck., F. rhen. 1870 (*"Peziza sc."*) S! = Herb. Barbey-Boiss. 1171 (*"Microp. sc."*) S! UPS! – Syd., Myc. march. 1582 (*"Moll. Karstenii* var. *Caricis"*) S! UPS!

[Non: Jaap, F. sel. 151 (*"Pezizella turgidella"*). – Rbh., F. eur. 1119 (*"Peziza cornea"*). – Syd., Myc. germ. 1003 (*"Pezizella turgidella"*), 1941 (id.), 3145 (*'Moll. cornea'*), 3549 (id.). – Syd., Myc. march. 366 (*"Helotium aspidiicolum"*). – All = *Mollisia* spp.]

Ill.: Figs. 1 E–G, 4 A; Rehm l.c. p. 510 (*Bel. aur.*); Dennis 1960 Pl. XX L (*Moll. cornea*) = 1968 Pl. XXIII L; Müller 1966 figs. 2c, 3 (*Act. sc.*).

Specimens seen

Sweden: Uppland: Dalby "Jerusalem" (*J. eff.*) 3.X. 1975 K. & L. Holm 727c (UPS!).

Finland: Tavastia australis: Tammela Mustiala Pellinsuo (*Er. vag. & Carex* sp.) 6.IX. 1870 P. A. Karsten (lectotypus *Tr. ign.* & paratypus: Herb. Karsten 1534 H!); Mustiala Särkijärvi (*Sc. silv.*) 22.VIII. 1887 P. A. Karsten (typus *Moll. sylv.*).

Germany: Bayern: Haspelmoor nr. München (*Er. vag.*) 30.IX. 1910 G. Ade 19 (S!). – Brandenburg: Paulsborn nr. Berlin (*C. ac.*) VIII. 1887 P. Sydow (Myc. march. 1582; typus *Bel. aur.*). – Hessen: Mappen nr. Nassau (*Sc. silv.*) "vere" L. Fuckel (F. rhen. 1870; typus *Microp. sc.*).

England: Cheshire (*C. pan.*) II. 1949 W. G. Graddon (comp. Dennis ll.cc.). – Wiltshire: Spye Park (*C. pan.*) II. 1850, 18.III. 1850, 29.I. 1851, II. 1851 & III. 1859 C. E. Broome (vide supra; K! UPS!).

The records from Somerset (Batheaston area) are all erroneous (vide supra). That from Yorkshire (see Ramsbottom & Balfour-Browne 1951 p. 72) cannot be verified as no voucher specimen has been seen.

2. **Micropeziza karstenii** Nannf. nov. nom.

Actinoscypha graminis Karst., Medd. Soc. F. Fl. Fenn. 16: 5 (1888). – Typus (only coll.): Finland, Tammela, 'ad lacum Salois' (*Molinia coerulea*) P. A. Karsten (H; n.v.). [Non *Micropeziza graminis* (Desm.) Rehm.]

Matr.: various grasses, e.g. *Arrhenatherum, Calamagrostis, Cinna, Molinia, Poa.*

Exs.: Syd., Myc. germ. 2156 (*"Niptera Poae"*) S! UPS!

Ill.: Figs. 2 A–E, 4 B; Müller 1966 figs. 1, 2b.

Specimens seen

Sweden: Småland: Kärda Källunda (*Cal. canescens*) 28.VI. 1929 J. A. N. 2168 (UPS!). – Uppland: Uppsala (Bondkyrka) Ulleråker (*Cal. can.*) 13.VI. 1946 S. Lundell (UPS!). – Gästrikland: Gävle Lövudden (*Cal. can.*) 14.VII. 1945 J. A. N. 7739 (UPS!); (*Cal. purpurea*) 2.VII. 1963 J. A. N. 18201e (UPS!). – Hälsingland: Forsa Mt Storberget (*Cinna latifolia*) 22.VII. 1936 G. Lohammar (S! UME! UPS!). – Jämtland: Nyhem Dockmyr (*Cal.* sp.) 24.VI. 1975 J. A. N. 23947e (K! UPS!). Åre Handöl (*Cal.* sp.) 20.VII. 1951 J. A. N. 11520b & 11522a (UPS!).

Finland: Tavastia australis: Tammela Salois (*Cal.* sp.) VII. 1887 K. Starbäck (Herb. Karsten 1494, H!); (*Mol. coer.*) VIII. 1887 P. A. Karsten & K. Starbäck (isotypus?; S!).

Germany: Bayern: Bayrischer Wald auf dem Rachel (*Cal. can.*) 7.VIII. 1923 H. Sydow (Myc. germ. 2156).

Switzerland: K^t Graubünden: Fürstenalp 1850 m (*Cal. varia*) VIII. 1903 A. Volkart (S! as *Mollisia poaeoides*, det. Rehm). – K^t Wallis: Aletschreservat Moränenweg (*Arrh. versicolor & Poa alpina*) 24.VII. 1964 E. Müller (l.c.: ZT!); Belalpweg (*Cal. villosa*) 26.VII. 1964 E. Müller (l.c.; ZT!).

Austria: Tirol: Ortler Gumpenhöfe (*Festuca?*) VI. 1884 H. Rehm (1891 p. 559, 1914 p. 103 as *Niptera poae;* S!).

3. **Micropeziza poae** Fuck.

Fuckel, Jb. Nassau, Ver. Naturk. 23–24 (= Symb. Myc.): 291 (1870). – [*Peziza Poae* Fuck., F. rhen. 1174 (1866; nom. nud.).] – *Mollisia Poae* Sacc., Syll. fung. 8: 343 (1889). – *Niptera Poae* Rehm in Rbh., Krypt.-Fl., ed. 2, 1:3: 558 (1891). – Typus (only coll.): Fuck., F. rhen. 1174 (*Poa sudetica* = *P. chaixii*).

Matr.: various grasses, e.g. *Calamagrostis, Festuca, Poa.*

Exs.: Fuck., F. rhen. 1174 (*"Peziza P."*) S! = Hb. Barbey-Boiss. 1170 (*"Mollisia P."*) S! – Syd., Myc. march. 962 (*"Mollisia Karstenii"*) S! UPS!

[Non: Rehm, Ascom. 1221 (*"Niptera P."*), q.e. *Mollisia* sp. – Syd., Myc. germ. 2156 (*"Niptera P."*), q.e. *Microp. graminis*. – Thüm., F. austr. 838 (*"Microp. P."*), q.e. *Mollisia* sp.]

Ill.: Figs. 1 H–K, 4 C.

Specimens seen

Sweden: Uppland: Uppsala, Eriksbergsskogen (*Cal. canescens*) 28.VIII. 1942 S. Lundell (UPS!). Vänge "Fiby urskog" (*Cal. arundinacea*) 8.IX. 1930 J. A. N. 4115 (S! UPS!). – Gästrikland: Gävle "Arboretum Vallshage" (*P. nemoralis*) 16.VIII. 1975 J. A. N. 23966 (UPS! ZT!).

Germany: Bayern: Bayrischer Wald Arber (grass) IX. 1885 H. Rehm (S!). – Brandenburg: Grunewald nr. Berlin (*Cal. epigeios*) 16.IX. 1885 P. Sydow (Myc. march. 962). – Hessen: Oestrich Hinterlandswald (*P. chaixii*) "autumno" L. Fuckel (F. rhen. 1174; typus). – Thüringen: Oberhof (*F. altissima*) VII. 1906 O. Jaap (1914 p. 426; S!).

Austria: Tirol: Kaiser-Gebirge Stripsen-Joch (*Cal.?*) X. 1905 H. Rehm (S!).

Rehm's record (1891 p. 559; 1914 p. 103) from Ortler (Tirol) is erroneous and refers to *M. karstenii*, Jaap's (1914 p. 426) on *Glyceria fluitans* from Thüringen cannot be controlled as no specimen has been available.

4. **Micropeziza verrucosa** (E. Müll.) Nannf. nov. comb.

Actinoscypha verrucosa E. Müll., Ber. Schweiz. Bot. Ges. 76: 236 (1966). – Typus (by designation): Switzerland 21.VII. 1964 Müller (ZT!).

Matr.: Carex sempervirens.

Exs.: O.

Ill.: Figs. 2 F–K, 4 D; Müller 1966 figs. 2d, 5.

Specimens seen

France: Dép^t Savoie: Haute Maurienne Petit Mont Cenis 29.VI. 1966 E. Müller (l.c.; ZT!).

Switzerland: K^t Graubünden: Albulapass Murtel digl Crasp alv 14.X. 1972 E. Müller (ZT!). Alp Trida above Samnauntal c. 2450 m 11.VII. 1930 E. & G. Kretschmer (S! UPS!). – K^t Wallis: Aletschreservat Moosfluh nr. Brig 21.VII. 1964 E. Müller (typus, ZT!); Moränenweg 3.VIII. 1964 E. Müller (ZT!) and 20.IX. 1965 E. Müller (l.c.) & F. Casagrande (ZT!). "In vallecula 'Menouve' ad montem summum Paeninum" 2100 m 13.VIII. 1939 D. Dutoit (UPS!).

Romania: Transylvania: "supra vallem Bulea prope pag. Árpás" 1900 m 22.VII. 1914 J. Tuzson (S!).

This species is probably rather common on its host, as I have been able to pick out three samples from the phanerogamic collections in S and UPS.

A North American specimen (U.S.A.: Washington E. Müller, on *Carex* sp.; ZT!) represents certainly an undescribed species close to *M. verrucosa* (see p. 329).

Scutomollisia Nannf. nov. gen.

Micropeziza Fuck. persimilis sed differt structura excipuli apotheciorum ut in *Mollisia* et *Pyrenopeziza,* extus "textura globulosa", margine cellulis elongatis claviformibus. – Species typica: *Micropeziza punctum* Rehm.

Very similar to *Micropeziza* Fuck. but differing in the structure of the apothecial excipulum, which agrees with that in the *Mollisia–Pyrenopeziza* complex, externally of "textura globulosa" and marginally with elongated, claviform cells.

1. **Scutomollisia leptoderma** Nannf. nov. sp.

Scutum ca. 0.2–0.3 mm diam., opacum, atrobrunneum, denique irregulariter stellatim findens. Excipulum apothecii "mollisioideum", tenue, extus paullo pigmentatum, in series (ad 70 μm longas) laxas liberas cellularum subcylindricarum, 2–4 μm diam. et ad 20 μm longarum dissolutum et in cellulam subglobosam–late pyriformem (8–12 × 8–12 μm) terminatas. Asci 45–75 × 9–12 μm, claviformes, utique I –, 8-spori. Sporae (haud maturae) 16–20 × 3.5–4.5 μm, subfusiformes, cito distincte medio uniseptatae. Paraphyses filiformes (ca 1 μm diam.), apice abrupte clavatae vel subglobosae (ad 6 μm crassae). – Hab. in culmis anni praeteriti *Junci arctici ×filiformis* in Lapponia Lyckselensi Sueciae. – Typus: 1.VIII. 1927 Nordenstam (UPS!).

Shield c. 0.2–0.3 mm in diam., circular or somewhat irregular, opaque, blackish brown, eventually breaking up into numerous narrowly triangular flaps clothing the apothecium. Hyphae of the shield c. 3–4 μm in diam.; their walls dark brown, c. 0.3–0.7 μm thick.

Excipulum thin, "mollisioid", externally faintly pigmented and dissolved into flaccid free rows (up to 70 μm long) of subcylindrical cells (2–4 μm in diam. and up to 20 μm long) and a terminal subglobose or broadly pyriform cell (c. 8–12 × 8–12 μm).

Asci 45–75 × 9–12 μm, claviform with broad rounded tips, unconditionally I –, 8-sporous.

Spores (hardly mature) 16–20 × 3.5–4.5 μm, subfusiform, straight or slightly curved rather early with a distinct median septum, hyaline.

Paraphyses filiform (c. 1 μm in diam.), apically abruptly clavate or subglobose (up to 6 μm in diam.), hyaline, not agglutinated.

Matr.: Juncus arcticus ×filiformis.

Exs.: O.

Ill.: Figs. 3 H–J, 4 H.

Specimen seen

Sweden: Lycksele lappmark: Stensele on the bank of Lake Storuman at Storuman Railway Station 1.VIII. 1927 S. Nordenstam (typus).

2. **Scutomollisia operculata** Nannf. nov. sp.

Scutum ca. 0.15–0.25 mm diam., opacum, atrobrunneum, sensim e matrice operculatim sublevans sed plerumque uno latere perpetuo affixum et ceteroquin apothecium lateraliter appressum, rarius circumcirca sublevatum et ad tempus apothecio superpositum. Excipulum apothecii "mollisioideum", extus pigmentatum, "textura globulosa", cellulis 5–10 μm diam., iis marginem versus doliformibus, ca. 7 × 4 μm, extremis claviformiter elongatis, saepe basi colliformiter constrictis, ad 10–12 μm longis. Asci claviformes, apicem versus subconice attenuati, 35–50(–60) × 5 μm, directe I +, 8-spori. Sporae (haud maturae) 8–11 × 2 μm, subcylindrice subclaviformes, apicibus rotundatis, guttatae, hyalinae. Paraphyses graciles, hyalinae, filiformes, ca. 1 μm diam., apice clavulate incrassatae, ad 2.5 μm diam. – Hab. in foliis anni praeteriti *Caricis binervis* in Hordaland Norvegiae. – Typus: Holm 756 (holotypus: UPS!, isotypus: BG!).

Shield of radiating hyphae, c. 0.15–0.25 mm in diam., circular or somewhat irregular, opaque, blackish brown, eventually not cracking by radiating fissures but lifted in its entirety from the matrix by pressure of the growing apothecium. As a rule the shield remains fixed to the matrix on one side and becomes on that side pressed to the apothecium; rarely it becomes lifted all round by the apothecium and rests on it until eventually falling off. Hyphae of the shield c. 3 μm in diam., their walls dark brown and 0.5–0.7 μm thick.

Excipulum typically "mollisioid", the outermost layer of "textura globulosa" with brown-walled cells, c. 5–7 μm in diam. Towards the margin the cells form distinct parallel rows, become barrel-shaped, c. 7 × 4 μm, the marginal cells clavate, with paler but yet distinctly pigmented walls, up to 10–12 μm long, often basally with a constricted neck.

Asci clavate, 35–50(–60) × 5 μm, sessile with a basal knob, upwards subconically attenuated with a minute apical plug (< 1 μm in diam.), directly I +, 8-sporous.

Spores (hardly mature) 8–11 × 2 μm, subcylindrically subclaviform, rounded in both ends and slightly tapering towards the lower end, straight or slightly curved, hyaline, with a row of rather large drops (vacuoles?).

Paraphyses filiform (c. 1 μm in diam.), slightly incrassated apically up to 2.5 μm, hyaline, not agglutinated.

Matr.: Carex binervis.

Exs.: O.

Ill.: Figs. 3 K, L, 4 I.

Specimen seen

Norway: Hordaland: Bergen Fyllingsdalen 24.III. 1976 K. & L. Holm 756 (typus).

3. **Scutomollisia punctum** (Rehm) Nannf. nov. comb.

Micropeziza punctum Rehm, Ber. Naturh. Ver. Augsburg 26: 65 (1881). – *Beloniella punctum* Rehm, Ascom. n. 261 b (1887); Hedwigia 26: 98 (1887). – *Niptera punctum* Sacc., Syll. fung. 8: 485 (1889). – *Belonidium punctum* Rehm in Rbh., Krypt.-Fl., ed. 2, 1:3: 569 (1891). – *Niesslella punctum* Höhn., Ber. Deutsch. Bot. Ges. 36: 470 (1919). – *Actinoscypha punctum* E. Müll., Ber. Schweiz. Bot. Ges. 76: 235 (1966). – Typus (only coll.): Rehm, Ascom. 261 (*Nardus stricta*).

Matr.: Nardus stricta and other grasses, e.g. *Calamagrostis* and *Poa*.

Exs.: Rehm, Ascom. 261 ("*Microp. p.*") S! UPS!; 261 b ("*Bel. p.*") S!

Ill.: Figs. 3 A–D, 4 E–F; Müller 1966 figs. 2 a (ascus tip erroneous), 4.

Specimens seen

Sweden: Hälsingland: Los, between Lake Fräkentjärn and Lake Nätsjön (*N. str.*) 25.VII. 1956 J. A. N. 14611 (H! UPS!). – Härjedalen: Tännäs Mt Hamrafjället (*N. str.*) 23.VII. 1933 J. A. N. 4658 b (UPS!). – Jämtland: Åre Högåsen (*N. str.*) 4.VIII. 1951 J. A. N. 11771d (UPS!).

Finland: Lapponia enontekiensis: Mt Valtioaivi c. 800 m (*Cal. neglecta*) 31.VII. 1960 L. & H. Roivainen (Müller 1966 p. 235; H!).

Germany: Bayern: Bayrischer Wald Arber (*N. str.*) IX. 1885 H. Rehm (Ascom. 261b; 1891 p. 569; 1914 p. 105). – Sachsen: Erzgebirge Fichtelberg 1902 W. Krieger (fide Höhnel 1919 p. 269).

Switzerland: K^t Graubünden and K^t Wallis: one find each (*N. str.*) (Müller 1966 p. 235; ZT!).

Austria: Tirol: Taschach-Glacier im Piz-Tal (*Poa* sp.?) VIII. 1875 H. Rehm (S! as *Niptera poae*).

Czechoslovakia: Cechy: Teplice (=Teplitz) (*N. str.*), summer 1873 F. v. Thümen (Rehm, Ascom. 261; typus).

Rehm's record (1891 p. 569) from Krain cannot be verified as no voucher specimen is to be found. His record (1914 p. 105) from Taubenberg (Oberbayern) is erroneous, and so is Jaap's (1914 p. 426) from Thüringen.

4. **Scutomollisia stenospora** Nannf. nov. sp.

Scutum 0.15–0.3 mm diam., opacum, atrobrunneum. Excipulum apothecii extus pigmentatum, "textura globulosa", cellulis ca. 6–8 μm diam., iis marginem versus claviformiter elongatis, extremis ad 20 × 3–4 μm. Asci 50–70 × 6–7 μm, graciles, anguste claviformes, apicem versus subconice attenuati, directe I +, 8-spori. Sporae (immaturae) 16–22 × 2 μm, subcylindricae–subclaviformes, saepe leviter curvatae, apicibus rotundatis, guttatae. Paraphyses filiformes (ca. 1 μm diam.), apice clavulate incrassatae (ad 2 μm diam.), hyaline. – Hab. in culmis anni praeteriti *Junci subnodulosi* in Scania Sueciae. – Typus: Holm 223a (UPS!).

Shield c. 0.15–0.3 mm in diam., circular or somewhat irregular, opaque, blackish brown. The material too young for showing how the apothecia becomes exposed. Hyphae of the shield c. 3 μm in diam.; their walls dark brown, c. 0.5–0.7 μm thick.

Excipulum typically "mollisioid"; the outermost layer of "textura globulosa" with brown-walled cells (c. 6–8 μm in diam.). Towards the margin the cells form distinct parallel rows and become elongated ± clavate (the marginal up to 20×3–4 μm) with paler but yet distinctly pigmented walls.

Asci c. 50–70×6–7 μm, gracile, clavate and subconically attenuated above, with a minute apical plug directly I+ (pure but not very dark blue), 8-sporous.

Spores (immature) 16–22×2 μm, subcylindrical–subclaviform with rounded ends, straight or slightly curved, hyaline with (usually 4) large drops (vacuoles?), the largest very close to the upper end.

Paraphyses filiform (c. 1 μm in diam.), septate, slightly incrassated apically (up to 2 μm in diam.), hyaline, not agglutinated.

Matr.: *Juncus subnodulosus*.

Exs.: O.

Ill.: Figs. 3 E–G, 4 G.

Specimen seen

Sweden: Skåne: Benestad Örup 14.VI. 1974 K. & L. Holm 223a (typus).

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Pollen and stigma conditions in the Balanophoraceae s. lat.

Bertel Hansen

Hansen, B. 1976 10 22: Pollen and stigma conditions in Balanophoraceae s. lat. *Bot. Notiser 129:* 341–345. Stockholm. ISSN 0006-8195.

A survey of the nuclear conditions in ripe pollen of the Balanophoraceae s. lat. is given. The survey includes 17 genera of a total of 19 in the family. It is based on 38 specimens investigated. Binucleate as well as trinucleate species occur in the family. For some of these taxa the stigmatic surface was investigated by SEM. ''Smooth'' as well as ''secretory'' stigmas were observed. These conditions may well correspond to the recently discovered ''dry'' and ''wet'' stigma conditions. The correlations of stigma conditions and number of nuclei in the pollen grains are demonstrated. One genus, *Scybalium,* is noteworthy in having species with binucleate as well as species with trinucleate pollen grains. Correlation with ''secretory'' and ''smooth'' stigmas, respectively, is here found even on the specific level.

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During my work on a revision of South American Balanophoraceae preparations of male flowers in Hoyer's solution were made. In one slide of *Corynaea sprucei* I was able to notice structures in the pollen grains, indicating that they had 3 nuclei. To my great surprise Brewbaker (1967) reported the Balanophoraceae to be binucleate, partly based on observations on *Helosis* and *Rhopalocnemis,* both of them close relatives of *Corynaea.* Davis (1966) stated that the pollen grains of the Balanophoraceae are 3-celled, when shed. Lotsy (1901) considers binucleate pollen grains to be the rule in *Rhopalocnemis,* but he has observed and illustrated trinucleate grains as well. Umiker (1920) and Fagerlind (1938 a) report trinucleate pollen grains in *Helosis*. Steindl (1945) found binucleate grains in *Cynomorium*.

Having assembled a large and representative collection from various herbaria for my revision I decided to make a survey of pollen nuclear conditions throughout the family. Pollen from herbarium specimens was treated with aceto-carmine. Sufficient staining was obtained in most cases within 20 hours, even in herbarium specimens more than 100 years old. Material preserved in alcohol or FAA generally stained badly or not at all and had to be discarded. Only slides with many well stained grains were used in determining the number of nuclei. The results are listed in Table 1 and some are illustrated in Fig. 1 A–H.

In the subfamilies Cynomorioideae, Dactylanthoideae, Sarcophytoideae, Lophophytoideae, and Balanophoroideae the binucleate condition is found without exception (Fig. 1 E–G).

In a specimen of *Balanophora latisepala* a number of grains turned out to be trinucleate (Fig. 1 H). When a young synandrium of the same collection was investigated, however, only binucleate grains were found. The trinucleate condition in this case is apparently due to completion of the second mitosis in old anthers as noted by Brewbaker (1967) and others and should not to be confused with the real trinucleate condition. Also in a specimen of *Balanophora polyandra* with 2 nuclei prevailing, grains with 3 and even 4 nuclei were seen. However, in such cases the shape of the nuclei was irregular and ill-defined.

In subfamily Helosidoideae the trinucleate

Table 1. Taxa and collections investigated. – A: Number of nuclei in pollen grains. – B: Stigma conditions, 0 "smooth", + "secretory".

Taxon	Collection	A	B
Cynomorioideae			
Cynomorium coccineum L.	Kuhbier et al. 1755	2	
Dactylanthoideae			
Dactylanthus taylorii Hook. f.	Ward s.n. 24.4. 1947	2	
Hachettea austrocaledonica Baill.	Mac Kee 12684	2	
Sarcophytoideae			
Sarcophyte sanguinea Sparrm.	Ecklon & Zeyher s.n.	2	
S. piriei Hutch.	Færkel s.n. May 1976	2	
Chlamydophytum aphyllum Mildbr.	Jans 1131	2	
Helosidoideae			
Scybalium jamaicense (Sw.) Schott & Endl.	Taylor 219	2	
S. jamaicense	Türckheim 2657	2	
S. jamaicense	Ekman 3348		+
S. fungiforme Schott & Endl.	Gehrt 39621	2	
S. fungiforme	Lemos s.n. Oct. 1962		+
S. depressum (Hook. f.) Eichl.	Steyermark 52634	3	
S. depressum	Fosberg & Core 21518		0
Helosis cayennensis (Sw.) Spr.	Holm-Nielsen et al. 4155	3	
H. cayennensis	Snetlhage s.n. 11/9-1923	3	
H. cayennensis	Maguire et al. 47091	3	0
Corynaea sprucei Eichl.	Holm-Nielsen et al. 6910	3	
C. sprucei	Williams & Gibson 28189	3	
C. sprucei	Grant 10029	3	
C. sprucei	Wurdack 952		0
Ditepalanthus malagasicus (Jumelle & Bathie) Fagerl.	Humbert s.n. 1950	3	
Rhopalocnemis phalloides Jungh.	Hook. f. & Thoms. s.n. 1850	3	
Exorhopala ruficeps (Ridl.) Steen.	Law s.n. 1880	3	
Lophophytoideae			
Lophophytum leandri Eichl.	Krapovickas 15509	2	
L. leandri	Hatschbach 19606		+
L. mirabile Schott & Endl.	Peckolt s.n. c. 1880	2	
Ombrophytum sp. nov.	Schunke 3943	2	
O. sp. nov.	Sparre 13049	2	
Juelia subterranea Asplund	Sleumer 3054	2	
J. subterranea	Shepard 246	2	
J. subterranea	Pfister s.n. Chile		+
Balanophoroideae			
Balanophora fungosa Forst. ssp. *indica* (Arn.) B. Hansen	Hennipman 3119 B	2	
B. dioica R. Br. ex Royle	Hook. f. & Thoms. s.n. c. 1850	2	
B. latisepala (Tiegh.) Lec.	Balgooy 2677	2	
B. latisepala	Kerr 9120	2	
B. latisepala	Kerr 7864	2	
B. latisepala	Kerr 3411	2	
B. latisepala	Tagawa et al. T 9898	2(3)	?
B. laxiflora Hemsl.	Iwatsuki et al. T 8385	2	
B. polyandra Griff.	Hook. f. & Thoms. s.n. c. 1850	2(3, 4)	
B. reflexa Becc.	Corner RSNB 5254	2	
B. harlandii Hook. f.	Larsen et al. 4589	2	
Langsdorffia hypogaea Mart.	Mosen 4404	2	
L. hypogaea	Allen 4773		+
Thonningia sanguinea Vahl	D. Müller s.n. 1963	2	

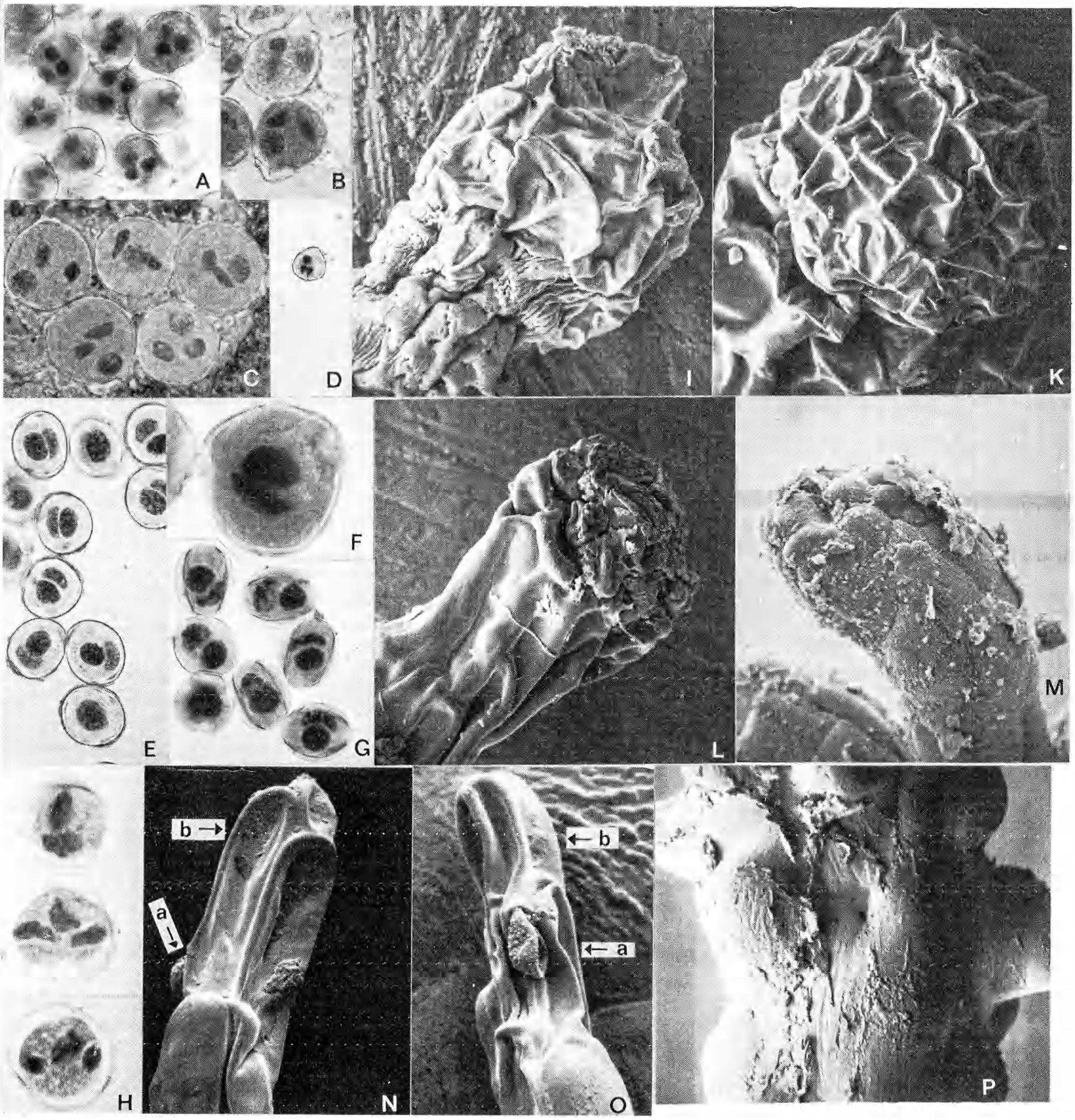

Fig. 1. A–H: LM microphotographs of pollen grains stained with aceto-carmine. – I–P: SEM micrographs of stigmas from herbarium specimens. – A: *Scybalium depressum,* Steyermark 52634, ×315. – B: *Helosis cayennensis,* Holm-Nielsen et al. 4155, ×315. – C: *Corynaea sprucei,* Holm-Nielsen et al. 6910, ×315. – D: *Exorhopala ruficeps,* Law s.n., ×125. – E: *Sarcophyte piriei,* Færkel s.n., ×400. – F: *Scybalium jamaicense,* Türckheim 2657, ×500. – G: *Lophophytum leandri,* Krapovickas 15509, ×315. – H: *Balanophora latisepala,* Tagawa T 9898, ×1000. – I: *Scybalium depressum,* Fosberg & Core 21518, ×500. – K: *Helosis cayennensis,* Maguire & al. 47091, ×500. – L: *Scybalium jamaicense,* Ekman 3348, ×200. – M: *Juelia subterranea,* Pfister s.n., ×135. – N, O: *Balanophora latisepala,* Tagawa T 9898, ×600. – P: *Langsdorffia hypogaea,* Allen 4773, ×320.

condition was invariably found in *Helosis, Corynaea, Ditepalanthus, Rhopalocnemis,* and *Exorhopala* (Fig. 1 A–D). *Scybalium* with 4 species known is particularly interesting. Binucleate pollen grains were found in *S. jamaicense* from the West Indies (Fig. 1 F) and *S. fungiforme* from the surroundings of Rio de Janeiro, but trinucleate pollen grains were found in *S. depressum* from the Colombian and Ecuadorian Andes (Fig. 1 A). Unfortunately pollen was not available from the E Brasilian *S. glaziovii.*

Taxonomic concept of Scybalium

Scybalium thus should be added to the exclusive list of 10 genera with binucleate as well as trinucleate grains given by Brewbaker (1967). However, Hooker fil. (1856) treated the three species of the present *Scybalium* known by him as *Phyllocoryne jamaicensis, Sphaerorhizon depressum* and *Scybalium fungiforme.*

The generic concept is usually a matter of individual taste to a much greater extent than the specific concept. In my opinion, the three species just mentioned form a completely natural group together with *Scybalium glaziovii,* a group that is clearly differentiated from the remaining Helosidoideae. In the *Scybalium* species the stem and inflorescence are covered by well-developed scaly leaves and bracts. In *Helosis, Corynaea, Ditepalanthus,* and *Exorhopala* the stems are completely destitute of scaly leaves, while in *Rhopalocnemis* some specimens are found to have very rudimentary scales. In the five genera of Helosidoideae just mentioned the inflorescences in the young stages are covered not by bracts but by the marginally coherent peltas of peltate scales. The nature of these peltate scales has been discussed by Fagerlind (1945). I support his theory that they are the sterile, peltately widened apical parts of secondary axes. In this character the Helosidoideae except *Scybalium* agree with some of the Lophophytoideae, which have binucleate pollen. Furthermore Helosidoideae as well as Lophophytoideae have two styles. However, in subfamily Helosidoideae the androecium is always transformed into a synandrium, while the male flowers are bistaminate in the Lophophytoideae.

But in what respect does *Scybalium* resemble the other Helosidoideae? First of all, the very uniform bicarpellate gynoecium consisting of a compressed inferior ovary with two styles, which is found in all genera and species; secondly, the structure of the androecium which is very similar in *Scybalium, Helosis,* and *Corynaea,* shown in illustrations by Richard (1822), Hook. fil. (1856), Fagerlind (1938 b). Regarding pollen morphology the *Scybalium* species investigated have polypantoporate grains in contrast to the rest of Helosidoideae and the Lophophytoideae, which have tricolpate or tricolporate grains.

It has been proposed by Schürhoff (1926) that trinucleate pollen grains represent the more advanced stage, a theory strongly supported by Brewbaker (1967). Thus, in this respect it seems appropriate to consider Lophophytoideae the more primitive of the two subfamilies. Likewise within the Helosidoideae the genus *Scybalium* would represent the primitive state, with *S. depressum* being more advanced.

Stigma conditions

Brewbaker (1957) and Brewbaker & Majumder (1961) reported on a syndrome of physiological differences linked to the binucleate and trinucleate pollen conditions. The characters in which differences were found to occur are such as viability of grains in vitro, storage longevity, site and type of self-incompatibility control systems.

Heslop-Harrison et al. (1975) commented on a newly discovered character apparently to some extent belonging to this syndrome, the surface conditions of the stigma. "Wet" stigmas (in the natural condition) are mostly restricted to groups with binucleate grains, whereas trinucleate grains are usually found associated with "dry" stigmas. O. Mattsson (personal communication) suggested a scanning electron microscopy (SEM) investigation of herbarium material based on the assumption that in originally wet stigmas some residual secretion would still be left on the stigmatic surface. A survey of the stigmas of a number of Balanophoraceae has been carried out. The styles were mounted on a specimen stub and subsequently coated under vacuum by gold. The interpretation of the SEM micrographs should be made with great caution. Irrelevant substances might easily attach to the stigma. The crustaceous residue might have dropped off or it might even cover the stigmatic surface completely and thus be overlooked. The results are listed in Table 1 and some examples are shown in Fig. 1 I–P. The term "smooth" is used for stigmas appearing in the SEM as clean and free from any secondary residue, while "secretory" is used for stigmas with a conspicuous crustaceous residue. The "smooth" condition might well correspond to the "dry" condition of Heslop-Harrison et al. (1975) and the "secretory" condition to the "wet". Bearing this in mind, a glance at Table 1 shows us in the Balanophoraceae at least in some cases a positive correlation on the one hand between "secretory" stigmas and binucleate grains, on the other hand between "smooth" stigmas and trinucleate grains, which even holds true down to the specific level within the remarkable genus *Scybalium*.

In *Balanophora,* a highly specialized genus with extreme morphological reductions, the female flower is reduced to an ovary and a style consisting of four rows of cells. The entire pistil measures about 1–2 mm in length. The style and stigma cover about 3/4 of the entire length and it is not possible to distinguish the stigmatoid part morphologically (Hansen 1972). Fig. 1 N and O show the apical stigmatoid part of two styles with a pollen grain attached at a. The origin of the material attached at b is not quite clear. It might be due to pollen grains having touched the style. In any case it can hardly be interpreted as a crustaceous residue of the same obvious kind as seen in Fig. 1 M and P. Further investigations are needed to show whether the binucleate genus *Balanophora* has "wet" stigmas.

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SEM-investigations were carried out with a Cambridge instrument at the Institute of Historical Geology and Palaeontology, University of Copenhagen. LM-investigations by means of a Leitz Dialux-Orthomat from the Danish State Science Council.

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Botanical literature

Blackall, W. E. & Grieve, B. J.: *How to know Western Australian wildflowers.* Second impression of parts I, II and III in one volume 1974 and part IV in another (1975). Part I–III with pp. 1–595 + I–CXXII, part IV with pp. 596–861 + 1–137. University of Western Australia Press. Distributed by The Richmond Publishing Co., Richmond, Surrey, England. Price £ 6.60 (parts I–III), £ 14.85 (part IV).

The present work is unique in being a key of about 860 pages printed from a handwritten original! This key includes about 3,000 species found in the southwestern districts (the Warren, Darling, Stirling, Avon, Eyre, Coolgardie, Austin and Irwing Districts) of Australia. These regions have mainly hot dry summers and cool humid winters, i.e. a Mediterranean type of climate. The vegetation thus consists chiefly of dry sclerophyllous scrub, but part of the region is desert and part consists of *Eucalyptus* and *Casuarina* woodland and *Eucalyptus* forest. In these districts are found many members of Restionaceae, Haemodoraceae, Casuarinaceae, Proteaceae, Myrtaceae, Dilleniaceae, Goodeniaceae, Epacridaceae, Myoporaceae, Stylidiaceae and other typically Australian families, not to mention the many interesting genera of, for example, Fabaceae and Rhamnaceae. Many genera are large and making keys for these is therefore not an easy task.

Though handwritten the text is clear and easily read, and the illustrations demonstrate typical features of the species or often whole branches or whole plants, but sometimes characteristics leading to new entries in the key. The Latin names given in the key lack names of authors, but this is partly compensated for in the indexes at the end of the volumes. In these the author is given for the Latin names in Parts II to IV, but not for those of the very extensive Part I. Information is also given on those districts where the species of Parts II to IV occur. The second volume (Part IV) has a somewhat larger format and contains 16 pages with colour photographs. In this part is also found a key to the families and a glossary.

It is my firm belief that this key will be of lasting importance to all who wish to determine southwestern Australian plants. It should be very useful in the field as well as in a herbarium. It will also be of tremendous help to taxonomists working on an extensive flora or a revision within the area. The neat drawings of leaves, fruits, flowers, etc. include information difficult to obtain from conventional keys or from descriptions. The book can therefore be strongly recommended to Herbaria as well as to professional botanists and amateurs who come into contact with this interesting flora. Moreover, in this book the possibilities of the pictorialized key are carried further, perhaps, than in any other work of this scope.

Rolf Dahlgren

Pankow, H. 1976: *Algenflora der Ostsee. II. Plankton* (einschl. benthischer Kieselalgen). Unter Mitarbeit von V. Kell und B. Martens. 493 S. 880 Abb. 175 Fotos. VEB Gustav Fischer Verlag, Jena. DM 71.–.

Bei der Bestimmung der Algen ist es eine äusserst mühsame Arbeit all die erforderliche Literatur zusammen zu tragen. Daher ist es erfreulich, dass ein zusammenfassendes Werk aller in der Ostsee vorkommenden Algen erschienen ist.

Dies Buch hat ein kleines, handliches Format und einen zusammenfassenden – vielleicht oft zu unvollständigen – Text und ist mit reichlichem Bildmaterial versehen. Da ich mich überwiegend mit Diatomeen beschäftige, habe ich vor allem diesen Teil kritisch betrachtet.

Die zu Beginn des Buches gegebene ,,Übersicht über das verwendete Halobiensystem'' wäre übersichtlicher gewesen, wenn der Verfasser Simonsens ausgezeichnetes, vollständiges Halobiensystem widergegeben hätte, wo ein Vergleich mit den Systemen von Ekman, Kolbe und Hustedt direkt gegeben ist. Von Vorteil wäre es gewesen alle Verkürzungen gesammelt zu erklären; nun sind einige im Text erklärt, andere fehlen. Was ist z. Beisp. mit "Orig." im Bildtext gemeint? Ist es das ursprünglich vom Autor der Art beschriebene Original oder ist es das Original der beiden Mitarbeiter, die lt. Vorwort die Zeichnungen verfertigt haben? Leider sind die ,,veränderten" Abbildungen oft schlechter als die ursprünglichen Originale. Als Mangel muss auch das Fehlen der Grössenangabe im Bildmaterial angesehen werden. Im Literaturverzeichnis vermisst man vielleicht Namen wie N. G. W. Lagerstedt, G. Lundquist & H. Thomasson, M.-B. Florin, N. Foged, U. Miller.

Betrachtet man jedoch das Buch als Ganzes als ,,dem Praktiker einen Schlüssel zu bieten, der ihn bei seiner Arbeit unterstützt" so erfüllt es seinen Zweck. Der Spezialist, der genauere Bestimmungen ausführen möchte, muss nach wie vor zur Spezialliteratur greifen.

Hannelore Håkansson

Fellenberg, G. 1974: *Chromosomale Proteine.* Funktion und Bedeutung bei höheren Organismen. 159 S. 24 Abbildungen. 15 Tabellen. Verlag Eugen Ulmer, Stuttgart.

The present volume introduces a new series of publications – "Phytologie. Klassische und moderne Botanik in Einzeldarstellungen". It deals with a rapidly developing field of molecular biology and thus runs the risk of becoming partly out of date within few years. Still, it is a valuable survey of a subject otherwise rather difficult of access for the non-expert.

A lucid account is given of our knowledge in this field, as well as of its many deficiences. The structure of different kinds of proteins (protamines, histones and acid chromosomal proteins) is described, as well as their occurrence and analytical methods of indicating them. Later, a detailed description is given of the synthesis, turnover and enzymatic modifications of chromosomal proteins. Subsequently their interactions with certain cell components, changes occurring in different parts of the cell cycle and during ontogenesis, organ and tissue specificity are described. The final chapter discusses the co-operation of different protein fractions with DNA and RNA and the regulation of gene activity (here called "Matrizenaktivität").

The book is essential to scientists working in different fields of molecular biology. It is also recommended to all those who wish to keep in contact with recent development in this area.

Sven Asker

Gerlach, D. 1976: *Das Lichtmikroskop. Eine Einführung in Funktion, Handhabung und Spezialverfahren für Mediziner und Biologen.* 311 pp. Georg Thieme Verlag, Stuttgart. ISBN 3-13-530301-2. Price DM 19.80.

Many students of biology and medicine are certainly not sufficiently familiar with the technical facilities of the compound microscope to make the best use of it. This very instructive manual presents the uses and handling of the compound microscope and therefore fills an obvious need. The mechanical and optical construction is described, and the physical facts behind the origin of the virtual image are clarified. Phase contrast microscopy, interference contrast microscopy, fluorescence microscopy, microscopy using polarized light and photomicrography are some of the numerous topics treated in detail. Practical instructions for adjustment and trouble-shooting are given in a number of appendices. The book is explicitly addressed to beginners and no particular previous knowledge is necessary. However, I am glad to say that after presenting basic information the book penetrates far more advanced topics, too, and is therefore of great interest to the advanced research worker as well. The type of offset employed (the right-hand margins are uneven and some of the illustrations are dull and greyish) by no means destroys the good impression made by this comprehensive little textbook with its concentrated presentation. An edition available to the non-German-speaking world would be welcome. Gerlach's book is to be highly recommended.

Gunnar Weimarck