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New species of Calathea from Panama and Costa Rica

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Three new species of *Calathea* (Marantaceae) are described: *Calathea caesariata* and *C. cuneata* from Panama and *C. plicata* from Panama and Costa Rica.

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The Marantaceae are a conspicuous element of the moist to wet lowland and lower montane tropical forests. Those species of the wetter forests tend to have low population densities and are generally widely scattered. It is in these wetter areas that recent additions to the flora of Panama have been and continue to be discovered. The majority of these additions are undescribed species rather than new records, which is most probably a reflection of the difficulties encountered in collecting in the adjacent areas such as the Atlantic slope of Costa Rica and especially the Chocó region of Colombia, rather than endemism. The number of species of Marantaceae currently known from Panama is 52.

In the recently accessible cloud forest area of Santa Fe near the Continental Divide in Veraguas Province, Panama, a number of new Calatheas have been discovered. Of interest are the distributional ties of several of these species with Costa Rica. *Calathea similis* Kennedy, *C. leucostachys* Hook. f., *C. plicata* Kennedy and *C.* aff. *guzmanioides* Smith & Idrobo are all found in northern Costa Rica on the Atlantic slope or near the Continental Divide in the Cordillera de Tilerán (Alejuela Province). Another *Calathea* at Santa Fe was previously known only from a single collection in southern Nicaragua and has yet to be described. Of the ten species of *Calathea* so far collected near Santa Fe, four, including *C. similis* and *C. leucostachys*, occur in the wet forests in eastern central Panama. *Calathea cuneata* Kennedy and two undescribed species are known only from Santa Fe but may be found in northeastern Costa Rica or eastern central Panama.

In this paper the term secondary bract is used in place of mesophyll in referring to that structure inserted above and opposing the bicarinate prophyll in the inflorescence, because of the long-established use of the term mesophyll in another sense (Andersson 1976 p. 41). This inflorescence structure has been referred to by various terms: Deckblatt (Eichler 1875); Zwischenblatt or mesophyllis (Schumann 1902); bract-like bodies (Thompson 1933); simple bract or mesophyll (Holttum 1951) and interphyll (Andersson 1976). Holttum (1974), in discussing the terminology of the Zingiberaceous inflorescence, states: "Thus the first short axis of the cincinnus, with a flower at its apex, is in the axil of a primary bract; later ones are all in the axils of secondary bracts." The same basic relationship pertains to the Marantaceae, the first floral shoot (axis of the cincinnus) is in the axil of the bract and the subsequent ones in the axils of the "mesophylls". The Marantaceae differ in that these floral shoots usually terminate in a pair of flowers and a prophyll is produced first on the axis and then, when present, the opposing "mesophyll" (for a detailed account see Andersson 1976). Since the "mesophylls" have the same functional position as the Zingiberaceous secondary bracts, the term secondary bract is preferred.

Calathea caesariata Kennedy sp. nov. – Fig. 1

Planta caulescens; folia 9–13; laminae undique villosae, venae longitudinales 14–20(–21) intra cm tria; petioli, vaginae et caules villosi. Bracteae distichae, 9–21, utrinque villosae, virides ad flavovirentes demum flavae; prophylla bicarinata marginibus villosis; sepala glabra albida apice tincto viridi; corollae flavae, lobi praeter caespitem pilorum ad apicem glabri, tubo cremeo; staminodium exterius flavidum tinctum violaceum, callosum bilobatum prope basin cremeum ad apicem tinctum violaceum.

Rhizomatous cauline herb 88–165 cm high, bearing 8–12 distichous leaves at the base. The final, uppermost leaf subtending the inflorescence borne above an elongated internode 13–58 cm long. *Rhizome* tough, somewhat woody in texture. *Cataphylls* narrowly ovate, inner ones acute, mucronulate at apex, grass-green, villous, innermost to 30 cm high, usually not persistent in mature, flowering individuals. *Leaf blade* semi-chartaceous, elliptic, apex acuminate, base obtuse to subround, subtending leaf 24–66 cm long and 7.6–12.5 cm wide, second to fifth from above 34–66 cm long and 7–13.6 cm wide. Leaf blade villous throughout, hairs pale tan, 2–4 mm long, upper surface glittering, grass-green, midrib yellow-green; leaf surface below light grey-green, midrib yellow-green. *Pulvinus* subround in cross section, yellow-green to olive-green, villous, occasionally subglabrous with row of hairs along upper and lower sides, confluent with petiole, (0.6–)1–3(–3.5) cm long in subtending leaf, others (1–)1.7–5.5 cm long. *Petiole* deep green, villous, 0–13 cm long in subtending leaf, second to fifth leaves 11–56 cm long, very rarely absent. *Leaf sheath* not auriculate, deep green, villous, 11–26(–32) cm long in subtending leaf, others 28–56 cm long. *Stem* green, villous.

Inflorescences (1–)2–3 per shoot, depending on age, the first one terminal, the others arising in the axil of the subtending leaf, laterally flattened, rectangular, 8–15.5 cm high and 5–7 cm wide, the second and third inflorescences smaller than the first. *Peduncle* green, villous, (8–)14–46(–55) cm long, longest in first inflorescence. *Bracts* (9–)14–21 in number, distichous, slightly leathery, pliable, broadly ovate to transverse broadly ovate, apex retuse, (3.0–)3.1–3.5 cm long and (3.1–)3.3–3.8 cm wide, each subtending up to 6 flower pairs. Adaxial surface of bract green in young inflorescences becoming yellow-green and finally yellow in old inflorescences, villous; abaxial surface villous in upper half, glabrous basally. *Bicarinate prophyll* membranaceous, triangular-ovate, apex acute, translucent yellow-green, darkest at apex, margins and lateral surface of carina villous, glabrous between carina, (2.6–)2.8–3 cm high and 1–1.3 cm wide. *Secondary bracts* membranaceous along the margins, the central portion thickened, ovate-elliptic to triangular-ovate, apex obtuse, translucent yellow-green, darker centrally, appressed villous, (2.3–)2.5–2.9 cm high and (0.7–)0.9–1.2(–1.3) cm wide. *Bracteoles* subtending individual flowers 1 per flower pair, (1–)1.2–1.8 cm high and 1–2.5 mm wide.

Sepals narrowly ovate-triangular, apex acute, translucent white below, apex tinged green, glabrous, 1.2–1.45 cm high and 2–3.5 mm wide. *Corolla tube* cream, 2–2.3 cm long; corolla lobes subequal, narrowly oblong-obovate, apex acute to 90°, yellow, 0.8–1 cm 'ong and 3–4 mm wide. *Outer staminode* dished, elliptic, apex emarginate to rounded, pale yellow tinged with pink-purple, 7–9 mm long and 5–7 mm wide. *Callose staminode* rectangular, apex cleft into two narrow lobes, basal and central callose portion semi-translucent cream, apex tinged pink-purple, 0.95–1.1 cm long and ca 4 mm wide. *Cucullate staminode* pink-purple, 4.5–5 mm long and ca 3 mm wide, provided with a subterminal filiform appendage. *Filament* pink with lateral petaloid appendage to 1.5 mm wide, adnate to lower 1/3 of anther; anther 2.5 mm long. Style and stigma pink. *Ovary* cream, glabrous, 2.5–3 mm high and 1.5–2 mm in diameter. *Capsule* smooth, thin, obovoid, pale yellow, 1.2–1.5 cm high and 7–9.5 mm wide; crowned by a persistent, live, light green calyx. *Seeds* usually 3 per capsule, obovoid, dark blue, 8.5–9.5 mm high and 4–5 mm wide, bearing a basal white aril 3.5–4.5 mm high.

Type: Panama. Prov. Panama: km 19 on the El Llano–Carti road, evergreen wet forest, ca 400 m, 26.3. 1975, H. Kennedy & R. L. Dressler 3500 (holotype F 1752000; isotypes DUKE, K, MO, PMA, U, US).

Other collections (all from the type locality or its surroundings): Dressler 4299 (COL); Kennedy &

Fig. 1. *Calathea caesariata*. A: Habit. – B: Inflorescence. – C: Flowers on upper surface of leaf; upper one tripped, lower one untripped. – D: Capsule with persistent calyx and arillate seeds on lower leaf surface.

Dressler 2424 (BM, CR, PMA, S), 2583 (US), 2715 (U), 3352 (GH); Kennedy, Dressler & Correa 2496 (B, MO, NY), Mori, Kallunki & Gentry 4579 (MO).

Flowering from February through September, mid dry season to mid or late rainy season. The start of flowering is variable; in 1976 it was delayed, the plants having just begun flowering in April.

This species occurs in evergreen wet forests most commonly at the forest edge or roadsides in recently disturbed areas. Like *Calathea similis* it is usually found in more or less open areas associated with second growth species and might be expected in naturally disturbed areas such as tree falls. During the past two years this species has become noticeably less prevalent in the area (along Carti road) which may be a result of its being shaded out.

This species is distinguished from other distichously-bracted species, *Calathea* subgenus *Calathea,* by its densely villous bracts, leaves (blade, petiole and sheath) and stems. It is most closely related to *C. lasiostachya* Donnell Smith differing from that species in (a) the wider lateral vein spacing of the leaf, 14–20(–21) (average 17), compared with 20–24 per 3 cm; (b) the entirely villous rather than glabrous or subglabrous (bearing short hairs near the base and apex) upper leaf surface; (c) the villous rather than glabrous or occasionally subglabrous adaxial bract surface and (d) the petals which are glabrous (except for a small tuft of hairs at the apex) rather than pubescent throughout. In both *C. lasiostachya* and *C. caesariata* the hairs are elevated on a base; in *C. lasiostachya* this base consists of a single ring of cells, whereas it is larger and more raised in *C. caesariata,* consisting of 3–4 rows of cells. The leading edge of the leaf and the subtending leaf sheath are usually tinged purple in *C. lasiostachya* whereas both are uniformly green in *C. caesariata*. The texture and color of the leaf blade, especially that of the lower surface, is like that of *C. similis* rather than *C. lasiostachya*. In *C. lasiostachya* the lower surface is smoother, darker in color and has a slight luster, whereas it is minutely irregular, opaque and semiglaucous in *C. caesariata*. The measurement of the number of veins was taken from the middle of the leaf, midway between the midrib and the leaf margin.

The specific epithet is taken from the Latin *caesariatus* meaning covered with hairs, referring to the totally villous nature of the plant.

Calathea cuneata Kennedy sp. nov. – Fig. 2

Planta acaulescens; folia 2–3, lamina anguste elliptica apice acuminato, base anguste cuneata, glabra praeter ad medianum tomentosa. Spica una obovoidea 7–10 cm longa; bracteae spiraliter dispositae atropurpureae, adpresse tomentosae, bracteae superiores obtrullatae vel obovatae; prophyllum bicarinatum ad apicem tomentosum, apice acuto, omne par florum bracteolis duabus comitatum. Tubus corollae 4.6–5 cm longus rima ad 2.3 cm longa; staminodium exterius obovatum retusum luteum; staminodium callosum petaloideum, ceterum simile staminodio exteriori.

Rhizomatous acaulescent herb, 1.2–1.7 m high, shoot bearing 2–3 leaves basally, the inflorescence terminal, borne well below the leaf blades. Occasionally a bladeless sheath may be found in place of the third leaf. *Cataphylls* narrowly ovate, somewhat papyraceous, apex of inner ones acute, mucronulate, obtuse in lower ones, purple, towards base and where covered by another cataphyll green to whitish, appressed tomentose (hairs 0.3 mm or less) above, subglabrous at base, innermost cataphyll 35–56 cm long. *Leaf blade* firm, slightly leathery, narrowly elliptic, apex acuminate to abruptly acuminate, base narrowly cuneate, (58–)65–89 cm long and 14–20 cm wide. Leaf blade above sparkling deep green, glabrous except for tomentose midrib, midrib dark olive-green nearly concolorous, leaf surface below opaque, light grey-green with yellow-green midrib, glabrous except appressed tomentose along midrib. *Pulvinus* yellow-green, glabrous except for row of hairs above, 4–7(–10) cm long, articulate with petiole, acuminately extended along the upper side of the petiole for 1.5–5 cm. *Petiole* green to olive-green, minutely puberulent (hairs less than 0.3 mm), 0–24.5 cm long, often absent in the innermost leaf. *Leaf sheath* not auriculate, margins papery, apex green or green tinged with reddish brown, pale greenish below to greenish white near base, appressed pubescent (hairs ca 1 mm or more) above, pubescence mainly on the margins below, if three leaves are present then the sheath of the innermost one is shorter, 25–30 cm long.

Inflorescence 1 per shoot, terminal, obconical to obovoid, 7–10.5(–11) cm high and 4.5–5 cm

Fig. 2. *Calathea cuneata*. A: Habit. – B: Inflorescence with tripped flowers. – C: Tripped flower. Note slit in upper 2 cm of the corolla tube.

in diameter. *Peduncle* pale green to whitish, occasionally tinged purple, appressed pubescent (hairs 1 mm or slightly longer), 15–27 cm long. *Bracts* 12–17 in number, spirally arranged, semi-coriaceous, the lowest bract frequently ovate, upper ones obtrullate to obovate, apex acute, 5.3–7.7(–8) cm high and 2.2–3.2 cm wide, each subtending 3 or more flower pairs. Adaxial surface of bract dark purple, appressed tomentose, basal 1/5 subglabrous; abaxial surface pale green, apical 1/4 appressed tomentose. *Bicarinate prophyll* membranaceous, narrowly ovate, apex acute, translucent white basally, pale green above, tinged purple apically, upper 2/3 appressed tomentose, 4–4.6(–5) cm high, 0.96–1.25 cm wide carina to carina and 1.4–1.8 cm total width. *Secondary bract* membranaceous, triangular-ovate, apex acute, translucent white basally, pale greenish above, apically tinged purple, upper 2/3 appressed tomentose, (4.1–)4.5–5.3 cm high and 1.4–1.6 cm wide. *Bracteoles* subtending individual flowers, 2, occasionally one per flower pair, membranaceous, one carinate the other channeled, narrowly triangular, transparent to translucent faint tannish, apically tinged purple, apex minutely puberulent, carinate one 2.8–3.4 cm long, other 1.2–2.5 cm long.

Sepals membranaceous above, herbaceous toward base, narrowly ovate to sublinear, apex acute, base white, tinged purple above, upper 1/3 translucent pale tan to transparent, glabrous, 3.2–3.7 cm long and 0.45–0.5 cm wide. *Corolla tube* white at base, cream to pale yellow above, 4.6–5 cm long, upper portion of corolla tube bearing a slit, base of corolla tube to slit 2.2–2.7 cm; corolla lobes subequal, narrowly ovate-triangular, apex twisted, acute, light yellow, glabrous, 2.7–3.1 cm long and 0.7–0.95 cm wide. *Outer staminode* obovate, apex retuse, basal 2/5 white, upper portion bright yellow, apical 1/5 light cream-yellow, 2.4–3 cm long and 1.1–1.6 cm wide. *Callose staminode* obovate, apex petaloid, rounded to retuse, callose portion white, petaloid portion yellow, (2.5–)3.3–3.6 cm long and 1.7–1.8 cm wide. *Cucullate staminode* bright orange, 0.7–0.9 cm long and ca 0.5 cm wide provided with a subterminal filiform appendage 2.5 mm long. *Anther* yellow ca 3 mm long, filament yellow with narrow petaloid appendage, upper 2/3 of anther free. Style and stigma golden. *Ovary* smooth, white, glabrous, 3.5–4.5 mm high and 2–2.5 mm wide. *Capsule* smooth, ovoid, apex subtruncate with persistent calyx.

Type: Panama. Prov. Veraguas: about 20 km NW of Santa Fe, near Continental Divide, 29.3. 1975, H. Kennedy & R. L. Dressler 3414 (holotype F on two sheets, 1759017, 1759018; isotypes GH, K, MO, PMA, US).

Flowering during the rainy season, beginning in late March to April; the termination of the flowering period unknown. This species occurs in a montane wet to cloud forest habitat in moderate shade within the forest.

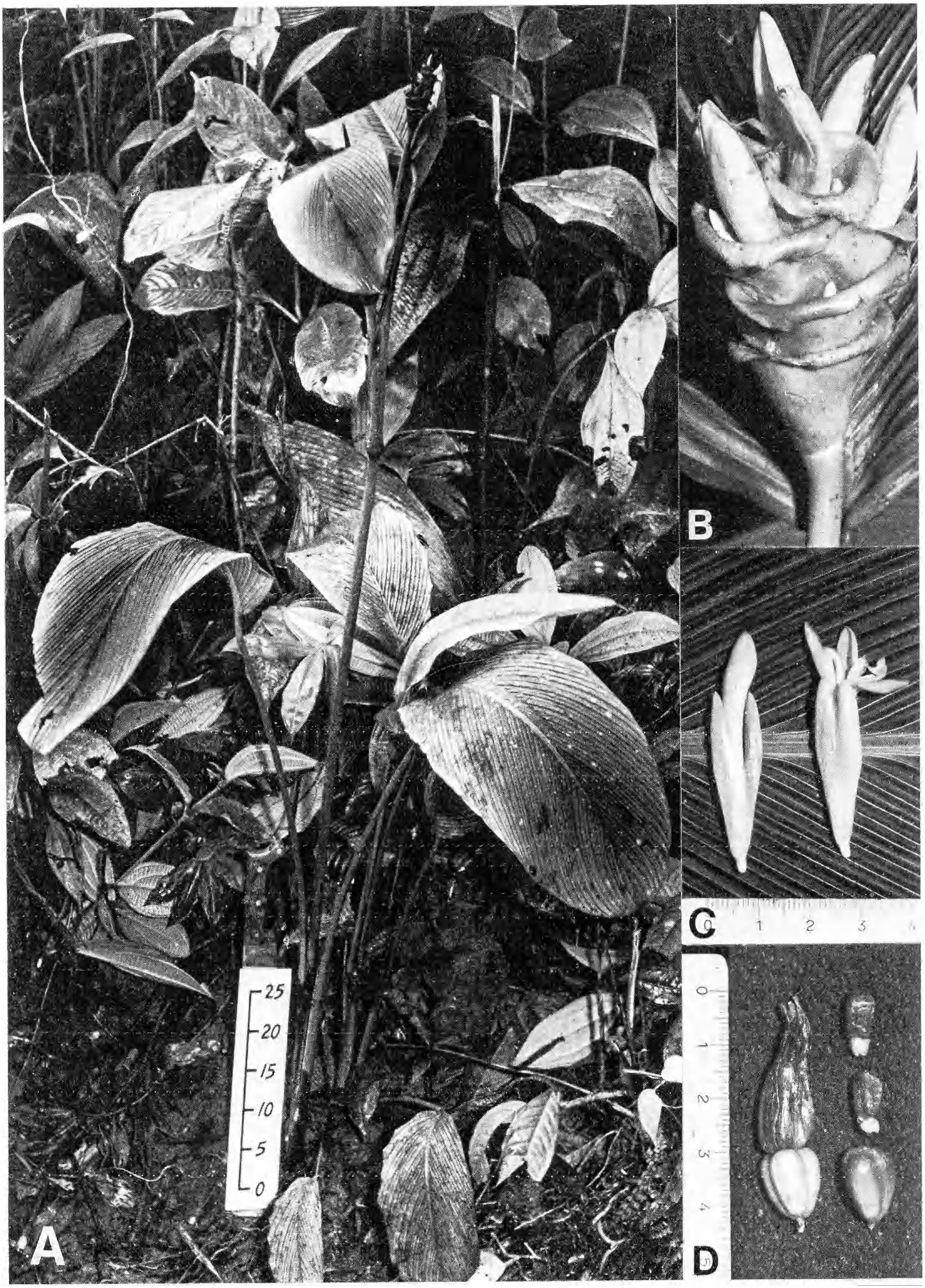
This species is easily distinguished from other Central American Calatheas by its cuneate (a 25–35 degree angle) leaf base, the 2–3 leaves per shoot, the relatively long (4–10 cm) glabrous pulvinus, the spirally arranged dark purple bracts, the long-tubed (4.6–5 cm) open yellow flower in which the callose and outer staminodes are similar in shape and coloring, and which bears a natural slit in the upper portion of the corolla tube.

The specific epithet is derived from *cuneatus*, meaning wedge-shaped, denoting the distinctive cuneate leaf base in this species.

Calathea plicata Kennedy sp. nov. – Fig. 3

Planta ad 1.3 m alta. Folia elliptica valde plicata apice rotundato acuminato, folia caulina basi rotundata, folia basalia basi cuneata, supra viridia glabra infra pallide viridia puberula, petioli foliorum summorum duorum desunt, alii ad 40 cm longi, pars superior glabra vel subglabra ad 4 cm longa. Spica ellipsoidea vel obovoidea pedunculo tomentoso, bracteae 7–9, spiraliter dispositae extus minutissime puberulae apice rotundato recurvato prope basin stramineae apicem versus pallide virides demum purpureae. Corollae tubo cremeo 3.3–3.5 cm longo, lobis pallide flavidis, staminodium exterius album obtriangulare bidentatum.

Fig. 3. *Calathea plicata.* A: Habit. Note the elongated stem internode separating the inflorescence and two subtending leaves from the basal leaves and the dark purple, old inflorescence. – B: Inflorescence. Note light color (yellow) of young inflorescence and the persistent calyces of developing capsules. – C: Flowers on upper leaf surface; left untripped, right tripped. – D: Capsule, nearly mature, with persistent, purple calyx at left; arillate seeds and capsule with calyx removed at right.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Caulescent herb 0.9–1.3 m high; 3–7 leaves per shoot, (1–)2–5 leaves borne basally, the inflorescence subtended by 2, rarely 1 or 3, leaves borne atop an elongated stem internode 66–90 cm in height. *Cataphylls* thin, herbaceous, narrowly ovate, apex acute, mucronulate, green, minutely tomentose, innermost 23–52 cm long. *Leaf blade* strongly ridged, elliptic, apex rounded with an abruptly acuminate point, base obtuse to rounded in cauline leaves, cuneate in basal leaves, uppermost subtending leaf 13.5–22(–32) cm long and 6–18 cm wide, basal leaves 33–47 cm long and 12.8–21 cm wide. Leaf blade above opaque, grass-green, glabrous, midrib yellow-green, puberulent, especially toward apex; leaf surface below dull grey-green, densely minute appressed tomentose throughout or hairs restricted to the lateral veins, hairs less than 0.3 mm long. *Pulvinus* broadly elliptic to round in cross section, yellow-green, glabrous to subglabrous (25×) with a row of minute hairs along the upper side, confluent with petiole, (0.6–)0.8–1.3 cm long in uppermost subtending leaf; other leaves 1.2–4 cm long. *Petiole* grass-green to light green, glabrous to subglabrous, absent in upper two subtending leaves (if present, the third may have a short petiole), basal leaves 12–29 cm long. *Leaf sheath* not auriculate, margins thin papery, light green, glabrous to subglabrous, minutely tomentose along margins, sheath of subtending leaves 7–17 cm long, basal leaves 29–45 cm long. *Stem* green to light olive-green with scattered minute hairs 0.3 mm or less, not visible to the naked eye.

Inflorescence terminal, obovoid to ellipsoid, imbricate, 5–6.5 cm high and 3–3.6 cm in diameter. *Peduncle* green to yellow-green, minutely appressed tomentose, felt rather than seen, 6–17 cm long. *Bracts* 6–9, spirally arranged, coriaceous, depressed ovate, apex obtuse to rounded, the apical margin recurved, lower bracts shallowly retuse, 2.3–3 cm high and 3–4.2 cm wide, the lower bracts wider and shorter than upper ones, each subtending up to 6 flower pairs. Adaxial surface of the bract yellow basally, the upper 1/3–1/2 light green, in age turning dark purple, puberulent; abaxial surface cream-yellow below, glabrous, recurved margin yellow-green, puberulent. *Bicarinate prophyll* membranaceous, broadly elliptical, apex obtuse, translucent pale yellow, in age turning purple, glabrous, 2–2.2 cm high and 1.4–1.8 cm wide total width, 0.8–0.9 cm wide carina to carina. *Secondary bracts* membranaceous, broadly elliptic to suboblong, obtuse, translucent pale yellow, glabrous, 1.9–2.1 cm high and 1.6–1.8 cm wide. *Bracteoles* subtending individual flowers 2 per flower pair, channeled, linear, acute, glabrous, 2–2.4 cm high and ca 0.3 cm wide.

Flower never opens spontaneously. *Sepals* thin, semi-spongy at base and centrally, channeled, narrowly obovate, obtuse, white at base, pale yellow above, apical 1/3 tinged greenish, glabrous, 2.8–3.2 cm long and ca 0.65 cm wide. *Corolla tube* cream, glabrous, 3.3–3.5 cm long; corolla lobes unequal, elliptic to ovate-elliptic, obtuse, pale yellowish, 1.7–1.8 cm long and 0.7–0.8 cm wide. *Outer staminode* obtriangular, bidentate, white, ca 1.2 cm long and ca 0.7 cm wide. *Callose staminode* wholly callose, rectangular, golden-orange, ca 1.3 cm long. *Cucullate staminode,* ca 1.1 cm long and ca 0.45 cm wide, provided with a subterminal filiform, channeled appendage 1.5 mm long. Stigma and style golden. *Ovary* white, glabrous, ca 2 mm long. *Capsule* obovoid, smooth, thin, rounded at the apex, 1.3–1.4 cm high and 0.9–1.05 cm wide, crowned by a purple expanded, live calyx. *Seeds* usually 3 per capsule, trigonous, rugose on outer surface, slate-grey, 8–9 mm high and 5–6 mm wide, bearing a basal white aril 3–4 mm high.

Type: Panama. Prov. Veraguas: about 20 km NW of Santa Fe, near Continental Divide, 650–800 m, 8.9. 1974, R. L. Dressler 4738 (holotype US).

Other collections: Panama. Prov. Veraguas: about 20 km NW of Santa Fe, near Continental Divide, 29.3. 1975, H. Kennedy & R. L. Dressler 3425 (F). – Costa Rica. Prov. Alajuela: 10 km N of Río Naranjo on the Caribbean slope, 450 m, 10° 45′ N, 85° 03′ W, 7.11. 1975, W. C. Burger & R. Baker 9801 (F); tall wet forest E of Río San Rafael and S of the hotsprings, W of La Marina, 500 m, 10° 23′ N, 84° 23′ W, 19.5. 1968, W. C. Burger & R. G. Stolze 5035 (F); montane wet forest 15–20 km NNW of San Ramón, along Calle Los Angeles beyond La Balsa, ca 1000 m, 19.9. 1972, H. Kennedy 1660A (MO, sterile).

Flowering during the rainy season, March to October.

This species occurs in the montane wet to cloud forest habitats in moderate shade within the forest.

This species is readily distinguished from other Costa Rican and Panamanian species of

Calathea by the strongly ridged, elliptical leaves and the closed flowers which extend well beyond the bracts at anthesis. *Calathea allenii* Woodson, which also has a plicate leaf, is easily distinguished from *C. plicata* because of the former's numerous bracts which are cleft at the apex with the two lobes overlapping, rather than entire at the apex. *Calathea plicata* is closely related to an undescribed species from the Osa Peninsula, Costa Rica (Kennedy 1601, US), which also has a closed flower and a (less strongly) plicate leaf, but differs from the latter in having pubescent, rounded or broadly obtuse bract margins. The undescribed species, on the other hand, has glabrous bract margins which are acuminate centrally, and basal leaves single or lacking.

The specific epithet is taken from the Latin *plicatus* meaning folded into pleats or furrows and referring to the strongly ridged nature of the leaf.

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References

Andersson, L. 1976: The synflorescence of the Marantaceae. Organization and descriptive terminology. *Bot. Notiser 129:* 39–48.

Eichler, A. W. 1875: *Blüthendiagramme construirt und erläutert. I.* Leipzig.

Holttum, R. E. 1951: The Marantaceae of Malaya. *Gard. Bull. Singapore 13:* 254–296.

– 1974: A commentary on comparative morphology in Zingiberaceae. *Gard. Bull. Singapore* 27: 155–165.

Schumann, K. 1902: Marantaceae. *In* A. Engler, *Das Pflanzenreich IV. 48.* Leipzig.

Thompson, J. McLean 1933: Studies in advancing sterility. VI. The theory of Scitaminean flowering. *Publ. Hartley Bot. Labor. 11:* 5–111.

Aquatic fungi of Scandinavia

Some species of Aphanomyces

T. W. Johnson, Jr.

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Aphanomyces helicoides, A. keratinophilus, A. laevis, A. scaber, A. sparrowii, and *A. stellatus* are reported for the first time from the southern Scandinavian peninsula. The circumscription of *A. sparrowii* (known previously only from a single collection) is expanded to include a description of planont discharge and a variety of antheridial branch origin types. Brief descriptive notes are given for the other species.

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Scott's (1961) authoritative treatment of the genus *Aphanomyces* did much to lift obscurity from the concepts of certain of its troublesome species. He could not, of course, foresee all future problems in species delimitation, and as a result some taxa remain puzzling entities. Moreover, as more and more representatives of the genus are recovered and examined, obvious discrepancies appear in descriptive characters (or in their interpretation), and make species identification uncertain. Johnson's (1974) account of unnamed representatives in the *A. scaber–A. stellatus* complex illustrates adequately the existence of intermediate forms that at the time defied confident identification.

The soils and waters of the southern Scandinavian Peninsula, like those of Iceland (Johnson 1974), are abundant in representatives of *Aphanomyces*. The characteristics of numerous specimens from this portion of Scandinavia, together with the forms in the Icelandic flora, now make it possible to be more precise in the identification of certain taxa. This paper treats six species of *Aphanomyces,* with particular emphasis on morphological variation. Insofar as available records indicate, none of these taxa has been previously reported from Sweden or Norway. One species, *A. astaci* Schikora, is of course already well known in Sweden, particularly through the scholarly investigations by Unestam. His 1973 paper should be consulted for the bibliography covering the various aspects of this organism in depletion of crayfish in Swedish waters.

Methods

Techniques for the collection and culture of species of *Aphanomyces* are treated by Scott (1961). Although several sources of organic matter (and naturally occurring organic debris) have been used as bait in gross cultures (Scott 1961), hempseed halves, or 5–6 mm^2 pieces of roach wing or boiled snake skin (Johnson 1974) have proven most generally useful in collecting and propagating representatives of the genus. Blonde infant hair (Sparrow 1960) is essential for the recovery of keratinophilic forms. In Sweden and Norway, specimens are found frequently (by proper gross culture methods) in pasture or farmed soils, in that from roadside ditches and hardwood forests, and in water and organic debris from lakes, streams, and intermittently wetted depressions. Representatives are much less common in acid bogs, and are seldom recovered from forest soils below the litter of conifers.

Most of the taxa in *Aphanomyces* have not been propagated in pure culture, although techniques are extant (Scott 1961, Seymour & Johnson 1973). Unifungal cultures are relatively easy to obtain, and indeed the fungi grown therein may be more accurately expressive of the characteristics of species than those specimens propagated in pure, single-spore cultures. A small portion of infested bait bearing sporulating hyphae of thalli from a gross culture are placed in a few drops of filtered, autoclaved (121°C, 15 min.) lake or pond water in the bottom of a sterile, plastic Petri dish. To this culture are added one or two small pieces of pretreated bait (such as roach wing or snakeskin). The dishes are incubated at room temperature for 2–3 days, then half-filled with sterilized lake or pond water. The fungi usually transfer readily to the additional bait by this technique. Pretreated bait is prepared by floating bits of the substratum in Petri plates on unfiltered, unsterilized lake or pond water for 2 days. The bait is then removed, washed in distilled water, and then boiled for 3–5 minutes. These bits of bait – presumably partially decomposed by bacterial action – may then be used directly in gross cultures or unifungal cultures.

Save for the keratinophilic species (which was not isolated), specimens grown in unifungal cultures in 40 ml of a sterile 1:1 mix of distilled and filtered lake water were used for identification and characterization. Cultures were incubated at 23–25°C. All measurements and observations were based on a minimum of 50 determinations in each of two wet-mount slide preparations of the species. Where applicable, the 70% median and ranges in quantitative data were recorded in compiling descriptive notes on the representatives recovered from the samples. Scott's (1961) general treatment of the development of vegetative and reproductive structures in *Aphanomyces,* and particularly his revealing notes on abnormalities to be expected, provide essential background for an understanding of the group.

Voucher specimens of the fungi from Sweden are deposited in the collections of the Institute for Systematic Botany, University of Uppsala. The Norwegian vouchers are in the Institute for Marine Biology and Limnology, University of Oslo. In the account to follow, detailed collection data are given for two species only. The remaining taxa are widespread throughout the southern Scandinavian peninsula. The herbarium numbers cited are those from my serially numbered personal collections.

Aphanomyces laevis deBary

This is the most common species (deBary 1860) in the genus, a fact reflected in the Scandinavian collections as well: 103 known sites. The species has been described and illustrated fully by Scott (1961) and others (Johnson 1974). On all the usual substrates, the oögonia (18–31 µm in diameter) are smooth. Occasionally, as the predominantly diclinous antheridial branches disintegrate, some oögonia seem to be roughened. This appearance results from adherence to the oögonium wall of the persisting antheridial cells.

As had been noted in some of the specimens from Iceland (Howard et al. 1970, Johnson 1974), a few plants from Sweden and Norway were provided very sparsely with coiling antheridial branches. This is fundamentally a character of recognition for the next species.

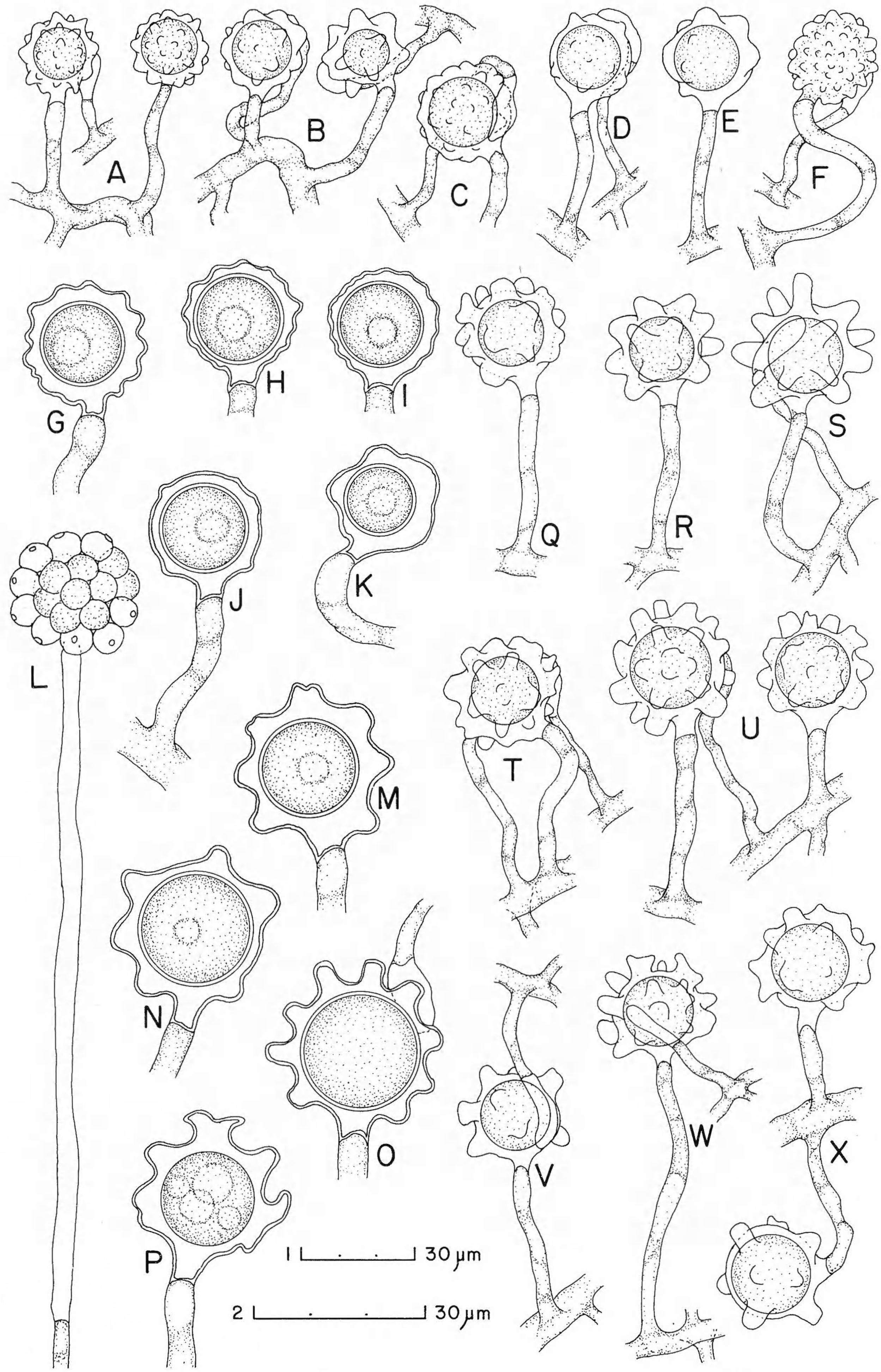
Aphanomyces helicoides von Minden

A combination of two principal structural features mark the typical expression of von Minden's (1915) species. The antheridial branches are extensively developed, and coil (sometimes very profusely and densely) about the hyphae, oögonial stalks, and oögonia. Clusters of somewhat gnarled, twisted, simple or sparingly branched, short, lateral extensions from vegetative hyphae constitute the second distinguishing feature, the hyphal knots (Cutter 1941).

Whether *Aphanomyces laevis* and *A. helicoides* are indeed separate species remains unresolved, although Scott (1961) maintained both were well-defined, valid taxa. Cutter (1941), Scott (1961), and Johnson (1974) should be consulted for illustrations of *A. helicoides.*

Collected (on hempseed) in but one locality in samples of water and organic debris expressed from mats of *Sphagnum* spp.: bog at Vadbacka (59° 50′ 10″ N, 17° 31′ 05″ E), west of Uppsala, Sweden, 3-VIII-76 (Herb. No. 13455, 13461, 13464, 13467).

Fig. 1. A–K: *Aphanomyces scaber.* – A–E: Oögonia showing variations in shape and density of ornamentations. – F: Surface view of densely papillate oögonium. – G: Papillate oögonium in optical section. – H: Irregular and papillulate oögonium in optical section. – I: Optical section of oögonium with irregular (crenate) wall. – J, K: Sparsely ornamented oögonia in optical section. – L–X: *Aphanomyces stellatus.* – L: Discharged sporangium; spore cysts are poroid. – M, N: Optical sections through oögonia; mature oöspores each containing a single, small, refractive globule. – O: Optical section through a mature oögonium with truncate and rounded tubercles, and papillae. – P: Optical section of an oögonium with broad papillae, and furcate tubercles; oöspore is immature. – Q: Broadly papillate and broadly tuberculate oögonium; one ornamentation furcate. – R: Broadly papillate oögonium. – S: Papillate and cylindro-tuberculate oögonium. – T–X: Oögonia showing common variations in shape and density of ornamentations. – Figs. G–K, M–P, scale 2; others, scale 1.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Aphanomyces keratinophilus (Ookubo & Kobayasi) Seymour & Johnson – Fig. 2 A–F

Existing collection records (Seymour & Johnson 1973) show this to be a widely distributed species, and in the southern Scandinavian peninsula it is particularly common in agricultural soils (59 collections). Originally considered to be a form of *Aphanomyces laevis,* the taxon was raised to specific rank (Seymour & Johnson 1973) on the basis of its pronounced antheridial branches and its keratinophilic habit. *Aphanomyces keratinophilus* is most often collected in Sweden and Norway on infant hair used as bait, but it occasionally appears on snakeskin bait as well.

Little can be added to the description of *Aphanomyces keratinophilus* from characterization of the Scandinavian plants. Most of the specimens had diclinous (Fig. 2 C), monoclinous (Fig. 2 E), and androgynous (Fig. 2 D) antheridial branches in about equal proportions. Monoclinous and androgynous branches predominate according to Seymour and Johnson. As is characteristic of this species, some oögonia were irregular (Fig. 2 C) or papillate (Fig. 2 D, in part); a few proliferated (Fig. 2 C).

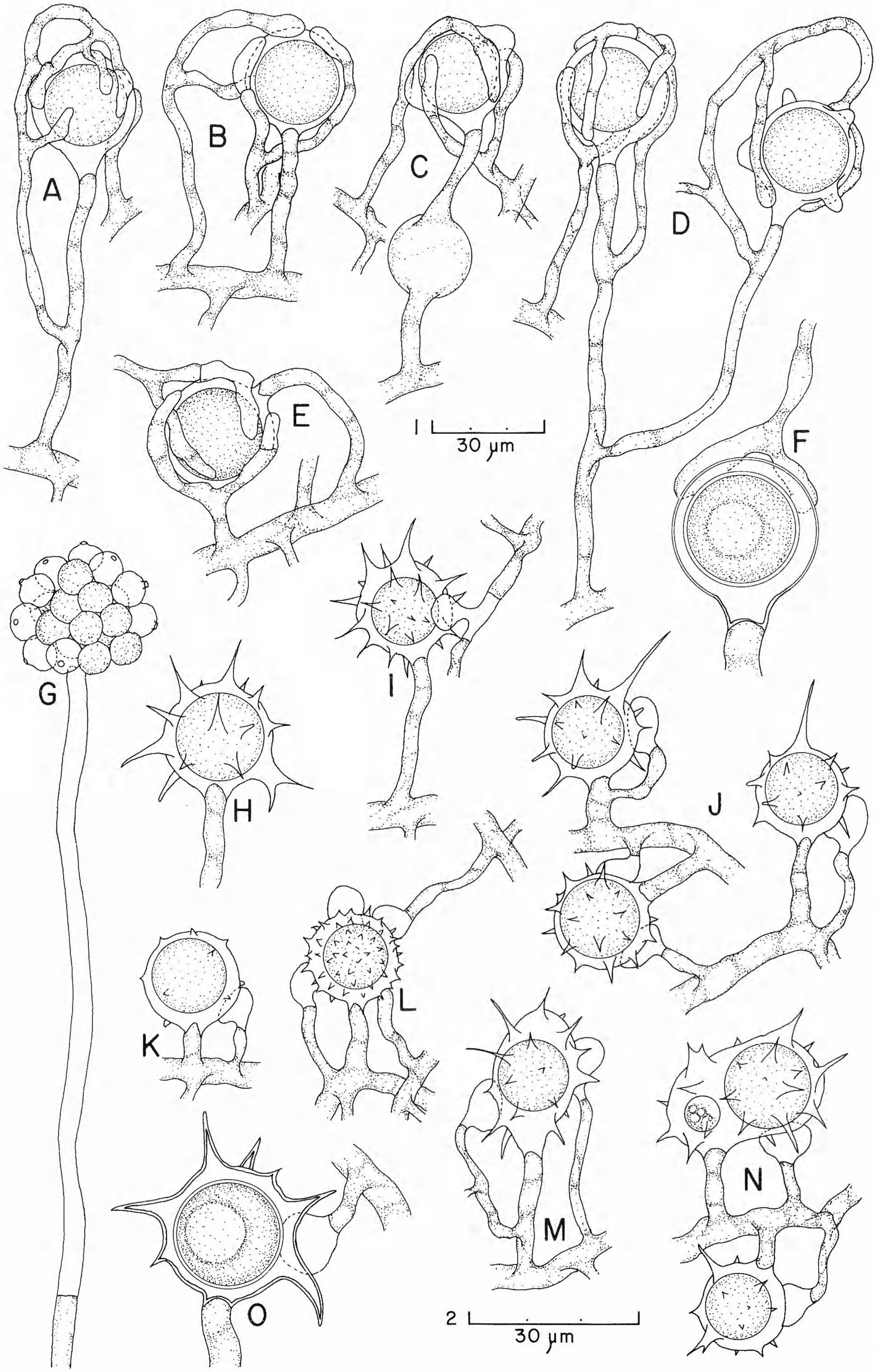
In general, the Scandinavian plants had somewhat longer oögonial stalks than is common for the species. None of the oögonia, however, was sessile as Johnson (1974) described for a variant of *Aphanomyces keratinophilus* from Iceland. Oögonium and oöspore sizes in the Scandinavian representatives were well within the ranges previously recorded (Seymour & Johnson 1973). No plants with oöspores in the size range of those described by Johnson (1974) for a second Icelandic variant of *A. keratinophilus* appeared among any of the specimens from Norway and Sweden.

Aphanomyces scaber deBary – Fig. 1 A–K

Perhaps no other species in the genus has been more difficult to define and has suffered from more widely divergent interpretation than *Aphanomyces scaber* (deBary 1860). Much of the uncertainty about the limits of this taxon seems to center in the interpretation of the shape of the oögonium wall ornamentations. In the description, deBary referred to the ornamentations as sharply pointed projections ("spitz"), but the accompanying figures (deBary 1860 pl. 20, figs. 14–16) show the vast majority of them to be rounded apically, and therefore papillate (Fig. 1 A, G) rather than spiny. Humphrey (1893) and Coker (1923) identified as *A. scaber* plants with roughened oögonial walls (crenate; see Fig. 1 I), or with papillate ones. Neither author illustrated spiny oögonia for *A. scaber.* Howard et al. (1970 fig. 9) figured one spiny oögonium in the illustrations they provided to describe, from Iceland, a plant alleged to be this species. Scott (1961 p. 53) refers to the oögonium wall ornamentations as "... sharp-pointed spines ...", and in two accompanying illustrations so depicts the oögonia. Two other illustrations provided by him (1961 pl. 7, figs. K, L) for this same species are of papillate oögonia. Although there is no way to be certain, deBary may well have misapplied the term "spitz" to his species. There can be no doubt that Humphrey (1893) used the term loosely; the spiny-walled form of *A. scaber* referred to in his text matter is illustrated as papillate.

Scott (1961) segregated out from *Aphanomyces scaber* all those forms which had been described as having roughened oögonial walls. This included, among others, one of the variants described by Humphrey (1893) and the *A. scaber* illustrated by Coker (1923). All plants

Fig. 2. A–F: *Aphanomyces keratinophilus.* – A: Oögonium with a diclinous and an androgynous antheridial branch. – B: Oögonium with a diclinous and a monoclinous antheridial branch. – C: Proliferated oögonium. – D: Branched oögonial stalk; right-hand oögonium is sparsely papillate. – E: Oögonium on a bent stalk. – F: Oögonium with mature oöspore. – G–O: *Aphanomyces sparrowii.* – G: Discharged sporangium; spore cysts are papillate. – H: Terminal oögonium. – I: Lateral oögonium with attendant diclinous, intercalary antheridial cell. – J: Cluster of oögonia showing the three types of antheridial branch origin. – K: Sparsely spiny oögonium and monoclinous antheridial branch. – L: Oögonium with small, abundant spines. – M: Ovoid oögonium with attendant androgynous and monoclinous antheridial branches. – N: Cylindrical oögonium with an aborted and a functional oöspore, and a short-stalked, spherical oögonium. – O: Oögonium with mature oöspore. – Figs. F, O, scale 2; others, scale 1.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with roughened oögonia – papillulate (Fig. 1 H) or crenate (Fig. 1 I) – were grouped by Scott into the new species *A. irregulare.* Like deBary (1860), Scott (1961) found little if any variation in the nature of the wall ornamentations. Howard et al. (1970) reported specimens from Iceland in which oögonia on the same hyphae were roughened (crenate), papillate, and spiny. This confirmed Humphrey's (1893) and Coker's (1923) conclusions regarding the identity of their material of *A. scaber,* but it must be recognized that neither of these investigators necessarily dealt with unifungal cultures in their observations. Largely on the basis of the Iceland plants, Howard et al. (1970) reduced *A. irregulare* to synonymy with deBary's *A. scaber.*

Although Johnson (1974) was aware of the earlier decision (Howard et al. 1970) to reduce *Aphanomyces irregulare,* he retained the name, and discussed the taxon in connection with Iceland specimens assigned merely to the "*A. scaber–A. irregulare–A. stellata*" (*sic*) complex. There are individuals among the numerous specimens of *Aphanomyces* from Sweden and Norway that confirm the action by Howard and his co-workers. Oögonium wall ornamentation in *A. scaber* is generally densely (Fig. 1 A, F, G) or sparsely (Fig. 1 D, J) papillate, to be sure, but there are several notable variations. The most common variant of the papillate pattern is the formation of papillulate (Fig. 1 H) or crenate (Fig. 1 I) oögonia. These, of course, are identical to the pattern in *A. irregulare.* In unifungal cultures of the Scandinavian plants 6–11 % of the oögonia were provided with some very broad and prominent papillae (Fig. 1 B, E). The primary spore cysts in both species release the secondary spores through papillae. While the antheridial branches of *A. scaber* and *A. irregulare* are predominantly diclinous, monoclinous ones are developed in the latter, and (rarely) androgynous ones in the former. In the Scandinavian material, all three types were found, although diclinous ones were more frequent. The unnamed ornamented representative of *Aphanomyces* described by Howard and Johnson (1969) may be only a small form of *A. scaber* lacking antheridial branches, but this cannot now be confirmed from living material.

Two structural characteristics seem consistently enough displayed among the many specimens at hand to be dependable taxonomically. First, the oögonium wall ornamentations of *Aphanomyces scaber* are generally small and inconspicuous, or the oögonia are crenate to papillulate. Second, the oögonia and oöspores of the species are small when compared to those of, for example, the closely allied *A. stellatus.* In the Scandinavian specimens of *A. scaber,* the oögonia are (14–)18–22(–26) µm in diameter. These sizes are similar to those given by Scott (1961) for *A. scaber* and for his *A. irregulare* as well. This further supports the view taken by Howard and his associates (1970) regarding the status of the latter.

Aphanomyces stellatus de Bary – Fig. 1 L–X

More than 80 collections of this species have been made in southern Sweden (principally in the Uppland region), and over 60 in Norway. The abundance of the species provides a generous sampling on which to base characterization and identification. As seems to have been in part the cause of difficulty in identifying the previous taxon, deBary's (1860) failure to emphasize the variations in shape of the oögonium wall ornamentations in *Aphanomyces stellatus* has led to later indecision in interpretation and identification. DeBary described the configuration of the oögonium in *A. stellatus* as stellate; the wall ornamentations were called blunt or conical.

In the Scandinavian plants, the oögonial wall ornamentations were commonly variable in shape even on the same oögonium (Fig. 1 T, V–X), but almost always are stout and prominent. More than half of the oögonia in most cultures possessed cylindro-tuberculate ornamentations (Fig. 1 S), or distinctly truncate tubercles (Fig. 1 O). About 40 % of the oögonia were marked by broadly papillate extensions of the wall (Fig. 1 N, R), and often oögonia displayed both papillate and broadly tuberculate ornamentations (Fig. 1 U, V). Some prominent, furcate or "indented" tubercles (Fig. 1 P, Q, W, X) were present on about 20 % of the oögonia in specimens from most of the collections. There is no doubt that deBary (1860 pl. 19, figs. 11–13) saw such variations in the ornamentations on the oögonia of his plants.

DeBary (1860) did not illustrate any oil deposition arrangement in the oöspores of *Aphanomyces stellatus.* Coker (1923 p. 164) thought the oöspores to be "...eccentric... with an inconspicuous lunate series of droplets on one side ...", but he did not illustrate this disposition of oil reserve. According to Scott (1961), *A. stellatus* lacks a conspicuous oil droplet in the oöspores. In the Scandinavian plants at hand, some oöspores each had a small, centric or eccentric oil globule (Fig. 1 M, N), but others (Fig. 1 O) were devoid of a visible oil deposit. The Icelandic plants which Johnson (1974 figs. 38–46) identified positively as *A. stellatus* had oöspores with an oil droplet (as is characteristic of most species in the genus). In this feature, at least, *A. stellatus* seems quite variable.

An occasional oögonium in unifungal cultures of *Aphanomyces stellatus* developed only a few broad, low papillae, and thus resembled some oögonia produced by *A. scaber* (Fig. 1 B). In *A. stellatus,* however, the oögonia (and oöspores) are generally noticeably larger than in *A. scaber*. The oögonia in the Scandinavian specimens were (21–)26–29(–34) μm in diameter (inclusive of the wall ornamentations), and the oöspores were (14–)21–24(–28) μm in diameter.

Earlier, Johnson (1974) described but did not name a number of ornamented species of *Aphanomyces* from Iceland. Comparing specimens of these plants with those from Sweden and Norway I can now identify with certainty some of the Icelandic specimens. Isolates 2892, and the plants illustrated by me (1974) in figures 60–68 as *A. scaber* were in reality *A. stellatus*. *Aphanomyces irregulare,* depicted in my paper as figures 53–59 is properly to be identified as *A. scaber,* as are the plants shown in figures 47–52 and 64–68 in the same publication.

Aphanomyces sparrowii Cutter – Fig. 2 G–O

Sparrow (1930) first observed this fungus in the internodal cells of a collection of *Nitella* sp. from New York. He identified it as *Aphanomyces phycophilus* deBary (1860), but later (1933 p. 532) noted that the fungus was too small and delicate, and the ornamentations too spine-like "... to be identical with *A. phycophilus.*" Cutter (1941), reexamining Sparrow's material (preserved?), agreed, and named the plants from New York *A. sparrowii.*

Aphanomyces sparrowii has been found but a single time in Scandinavia: on cellophane, in soil from stream bank at crossing of Route 154 over south end of Langen (59°43′25″ N, 11°00′30″ E), Norway, 25-VIII-75 (Herb. No. 12922 B). This is the first report of the recovery of living material of this species since its discovery by Sparrow in 1929.

The characteristics of the Norwegian plants varied somewhat from those of specimens in the only other known collection (Sparrow 1930). Generally, the oögonia had many large, sharp spines that were sometimes curved or furcate (Fig. 2 H, I, O), but in 6% of the cases, the spines were very short (Fig. 2 L), and in some instances sparse as well (Fig. 2 K). In exceptional cases (Fig. 2 J), the spines were 20–26 μm long; in the type material, 14 μm was the maximum length reported. Only diclinous antheridial branches were noted by Cutter in the specimens he examined. The specimens from Norway had androgynous (Fig. 2 J, M, in part) and monoclinous (Fig. 2 K, L, N) ones as well. There were minor variations between the type and the Norwegian plants in such features as oögonium shape and sporangium length. Oögonium size and oöspore diameter in the plants on cellophane were remarkably like those recorded (Cutter 1941) for the species.

An expanded description of *Aphanomyces sparrowii,* reflecting the variations exhibited by the Norwegian specimens, follows. The pattern of spore discharge behavior is described here for the first time.

Hyphae hyaline, intramatrical or extramatrical, sparingly branched. Sporangia filamentous, unbranched, 3.5–11 μm in diameter, up to 210 μm long; sometimes tapering imperceptibly toward the apex. Primary planonts formed in a single row in the sporangium; elongate at discharge, and usually connected to one another by a slender, cytoplasmic strand; emerging apically from the sporangium, rounding up immediately, and clustering in a loose ball at the orifice; each secondary planont emerging from a cyst through a small papilla, and swimming away at once as a laterally biflagellate cell; primary planont cysts 7–10 μm in diameter. Oögonia lateral or terminal; generally spherical, infrequently ovoid or cylindrical; wall thin, hyaline, unpitted, densely or sparsely ornamented with straight, curved, or furcate, short or long spines, these reaching a length of 26 μm; stalks slightly irregular or straight, of varying lengths, but generally (70% median) as long as the diameter of the oögonium, and up to three times longer than the diameter; (16–)21–24(–28) μm in diameter, exclusive of the ornamentations. Antheridial branches usually present, 1–3 attendant to the oögonia; simple or sparingly branched, often short; predominantly diclinous, occasionally (20%) androgynous or monoclinous; antheridial cells clavate to bell-shaped, applied terminally or laterally; fertilization tubes not observed. Oöspore single, but a second, small, aborted one occurring in a few oögonia; pale yellowish to pale golden yellow, containing a single, spherical, centric or subcentric, conspicuous oil globule; (14–)19–22(–26) μm in diameter; germination not observed.

Aphanomyces sparrowii superficially resembles *A. phycophilus* deBary, and Wille's (1899) *A. norvegicus* (originally described from Norway, this species has not again been found in the Scandinavian peninsula). While the oögonia of all three species are usually densely ornamented, the projections in *A. phycophilus* and *A. norvegicus* are short, conical, and rounded at the apex (papillate). Wille's and deBary's species are known only from infested algae, but as the Norway collection of *A. sparrowii* shows, substratum may be of little consequence taxonomically. The specimens described briefly from Iceland (Howard et al. 1970) under the name *A. norvegicus* certainly differ prominently from *A. sparrowii* as this species is represented in the single collection at hand.

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References

Bary, A. de 1860: Einige neue Saprolegnieen. *Jahrb. Wiss. Bot. 2:* 169–192.

Coker, W. C. 1923: *The Saprolegniaceae, with notes on other water molds.* North Carolina.

Cutter, V. M., Jr. 1941: Observations on certain species of Aphanomyces. *Mycologia 33:* 220–240.

Howard, K. L. & Johnson, T. W., Jr. 1969: Aquatic fungi of Iceland: some filamentous, eucarpic, and holocarpic species. *Mycologia 61:* 496–510.

– Seymour, R. & Johnson, T. W., Jr. 1970: Aquatic fungi of Iceland: Saprolegniaceae. *J. Elisha Mitchell Sci. Soc. 86:* 63–79.

Humphrey, J. E. 1893: The Saprolegniaceae of the United States, with notes on other species. *Trans. Amer. Phil. Soc., N.S. 17 (3):* 63–148.

Johnson, T. W., Jr. 1974: Aquatic fungi of Iceland: biflagellate species. *Acta Nat. Isl. No. 23.* Reykjavik.

Minden, M. von 1915: Phycomycetes. IV. Reihe: Saprolegniineae. *Kryptogam-Fl. Mark Brandenburg 5:* 476–606.

Scott, W. W. 1961: A monograph of the genus Aphanomyces. *Virginia Agr. Exp. Station Tech. Bull. No. 151.* Virginia.

Seymour, R. L. & Johnson, T. W., Jr. 1973: Saprolegniaceae: a keratinophilic Aphanomyces from soil. *Mycologia 65:* 1312–1318.

Sparrow, F. K., Jr. 1930: The non-sexual stage of Aphanomyces phycophilus. *Mycologia 22:* 118–121.

– 1933: Inoperculate chytridiaceous organisms collected in the vicinity of Ithaca, N.Y., with notes on other aquatic fungi. *Mycologia 25:* 513–535.

– 1960: *Aquatic Phycomycetes. 2 ed.* Michigan.

Unestam, T. 1973: Fungal diseases of Crustacea. *Rev. Med. Veter. Mycol. 8:* 1–20 (separate pagination).

Wille, N. 1899: Om nogle vandsoppe. *Vidensk. Selsk. Skr. Christiana (Mat.-Nat. Kl.) 1899 (3):* 1–14.

A new Tribulus (Zygophyllaceae) from India

M. M. Bhandari and V. S. Sharma

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Tribulus rajasthanensis Bhandari & Sharma sp. nov. is described from the NW Rajasthan desert in India.

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Tribulus rajasthanensis Bhandari & Sharma sp. nov. – Fig. 1

Tribuli terrestris valde affinis, attamen ab hac specie facile distinguendus coccis constanter magis dense hirsutis, spinis secundariis prominentibus firmioribus magis frequentibus et spinarum pari inferiore toto carenti.

Herba perennis vel raro annua, diffuse prostrata vel subascendens. Caules multi e rhizomate sublignoso orti, usque ad 30 cm longi, dense pubescentes atque eodem modo sparse hirsuti glabrescentes striati. *Folia* 2–5 cm longa, opposita vel in parte inferiore interdum alterna, ad nodos semper inaequalia, maiora paribus foliolorum 7, minora paribus foliolorum usque ad 5. *Foliola* 6–10×4–5 mm, obscure petiolulata, obliqua, oblongo-ovata vel lanceolato-ovata, acuta vel subobtusa, saepe mucronulata, subtus dense sericea vel villosa, supra sparse pubescentia vel glabrata. *Stipulae* 6–7×1.5–3 mm, subulatae, plerumque falcatae persistentes. *Flores* 1.5 vel 1.6 cm diam., laete lutei. *Pedunculus* 1–2 cm longus, saepe quam folium sustentum longior vel eo aequilongus, dense pubescens. *Sepala* 6–7×1.5–2.5 mm, lineari-lanceolata acuta, marginibus scariosis, extus villosa, intus in parte superiore minute pubescentia. *Petala* 6–8 × 4–5 mm, late obovato-cuneata, apice subtruncato-rotundata. *Stamina* 8–10, filamentis 3–4 mm longis, antheris 1.5–1.7 mm longis ovato-oblongis subaequalibus, base tuberculato-inflatis. *Stylus* usque ad 3 mm longus, elongatus cylindricus. *Stigma* pyramidale, saepe asymmetricum. *Glandulae intrastaminales* non connatae, late triangulares vel varie lobatae. *Glandulae extrastaminales* ca. 1 mm longae, rotundae, truncatae vel subemarginatae, quam instrastaminales crassiores. *Fructus* 5-coccus, ad maturitatem 1.2–1.4 cm latus; cocci 6–7 × 5–6 mm, constanter dense hispidi, coccis singulatim spinis duabus divergentibus 5–6 mm longis ad partem mediam insertis munitis praeterea spinis alteris 20–25, inaequalibus minoribus vel secundariis, dorse et cristatim dispositis et dispersis, atque saepe ad dimidiam longitudinis spinarum principalium attingentibus, spinis singulatim setis tuberculatis comparate multo longioribus terminatis. Numerus chromosomatum n = 6.

Closely allied to *Tribulus terrestris* L. but easily distinguished by its constantly much more densely hirsute cocci, having much more pronounced and stouter secondary spines, and complete absence of lower pair of spines.

Perennial or rarely annual, diffusely prostrate or somewhat ascending herb. *Stems* many from a somewhat woody rootstock, up to 3 dm long, densely pubescent and sparingly hirsute, glabrescent, striate. *Leaves* 2–5 cm long, opposite or sometimes alternate in the lower region, always unequal at the node, the larger with up to 7 pairs of leaflets, the smaller with up to 5 pairs of leaflets. *Leaflets* 6–10 × 4–5 mm, indistinctly petiolulate, oblique, oblong-ovate or lanceolate-ovate, acute or subobtuse, often mucronulate, densely silky-pubescent or villous beneath, sparingly pubescent or glabrate on the upper surface. *Stipules* 6–7 × 1.5–3 mm, subulate, usually falcate, persistent. *Flowers* 1.5–1.6 cm across, bright yellow. *Peduncle* 1–2 cm long, usually shorter than or as long as the subtending leaf, densely pubescent. *Sepals* 6–7 × 1.5–2.5 mm, linear-lanceolate, acute,

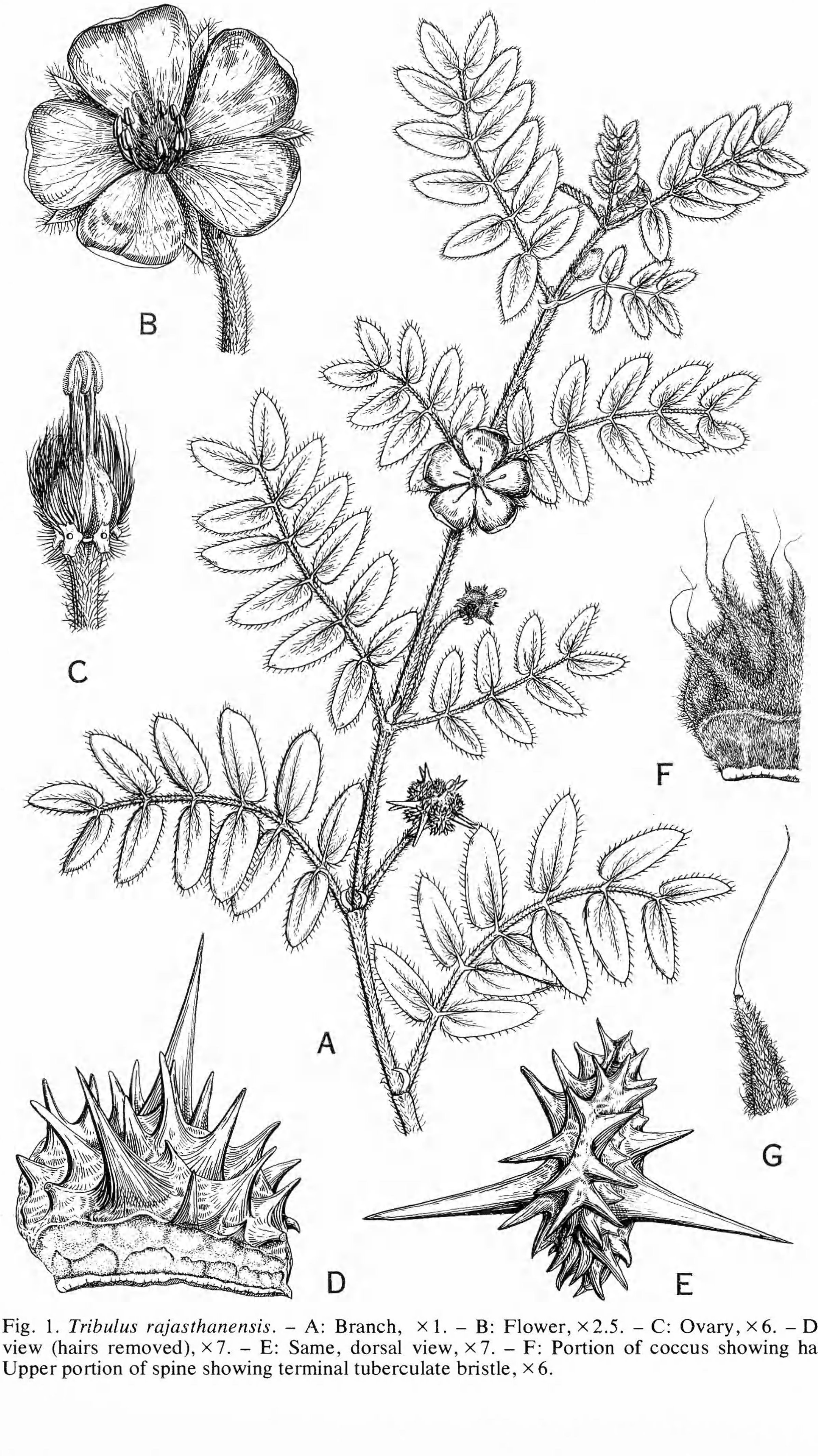

Fig. 1. *Tribulus rajasthanensis.* – A: Branch, ×1. – B: Flower, ×2.5. – C: Ovary, ×6. – D: Coccus, lateral view (hairs removed), ×7. – E: Same, dorsal view, ×7. – F: Portion of coccus showing hairiness, ×7. – G: Upper portion of spine showing terminal tuberculate bristle, ×6.

margins scarious, villous outside, minutely pubescent inside in upper half. *Petals* 6–8 × 4–5 mm, broadly obovate-cuneate, with somewhat truncate apex. *Stamens* 8–10; filaments 3–4 mm long; anthers 1.5–1.7 mm long, ovate-oblong, subequal. *Ovary* with bulbous-based bristly hairs directed upwards. *Style* up to 3 mm long, elongate, cylindrical. *Stigma* pyramidal, often asymmetric. *Interstaminal glands* not connate, broadly triangular or variously lobed. *Extrastaminal glands* c. 1 mm long, round, truncate or somewhat emarginate, thicker than the interstaminal glands. *Fruit* breaking up into 5 cocci, 1.2–1.4 cm wide at maturity (excl. two main spines); *cocci* 6–7 × 5–6 mm, invariably densely hispid, each with two, 5–6 mm long, divergent spines inserted almost centrally, and with 20–25 unequal, smaller (secondary) ones, crested as well as dispersed at the back and often reaching half the length of the main spines; every spine terminated by a tuberculate bristle much longer than the spine itself.

Collections. India, Rajasthan. Jodhpur distr., common on the rocky plateau of Massuria, 3.10. 1959, Bhandari 537 (CAL holotype, K, JAC, CAL, LWG); 10.8. 1959, Bhandari 12 (JAC); 29.3. 1955, Tandon 337 (JAC) – Jaisalmer distr., on rocks N Jaisalmer, 22.8. 1961, Bhandari 985 (JAC); 1.12. 1955, Vasvani s.n. (JAC) – Ajmer distr., Beawar-Jodhpur road, near Sendra, on gravelly ground, 13.9. 1960, Sharma 1618 (LWG).

Chromosome number. *Tribulus rajasthanensis* has n = 6 (voucher: Kailana on rocks, Jodhpur, Bhandari 35, JAC). In other Indian representatives of the *Tribulus terrestris* complex n = 6 as well as 12, 18 and 24 has been found.

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The main subdivisions of Leguminosae

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On the basis of seed morphology, distribution of alkaloids, flavonoids and canavanine and susceptibility to *Uromyces* rusts, De Candolle's classification of the Leguminosae into two major groups (Rectembriae and Curvembriae) seems superior to the more familiar recognition of the three subfamilies Mimosoideae, Caesalpinioideae and Papilionoideae. De Candolle's association of the Swartzieae with the Papilionoideae is more in line with flavonoid distribution than their currently accepted position in the Caesalpinioideae.

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The earliest comprehensive taxonomic treatment of the Leguminosae is that of De Candolle (1825), who arranged this vast array of plants into two "suborders" with a number of subordinate taxa:

Suborder I. Curvembriae (embryo axis curved)
  1. Papilionaceae (sepals free, stamens perigynous, corolla papilionate)
    a. Phyllolobae (cotyledons thin and leafy), 3 tribes, 7 subtribes
    b. Sarcolobae (cotyledons fleshy), 3 tribes
  2. Swartzieae (calyx inflated with indistinct lobes, stamens hypogynous, corolla 0–2), 1 tribe
Suborder II. Rectembriae (embryo axis straight)
  1. Mimoseae (sepals and petals valvate, stamens hypogynous), 1 tribe
  2. Caesalpineae (petals imbricate, stamens perigynous), 3 tribes

This arrangement was accepted only by Loudon (1841), and was followed by the system of Bentham & Hooker (1862), in which the Leguminosae are divided into three "suborders":

Suborder I. Papilionaceae (calyx gamosepalous; posterior petal outermost; radicle inflexed or curved, rarely short and straight), 11 tribes
Suborder II. Caesalpinieae (calyx free, rarely gamosepalous; petals imbricate, posterior innermost; radicle straight, rarely slightly oblique; stamens usually free), 7 tribes
Suborder III. Mimoseae (flowers regular, small; calyx gamosepalous or free, valvate; petals valvate, usually connate at base; stamens free or monadelphous), 5 tribes

Bentham & Hooker kept De Candolle's Swartzieae as one of the 11 tribes constituting their Papilionaceae. The system of Bentham & Hooker was later modified by Taubert (1891), who treated their "suborders" as subfamilies and moved the Swartzieae to the Caesalpinioideae.

The subdivision of Leguminosae into three subfamilies has received universal acceptance, although some authors (e.g. Jones 1955, Hutchinson 1964, Dahlgren 1975) went so far as to promote the Leguminosae to an order (Fabales or Leguminales) with three families (Mimosaceae, Caesalpiniaceae and Papilionaceae or Fabaceae). This represents only a hierarchical adjustment without any improvement in diagnoses or circumscription of the three groups.

We have set out to study the taxonomic subdivision of Leguminosae in the light of seed morphology, chemistry and susceptibility to rusts. These characters have been selected because they have been studied in so many

Table 1. The distribution of 7 characters from seed morphology within the Leguminosae.

Mimosoideae and Caesalpinioideae	Papilionoideae
Ovules anatropous	Ovules campylotropous
Seeds symmetrical, chalaza and hilum at opposite ends	Seeds asymmetrical, raphe shorter than antiraphe
Hilum small, rounded, with a median grove	Hilum relatively large, elongate, sometimes without median grove
Cotyledons cordate at base	Cotyledons ovate–elliptical, never cordate
Radicle and embryo axis short and straight	Radicle and embryo axis elongate and curved or in a short spiral
Funicle long, sometimes spirally twisted	Funicle short, never spirally twisted
One vascular bundle recurrent in the subhilar tissue of the median line around the seed	Two recurrent vascular bundles in the subhilar tissue of the median line around the seed

genera and species that it should be possible to make generalizations of the taxonomic conclusions that might accrue from the analysis.

Seed morphology

Table 1 shows strong correlation among characters from seed morphology recorded by Corner (1951) and Isely (1955). The distinction between two main groups of leguminous plants comes out clearly: one group covers the Mimosoideae and Caesalpinioideae, the other is equivalent to the Papilionoideae. The two groups coincide with De Candolle's two "suborders" Rectembriae and Curvembriae respectively. The currently accepted classification into three subfamilies does not so well reflect the known facts about seed morphology.

The alkaloid pattern

According to the reviews by Mears and Mabry (1971) and Gibbs (1974), there are some 260 alkaloid compounds distributed in about 400 species from 67 leguminous genera. On the basis of their chemical structure, these compounds have been classified by Mears and Mabry into 19 groups, 4 of which include highly infrequent substances. The distribution of the remaining 15 groups among the genera and species of the three traditional subfamilies of Leguminosae is given in Table 2.

Of the three subfamilies, the Papilionoideae is richest in alkaloids, both in terms of number of compounds and number of species producing them. This is especially evident in the case of tertiary and quaternary quinolizidine derivatives, where hardly any of the papilionaceous species examined so far is lacking in them. Moreover, of the 15 groups of alkaloids represented in Table 2, 11 are totally confined to members of the Papilionoideae, whereas three of the remaining four can be encountered in all three subfamilies with a notable concentration of phenylalanine- and tyrosine-derived alkaloids in the Mimosoideae. The taxonomic implication of this biased distribution of alkaloids in Leguminosae is that the Mimosoideae and Caesalpinioideae ought to come closer to each other than either of them to the Papilionoideae. This is further support to De Candolle's idea of recognizing only two main groups of leguminous plants.

Canavanine

The Leguminosae are unique among angiosperms in possessing the free non-protein amino acid canavanine in their seeds (92 families tested; Turner & Harborne 1967). Furthermore, of the 10 species (representing 7 genera) of Mimosoideae and the 26 species (from 17 genera) of Caesalpinioideae examined none contains canavanine. By contrast, nearly 550 species from 127 genera of the Papilionoideae have been tested for the occurrence of this acid and no less than 271 species (i.e. c. 50%) representing 54 genera reacted positively (Alston & Turner

Table 2. The distribution of 15 groups of alkaloids among the genera (g) and species (spp) of the three subfamilies of Leguminosae. M Mimosoideae, C Caesalpinioideae, P Papilionoideae.

Groups of alkaloids	Number of compounds	Subfamilies					
		M		C		P	
		g	spp	g	spp	g	spp
Binary quinolizidine	6	0	0	0	0	7	36
Tertiary quinolizidine	9	0	0	0	0	19	125
Quaternary quinolizidine	36	0	0	0	0	22	183
Matrine (quinolizidine)	7	0	0	0	0	4	15
Quinternary quinolizidine	9	0	0	0	0	2	10
Unknown quinolizidine	18	0	0	0	0	9	21
Pyrrolizidine *(Crotalaria)*	53	0	0	0	0	3	43
Physostigma	7	0	0	0	0	2	7
Erythrina	14	0	0	0	0	1	31
Ammodendrine-hysterine	5	0	0	0	0	2	11
Alkylamine and related compounds	15	0	0	0	0	18	21
Erythrophleum	9	0	0	1	4	0	0
Phenylalanine and tyrosine-derived	12	3	34	2	2	8	12
Bicyclic tryptophane-derived	15	4	17	2	2	8	35
Tricyclic tryptophane-derived	3	1	1	1	1	1	1
Total number of taxa screened		7	47	5	11	55	336

1963, Bell 1958, 1962, 1966, 1971, Bell & Fowden 1964, Bell & Tirimanna 1965, Turner & Harborne 1967).

Although canavanine has been found in the seeds of only 50% of the species examined from the Papilionoideae, its total absence in the other two subfamilies suggests a higher degree of taxonomic affinity between them than between either of them and the Papilionoideae.

Flavonoids

The results of extensive surveys to date (Bate-Smith 1962, Harborne 1967, 1971, Gibbs 1974) show that every species of the Leguminosae contains flavonoids of some kind. They also brought to light some further taxonomically important facts:

(1) The three common flavonols myricetin, quercetin and kaempferol are almost exclusively confined to the predominantly arborescent Mimosoideae and Caesalpinioideae, with only a rare occurrence in the Papilionoideae.

(2) The natural tannins of the leucoanthocyanidin group (which are essential to the leather industry) are nearly universal in both the Mimosoideae and Caesalpinioideae, and have as yet been identified in only a few woody species of Papilionoideae.

(3) The two common flavones luteolin and apigenin are strictly confined to the Papilionoideae.

(4) Some 55 different compounds of the isoflavonoid group occur characteristically in the Papilionoideae. They have been found in species from 9 of the 10 tribes constituting this subfamily, and it is felt (Harborne 1967) that more intensive search might well reveal their presence in the remaining tribe (Loteae).

Isoflavonoids have also been found in the heartwood of *Swartzia madagascariensis*, *Cordyla africana* (both from the tribe Swartzieae) and *Amphimas pterocarpoides* which have often been grouped with the Caesalpinioideae. These are the only reports of isoflavonoids in leguminous plants other than Papilionoideae. However, these genera were associated with the Papilionoideae by De Candolle (1825) as well as Bentham & Hooker (1862) and Hutchinson (1964).

Rust susceptibility

Leguminous plants have for long been known as suitable hosts to numerous species and physiological races of *Uromyces* Link, but this seems to be the first attempt to apply rust susceptibility data in the taxonomy of the Leguminosae. We collected all the records of *Uromyces* species on leguminous plants made by Ahmed (1956), Arthur (1929), de Bary & Rehm (1884), Erickson (1930), Gäumann (1959), Oudemans (1919–20), Saccardo (1888–1905) and Wilson & Henderson (1966) from all parts of the world. It appeared that several hundred leguminous species from 65 genera are susceptible to 138 *Uromyces* species. The susceptible genera are the following:

Mimosoideae (3 genera): *Acacia, Inga, Prosopis.*

Caesalpinioideae (1 genus): *Bauhinia.*

Papilionoideae (61 genera): *Anagyris, Anthyllis, Arachis, Aspalathus, Astragalus, Bolusia, Bonaveria, Cajanus, Camptosema, Caragana, Cicer, Cladrastis, Clitoria, Colutea, Coronilla, Crotalaria, Cytisus, Desmodium, Dolichos, Dorycnopsis, Ervum, Galega, Genista, Glycyrrhiza, Gueldenstaedtia, Hedysarum, Hippocrepis, Hymenocarpus, Indigofera, Inocarpus, Laburnum, Lathyrus, Lens, Lespedeza, Lotus, Lupinus, Medicago, Melilotus, Mucuna, Neurocarpum, Onobrychis, Ononis, Ornithopus, Oxytropis, Phaca, Phaseolus, Pisum, Pseudarthria, Psophocarpus, Psoralea, Ptelea, Sarothamnus, Sophora, Spartium, Tetragonolobus, Trifolium, Trigonella, Ulex, Vicia, Vigna.*

It appears that, in terms of number of genera, the Papilionoideae are far more susceptible to *Uromyces* rusts than the Mimosoideae and Caesalpinioideae, which together contribute only 4 of the 65 susceptible genera.

It has not been possible to count exactly the number of susceptible species since many records are made only in terms of genera. Nevertheless, while only a few species from the Mimosoideae and Caesalpinioideae are on record as yielding to rust attacks, about 60 *Trifolium* species, 50 *Vicia* species, 30 *Phaseolus* species and 20 *Lathyrus* species (making a total of 160 species from only 4 of the 61 papilionoid genera in the list) are known to harbour these parasites.

Of the 138 *Uromyces* species afflicting the Leguminosae, only 13 species infect members of the Mimosoideae and Caesalpinioideae. The remaining 125 rust species have been encountered on members of the Papilionoideae only.

Again, the results indicate a major distinction between the Mimosoideae and Caesalpinioideae as one group and the Papilionoideae as another.

Discussion

The observations on seed morphology, distribution of alkaloids, canavanine, flavonoids and susceptibility to *Uromyces* rusts point collectively to the recognition of only two major groups within the Leguminosae:

Group A (Mimosoideae and Caesalpinioideae) is defined by a combination of anatropous ovules, cordate cotyledons, straight radicle and embryo axis, long funicle which may be spirally twisted, one vascular bundle in the subhilar tissue of the seed coat, total lack of quinolizidine, pyrrolizidine and alkylamine alkaloids, absence of canavanine, a high yield of flavonols (myricetin, quercetin, kaempferol) and tannins of the leucoanthocyanidin type, and a meagre record of susceptibility to *Uromyces* species.

Group B (Papilionoideae, including the Swartzieae) is characterized by campylotropous ovules, ovate–elliptical cotyledons, curved or spiral radicle and embryo axis, short funicle, two vascular bundles in the subhilar tissue of the seed coat, a high content of alkaloids (especially quinolizidine, pyrrolizidine and alkylamine derivatives), the presence of canavanine, the rich production of flavones (luteolin and apigenin) and a wide range of isoflavonoids, and a vast record of rust susceptibility.

Groups A and B are comparable with De Candolle's two "suborders" Rectembriae and Curvembriae respectively, and to this extent his classification of the Leguminosae is superior to all subsequent treatments which substituted these two major groups by three groups of equal hierarchical status. However, the six clearly papilionaceous genera *Arachis, Voandzeia, Brongniartia* (including *Peraltea*), *Andira, Geoffroea* and *Dipteryx* constituting the tribe Geoffreae in De Candolle's Caesalpineae should be moved to the Papilionoideae. *Brownea* is the only genus in this tribe that should be left in the Caesalpinioideae. This minor modification will make De Candolle's system fully compatible with the results presented here.

References

Ahmed, S. 1956: Uredinales of West Pakistan. *Biologia 2:* 26–101.

Alston, R. E. & Turner, B. L. 1963: *Biochemical systematics*. New Jersey.

Arthur, J. C. 1929: *The plant rusts (Uredinales)*. New York.

Bate-Smith, E. C. 1962: The phenolic constituents of plants and their taxonomic significance. I. Dicotyledons. *J. Linn. Soc. (Bot.) 58:* 95–173.

Bell, E. A. 1958: Canavanine and related compounds in the Leguminosae. *Biochem. J. 70:* 617–619.

– 1962: Associations of ninhydrin-reacting compounds in the seeds of 49 species of Lathyrus. *Biochem. J. 83:* 225–229.

– 1966: Amino acids and related compounds. *In* T. Swain (ed.), *Comparative phytochemistry*. London and New York.

– 1971: Comparative biochemistry of non-protein amino acids. *In* J. B. Harborne, D. Boulter & B. L. Turner (eds.), *Chemotaxonomy of the Leguminosae*. London and New York.

– & Fowden, L. 1964: Studies on amino acid distribution and their possible value in plant classification. *In* C. A. Leone (ed.), *Taxonomic biochemistry and serology*. New York.

– & Tirimanna, A. S. L. 1965: Associations of amino acids and related compounds in the seeds of forty-seven species of Vicia: their taxonomic and nutritional significance. *Biochem. J. 97:* 104–111.

Bentham, G. & Hooker, J. D. 1862: *Genera Plantarum I*. London.

Corner, E. G. H. 1951: The leguminous seeds. *Phytomorph. 1:* 117–150.

Dahlgren, R. 1975: *Angiospermernes taxonomi 3*. Copenhagen.

de Bary, A. & Rehm, H. 1884: Die Pilze. *In* Rabenhorst's *Kryptogamenflora von Deutschland, Oesterrich und der Schweiz I*. Leipzig.

De Candolle, A. P. 1825: *Prodromus Systematis Regni Vegetabilis II*. Paris.

Erickson, J. 1930: *Fungous diseases of plants*. London.

Gäumann, E. 1959: Die Rostpilze Mitteleuropas. *Beitr. KryptoFlora Schweiz XII*. Bern.

Gibbs, R. D. 1974: *Chemotaxonomy of flowering plants*. Montreal and London.

Harborne, J. B. 1967: *Comparative biochemistry of the flavonoids*. London and New York.

– 1971: Distribution of flavonoids in the Leguminosae. *In* J. B. Harborne, D. Boulter & B. L. Turner (eds.), *Chemotaxonomy of the Leguminosae*. London & New York.

Hutchinson, J. 1964: *The genera of flowering plants 1*. Oxford.

Isely, D. 1955: Observations on seeds of the Leguminosae: Mimosoideae and Caesalpinioideae. *Proc. Iowa Acad. Sci. 62:* 142–149.

Jones, G. N. 1955: Leguminales: a new ordinal name. *Taxon 4:* 188–189.

Loudon, J. C. 1841: *An encyclopaedia of plants*. London.

Mears, J. A. & Mabry, T. J. 1971: Alkaloids in the Leguminosae. *In* J. B. Harborne, D. Boulter & B. L. Turner (eds.), *Chemotaxonomy of the Leguminosae*. London and New York.

Oudemans, C. A. J. A. 1919–20: *Enumeratio Systematico Fungorum*. La Hague.

Saccardo, P. A. 1888–1905: *Sylloge Fungorum, 7, 9, 11, 14, 16, 17*. Johnson Reprint Corp., New York.

Taubert, P. 1891: Leguminosae. *In* A. Engler & K. Prantl (eds.), *Die natürlichen Pflanzenfamilien, III, 2*. Leipzig.

Turner, B. L. & Harborne, J. B. 1967: Distribution of canavanine in the plant kingdom. *Phytochem. 6:* 863–866.

Wilson, M. & Henderson, D. M. 1966: *British rust fungi*. Cambridge.

New taxa and names in Psychotria (Rubiaceae) in Sri Lanka

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Sohmer, S. H. 1977 01 28: New taxa and names in Psychotria (Rubiaceae) in Sri Lanka. *Bot. Notiser 129:* 377–381. Stockholm. ISSN 0006-8195.

Psychotria gardneri (Thwaites) Hooker f. var. *jayasuriyae* Sohmer and *P. zeylanica* Sohmer are described as new. *Psychotria waasii* Sohmer and *P. fosbergii* Sohmer are given as new names for the species previously known as *P. filipes* (Thwaites) Hooker f. and *P. elongata* (Wight) Hooker f., respectively, which are later homonyms.

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While revising *Psychotria* in Sri Lanka for the Flora of Ceylon Project, sponsored jointly by the University of Ceylon, Peradeniya, Department of Agriculture, Peradeniya and the Smithsonian Institution, Washington, the following additions and changes for the genus were found to be required.

Psychotria gardneri (Thwaites) Hooker f. var. **jayasuriyae** Sohmer var. nov.

Arbor parva vel frutex ad 3 m altus, petiolis foliorum 0.1–1.5 cm longis, laminis foliorum obovatis vel ellipticis coriaceis 0.8×2 to 3×6 cm latis longisque, basibus acutis, apicibus acutis vel acuminatis, nervis lateralibus 4–7 paribus, in axillis saepe foveis conspicuis instructis, inflorescentia 2.5–5.5 cm longa, ramis verticillatis, corolla tubo apicem versus dilatato fauci non hirsuto, fructu globoso 5–7 mm longo, pyrenis asulcatis endospermio ruminato. A var. *gardneri* foliis parvioribus, inflorescentia parviore, et corolla tubo fauci non hirsuto distinguenda.

Type: Sri Lanka, Nuwara Eliya Dist.: Diyagama Tea Estate Road to Horton Plains, 27 Oct. 1975, Sohmer & Sumithraarachchi 9986 (US holotypus! BISH, F, GH, K, MO, NY, P, PDA, UWL, W isotypi!).

Small tree or shrub to 3 m. *Leaves* with narrow, ovate, caducous stipules 2–5 mm long, with petioles 0.1–1.5 cm long and with obovate, elliptic, retuse, coriaceous blades 0.8×2 to 3×6 cm wide and long, acute at base, and with acute to abruptly short-acuminate apices, and often with conspicuous pits in the axils of the 4–7 pairs of lateral veins. *Inflorescence* with one main axis, 1.5–3.5 cm long and with up to 3 nodes which each have whorls of 4 branches, each branch subtended by prominent, wide, dilated bracts and terminated by cymose clusters of 9–20 sessile flowers. *Calyx* 1.5–2 mm long with tube dilated towards the apex and with small acute lobes. *Corolla* white, 3.5–4.5 mm long with the tube dilated towards the summit and glabrous at the throat and with the lobes about equal to the tube and reflexed at anthesis. *Fruit* globose, 5–7 mm long with pyrenes not sulcate and with endosperm ruminate. The type specimen is illustrated in Fig. 1.

Distribution and ecology: Rather widely distributed in the Central Highlands in montane forests from about 1 500 to 2 000 m, although not particularly common. Flowering usually begins in March–April and the fruits mature by August–September. Endemic to Sri Lanka.

Specimens examined: Nuwara Eliya Dist.: Gonipitiya Tea Estate boundary jungle, Sohmer & Sumithraarachchi 10179 (GH, MO, NY, PDA, US, UWL); Fairyland Tea Estate, remnant boundary jungle, Sohmer and Sumithraarachchi 10212 (GH, MO, NY, PDA, US, UWL); ridge west of Nuwara Eliya Town, Fosberg 36770 (US); forest above Lindula, Kostermans 24606 (K); slopes above Hakgala Botanic Gardens, Cooray 7002119R (PDA, US); Elk Plains near Ambawella, Kostermans s.n. Apr. 1969 (K). – Badulla Dist.: Namunukula, Tirvengadum, Cramer, Waas & Bandaranayake 595 (PDA, US). – Without collection data: Collector unknown (K).

Fig. 1. *Psychotria gardneri* var. *jayasuriyae* Sohmer (holotype, US).

The individuals of this taxon have masqueraded rather successfully in Sri Lanka in years past as members of what has been called *Psychotria bisulcata* W. & A. due to a remarkable resemblance in habit and leaf morphology. The seeds, however, are ruminate, and not sulcate as are those of the individuals of the latter taxon. The most obvious characters that delimit this taxon from *P. bisulcata* (now *P. zeylanica*) reside in the morphology of the inflorescence. In both varieties of *P. gardneri* the branches of the inflorescence are verticillate, not opposite, and are subtended by relatively broad, conspicuous bracts. These bracts also distinguish the species from all other Sri Lankan representatives of the genus. *Psychotria gardneri* var. *jayasuriyae* differs from the nominate variety by the smaller leaves, smaller inflorescences, and the corolla tube that is glabrous, not bearded at the throat.

The variety is named after Mr A. H. Magdon Jayasuriya, a botanical assistant with the Flora of Ceylon Project who has aided me immensely in the field and in the herbarium.

Psychotria zeylanica Sohmer sp. nov.

Psychotria bisulcata sensu auctt. non Wight and Arnott, Prodr. Fl. Penins. Indiae Orient. 434 (1834); G. H. K. Thwaites, Enum. Pl. Zeyloniae. 148 (1859); J. D. Hooker, Fl. British India 3: 171 (1880) (in part); H. Trimen, Hand-Book Fl. Ceylon 2: 362 (1894).

Arbor parva vel frutex ad 3 m altus, ramosissimus, caulibus junioribus saepe flavovirentibus, stipulis irregularibus ovatis-deltatis, acuminatis, laminis foliorum nervis lateralibus 5–10 paribus nervis tertiariis in paginis inferioribus plerumque conspicuis, ramis inflorescentiarum divaricatis bracteis parvulis subtentis et apicem versus floribus pedicellatis in cymulis dispositis, calyce glabro 2–2.5 mm longo apicem versus valde dilatato latior quam corolla, corolla 5–6 mm longa, fructu obovoideo-ellipsoideo 9–12 mm longo, pyrenis 2-sulcatis endospermio non ruminato. A *Psychotria bisulcata* W. & A. inflorescentia ramis divaricatis stipulis acutis non acuminatis nervis tertiariis foliorum plerumque conspicuis distinguenda.

Type: Nuwara Eliya Dist.: Moray Tea Estate trail to Adam's Peak, Maskeliya, Sohmer & Sumithraarachchi 9902 (US holotypus! BISH, F, GH, K, MO, NY, P, PDA, UWL, W isotypi!).

Shrubby tree to 3 m, diffusely branched, with ovate-deltoid, glabrous, caducous stipules to 12 mm long, leaving a laciniate scar after abscission. *Leaves* with petioles 0.1–1.5 cm long and with obovate, oblanceolate or elliptic, coriaceous blades 0.8 × 2.9 to 4.5 × 12 cm wide and long, acute to obtuse at base, obtuse or acute at apex, often with a mucronate tip or long acuminate one, frequently with pits in the axils of the 5–9 pairs of lateral veins and with tertiary veins often relatively conspicuous below. *Inflorescence* with one main axis 2.4–6 cm long with divaricate, opposite branching which begins, usually, 1/2 to 3/4 of the way from the base, the branches subtended by small bracts and usually terminated by cymose clusters of flowers. *Calyx* glabrous 2–2.5 mm long, abruptly dilated towards the apex, and much wider than the base of the corolla tube, with small triangular lobes. *Corolla* white 5–6 mm long, with tube slightly dilated terminally, and bearded at throat and with ovate lobes about equal to the tube. *Stamens* exserted at anthesis and stigmas included. *Fruit* obovoid-ellipsoid, black, 9–11 mm long and 4–6 mm wide at maturity, capped by persistent and frequently very prominent calyx, with pyrenes with 2 deep sulci on back and endosperm not ruminate. The type specimen is shown in Fig. 2.

Distribution and ecology: Very common and widespread in the wet forests of the Central Highlands above about 1500 m. Flowering commences about March–April and often continues until December–January, and individuals in flower and fruit can frequently be seen during the last months of the year. Endemic to Sri Lanka.

Representative specimens: Nuwara Eliya Dist.: Pidurutalagala, Cramer & Tirvengadum 3896 (US); Adam's Peak Trail from Moray Tea Estate, Maskeliya, Sohmer & Sumithraarachchi 9963 (PDA, US, UWL); Diyagama Tea Estate road to Horton Plains, Sohmer & Sumithraarachchi 9984 (BISH, F, GH, K, MO, NY, P, PDA, US, UWL), 9990 (MO, NY, PDA, US, UWL); slopes above Hakgala Botanic Garden, Hoogland 11494 (PDA, US), Sohmer & Sumithraarachchi 10076 (BISH, F, GH, K, MO, NY, P, PDA, US, UWL); Totupola, Worthington 1734 (PDA); Horton Plains near Farr Inn, C. F. & R. J. van Beusekom 1496 (PDA, US), Comanor 961 (PDA, US); Horton Plains near Big World's End, Sohmer & Sumithraarachchi 10041 (BISH, F, GH, GOET, K, MO, NY, P, PDA, US, UWL, W). – Badulla Dist.: Namunukula, Tirvengadum, Cramer, Waas, & Bandaranayake 592 (US).

This species differs in several respects from the one which Wight and Arnott (l. c.) described from the Nilgiri Highlands of Southern India and

Fig. 2. *Psychotria zeylanica* Sohmer (holotype, US).

which name was used for this taxon in Sri Lanka up to the present. The inflorescence of *P. zeylanica* always has opposite, not verticillate branching, and the first branching node usually occurs at least half way from the base or more. In many instances, the first branching node will be 3/4 to 4/5 from the base (Fig. 2). The stipules are deltoid ovate and acute, whereas in *P. bisulcata* Wight & Arnott the stipules are ovate with long acuminate, almost aristate tips. The leaves more often than not in *P. zeylanica* have the tertiary veins conspicuous below, and the flowers and fruits are larger. The fruit is usually conspicuously capped by the persistent calyx tube.

Psychotria waasii Sohmer nom. nov.

Psychotria bisulcata var. *β* Thwaites, Enum. Pl. Zeyloniae 148 (1859).

Psychotria filipes Hooker f., Fl. British India 3: 170 (1880), non A. Gray, Proc. Amer. Acad. 4: 46 (1850); H. Trimen, Hand-book Fl. Ceylon 2: 361 (1894). – *Type:* Gardner 4508 (K lectotype!).

A new specific name is required for this taxon which was first noted by Thwaites, who, however, did not name it. The name given to it by J. D. Hooker, who provided a concise identification at the same time, is a later homonym. The specific epithet *filipes* had already been used by Asa Gray for a species of *Psychotria* from Fiji. The new name is given in honor of Mr Shelton Waas, another botanical assistant of the Flora of Ceylon Project who has given me great aid during my field work in Sri Lanka.

Psychotria fosbergii Sohmer nom. nov.

Psychotria elongata (Wight) Hooker f., Fl. British India 3: 163 (1880), non Bentham ex Örsted, Kjoeb. Vidensk. Meddel. 32 (1852); H. Trimen, Hand-Book Fl. Ceylon 2: 359 (1894). – *Grumilea elongata* Wight, Icones Pl. Indiae Orient. 3:t. 1036 (1845). – *Type* (herein designated): t. 1036 in Wight, Icones Pl. Indiae Orient. part III (1845), lectotype.

The name *Psychotria elongata* (Wight) Hooker f. is a later homonym. The new name honors Dr F. R. Fosberg.

Acknowledgements. I thank Drs F. R. Fosberg, Lyman Smith and P. S. Green for reviewing the manuscript and offering suggestions, and Dr D. Nicolson for aid in several points concerning Latin terminology. A Smithsonian Institution Postdoctoral Research Fellowship presented me with the opportunity to do this work concomitant with a leave-of-absence granted by the University of Wisconsin-La Crosse with financial support. The Flora of Ceylon Project made field work in Sri Lanka possible.

The genus Dipsacus in tropical Africa

Inga Hedberg and Olov Hedberg

Hedberg, I. & Hedberg, O. 1977 01 28: The genus Dipsacus in tropical Africa. *Bot. Notiser 129:* 383–389. Stockholm. ISSN 0006-8195.

Field and herbarium studies demonstrate that all high-level material of *Dipsacus* L. (Dipsacaceae) in Ethiopia and East Africa forms one ± continuous variation range, which displays striking ecoclinal variation in height and branching, and includes the type material not only of *D. pinnatifidus* Steud. ex A. Rich., *D. appendiculatus* Steud. ex A. Rich., *D. bequaertii* De Wild., *D. kigesiensis* Good, and *D. eremocephalus* Pichi Sermolli but also of *D. acaulis* (Steud. ex A. Rich.) Napper (*Simenia acaulis* (Steud. ex A. Rich.) Szabo). The Asiatic *D. inermis* Wall. ex Roxb. falls in most respects within the same variation range, but pending a generic revision we refrain from further nomenclatural changes.

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In the course of the revision of the genus *Dipsacus* L. for the "Afroalpine Vascular Plants" (Hedberg 1957) *D. pinnatifidus* Steud. ex A. Rich. was found to be so variable in leaf shape, size of flower heads, length of involucral bracts and length of receptacle scales that four other taxa (*D. pinnatifidus* var. *integrifolius* Engl., *D. appendiculatus* Steud. ex A. Rich., *D. bequaertii* De Wild. and *D. kigesiensis* Good) were reduced to synonymy. When in 1973 the senior author had the opportunity to visit the two highest mountain areas in Ethiopia, the High Simien and Bale Mts, he paid special attention to this genus as well as to the enigmatic genus *Simenia,* described from the Simien mountains. Its only species was first described as *Cephalaria acaulis* (Richard 1847–1848 p. 368), then promoted by Szabo (1940 p. 404) to an independent genus, and transferred again by Napper (1968 p. 470) to a species of *Dipsacus* conspecific with the later described *D. eremocephalus* Pichi Sermolli. The field studies in this area gave the impression that the short-stemmed and sparsely branched specimens earlier referred to *Simenia* only represent one end of a ± continuous variation range (Fig. 1; cf. Hedberg 1975). In Bale Mts the variation is even wider, specimens from above 4100 m altitude being almost acaulescent (Fig. 1C). In order to clarify the taxonomic position of *Dipsacus acaulis* (Steud. ex A. Rich.) Napper a detailed morphological study was made on a representative herbarium material from Ethiopia. Measurements and diagram construction were made in collaboration with R. Svensson and M. Wigren.

Material and methods

Apart from field observations by O. Hedberg this revision is based on herbarium material from BM, K, LE, P, S and UPS (abbreviations according to Holmgren & Keuken 1974). All adequately labelled Ethiopian material available was measured, comprising 28 collections. The main distinctive characters used within this group by earlier authors (Richard 1847–1848 p. 367, De Wildeman 1921–1922 p. 555, Good in Good, Baker & Norman 1924 p. 334, Szabo 1940 p. 404, and Pichi Sermolli 1951 p. 223) concern the height and branching of the stem, leaf shape and pubescence, size of flower heads, length of involucral bracts, length of receptacle scales, and occurrence of prickles on the stem. Most of these characters have been shown to display rather continuous variation in East African material (Hedberg 1957 p. 322). The present study was therefore

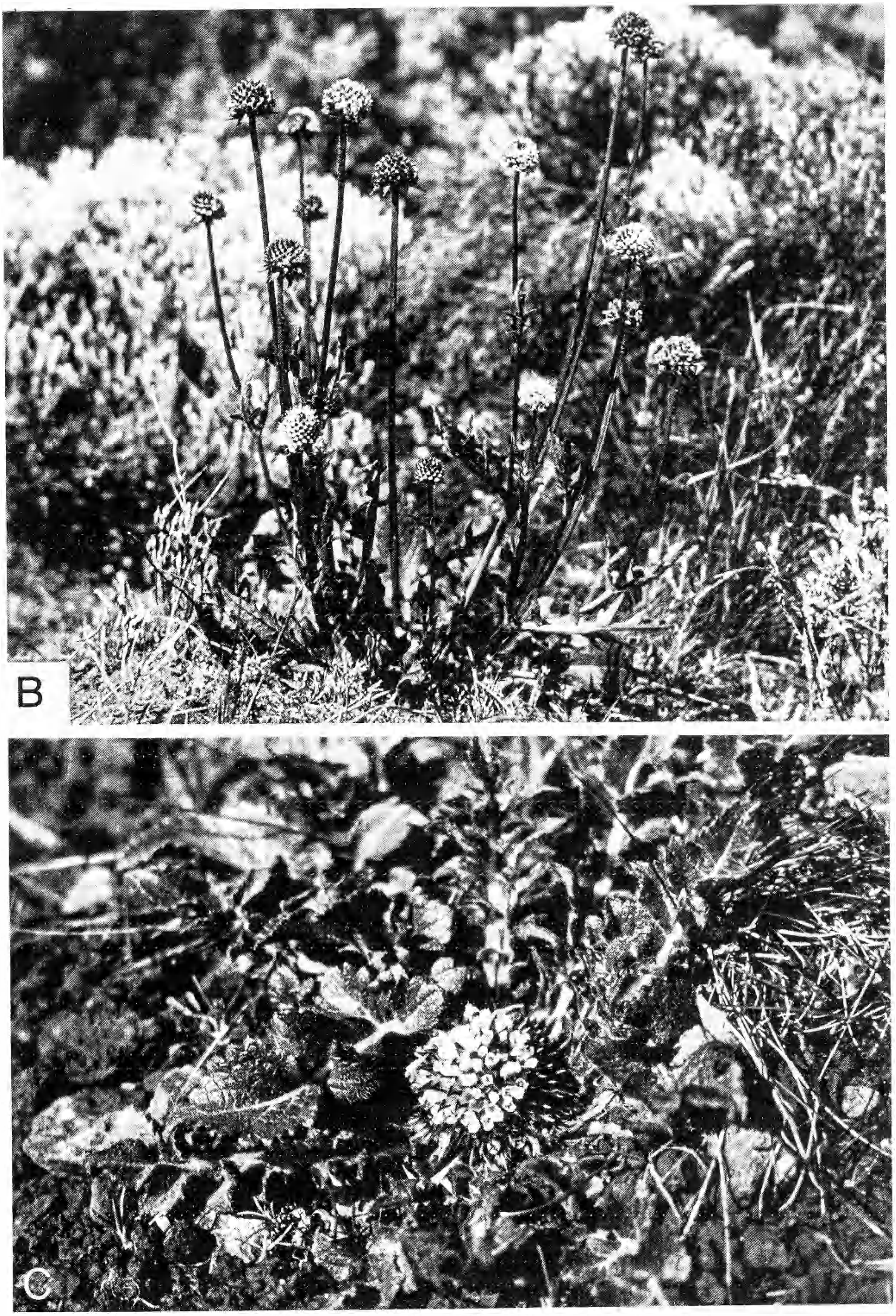
Fig. 1. *Dipsacus pinnatifidus*. – A: Bale Mts, Bale National Park, near the Headquarters, 3200 m, in open *Hypericum* woodland. Height of specimen c. 1.5 m. – B: Bale Mts. near Garba Guracha Camp. 3950 m. Height of specimen c. 0.4 m. – C: Bale Mts, Mt Batu, 4150 m. Diameter of rosette c. 13 cm. – A–C: Photo O. Hedberg XI. 1973.

concentrated on those features which appeared most promising, viz. plant height, length of receptacle scales, occurrence of pinnatipartite leaves, and occurrence of prickles on the stem. The plant height was measured along the longest shoot of each collection or taken from statements on the labels. The figure for length of the receptacle scales represents the mean of three measurements from each collection (in order to avoid dissection of too many capitula only the dark-coloured terminal portion was measured, cf. Fig. 5). The occurrence of pinnatipartite leaves and stem prickles was assessed according to scales with three degrees (cf. Fig. 4). The results are given in the diagrams in Figs. 2–4.

Results and discussion

The length of the stem displays very wide variation in this material (Figs. 2, 4), ranging from 300 to 1.5 cm (or even 0.5 cm in one specimen of Hedberg 5592). Fig. 2 demonstrates negative correlation between plant height and altitude, suggesting that this character is strongly influenced by environmental conditions. The plant height therefore seems useless for taxonomic separation within this group. Similar clinal variation in stem length has been demonstrated, e.g., in *Conyza subscaposa* O. Hoffm. (Hedberg 1957 p. 336).

Also the size and shape of the terminal portion of the receptacle scales show a wide variation in the material studied, from very short and obtuse to long and acuminate (Figs. 3, 5). In this feature as well the variation is far too continuous to support taxonomic segregation (cf. Hedberg 1957 p. 332 for material from Tropical East Africa).


B
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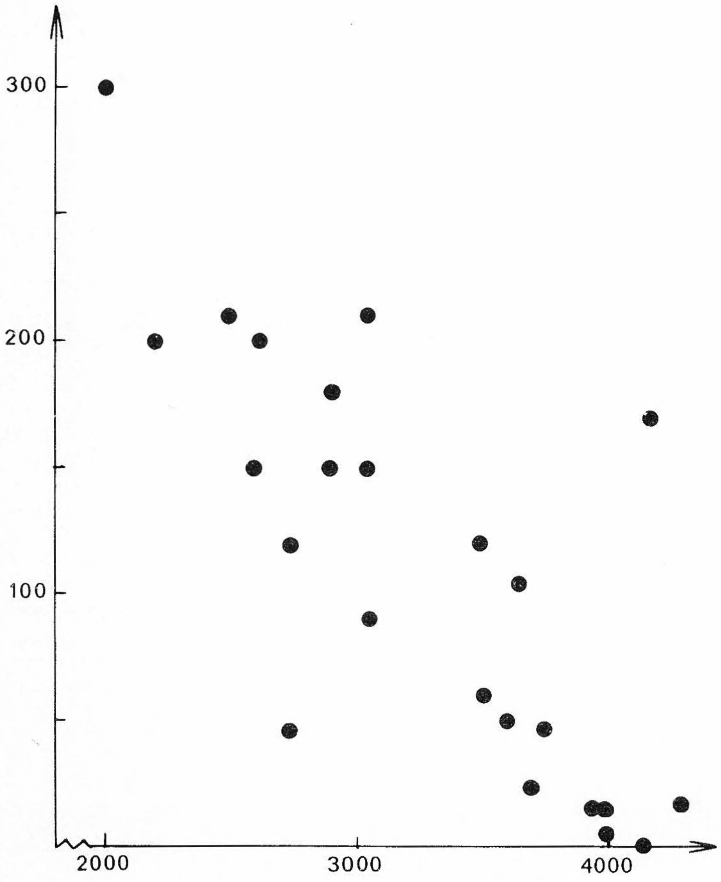

Fig. 2. *Dipsacus pinnatifidus*. Relation between altitude (horizontal axis, m), and specimen height (vertical axis, cm) in the herbarium material investigated.

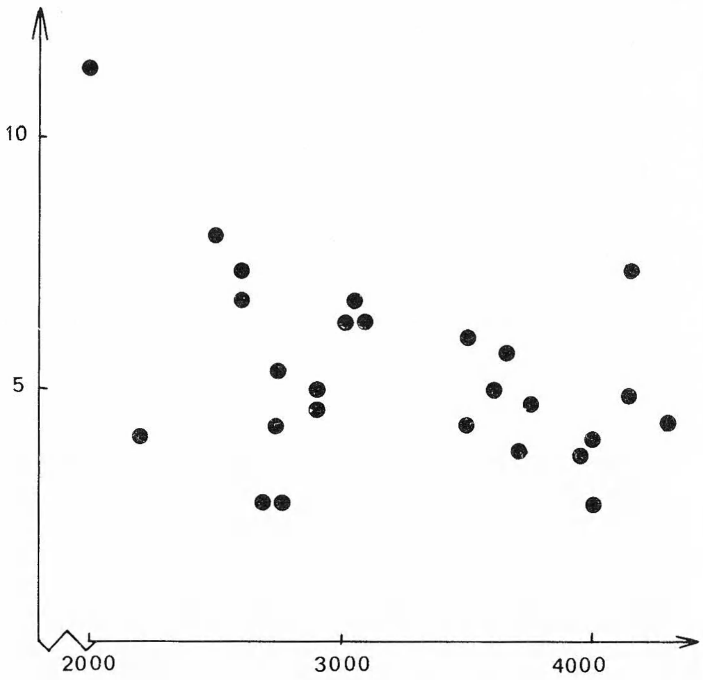

Fig. 3. *Dipsacus pinnatifidus*. Relation between altitude (horizontal axis, m), and length of the terminal portion of the receptacle scales (vertical axis, mm) in the herbarium material investigated.

The positive correlation between receptacle scale length and plant height demonstrated in Fig. 4 is to be expected, since taller and more vigorous specimens are likely to have larger flowers and inflorescences, but there is no distinct correlation between receptacle scale length and altitude (Fig. 3).

Leaf shape turns out to be a very variable feature. Specimens with entire leaves and those with pinnatipartite leaves often occur in the same population, as in the type collection of *Dipsacus pinnatifidus,* and there is no absolute coincidence between the occurrence of entire leaves and the variation in the other characters studied (Fig. 4). Also in material from Tropical East Africa leaf shape was found useless for taxonomic subdivision of this group (Hedberg 1957 p. 332). On the other hand, the frequency of specimens with entire leaves seems to differ in different populations – they appear to be less common in Bale Mts than in the Simien.

The occurrence of prickles on the stem, finally, was also found of little taxonomic use in this group. Prickly stems were found only in specimens taller than 40 cm, and not above 3650 m altitude. But prickly and unarmed specimens often occur together in the same area, and this feature varies independently of leaf shape and length of receptacle scales (Fig. 4).

According to Szabo (1940) his new genus *Simenia* differs from *Dipsacus* and *Cephalaria* in fruit anatomy, having a larger number of "stereome strands". Investigation of sections of fruits from a larger material (Schimper 563, Hedberg & Aweke 5350, 5397, Thulin 1470, Hedberg 5539, 5592) revealed no anatomical difference between Schimper 563 (the type collection of *Simenia acaulis* (Steud. ex A. Rich.) Szabo) and the other material, however. The sclerenchymatic strands evidently become more distinct when the fruit ripens, and presumably the samples studied by Szabo were not of comparable ages.

Obviously none of the presumed distinctive characters does in fact support taxonomic subdivision within the material studied. All the specimens investigated must therefore be grouped in one species, the correct name of

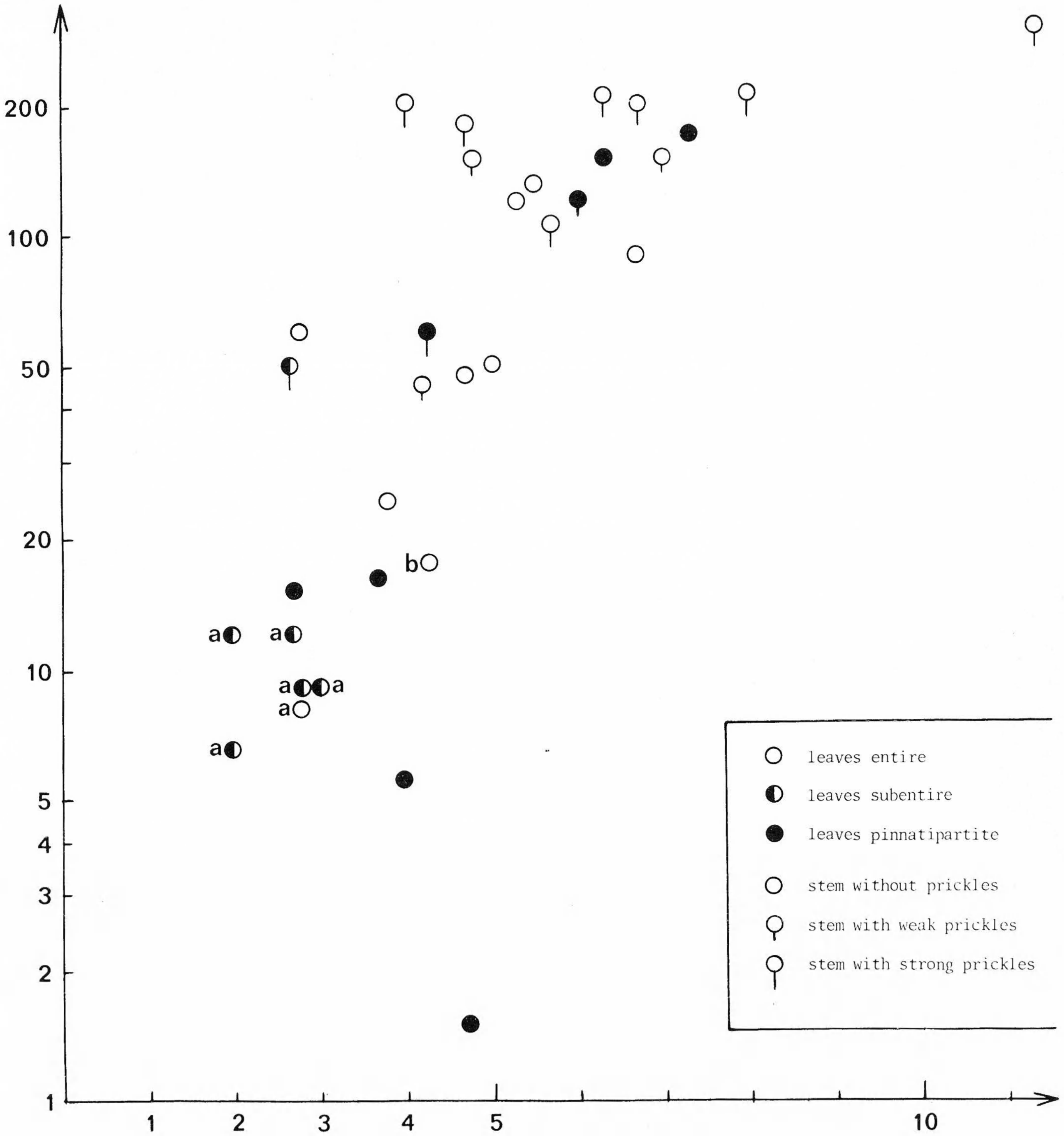

Fig. 4. *Dipsacus pinnatifidus*. Correlated variation in receptacle scale length (horizontal axis, mm), specimen height (vertical axis, cm, logarithmic scale), leaf dissection and occurrence of prickles on the stem. – a denotes sheets from the type collection of *Simenia acaulis*, b denotes the type collection of *Dipsacus eremocephalus*.

which is *Dipsacus pinnatifidus* Steud. ex A. Rich. The other taxa described on this material, including *Dipsacus (Simenia) acaulis* and *D. eremocephalus* must be reduced to synonymy.

As long as only African material is considered the situation now appears satisfactory. But when also Asiatic material is considered matters become more complicated. The Himalayan species *Dipsacus inermis* Wall. ex Roxb. falls in most respects within the same variation range as the African plant, and it could easily be justified to lump the two, in which case the African material should be called *D. inermis*.

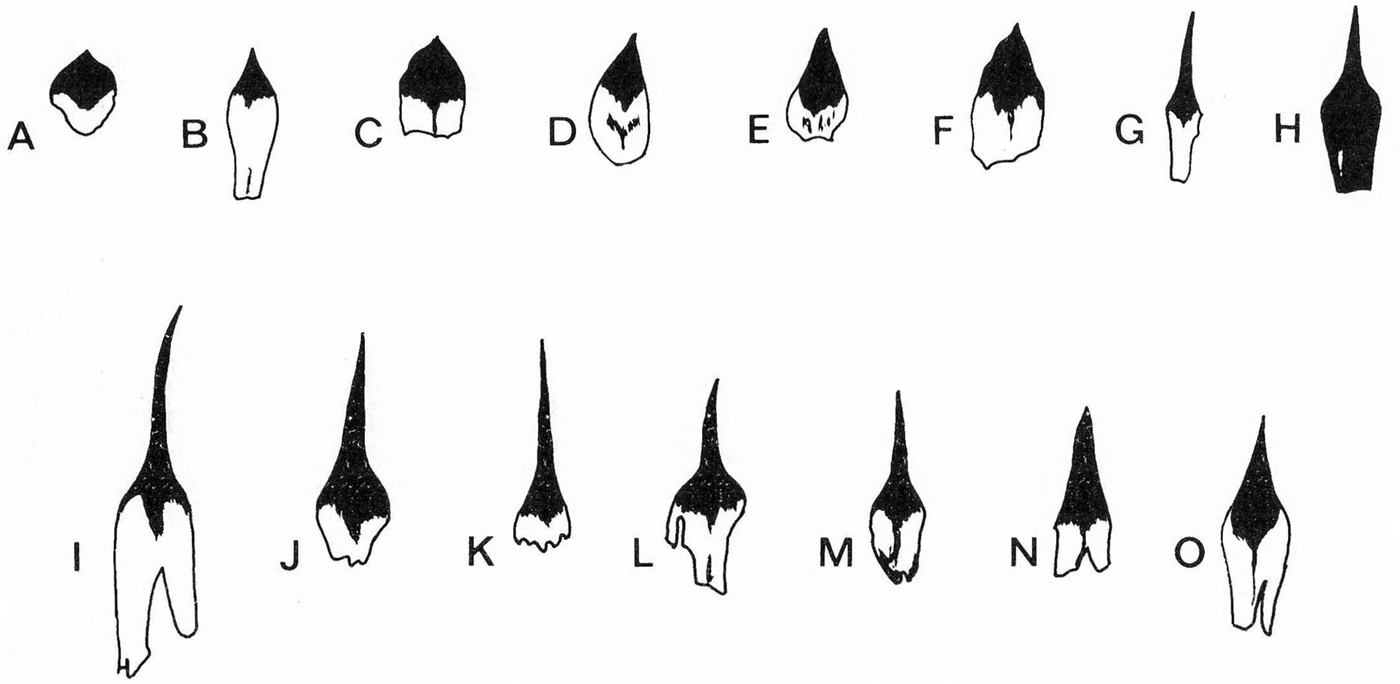

Fig. 5. *Dipsacus pinnatifidus*. Representative receptacle scales from 15 collections. A Schimper 563, B Thulin 1470, C Hedberg & Aweke 5397, D Hedberg 5592, E Hedberg 5539, F Hedberg & Aweke 5350, G Hedberg 71 (Kenya, Elgon, 3700 m, UPS), H Lye & Lester 998 (Uganda, near Kashengi, 2300 m, UPS), I Fries & Fries 745 (Kenya, Mt Kenya, 2350 m, UPS), J Fries & Fries 2755 (Kenya, Mt Aberdare, 3000 m, UPS), K Fries & Fries 1339 (Kenya, Mt Kenya, 3000 m, UPS), L Hedberg 1027 (Kenya, Mt Elgon, 2700 m, UPS), M Fries & Fries 2778 (Kenya, Aberdare, 3000 m, UPS), N Hedberg 4187, O Hedberg 5592. – All ×2.

The same chromosome number ($2n=18$) has been counted in both (Hedberg & Hedberg 1977, Bolkhovskikh et al. 1969). But the taxonomic interrelations between *Dipsacus inermis, D. mitis* D. Don, *D. asper* Wall. ex DC., *D. japonicus* Miq., *D. pilosus* L. and *D. strigosus* Willd. are far from satisfactorily known, and pending a taxonomic revision of the genus we have therefore refrained from further nomenclatural changes for the African plant.

The type of variation displayed by *Dipsacus pinnatifidus* is of considerable interest from an evolutionary point of view. Firstly, this species provides an uncommonly beautiful example of an ecocline, showing progressive adaptation to the increasingly severe environmental conditions towards higher altitudes (cf. Hedberg 1964 pp. 73, 87, Figs. 71–75; 1973 p. 79 and Pl. V; 1975). The adaptive nature of this reduced height was suggested by Mooney on the label of collections 843 a, b: "herb dwarfed by its environment". Secondly, whereas the species occurs in mountain areas throughout East Tropical Africa and Ethiopia it has only become thoroughly adapted to afroalpine conditions in Ethiopia, particularly in Bale Mts. In Tropical East Africa it has been recorded from the afroalpine belt only on Elgon (where it ascends to 3950 m, Hedberg 1957 p. 183). Thirdly, as emphasized above, different mountain populations evidently differ not only in the extent of adaptation to high level conditions but also, e.g., in frequency of specimens with pinnatifid leaves and prickly stem, etc. Further detailed investigations of this species including population studies, controlled hybridizations and comparative cultivation would certainly be worth while.

Equally rewarding might be a detailed study of the European and Asiatic taxa mentioned above. In this study should also be included *D. cephalarioides* Matthews & Kupicha, recently described from Turkey (Chamberlain et al. 1972 p. 327). The interspecific differences between at least some of these taxa depend on characters which in African material display continuous variation. It might therefore be easier to distinguish between the Eurasian taxa themselves than to keep them separate from *D. pinnatifidus*.

Synopsis

Dipsacus pinnatifidus Steud. ex A. Rich.

A. Rich., Tent. Fl. Abyss. 1 p. 367 (1848). – Orig. coll.: Ethiopia, Simien, Mt Aber., Schimper II: 665 (K, P lectotype, S).

D. pinnatifidus var. *integrifolius* Engl. Bot. Jahrb. 19 Beibl. 47 p. 49 (1894). – Orig. coll.: Tanganyika, Kilimanjaro, Volkens 862, 967 (BM isosyntypes), 1550 (E, LE isosyntype).

D. appendiculatus Steud. ex A. Rich. l. c. – Orig. coll.: Ethiopia, Simien, Mt Aber. Schimper II: 865 (K, P holotype).

D. bequaertii De Wild. Pl. Bequaert. 1 p. 554 (1922). – Orig. coll.: Belg. Congo, Ruwenzori, Lanuri Valley, 3000 m, Bequaert 4655 (BR holotype).

D. kigesiensis Good, Journ. Bot. (Lond.) 62 p. 334 (1924). – Orig. coll.: Uganda, Kigezi, Behungi, Godman 189 (BM holotype).

D. eremocephalus Pichi Sermolli, Missione Stud. Lago Tana, 7 (1) p. 223 (1951). – Orig. coll.: Ethiopia, Simien, NE slope of Mt Buahit, 4300 m, Pichi Sermolli 2619 (FI holotype, K photograph).

Cephalaria acaulis Steud. ex A. Rich. Tent. Fl. Abyss. 1 p. 368 (1848). – *Simenia acaulis* (Steud. ex A. Rich.) Szabo, Matemat. Termeszettud. Ertes. 59 p. 404 (1940). – *Dipsacus acaulis* (Steud. ex A. Rich.) Napper, Kew Bull. 21 (2) p. 470 (1968). – Orig. coll.: Ethiopia, Simien, Mt Buahit, Schimper 563 (K, P holotype, UPS).

Collections measured

All collections from Ethiopia.

Beghemder: Mt Bachit, Schimper 563 (K four sheets, UPS two sheets) – Mt Buahit, 4300 m, Pichi Sermolli 2619 (K photograph) – Geech, 3600 m, Hedberg & Aweke 5350 (UPS); 3700 m, Hedberg & Aweke 5397 (UPS) – Lori, 3500 m, Scott 272 (K) – Meda, 2900 m, Mooney 6172 (K).

Tigre v. Beghemder: Schimper 1436 (K).

Godjam: Choké Mts, 2750 m, Evans 354 (K); 3050 m, Evans & Hiller 90 (K); 3050 m, Evans & Lythgoe 11 (K); 3050 m, Leakey 109 (K); 3650 m, Flenley & Leakey 615 (K).

Shoa: 34 km W of Ambo, 2490 m, Meyer 7671 (K).

Harar: Kondudo Mts, 2600 m, Burger 1224 (K) – Gara Mulatta, 2900 m, Burger 2358 (K).

Kaffa: Yasukela near Abera, 2000 m, Mooney 8702 (K) – Dekano, 2620 m, Mooney 8278 (K).

Arussi: Gobe, 2700 m, Thulin 1470 (UPS) – Mt Chillalo, 2750 m, Mooney 5171 (K); above 2750 m, Mooney 5163 (K) – Mt Galama, 2750 m, Hedberg 4187 (K).

Bale: Angasu, 3500 m, Mooney 8305 (K) – above Rira, 4000 m, Mooney 8343 a (K), 8343 b (K) – Garba Guracha, 3950 m, Hedberg 5539 (UPS) – Mt Batu, 4150 m, Hedberg 5592 (UPS).

Gamu-Gofa: Mt Tola, 4150 m (?), Mulvany 29 (K).

Sidamo: Agheremariam, 2200 m, Gillett 14703 (K).

References

Bolkhovskikh, Z. et al. 1969: *Chromosome numbers of flowering plants*. Leningrad.

Chamberlain, D. F., Matthews, V. A. & Pesmen, H. 1972: Materials for a flora of Turkey XXVII. *Notes Bot. Gard. Edinb. 31:* 325–329.

De Wildeman, E. 1921–1922: *Plantae Bequaertianae 1*. Gand.

Good, R. D. O., Baker, E. G. & Norman, C. 1924: New plants from central Africa. *Journ. Bot. (London) 62:* 332–335.

Hedberg, I. & Hedberg, O. 1977: Chromosome numbers of afroalpine and afromontane angiosperms. *Bot. Notiser 130* (in press).

Hedberg, O. 1957: Afroalpine vascular plants. A taxonomic revision. *Symb. Bot. Upsal. 15 (1)*.

– 1964: Features of afroalpine plant ecology. *Acta Phytogeogr. Suec. 49*.

– 1973: Adaptive evolution in a tropical-alpine environment. *In* V. H. Heywood (ed.), *Taxonomy and ecology*, pp. 71–92. London and New York.

– 1975: Studies of adaptation and speciation in the afroalpine flora of Ethiopia. *Boissiera 24:* 71–74.

Holmgren, P. K. & Keuken, W. (eds.) 1974: Index Herbariorum 1. The herbaria of the world. Ed. 6. *Regnum Veg. 92*.

Napper, D. M. 1968: Notes on some tropical and South African Dipsacaceae. *Kew Bull. 21:* 463–470.

Pichi Sermolli, R. 1951: Fanerogame raccolte nel Bacino Idrografico del Lago Tana, nel Semièn, nella Regione dei Tucùr-Dinghià ed in Eritrea. *Miss. Stud. Lago Tana 7, Rich. Bot. 1*. Roma (Accad. Naz. Lincei).

Richard, A. 1847–1848: *Tentamen Florae Abyssinicae 1*. Parisiis.

Szabo, Z. 1940: Eine neue Gattung der Familie der Dipsacaceen. *Matemat. Termeszettud. Ertes. 49:* 397–410.

Equisetites fylensis sp. nov. in the Middle Jurassic flora of Eriksdal, Fyledalen, Southern Sweden

Hans Tralau

Tralau, H. 1977 01 28: Equisetites fylensis sp. nov. in the Middle Jurassic flora of Eriksdal, Fyledalen, Southern Sweden. *Bot. Notiser 129:* 391–394. Stockholm. ISSN 0006-8195.

Equisetites fylensis sp. nov. is described from layer No. 36 of the Bajocian-Bathonian beds at Eriksdal in southern Sweden. Comparison has been made with about 100 fossil species of *Equisetites,* five of which are briefly discussed.

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The Middle Jurassic macroflora of the section exposed in the gravel pit at Eriksdal in the valley of the river Fylan, Scania, was described by Tralau in 1966. In 1968 Tralau also described the microflora of these Bajocian-Bathonian beds. Since those days the author has repeatedly collected fossils at this locality, and a considerable collection of fossil plants has been accumulated. Inevitably, ten years of collecting resulted in several new, well-preserved specimens some of which deserve to be described. This publication is intended to be the first in a series of descriptions and redescriptions of fossils from the flora of Eriksdal aiming at a fuller understanding of the vegetation in south Sweden during Dogger time. The *Equisetites* specimens described as a new species in the present publication were collected in layer No. 36 in the gravel pit at Eriksdal. Reference is made to Tralau 1966 (Figs. 1–2) and 1968 (Figs. 1–2) for maps of location and detailed descriptions of the Bajocian-Bathonian sequence of strata at this locality. Layer No. 36 consists of a sandy and silty clay immediately overlying a coal seam (Layer No. 37) and contains an abundance of macroscopic plant fragments.

Specimens of *Equisetites fylensis* sp. nov. were encountered earlier by Nilsson (see Tralau 1968, pl. XXIV, fig. 1) in an unidentifiable place at Eriksdal, mentioned as "the inner part of the tunnel" (no longer accessible). This material was provisionally referred to *Equisetum (Equisetites) laterale.* Closer examination, however, proved this species distinct from *Equisetites lateralis,* although, admittedly, there is a close resemblance between the two. Another species of *Equisetites,* i.e., the one described by Möller & Halle (1913) as *Equisetites mobergii,* "one of the most characteristic plants at Kurremölla" is probably also from the Eriksdal area, i.e., from the gravel pit under consideration. Unfortunately we do not know exactly where their specimens were collected, at least not in relation to the present-day quarry, which did not exist during those days. This species is quite distinct from the one about to be described, and specimens of *E. mobergii* have never been found again within the area of the fossil flora of Eriksdal.

The genus *Equisetites* is known since the Permian and seems to have been most abundant with regard to number of species during Triassic and Jurassic times. At present there are at least 100 recognized species (Boureau 1964, Vakhrameev 1964, Vakhrameev, Dobruskina, Zaklinskaya & Meyen 1970).

Equisetites fylensis Tralau sp. nov. – Fig. 1

Type specimen: Swedish Museum of Natural History, Section of Palaeobotany, S-104 05 Stockholm (Fig. 1 A).

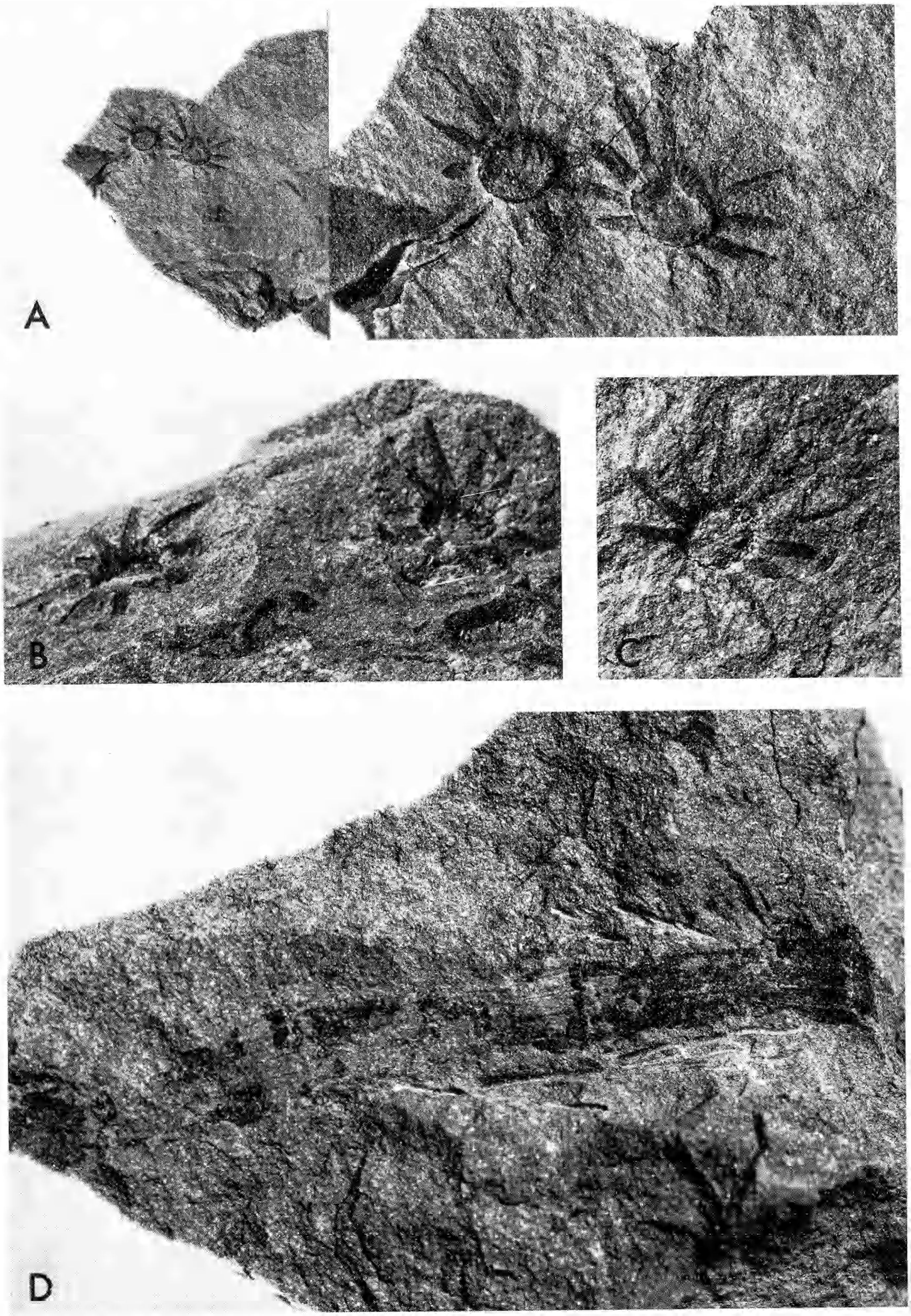

Fig. 1. *Equisetites fylensis* Tralau sp. nov.

Aerial stem slender, unbranched, normally 4–5 mm wide at node; nodes slightly swollen; branches have not been observed in the nodal region of the aerial shoot; internode normally 14–20 mm long, transversed by ± 6 flattened ribs on the visible side (consequently about 12 ribs all around the stem); leaf sheath 5–10 mm long, forming a cup-like structure emerging into 12 acute leaf teeth in most cases; free leaf teeth straight and (3?)–6 mm long; rhizome unknown.

Although there are numerous Jurassic *Equisetites* species from all parts of the world known at present, no species is identical with the one described above. However, some of the fossil species are close to the present one. *Equisetites lateralis,* described by Phillips (1829) from the Yorkshire Jurassic as *Equisetum laterale* is one of the closest related species. *Equisetites lateralis* is distributed over vast geographic areas, ranging from China in the East (Sze 1931, 1933; Teilhard de Chardin & Fritel 1925) to Romania (Semaka 1956), and to the Precaspian area (Baranova, Kirichkova & Sauer 1975), as well as England in the West of the Eurasian continent. However, *Equisetites lateralis* differs distinctly from *E. fylensis* by having a somewhat wider stem and at least twice the number of leaf teeth. *E. elegans* described by Vladimirovich (1960) is similar to the present species, although the name is invalid, as Kräusel (1959) has previously described a certain *E. elegans* from the Keuper of Switzerland. *E. elegans* sensu Vladimirovich was also mentioned by Baranova, Burakova & Bekasova (1963) in the Jurassic flora of Turkmenia and it was renamed as *E. turgaicus* by Kirichkova in Baranova, Kirichkova & Sauer (1975). This species is close to the present species with regard to size, but it differs distinctly in the number and shape of the leaf teeth. Another closely related species is *E. endoi,* described by Kon'no (1962) from the Bajocian-Bathonian of Japan. With regard to leaf sheath and leaf teeth morphology, this species is without doubt the most closely related of all *Equisetites* known at present. However, the length of the internodes is so distinctly different in the two species under consideration that I do not hesitate to refer the present material to a species of its own. In the Eriksdal material no rhizomes have been found, nor could any epidermal remains be obtained. The matrix is relatively coarse, which might well be the reason why organic matter is so badly preserved in the specimens investigated. As specimens referable to this species have been found earlier, as mentioned above, better preserved material may turn up on later occasions, thus giving us a more complete picture of the present species. As a rule, fossil remains of *Equisetites* tend to be fragmentary and it is virtually impossible to obtain a complete picture of the whole plant, let alone the variability of the population.

References

Baranova, S. E., Burakova, A. T. & Bekasova, N. B. 1963: Stratigrafiya, litologiya i flora jurskikh otloshenij Tuarkyra. *VSEGEI nov. ser. 88.*

– Kirichkova, A. I. & Sauer, V. V. 1975: Stratigrafiya i flora jurskikh otloshenij vostoka Prikaspiskoj vpadinij. *VNIGRI Trudy 332.*

Boureau, E. 1964: *Traité de paléobotanique, III. Sphenophyta, Noeggerathiophyta.* Paris.

Kon'no, E. 1962: Some species of Neocalamites and Equisetites in Japan and Korea. *Sci. Rep. Tohoku Univ., Ser. 2, Geol. Spec. Vol. 5:* 21–47.

Kräusel, R. 1959: Die Keuperflora von Neuewelt bei Basel III. Equisetaceen. *Mem. Suiss. Paleont. 77:* 1–19.

Möller, H. & Halle, T. G. 1913: The fossil flora of the coal-bearing deposits of south-eastern Scania. *Ark. Bot. 13 (7).*

Phillips, J. 1829: *Illustrations of the geology of Yorkshire: or, a description of the strata and organic remains of the Yorkshire coast.* York.

Semaka, A. 1956: Contributii a la flora liasica de la Vulcan-Codlea. *Acad. Rep. Popul. Rom., Bul. Sti., Sect. Sti. Geol. Geogr. 1:* 1–2, 107–121.

Sze, H. C. 1931: Beiträge zur Liassischen Flora von China. *Mem. Nat. Res. Inst. Geol. Nanking 12:* 1–85.

– 1933: Mesozoic plants from Kansu. *Mem. Nat. Res. Inst. Geol. Nanking 13:* 65–76.

Teilhard de Chardin, O. & Fritel, P. H. 1925: Note sur quelques grès Mésozoiques à plantes de la Chine septentrionale. *Bull. Soc. Géol. France 4: 25:* 523–540.

Tralau, H. 1966: Botanical investigations in the fossil flora of Eriksdal in Fyledalen, Scania. *Sv. Geol. Unders. Ser. C 611, Årsb. 60 (6).*

– 1968: Botanical investigations in the fossil flora of Eriksdal in Fyledalen, Scania. *Sv. Geol. Unders. Ser. C 633, Årsb. 62 (4).*

Vakhrameev, V. A. 1964: Jurassic and early Cretaceous floras of Eurasia and the palaeofloristic provinces of this period. *Acad. Sci. USSR, Geol. Inst. 102.*

– Dobruskina, I. A., Zaklinskaya, E. D. & Meyen,

S. V. 1970: Palaeozoic and Mesozoic floras of Eurasia and phytogeography of this time. *Acad. Sci. USSR, Geol. Inst. 208.*

Vladimirovich, V. P. 1960: Novyj vid liasovogo khvoshcha severo-zapadnogo Kazakhstana i Sibiri. *In Novye vidy dvernikh rastenij bespozvonochnykh SSSR. Moskva:* 32–34.

Structure and function of trichomes in Spartocytisus filipes

Ole B. Lyshede

Lyshede, O. B. 1977 01 28: Structure and function of trichomes in Spartocytisus filipes. *Bot. Notiser 129:* 395–404. Stockholm. ISSN 0006-8195.

The T-shaped trichomes of the stem of *Spartocytisus filipes* Webb & Berth. are tricellular. The structure and fine structure of the hairs are described and discussed in relation to experiments of water absorption. The results clearly indicate that absorption takes place. The role of the trichomes is briefly discussed in relation to the ecology of the plant.

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Plants often have hairs with anatomical features fitting them for water absorption. Thin walls or pores in the basal cells, often intruding deep into the underlying tissue, are characteristic of these hairs. Volkens (1887) described several such hairs and demonstrated their ability to absorb water in desert plants from North Africa. Marloth (1910, 1926) observed similar features in South African xerophytes. The water-absorbing trichomes of the Bromeliaceae (Haberlandt 1924) are another well-known example. Other results are summarized by Uphof (1962) together with a review of literature.

Trichomes on the assimilating stems of *Spartocytisus filipes* Webb & Berth. (Fabaceae) probably absorb water. The development and structure of these trichomes are described and experiments concerning water absorption are presented.

Material and methods

FAA-fixed stems of *Spartocytisus filipes* from the Canary Islands and fresh stems from plants in the Botanical Garden of Copenhagen were used.

Cross and longitudinal sections were cut on a cryostat microtome (8–12 μ) and stained with safranin fast green, Johansen's quadruple stain (Johansen 1940), or sudan IV. Histochemical reactions were carried out with ruthenium red and hydroxylamine-ferric chloride.

For electron microscopy small pieces of fresh stems were fixed in 3 % glutaraldehyde and postfixed in 2 % OsO_4, both in 0.1 M KH_2PO_4 buffer, pH 6.8. After embedding in EPON 812 (Juniper et al. 1970) sections were cut with glass knives on a LKB ultrotome type 4801A, stained in uranyl acetate followed by lead citrate and examined in a JEOL JEM T7 electron microscope.

For scanning electron microscopy young stems were dried by the "critical point" method (Anderson 1951) and covered with gold.

To demonstrate water absorption a 0.05 % aqueous solution of the flourescent stain rhodamine B was used. On excised branches small containers, made from plastic tubing, were placed around the third internode below the shoot apex. The containers were filled with solution and sealed with lanolin. Next day the absorbing parts of the stems were quickly removed from the plant and embedded in a block of 15 % gelatine by melting a hole with a hot needle followed by rapid freezing with carbon dioxide to prevent secondary movement of the stain in the material. Cross and longitudinal sections (8 μ) were cut on a cryostat microtome, dried with hot air, and kept dry over $CaCl_2$ until mounting in paraffin oil for examination in a fluorescence microscope. These procedures were repeated on stems with naturally shed hairs. Other stems with hairs were placed in rhodamine B and in water for use as controls.

Morphology and anatomy

Spartocytisus filipes is a broom-like tree endemic to the Canary Islands where it grows among lava blocks in the xeric coastal zone

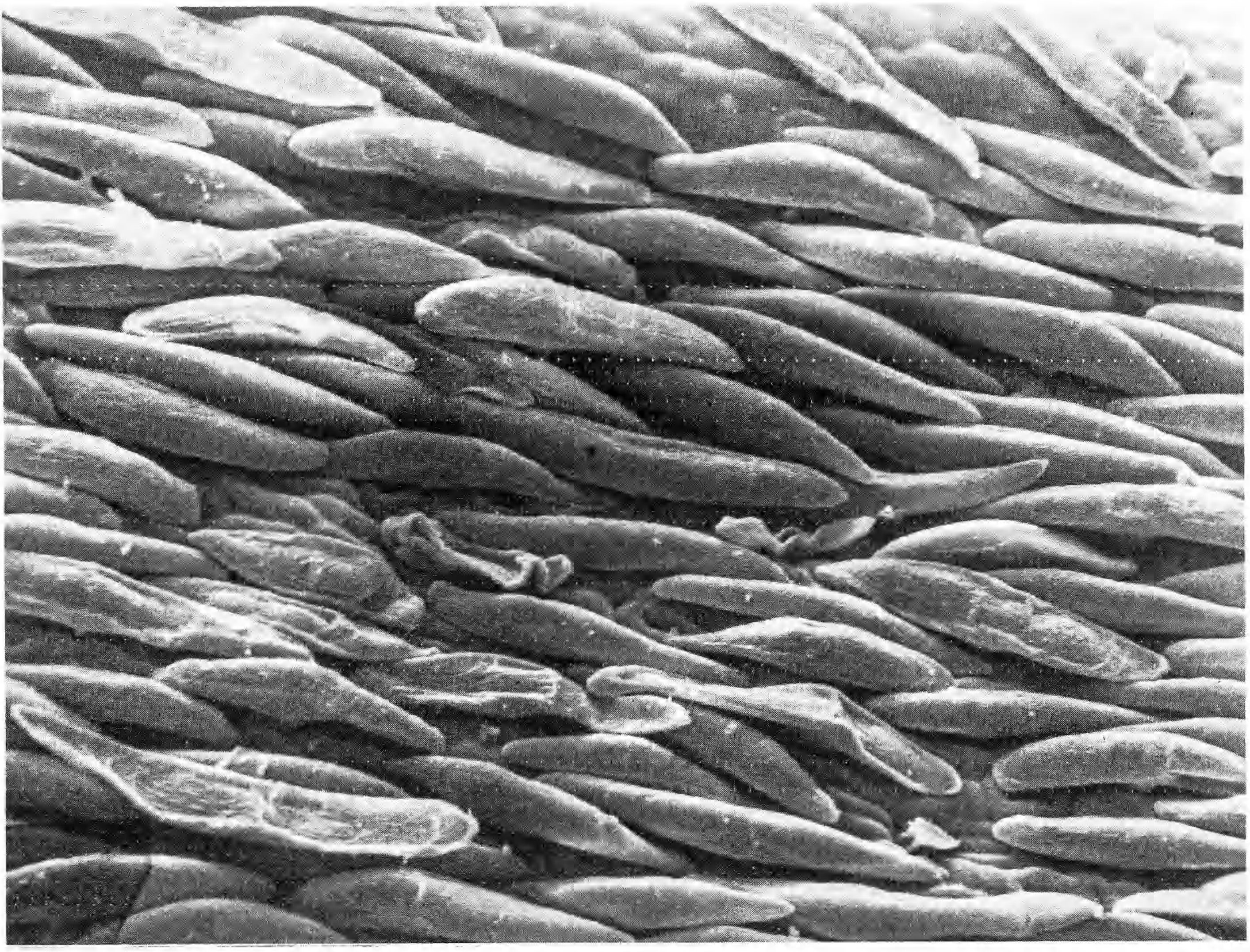

Fig. 1. Surface of stem near apex. T-shaped trichomes, swollen and collapsed, covering the stem. In center two developing hairs. Scanning electron micrograph. ×425.

(0–700 m). In this zone heavy dew falls are common (Burchard 1929, Ceballos & Ortuno 1951, Lems 1960).

The plant is a stem assimilant as its small trifoliate leaves are shed early in the growing season. The stems are slightly furrowed. The apex is densely covered by small T-shaped trichomes (Fig. 1). Away from the apex the trichomes are more dispersed and situated only in the furrows. In branches more than a year old they are usually shed.

The anatomy of the stem has been described by Pellegrin (1908) and Taylor (1937), neither of whom, however, mentioned the trichomes.

Inside the epidermis there is a multilayered chlorenchyma alternating with fibre strands. An endodermoid layer, 1–2 cells thick, surrounds the stelar tissues and each of the fibre strands near the periphery (Fig. 2). Inside is the vascular cylinder.

The trichomes

The trichomes consist of an apical "hair cell", a stalk cell, and a basal cell (Fig. 3).

The "hair cell" is about 1/3 mm in length and elongated parallel to the axis of the stem. It has very thick cellulose walls covered by a thin cuticle with small warts. Ruthenium red stains these walls but not the cuticle dark red, whereas the specific hydroxylamine-ferric chloride method (Jensen 1962) shows several pectic zones. They correspond to isotropic zones seen by polarized light. In longitudinal sections it is seen that canals or fissures extend from the cell

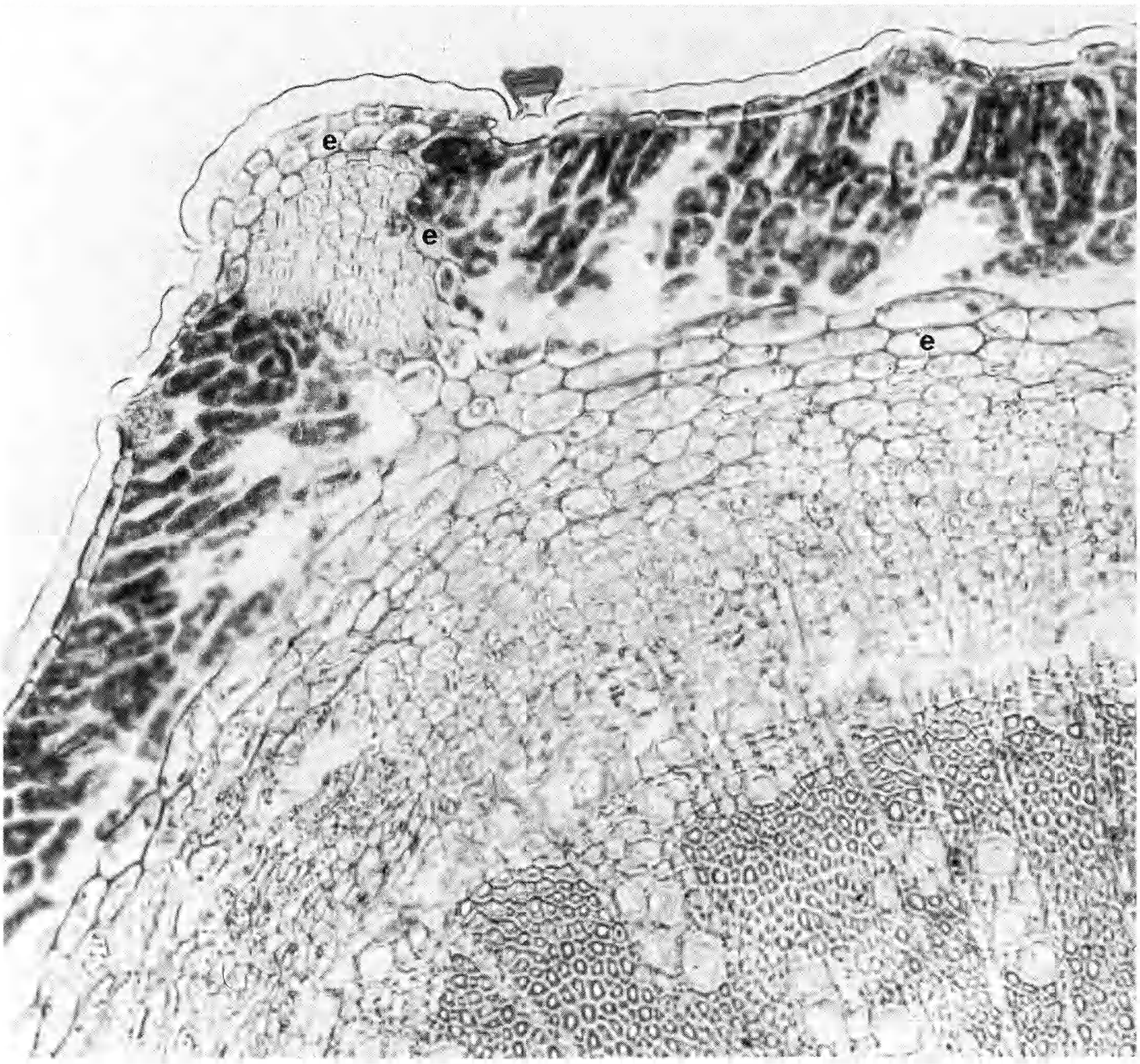

Fig. 2. Cross section of stem. Epidermis with thick outer wall, trichome, and sunken stomata. Palisade cells. Fibres. e: endodermoid layer surrounding vascular cylinder and peripheral fibres. Safranin fast-green. ×240.

lumen through the basal wall and widen to small triangular spaces in its lower part (Fig. 4).

When sections of stems with trichomes are placed in water the walls of the apical "hair cell" swell. In dehydrating media they shrink so much that the distal wall most often collapses into the cell lumen giving the hair the shape of a wineglass when observed in cross section (Fig. 5).

The stalk cell is short and nearly funnel-shaped. It is surrounded by cutinized walls including the wall towards the apical cell (Fig. 3).

The basal cell is similar to the ordinary epidermal cells. It is, however, sunken below their level and is separated from the stalk cell by a thick cutinized wall, similar to the outer wall of normal epidermal cells (Fig. 5).

T-shaped trichomes are also found on the lower surface of the leaves. It is interesting that the stalk cell and the basal cell are separated by a thick cutinized wall whereas the outer

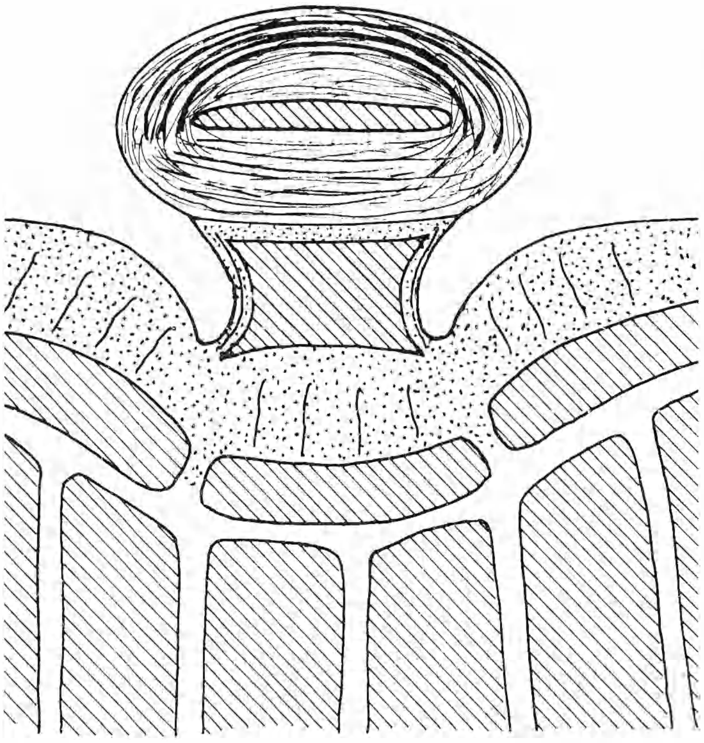

Fig. 3. Schematical drawing of trichome in cross section, partly based on electron micrographs. Cutinized walls shaded. Pectic zones and microchannels indicated by thick lines in the walls.

wall of normal epidermal leaf cells is covered by a thin cuticle only.

The development of the trichomes is illustrated in Fig. 6. The trichomes seem to develop very rapidly, mature hairs being found very near the apical meristem. Furthermore, they do not develop successively as young hairs are found dispersed among mature hairs (Fig. 1).

Electron micrographs of cross sections of the "hair cell" wall show several layers separated by electron-dense lines which may correspond to the pectin zones already mentioned. The outermost layer appears darker, perhaps because of a greater content of pectin in the matrix between the cellulose microfibrils (Fig. 7). A fibrillose structure parallel to the surface is observed. The structure of the inner layers suggests an orientation nearly parallel to the axis of the trichome. Holes, which probably are artefacts due to the knife, are sometimes seen in the inner layers (Fig. 8). Such artefacts are usually found in gelatinous fibres in which the microfibrils are orientated almost parallel to the long axis (Coté & Day 1962). The outer layer may be the primary wall and the inner layers the secondary wall. Tiny channels are seen in the distal wall of the apical cell radiating towards the surface.

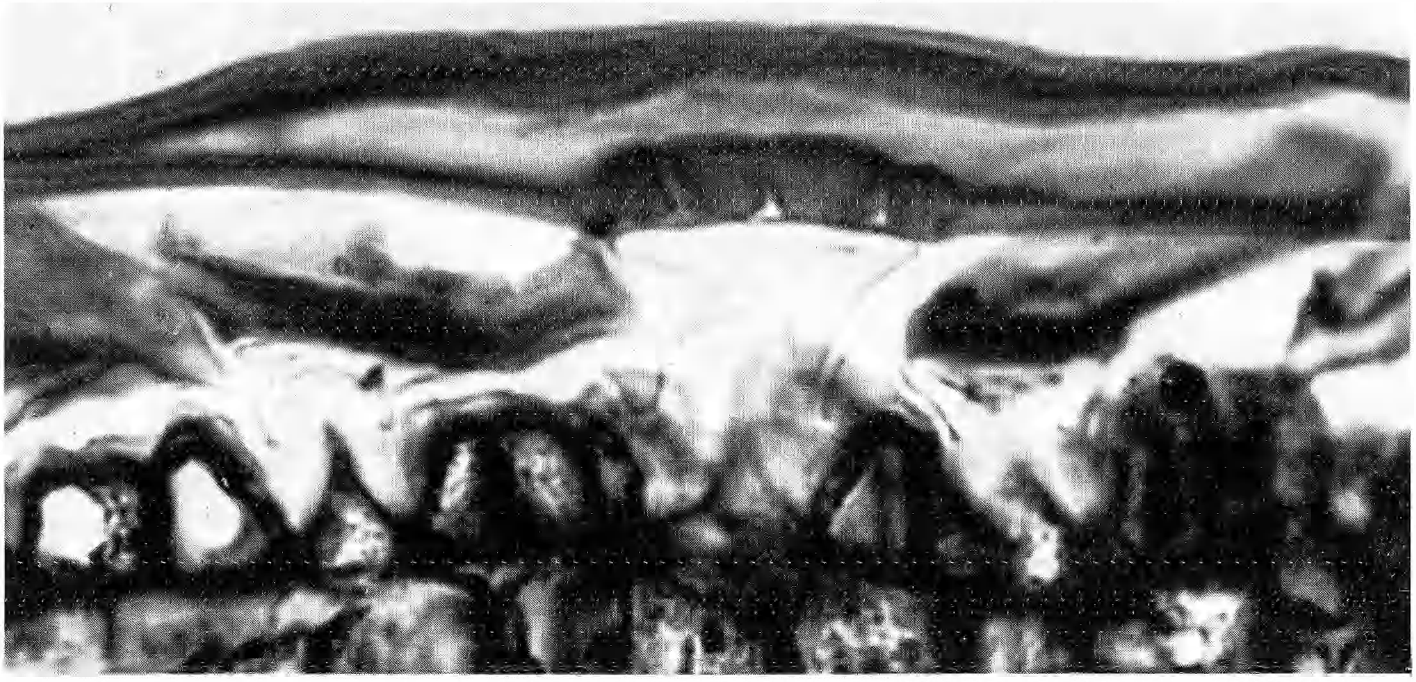

Fig. 4. Trichome, longitudinal section. Canals in basal wall of "hair cell" widening to triangular extensions. Safranin fast-green. × 1085.

The cutinized side-walls of the stalk cell are homogeneous with an electron-dense zone parallel to their surfaces. In the wall between the stalk cell and the basal cell, electron-dense lines having the appearance of microchannels are to be found (Fig. 3).

Absorption

Because the lignified and cutinized elements have a white and blue-white autofluorescence, a red fluorochrome, rhodamine B, was used as tracer. Rhodamine B is a lipophilous stain (Drawert 1968) and, therefore, it stains cutinized walls. Furthermore, it adheres to lignified walls (Frey-Wyssling 1959), a feature also demonstrated in the present study.

In stems treated with rhodamine B the cutinized walls and cuticles thus show a red fluorescence, strongest in the walls of the stalk cell. The xylem opposite to hairs show red fluorescence too, thus clearly proving that an absorption from the plant surface takes place (Fig. 9). In the tissues between the hairs and the xylem, red fluorescence could be traced in the walls of palisade cells, endodermoid cells, and in the middle lamellae of extraxylary fibres. In some palisade cells some unidentified globular bodies also fluoresce in a red colour. The control stems placed in rhodamine B have red fluorescence in all xylem bundles far up into the stem.

Absorption also occurs in older stem where the hairs had been naturally shed, but only in the peripheral layers.

Sections of normal control stems placed in a drop of rhodamine B show the same results as above except that the stalk cell walls do not fluoresce red, but instead retain their own blue-white colour.

Following absorption over a three-day period there is no sign of the stain in the xylem. The xylem in stems placed in the stain give similar negative results. The reason may be that rhodamine B is a redox-indicator which develops into a non-visible leuco-compound (Stadelmann & Kinzel 1972).

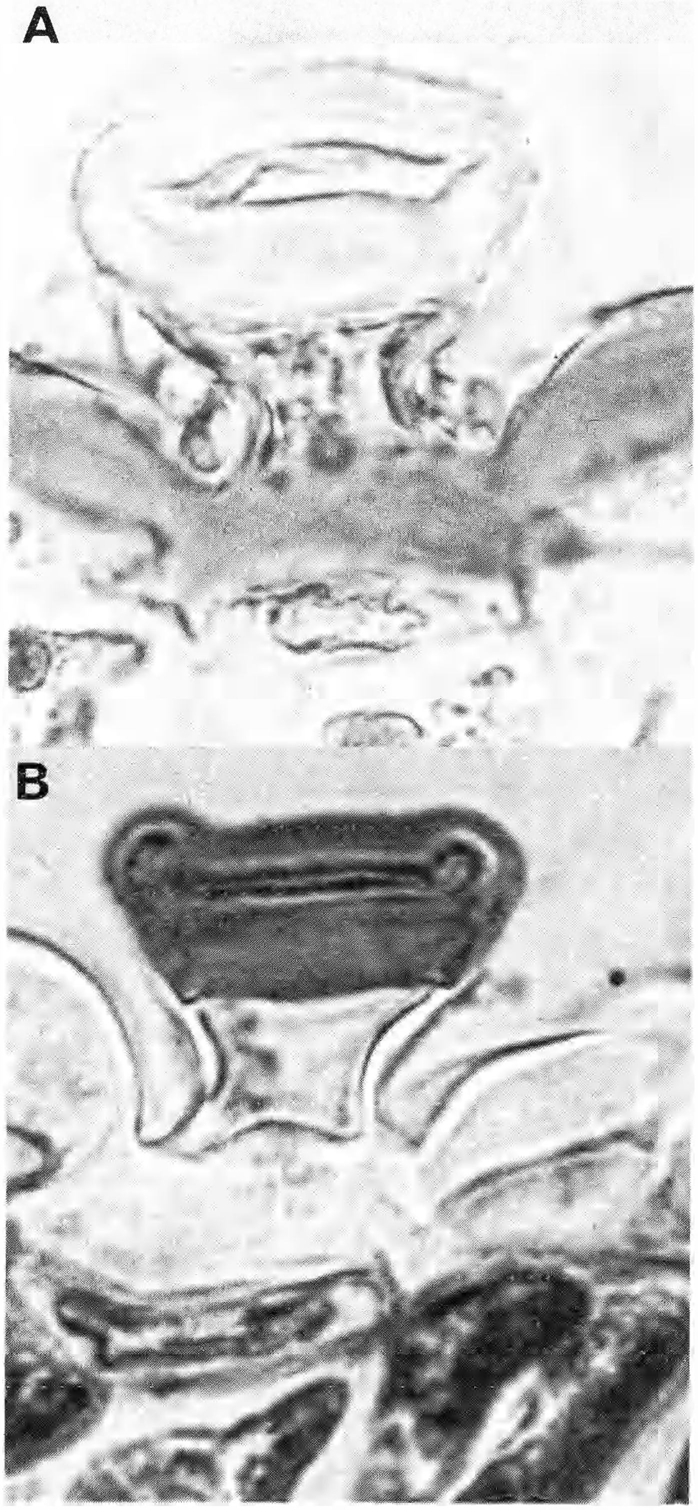

Fig. 5. Trichome, cross section. – A: Swollen "hair cell". Sudan IV. – B: Dehydrated "hair cell". Safranin fast-green. – Basal cell below level of epidermis. × 1280.

Discussion

In *Spartocytisus filipes* the thick walls between the cells of the hairs, especially the cutinized wall between the stalk cell and the basal cell, are not indicative of a water-absorbing function. On the other hand, the swelling of hydrated and the collapse of dehydrated "hair cell" walls are suggestive of such a function. This possibil-

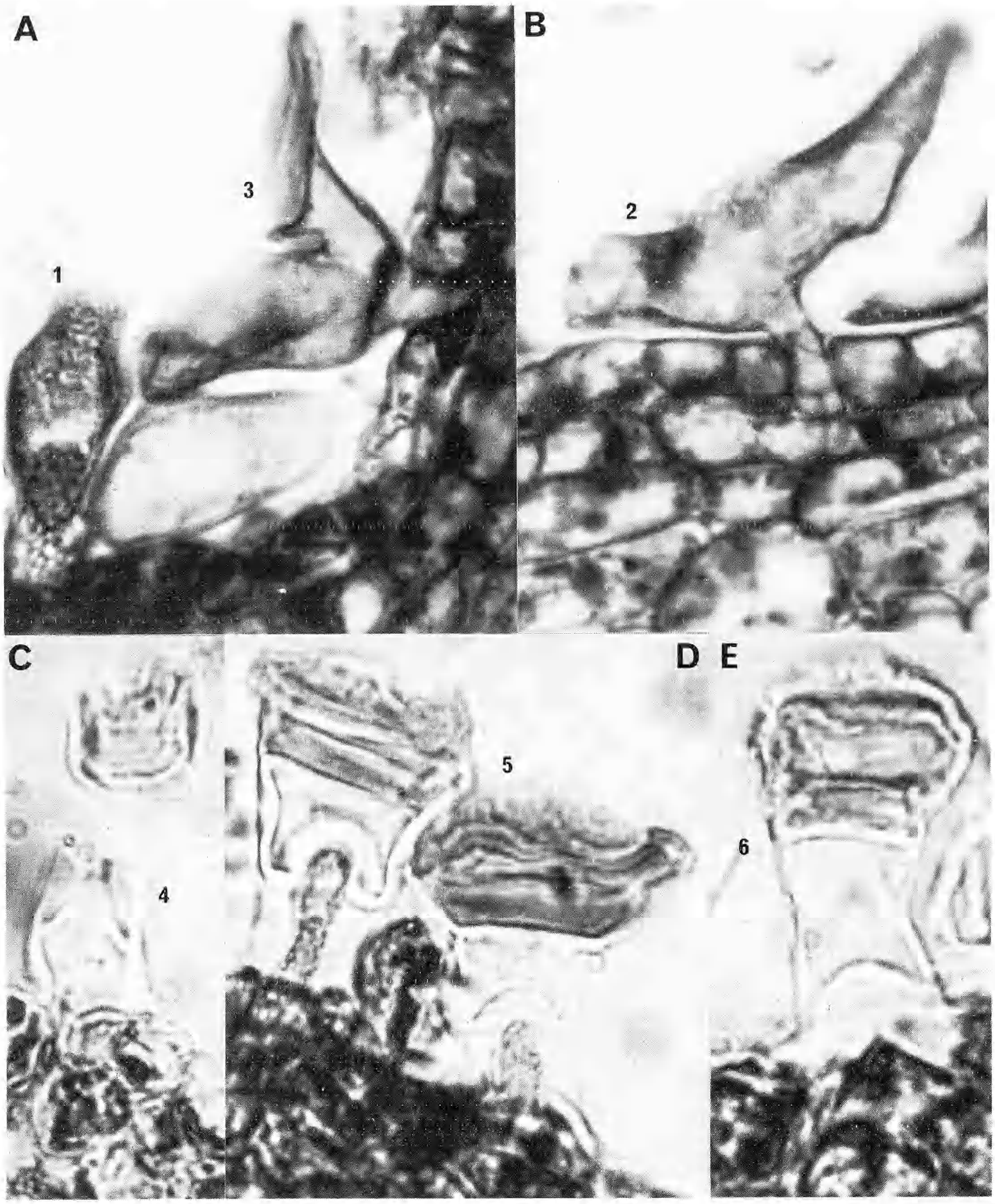

Fig. 6. Development of trichome in six stages (nos. 1–6). – 1. (A): Protruding epidermal cell. – 2. (B): Outer part of cell elongates parallel to surface. – 3. (A): Apical cell established by wall formation. – 4. (C): Formation of wall between stalk cell and basal cell. Wall develops centripetally (see Lems & Holzapfel 1968). "Hair cell" torn away. – 5. (D): Further development of wall. Basal cell bulges into stalk cell. Between the mature hairs trichome in stage 1. – 6. (E): Withdrawal of basal cell forming thick cutinized wall. – Johansen's quadruple stain. × 1245.

ity is supported by the large content of pectic substances and the ultrastructure of the "hair cell" wall. In the secondary wall of this cell the orientation of the cellulose microfibrils is parallel to the cell axis. This feature allows for better water absorption than when fibrils are arranged in a helix as they usually are in most secondary cell walls. The primary wall is exceptionally thick, presumably supporting the cell when it swells or shrinks according to its water status.

The swelling of the "hair cell" and the marked difference in staining response of the cutinized walls of the stalk cell following rhodamine B treatment, being red after absorption but giving no reaction in the control sections, suggests that absorption occurs through the cell walls of the trichomes. The passage through the thick cutinized wall between the stalk cell and the basal cell may possibly be due to a high content of hydrophilic pectic substances in this wall and, perhaps, also to the presence of microchannels. These features are also found in the outer wall of normal epidermal cells, the microchannels being pectin-rich according to the hydroxylamine-ferric chloride reaction (Lyshede 1974). As seen in the fluorescence microscope the further water transport occurs mainly through the apoplast. This may be due to a water potential gradient caused by the tension of the water in the xylem elements. Osmotic forces may add to this.

The collapse of the apical cell when it is dehydrated suggests a valve-like function. This is well known in the Bromeliaceae, the peltate trichomes of which "collapse" during dehydration (Haberlandt 1924). Cowan (1950) describes water absorption in the peltate hairs in the leaves of *Rhododendron*. During dry seasons these hairs collapse, secreting a material that covers the trichomes thus checking transpiration.

It was shown by Meusel (1965) in *Spartocytisus supranubius*, a plant having the appearance of a rolled-up hedgehog, how it "caught" water from clouds drifting through it. *S. supranubius* grows in the upper of three vertical climate zones on the Canary Islands under conditions similar to, but much more xeric than the lowest zone where *S. filipes* grows. Water from fog or dew must likewise easily condense on the stiff slender branches of *S. filipes*. The water runs along the branches to the ground from where the roots can absorb it. However, while covered by water, the results of this study indicate that the trichome-bearing branches must be able to absorb much of it.

Being similar in their morphology and anatomy, both species must be considered to have adaptive characters for water absorption from rain, dew, fog, or clouds in a xeric climate. The dense hairy cover of the shoot apex will be able to supply this vulnerable part of the plant immediately whenever water is available. However, the physiological and ecological significance of this absorption mechanism cannot be estimated from this experiment as the amount of water necessary for supporting life in this plant is unknown.

The wide range of functions connected with plant hairs is reviewed by Netolitzky (1932), Uphof (1962) and Johnson (1975). One is the lowering of transpiration. Under the dense layer of hairs, the shoot apex is covered by a thin cuticle which by itself provides little protection against cuticular transpiration. The space between the cuticle and the trichomes, probably filled with damp air, will lower cuticular transpiration. Furthermore, the wind will be kept away. Because the hairs develop at random, any gaps in the hair cover can be filled when they arise, e.g., due to stretching of the shoot.

The warty surfaces of the hairs are shiny, showing reflection of light thus protecting the photosynthetic apparatus against too much light. It is reasonable also that the plant temperature is lowered by this reflection of light as much of the light energy is lost to the plant in this way.

Thus the trichomes of *S. filipes* may function in different ways to protect the young stem apices of the plant. The functions are probably carried out simultaneously, and therefore the plant is able to cope with whatever kind of external conditions arise. Together with other features of the plant, the hairs help it to survive the conditions of the habitat.

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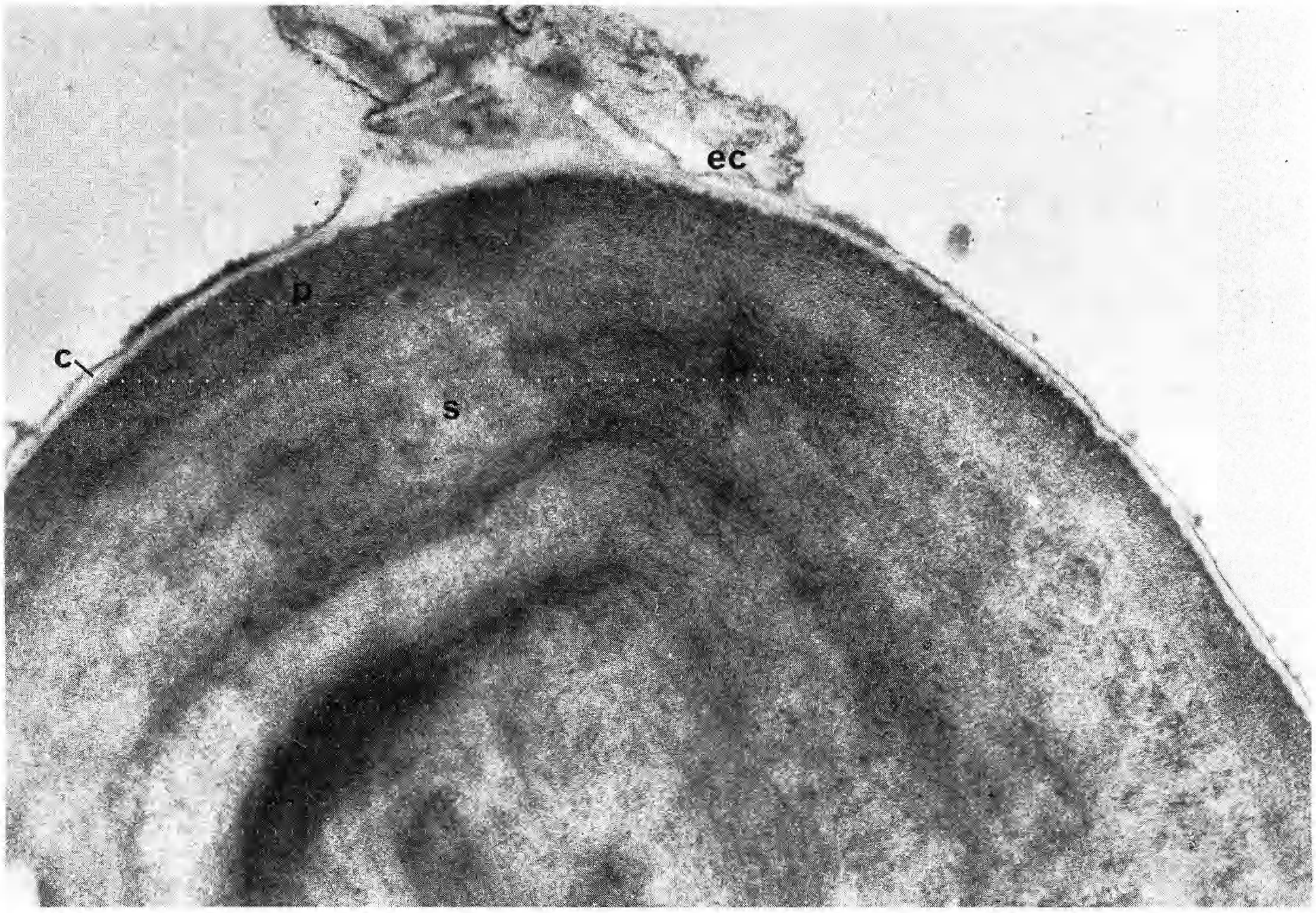

Fig. 7. Trichome, cross section. ec epicuticular material, c cuticle, p primary wall, s secondary wall, four layers separated by pectic zones. Electron micrograph. ×37,000.

References

Anderson, T. F. 1951: Techniques for the preservation of three-dimensional structure in preparing specimens for the electron microscope. *Trans. N. Y. Acad. Sci. Ser. 2, 13:* 130–134.

Burchard, O. 1929: *Beiträge zur Ökologie und Biologie der Kanarenpflanzen.* Stuttgart.

Ceballos, L. & Ortuno, F. 1951: *Vegetación y flora forestal de las Canarias Occidentales.* Madrid.

Coté, W. A. & Day, A. C. 1962: The G-layer in gelatinous fibres. Electron microscopic studies. *Forest. Prod. Jour. 12:* 333–338.

Cowan, J. M. 1950: *The Rhododendron leaf.* Edinburgh.

Drawert, H. 1968: Vitalfärbung und Fluorochromierung pflanzlicher Zellen und Gewebe. *Protoplasmatologia II D3.*

Frey-Wyssling, A. 1959: *Die pflanzliche Zellwand.* Berlin, Heidelberg und Göttingen.

Haberlandt, G. 1924: *Physiological plant anatomy.* Leipzig.

Jensen, W. A. 1962: *Botanical histochemistry.* San Francisco and London.

Johansen, D. A. 1940: *Plant microtechnique.* New York and London.

Johnson, H. B. 1975: Plant pubescence: an ecological perspective. *Bot. Rev. 41:* 233–258.

Juniper, B. E., Cox, C. G., Gilchrist, A. J. & Williams, P. R. 1970: *Techniques for plant electron microscopy.* Oxford and Edinburgh.

Lems, K. 1960: Floristic botany of the Canary Islands. *Sarracenia 5.*

– & Holzapfel, C. M. 1968: Evolution in the Canary Islands. I. Phylogenetic relations in the genus Echium (Boraginaceae) as shown by trichome development. *Bot. Gaz. 129:* 95–107.

Lyshede, O. B. 1974: *Anatomical studies of Spartocytisus filipes, Spartocytisus nubigenus and Genista aetnensis in relation to their ecological conditions and with special reference to the epidermal structures.* [In Danish.] Thesis, Copenhagen.

Marloth, R. 1910: Notes on the absorption of water by aerial organs of plants. *Trans. Roy. Soc. S. Africa 1:* 429–433.

– 1926: Weitere Beobachtungen über die Wasseraufnahme der Pflanzen durch oberirdische Organe. *Ber. Deutsch. Bot. Ges. 44:* 448–455.

Meusel, H. 1965: Die Reliktvegetation der Kanarischen Inseln in ihre Beziehungen zur süd- und mitteleuropäischen Flora. *In* M. Gersch: *Gesam-*

Fig. 8. Trichome, cross section. Artificial holes in secondary wall due to direction of microfibrils. Legends as in Fig. 7. Electron micrograph. ×36,000.

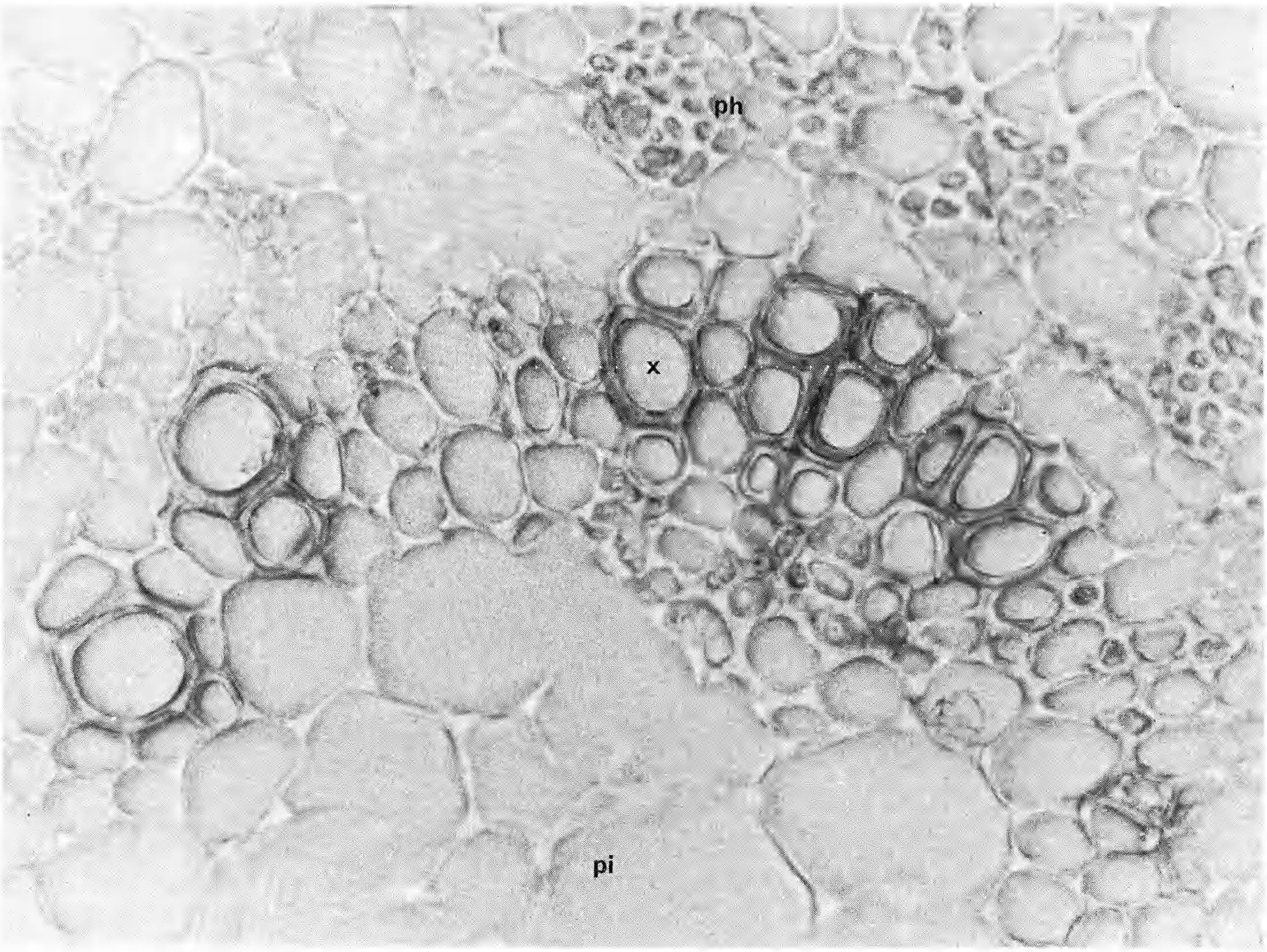

Fig. 9. Vascular tissues in stem. x xylem, ph phloem, pi pith. The walls of water-transporting xylem elements stained with absorbed rhodamine B solution. Secondary thickening of stem has not begun. ×640.

melte Vorträge über moderne Probleme der Abstammungslehre 1: 117–136. Jena.

Netolitzky, F. 1932: Die Pflanzenhaare. *Handb. d. Pfl.-anat. IV, 1.* Berlin.

Pellegrin, F. 1908: Recherches anatomiques sur la classification des Genets et des Cytises. *Ann. Sci. Nat. IX. Ser. 7:* 129–320.

Stadelmann, E. J. & Kinzel, H. 1972: Vital staining of plant cells. *In* D. M. Prescott: *Methods in cell physiology 5:* 325–372. New York and London.

Taylor, R. A. 1937: Studies on the genera Cytisus and Genista. *Trans. Bot. Soc. Edinb. 32:* 278–286.

Uphof, J. C. T. 1962: Plant hairs. *Handb. d. Pfl.-anat. IV, 5.* Berlin–Nikolassee.

Volkens, G. 1887: *Die Flora der aegyptisch-arabischen Wüste auf Grundlage anatomisch-physiologischer Forschungen.* Berlin.

Konidienproduktion und -kolonisation von Süsswasser-Hyphomyceten im Kaltisjokk (Lappland)

Agnes Müller-Haeckel und Ludmilla Marvanová

Müller-Haeckel, A. & Marvanová, L. 1977 01 28: Konidienproduktion und -kolonisation von Süsswasser-Hyphomyceten im Kaltisjokk (Lappland). [Conidia production and colonization by freshwater Hyphomycetes in Kaltisjokk (Lapland).] *Bot. Notiser 129:* 405–409. Stockholm. ISSN 0006-8195.

Conidia of Hyphomycetes were counted continuously during one vegetation period in the drift from Kaltisjokk, a tributary of the river Stora Lule Älv, which is situated on the Arctic Circle in N Sweden. The highest number of conidia occurred in September–October (coinciding with leaf-fall). No diurnal variation in the conidial drift has been detected. Altogether seven species of Hyphomycetes were found. The dominant species were *Flagellospora curvula* and *Lemonniera centrosphaera,* the latter new to Sweden. Conidia which had been caught on plexiglass slides (total area 10 cm^2) during two-hour periods were compared with those in the drift. No superiority in colonization of tetraradiate conidia over sigmoid conidia has been found.

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Die Süsswasser-Hyphomyceten sind als eine eigene ökologische Gruppe von Ingold (1942) erkannt und von ihm eingehend untersucht worden. Ähnliche floristische Studien dieser Gruppe sind später in anderen Ländern durchgeführt worden. In Schweden hat Nilsson (1964) eine umfassende Bestandsaufnahme der Süsswasser-Hyphomyceten des Landes geliefert. Die Artenzahl nimmt vom Süden nach Norden markant ab: Nilsson (1964) fand nur fünf der 39 für ganz Schweden bekannten Arten in Torne Lappmark.

Bei Untersuchungen an einzelligen, benthischen Algen im Kaltisjokk, einem ca. 20 km nördlich des Polarkreises verlaufenden Zufluss zum St. Lule Älv wurden 1967 regelmässig Konidien von Hyphomyceten gefunden. Die Resultate der während einer Vegetationsperiode in den Proben gefundenen Hyphomyceten-Konidien sollen hier dargelegt werden.

Methoden

Die Konidien im frei fliessenden Wasser wurden aus Proben, in Zweistunden-Intervallen über 24 Stunden (automatische Probenentnahme) oder um 10:00 in 14 Tage-Intervallen an fünf resp. drei verschiedenen Lokalen (Abb. 1) im Kaltisjokksystem entnommen, bestimmt und ausgezählt (Konidien/Liter Bachwasser).

An fünf Lokalen (Abb. 1) wurden Plexiglasplättchen von 10 cm^2 Gesamtoberfläche jeweils über zwei Stunden während einer 24-Stundenperiode im Bach exponiert (Anzahl Konidien/10 cm^2 Fläche, 2 Stunden; z. T. automatische Probenentnahme). Die Plättchen wurden nach der Exposition in dest. Wasser ausgeschüttelt und die Proben mit Jodjodkali fixiert. Alle Proben wurden unter dem Planktonmikroskop quantitativ ausgewertet (Methodenbeschreibung siehe auch Müller-Haeckel 1967, 1970).

Ergebnisse

Von den Süsswasser-Hyphomyceten ist bekannt, dass sie als Saprophyten auf im Wasser liegendem, verrottendem Laub verschiedener Gehölze (in Nordschweden *Alnus, Salix, Betula*) leben und Konidien produzieren. Diese werden

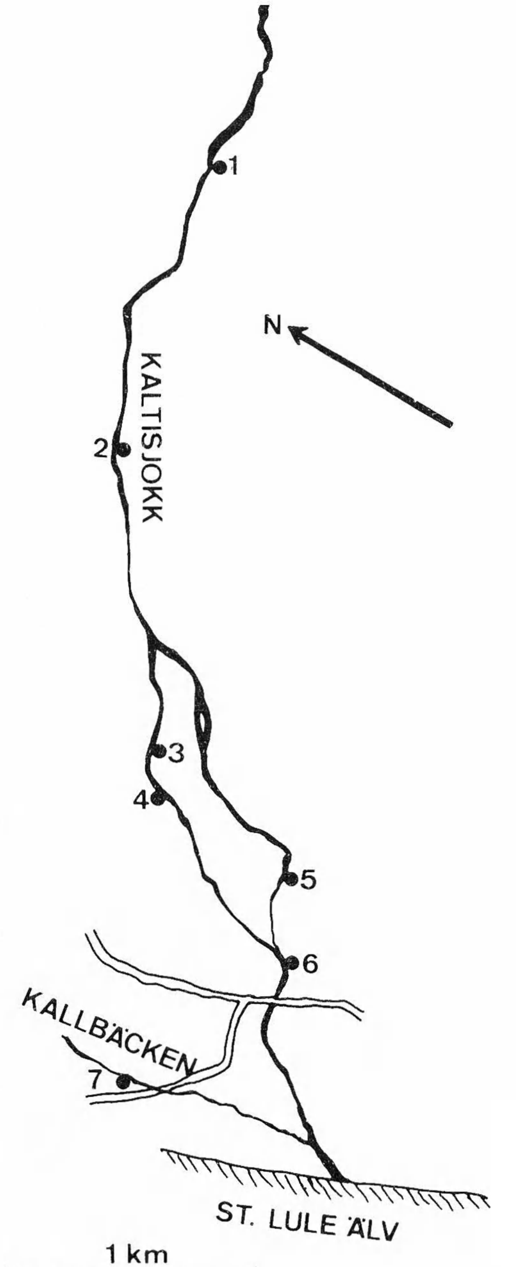

Fig. 1. Map of the Kaltisjokk area with the seven Untersuchungslokalen. – (1) Ruhig fliessendes Wasser bis zu 1 m tief. – (2) Stark strömendes Wasser 0,50 bis 0,75 m tief. – (3) In der Mitte eins 100 m langen Wasserfalles 0,10 bis 0,30 m tief. – (4) Auslauf aus einer ca. 3 m tiefen Stillwasserzone. – (5) Seitenarm der Kaltisjokk, 0,05 bis 0,10 m tief. – (6) Ruhig fliessender Bachbereich, ca. 0,70 m tief. – (7) Kallbäcken, ca. 1 m breit und 0,20 bis 0,40 m tief.

Fig. 1. Map of the Kaltisjokk area with the seven localities studied. – (1) Slowly flowing water, up to 1 m deep. – (2) Rapidly flowing water, 0.50–0.75 m deep. – (3) In the centre of a waterfall about 100 m long; water depth 0.10–0.30 m. – (4) Outflow from a zone with still water, c. 3 m deep. – (5) Branch of the Kaltisjokk, 0.05–0.10 m deep. – (6) Slowly flowing water, c. 0.7 m deep. – (7) The rivulet Kallbäcken, c. 1 m broad and 0.20–0.40 m deep.

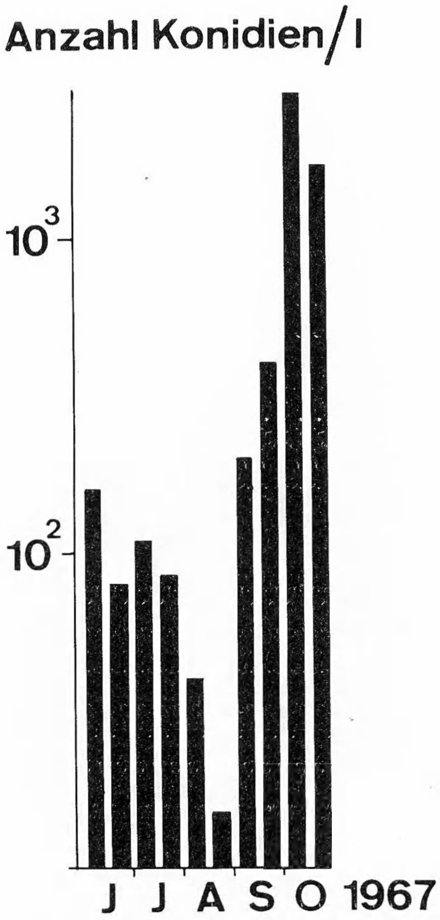

Abb. 2. In der Drift gefundene Hyphomyceten-Konidien (Summe der Konidien aller Arten) im unteren Kaltisjokk (Lokal 6, Abb. 1) von Juni bis Oktober 1967. Ordinate: Anzahl Konidien/Liter Bachwasser, Abszisse: Zeit in 14-Tageintervallen.

Fig. 2. Number of conidia per l water (vertical axis) in Kaltisjokk (locality 6, Fig. 1) from June to October 1967 (horizontal axis, intervals of two weeks).

freigesetzt, sobald sie ausgereift sind. Die meisten Untersuchungen an Hyphomyceten wurden in der Weise durchgeführt, dass verrottende Laubblätter aus den Bächen gesammelt und auf ihre Pilzflora untersucht wurden. Unsere, während einer Vegetationsperiode kontinuierliche Untersuchung der im Wasser treibenden Konidien betrifft die Konidien- Freisetzungsaktivität der Hyphomyceten bzw. der Aktivität, die hinter der Konidienproduktion steht. Die meisten Hyphomyceten-Spezialisten sind zu dem Resultat gekommen, dass Hyphomyceten während des ganzen Jahres an den geeigneten Plätzen zu finden seien mit Bevorzugung von Herbst, Winter und frühem Frühjahr (Ingold 1942, 1975, Ranzoni 1963, Nilsson 1964, Marvanová & Marvan 1963, Iqbal & Webster 1973). Nach unserer Untersuchung

Tabelle 1. Konidiendrift (Konidien/Liter) von Hyphomyceten von fünf Lokalen im Kaltisjokksystem in Zweistundenintervallen am 8. Juli 1967.

Table 1. Drift of hyphomycete conidia (conidia per liter) on five localities along Kaltisjokk 8.7. 1967 (intervals of two hours). Code to the localities in Fig. 1.

Lokal (Locality)	Zeitintervall (Time interval)											
	0–2	2–4	4–6	6–8	8–10	10–12	12–14	14–16	16–18	18–20	20–22	22–24
Wasserfall (Lokal 3)	160	280	–	320	160	200	200	200	40	240	160	160
Stillwasserauslauf (Lokal 4)	80	120	240	120	200	200	440	160	240	480	120	200
Seitenarm (Lokal 5)	240	160	160	1040	680	360	120	240	200	320	600	400
Kaltisjokk V (Lokal 6)	280	280	40	120	280	240	200	400	240	280	440	240
Kallbäcken (Lokal 7)	120	360	80	80	200	240	120	320	240	160	440	360

zeigt die Aktivität der Konidienproduktion an einem Ort im Bach (Lokal 6, Abb. 1) eine ausgeprägte jahreszeitliche Variation (Abb. 2). Im Frühjahr und vor allem im Herbst (September–Oktober) liegen die Werte der Konidien per Liter Bachwasser hoch über denen vom Sommer, speziell August. Dasselbe zeigten zwei weitere Lokale im Kaltisjokk (Lokal 1 und 2, Abb. 1), aber mit geringeren Konidienmengen.

Das Maximum der Konidiendrift fällt mit dem Laubfall, also Substratreichtum, für diese Pilze zusammen. Die Konidienproduktion ist nicht positiv mit der Wassertemperatur korreliert, denn diese liegt im Kaltisjokk im Juli/August am höchsten mit Werten bis zu 18°C, während sie im Oktober bereits auf 7°C (Anfang Oktober) bis 0,4°C (Ende Oktober) gesunken ist (Müller 1970).

Tabelle 1 zeigt die Anzahl treibender Konidien am 8. Juli 1967 von fünf verschiedenen Lokalen im Kaltisjokksystem. Die je zwölf Werte des Tages lassen keine tagesperiodische Ordnung der Konidien-„Drift" erkennen, wie wir sie z.B. für einzellige, benthische Algen in fliessenden Gewässern finden (Müller-Haeckel 1973). Vielmehr variierten die Konidienmengen im Bach stark und unregelmässig während einer 24-Stundenperiode. Die vier ersten Lokale in der Tabelle 1 folgen in der Strömungsrichtung des Kaltisjokk aufeinander (Abb. 1). Eine Anhäufung von Konidien in den unteren Bachbereichen fand nicht statt.

Insgesamt wurden im Kaltisjokk Konidien von sieben verschiedenen Hyphomycetenarten gefunden, im sommerkalten Zufluss, Kallbäcken, dagegen nur vier (mit * versehen):

Flagellospora curvula Ingold* (Abb. 3 D; von Nilsson (1964) für Torne Lappmark angegeben)

Lemonniera centrosphaera Marv.* (Abb. 3 A, B; erstmals in Schweden gefunden)

Anguillospora longissima (Sacc. & Syd.) Ingold* (Abb. 3 C)

Geniculospora inflata (Ingold) Nilsson ex Marvanová & Nilsson* (Abb. 3 E)

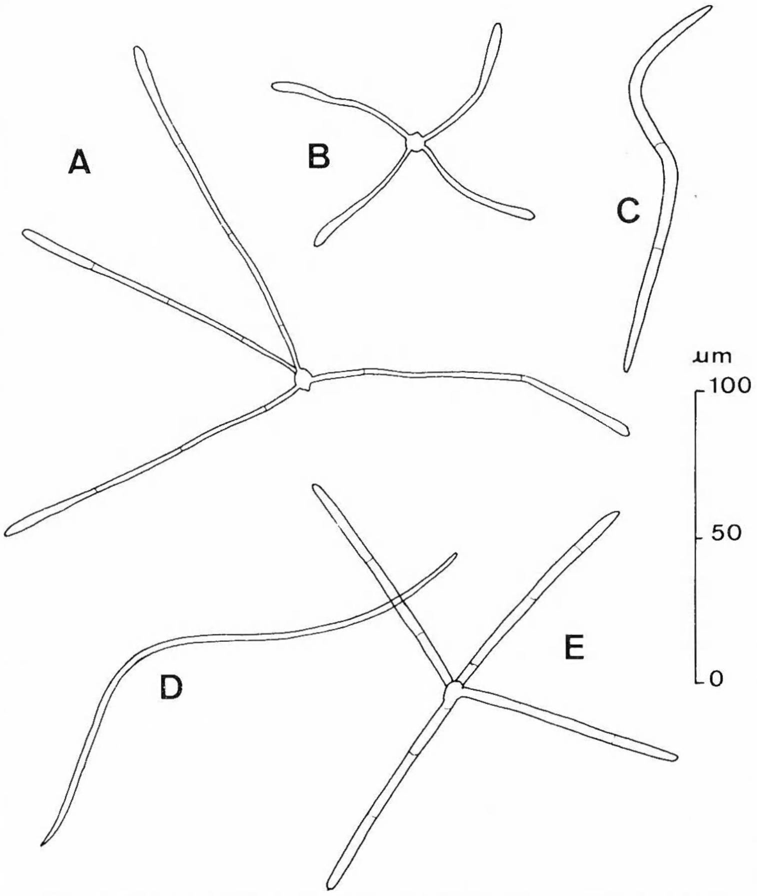

Abb. 3. Konidien der vier häufigsten im Kaltisjokk vorkommenden Hyphomycetenarten. *(Conidia of the four commonest species of Hyphomycetes in Kaltisjokk.)* – A, B: *Lemonniera centrosphaera.* – C: *Anguillospora longissima.* – D: *Flagellospora curvula.* – E: *Geniculospora inflata.*

Tabelle 2. Drift (Anzahl Konidien/Liter) und Kolonisation (Anzahl Konidien/10 cm^2 und 2 Stunden), beides Mittelwerte aus 12 Zweistundenintervall-Proben, und der Quotient aus beiden (D:K) von *Flagellospora curvula* (sigmoid) und *Lemonniera centrosphaera* (tetraradiat) von vier Lokalen.

Table 2. Drift (number of conidia per liter) and colonization (number of conidia per 10 cm^2 and 2 hours; both are means from 12 intervals of two hours), and the quotient (D:K) between them. *Flagellospora curvula* is sigmoid and *Lemonniera centrosphaera* is tetraradiate. Four localities in the Kaltisjokk area.

Lokal	*Flagellospora*	*Lemonniera*
Kaltisjokk (Lokal 6) 8.7. 1967		
Drift	200	53
Kolonisation	98	16
D:K	2.0	3.3
Kaltisjokk (Lokal 6) 16.9. 1967		
Drift	1093	87
Kolonisation	401	150
D:K	2.7	0.6
Kallbäcken (Lokal 7) 8.7. 1967		
Drift	63	163
Kolonisation	47	9
D:K	1.3	18
Kallbäcken (Lokal 7) 16.9. 1967		
Drift	227	37
Kolonisation	190	26
D:K	1.2	1.4
Seitenarm (Lokal 5)		
Drift	243	133
Kolonisation	112	17
D:K	2.2	7.8
Stillwasserauslauf (Lokal 4)		
Drift	203	13
Kolonisation	215	3
D:K	0.9	4.3

Lemonniera aquatica de Wild (von Nilsson (1964) für Torne Lappmark angegeben)
Lemonniera terrestris Tubaki
Tricellula aurantiaca (Haskins) Arx

Dominierend traten die beiden erst genannten Arten im Kaltisjokk auf, die beiden folgenden Arten in der Liste waren seltener und die Konidien der drei zuletzt genannten wurden nur vereinzelt im Kaltisjokk, dagegen gar nicht im Kallbäcken gefunden.

Diskussion

Ingold (1959, 1966) weist auf die ökologische Bedeutung der Konidienform hin, indem er meint, dass tetraradiate Formen leichter auf dem Substrat kolonisieren oder haften als sigmoide Formen.

Webster (1959) hat im Laboratorium experimentell belegt, dass tetraradiate Konidien leichter oder fester an Glasstäbchen im strömenden Wasser haften als sigmoide Konidien. Für die beiden dominierenden Hyphomycetenarten im Kaltisjokk (*Flagellospora curvula* mit sigmoider Konidienform und *Lemonniera centrosphaera* mit tetraradiater Konidienform) konnten wir dies bei Plexiglasplättchen als Substrat nicht bestätigen. Tabelle 2 zeigt Drift und Kolonisation der Konidien der beiden genannten Arten jeweils als Mittelwerte von 12 Zweistundenintervallproben eines Tages von vier Lokalen und aus zwei Jahreszeiten. Der Quotient Drift/Kolonisation als Ausdruck für Effektivität der Kolonisation lässt nur in einem Fall *Lemonniera* in der Kolonisation *Flagellospora* überlegen erscheinen. Die Quotientwerte zeigen, dass *Flagellospora curvula* in der Kolonisation auf Plexiglas stetiger ist als *Lemonniera centrosphaera,* deren Kolonisationseffektivität sehr wechselnd war. Unsere Ergebnisse sind mit denen von Webster (1959) nicht direkt vergleichbar. Während Webster mit quer zur Strömungsrichtung und vertikal orientierten Glasstäbchen arbeitete, deren Oberfläche mit einer dünnen Kollodiumschicht versehen war, beziehen sich unsere Werte auf in der Strömungsrichtung und horizontal exponierte Plexiglasplättchen. Am Lokal 3 (Abb. 1) im Wasserfall wurden keine Konidien auf den ausgesetzten Plexiglasplättchen gefunden.

Zitierte Literatur

Ingold, C. T. 1942: Aquatic hyphomycetes of decaying alder leaves. *Trans. Br. Mycol. Soc. 25:* 339–417.
– 1959: Submerged aquatic hyphomycetes. *J. Quekett Microscop. Club Ser. 4, 5:* 115–130.
– 1966: The tetraradiate aquatic fungal spore. *Mycologia 58:* 43–56.
– 1975: An illustrated guide to aquatic and waterborne hyphomycetes (Fungi imperfecti) with notes on their biology. *Freshwater Biol. Ass. Sci. Publ. No. 30.*
Iqbal, S. H. & Webster, J. 1973: Aquatic hyphomycete spora of the river Exe and its tributaries. *Trans. Br. Mycol. Soc. 61:* 331–346.

Marvanová, L & Marvan, P. 1963: Einige Hyphomyceten aus den fliessenden Gewässern des Hrubý Jeseník. *Acta Musei Silesiae Ser. A, 12:* 101–118.

Müller, K. 1970: Das Untersuchungsgebiet der ökologischen Station Messaure. *Oikos, Suppl. 13:* 9–13.

Müller-Haeckel, A. 1967: Tages- und Jahresperiodik von Ceratoneis arcus Kütz. *Oikos 18:* 351–356.

– 1970: Tages- und Jahresperiodik einzelliger Algen in fliessenden Gewässern. *Österreichs Fischerei 23:* 97–101.

– 1973: Experimente zum Bewegungsverhalten von einzelligen Fliesswasseralgen. *Hydrobiologia 41:* 221–246.

Nilsson, S. 1964: Freshwater hyphomycetes. *Symb. Bot. Upsal. 18(2):* 5–130.

Ranzoni, F. V. 1953: The aquatic hyphomycetes of California. *Farlowia 4:* 353–398.

Webster, J. 1959: Experiments with spores of aquatic hyphomycetes. *Ann. Bot., N. S. 23:* 595–611.

Species of Urocystis on Juncaceae

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Vánky, K. 1977 01 28: Species of Urocystis on Juncaceae. *Bot. Notiser 129:* 411–418. Stockholm. ISSN 0006-8195.

Drawings and descriptions are given for the species of *Urocystis* (Ustilaginales) on Juncaceae, viz., *U. johansonii* (Lgh.) Magn., *U. junci* Lgh., *U. lagerheimii* Bub., *U. luzulae* (Schröt.) Winter and *U. tothii* Vánky sp. nov. (on *Juncus compressus* Jacq.). The type collection of *U. lagerheimii* var. *obscura* (Liro) Zundel belongs to *U. tothii*.

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In the summer of 1974 the Hungarian mycologist Dr Sándor Tóth collected at Hortobágy (Hungary) many samples of *Juncus compressus* Jacq. heavily infected by a species of *Urocystis*. I have compared the samples with all known species of *Urocystis* on *Juncus* and *Luzula* and found it different. It is described here as a new species under the name of *Urocystis tothii* Vánky in honour of its discoverer.

Material and methods

I have made the studies and descriptions of the species – wherever this was possible – by investigating the type specimens (indicated by exclamation (!) points), as well as other material. The spores have been studied in lactophenol solution heated to the boiling point to give the spores their original turgidity. The dark spores were first discoloured under cover glass in 30 % hyperoxide solution for about 30 minutes. The measurements were made at 1000 ×. To establish the ratio spores/spore balls, 200 spore balls were counted. A list of studied specimens is given at the end of the description of each species. The names of herbaria are abbreviated according to Index Herbariorum. HUV stands for the author's private herbarium (Herbarium Ustilaginales Vánky)

Key to the species of Urocystis on Juncaceae

1. On *Luzula* .... 4. *U. luzulae*
   On *Juncus* 2
2. Spores large, 16–24 μm in length .... 3. *U. lagerheimii*
   Spores smaller, 10–17 μm in length 3
3. The number of spores in a spore ball 1–20 or more. Sori in the interior of the culms .... 2. *U. junci*
   The number of spores in a spore ball fewer, 1–10 4
4. Sori as bulb-like swellings in the basal part of leaves. One-spored spore balls few (< 10 %) . 1. *U. johansonii*
   Sori as streaks in the leaves and culms. One-spored spore balls not so few (> 10 %) .... 5. *U. tothii*

1. **Urocystis johansonii** (Lagerheim) Magnus

Magnus, Verh. Bot. Ver. Prov. Brandenb. 37, Abh.: 94, 1895. – *Urocystis junci* Lgh. *β. johansonii* Lgh., Bot. Not. 1888(5): 201, 1888. – *Tuburcinia johansonii* (Lgh.) Liro, Ann. Univ. Fenn. Abo. A. 1(1): 34, 1922. – *Type* on *Juncus bufonius* L., Sweden, Småland, Ö. Torsås par., Sunnansjö, 18.VII. 1887, C. J. Johanson (!); Vgr. M. rar. sel. 11 (!).

Sori (Fig. 1) as swellings in the basal parts of rosular leaves, giving a bulb-like aspect, lead-coloured, at first covered by the epidermis which

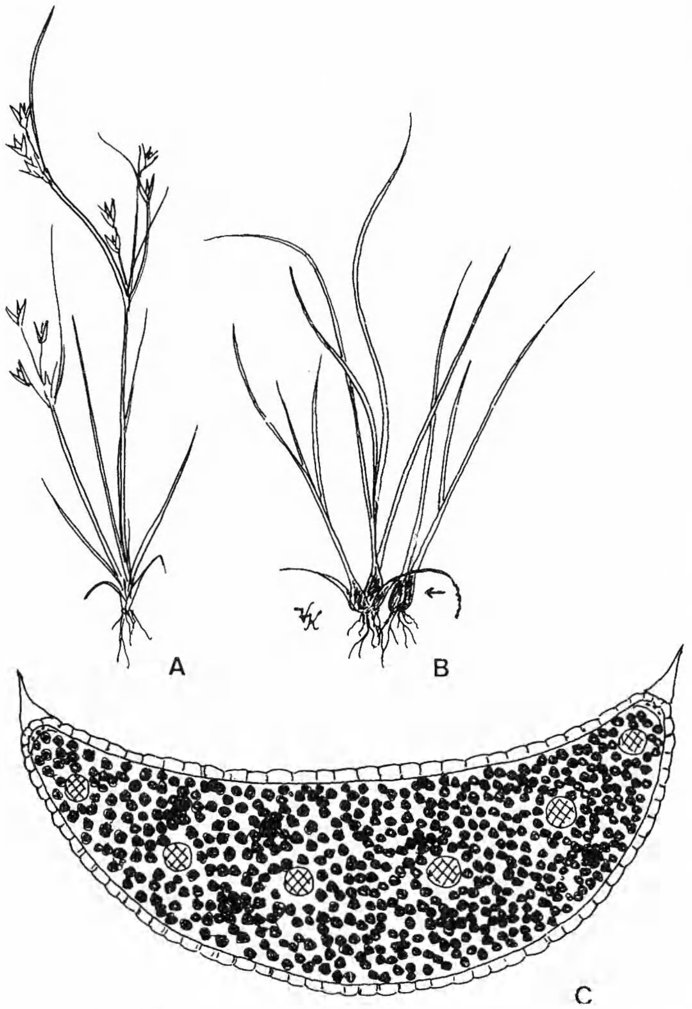

Fig. 1. *Urocystis johansonii* on *Juncus bufonius*. – A: The uninfected host plant. – B: Plant with fungus sori. – C: Cross section through the sorus with the spore mass in the chlorenchyma.

finally ruptures exposing the black, powdery mass of spore balls. *Spore balls* (Fig. 6 A) globose, ovoidal to irregular, 16–32 × 17–38 µm in diam., composed of 1–7(–10) central spores surrounded by a continuous layer of peripheral sterile cells. *Spores* globose, subglobose or irregular, dark brown, (7.2–)8–12 × (10.4–)11.2–15.2(–16) µm in diam., smooth. *Sterile cells* yellowish-brown, variable in size, 4–12 µm in length, with thick wall on the base and sides (c. 1.2 µm) and thin, smooth wall (c. 0.4 µm) on the free surface, collapsed with age. The infected plants remain sterile.

Distribution: on *Juncus bufonius* L.: Europe (Czechoslovakia, Finland, Norway, Poland, Rumania, Soviet Union, Sweden), N. Africa (Morocco ?, n. v.; Fig. 242 N in Ch. Zambettakis, Les Ustilaginales des plantes d'Afrique (1971) does not represent *U. johansonii*).

Specimens studied. On *Juncus bufonius:* (1) Vgr. M. rar. sel. 11. Suecia, Småland, Ö. Torsås par., Sunnansjö, 18.VII. 1887, C. J. Johanson (sub *Urocystis junci* Lgh. v. *johansonii* Lgh.) (HUV, S) – (2) Fgi. herb. T. Vestergren (idem No. 1) (HUV, S) – (3) Syd. Mycoth. Marchica, 2627. Berlin, Jungfrauheiden, VII. 1889, P. Sydow (sub *Urocystis junci* Lgh. var. *johansonii* Lgh.) (BP, HUV, S, UPS) – (4) Syd. Ustil. 85. Arkt. Norwegen, Jägerwandet pr. Tromsö, VIII. 1893, G. Lagerheim (sub *Urocystis junci* Lgh. b. *johansonii* Lgh.) (BP, BUCM, HUV, LE, S, UPS) – (5) Rbh.-Pzke., Fgi. eur. extraeur. 4106 (idem No. 4) (BP, HUV, S) – (6) Fl. Moravica. Ad viam turisticam Strílky-Vlcák in decl. Chriby, 2.VII. 1931, Zavrel (BRNM) – (7) Romania, Oltenia, rn. Novaci, SE Prigoria, 18.VII. 1955, I. Şerbănescu (BUCM) – (8) Romania, reg. Argeş, rn. Horezu, E. Tg.-Slăveşti, 14.VII. 1960, N. Roman (HUV) – (9) K. Vánky, Ustil. 46. Romania, Transilvania, pr. urbem Hunedoara (Vajdahunyad), 7.VII. 1961, K. Vánky (BP, BUCM, HUV, LE, LD, M, S, UPS) – (10) Romania, Transilvania, pr. urbem Bistriţa (Beszterce) ad pag. Sărata (Besenyö), 5.VII. 1962, N. & Şt. Roman (HUV).

2. **Urocystis junci** Lagerheim

Lagerheim, Bot. Not. 1888(5): 201, 1888. – *Urocystis junci* Lgh. *α genuina* Lgh., Bot. Not. 1888(5): 201, 1888. – *Tuburcinia junci* (Lgh.) Liro, Ann. Univ. Fenn. Abo. A. 1(1): 33, 1922. – *Urocystis junci* Magn., Verh. bot. Ver. Prov. Brandenb. 37: 93, 1895. – *Type* on *Juncus filiformis* L., Switzerland, at the Berninabach near Pontresina, VIII. 1888, G. Lagerheim (!); in Roumeg., Fgi. sel. exs. 4870 (!).

Sori (Fig. 2) in the interior of the culms, filling it with a dusty brownish-black mass of spore balls. The culms often rupture longitudinally (up to 15 cm) disclosing the spore mass. *Spore balls* (Fig. 6 B) globose to irregular, varying in form and size, 20–44 × 22–56(–64) µm in diam., composed of 1–20 (or more) spores completely invested by sterile cells. *Spores* subglobose, ovoidal or slightly irregular, 9.6–12.8 × 11.2–16(–19.2) µm in diam., reddish-brown, smooth. *Sterile cells* variable in shape and size, 5.6–14.4(–16) µm long, light reddish-brown, often collapsed by drying.

Note. A specimen of "*Urocystis junci*" on *Juncus silvaticus* Stems from Great Britain (Herb. IMI 582) has spores and sterile cells much darker than the type. The spore balls are smaller (16–30 × 20–44 µm) and are only 1–8-spored. The spores measure 9.6–12(–12.8) × 12–16 µm. More extensive studies are necessary in order to find out whether it is a separate species. The small fragment obtained was quite insufficient for this purpose.

Distribution: on *Juncus arcticus* Willd. ssp. *intermedius* Hyl.: Europe (Iceland). – *J. balticus* Willd.: Europe (Soviet Union: Latvia), N. America (USA). – *J. biglumis* L.: Greenland. – *J. filiformis* L.: Europe (Austria, Czechoslovakia, Finland, Germany, Poland, Soviet Union, Sweden, Switzerland), Asia (Soviet Union) – *J. silvaticus* Stems: Europe (Great Britain) (?).

Specimens studied. On *Juncus arcticus* ssp. *intermedius:* Fl. Islandica 17217. Kjósarsýsla, Mt Ulfarsfell, ab. 10 km E of Reykjavík, 13.VII. 1962, J. A. Nannfeldt (UPS).

On *Juncus balticus:* (1) Griffiths, East Amer. Fgi. 221. USA, Nev., Quinn River Crossing, VII. 1901, D. Griffiths & Morris (HUV, S) – (2) J. Smarods, Fgi. latvici exs. 805. Prov. Vidzeme, Kr. Riga, Riga-Daugavgriva, 28.VII. 1939, J. Smarods (sub *Tuburcinia junci* (Lgh.) Liro) (LE, M, S) – (3) F. Petrak, Mycoth. gener. 385. (idem No. 2) (M, S, UPS).

On *Juncus biglumis:* Groenlandia bor.-occid., Murchinson Sound, Igdloluansuit. 77,45 N., 20.VIII. 1921, J. N. Nygaard (UPS).

On *Juncus filiformis:* (1) Switzerland, Pontresina, VIII. 1888, G. Lagerheim (BP, S) – (2) Roumeg. Fgi. sel. exs. 4870. (idem No. 1) (S) – (3) Krieger, Fgi. saxon. 604. (a) In der Nähe von Skassa bei Grossenhain, 27.V. 1890; (b) Zwischen Waltersdorf u. Prossen, sächs. Schweiz, 8.VI. 1890, W. Krieger (S) – (4) Syd. Mycoth. Marchica, 3506. Potsdam, Nuthewiesen, 16.VII. 1892, P. Sydow (sub *Urocystis junci* Lgh. *α genuina* Lgh.) (HUV, S) – (5) Syd. Ustil. 43. Pommern, Rügenwaldermünde, VII. 1893, P. Sydow (sub *Urocystis junci* Lgh. *α genuina* Lgh.) (HUV, LE, M, S, UPS) – (6) Syd. Ustil. 347. Bohemia, Tabor, 4.VI. 1904, Fr. Bubák (BP, LE, M, S, UPS) – (7) O. Jaap, Fgi. sel. exs. 223. Thüringien, am Stieglitzteich bei Oberhof, ca. 700 m., 18.VII. 1906, O. Jaap (M, S) – (8) Fl. moravica. Vel. Meziříčí, 18.VIII. 1908, R. Picbauer (BRNM) – (9) Herb. Myc. Kupka, Austria, Steierm., Eisenerz, VII. 1911, T. Kupka (M) – (10) Herb. Myc. Kupka, Görkau, Böhm. Erzgeb., Sommer 1914, T. Kupka (M) – (11) Liro, Mycoth. fenn. 208. Fennia, Nylandia, Kerava, VII. 1915, E. Kitunen (sub *Tuburcinia junci* (Lgh.) Liro) (HUV, M, S) – (12) Herb. R. Picbauer, Ad Valečov pr. Okrastdice (Nem. Brod), 31.VII. 1924, E. Baudyš (BRNM) – (13) F. Petrak, Fl. Bohem. et Morav. exs. 2231. Mähren, Zdár, VII. 1926, R. Picbauer (sub *Tuburcinia junci* (Lgh.) Liro) (M, S) – (14) Fl. moravica, Ad Znetinek pr. Vel. Meziříčí, 7.VIII. 1926, R. Picbauer (sub *Tuburcinia junci* (Lgh.) Liro) (BRNM, S) – (15) Fl. moravica, Znetinek ad Zdár, 8.VIII. 1926, R. Picbauer (sub *Tuburcinia junci* (Lgh.) Liro) (HUV) – (16) Fl. moravica. Prata ad Svetlá pr. Telč. 8.IX. 1927, R. Picbauer. (sub. *Tuburcinia junci*) (BRNM) – (17) Fl. moravica. Vel. Meziříčí ad Olší, 12.VIII. 1928, R. Picbauer (sub *Tuburcinia junci*) (BRNM) – (17) Sweden, Skåne, Osby, 4.VII. 1932, H. Christoffersson (sub *Tuburcinia junci* (Lgh.) Liro) (HUV, LD) – (19) Fgi. exs. fenn. 180. Fennia, Regio Aboensis, Nauvo, Seksnappa, 6.VII. 1946, Lauri E. Kari (sub *Tuburcinia junci* (Lgh.) Liro) (M, S) – (20) Fgi. Cechoslovenici, Kostelec nad Černými Lesy, 26.VIII. 1953, K. Kroan (Herb. M. Soucková in BRNM).

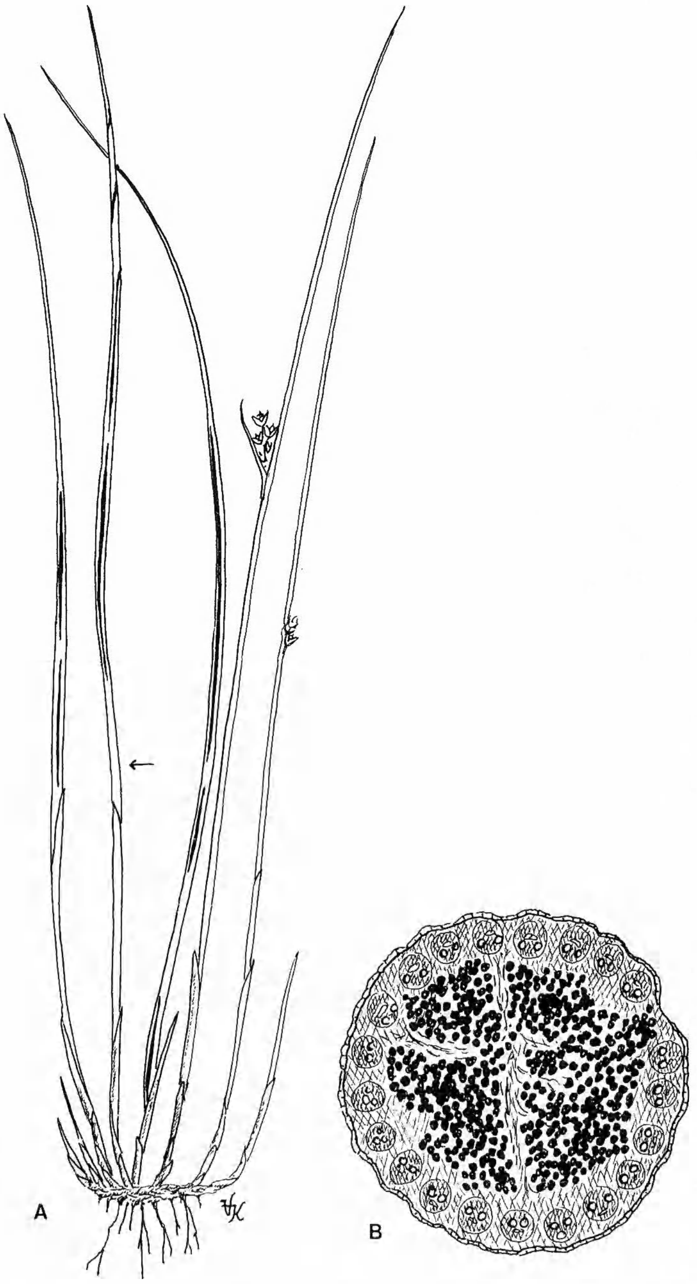

Fig. 2. A: *Urocystis junci* on *Juncus filiformis*. – B: Cross section through the culm with the fungus sori.

On *Juncus silvaticus:* Great Britain, Norfolk, Burnfen Broad, 2.VIII. 1945, E. A. Ellis (IMI).

3. **Urocystis lagerheimii** Bubák

Bubák, Arch. pro přirod. výzkum Čech 15(3): 64, 1912 (n. v.); Arch. Naturw. Landesdurchf. Böhmen 15(3): 63, 1916. – *Tuburcinia lagerheimii* (Bub.) Liro, Ann. Univ. Fenn. Abo. A. 1(1): 35, 1922. – *Type* on *Juncus compressus* Jacq., Sweden, Öland, Borg-

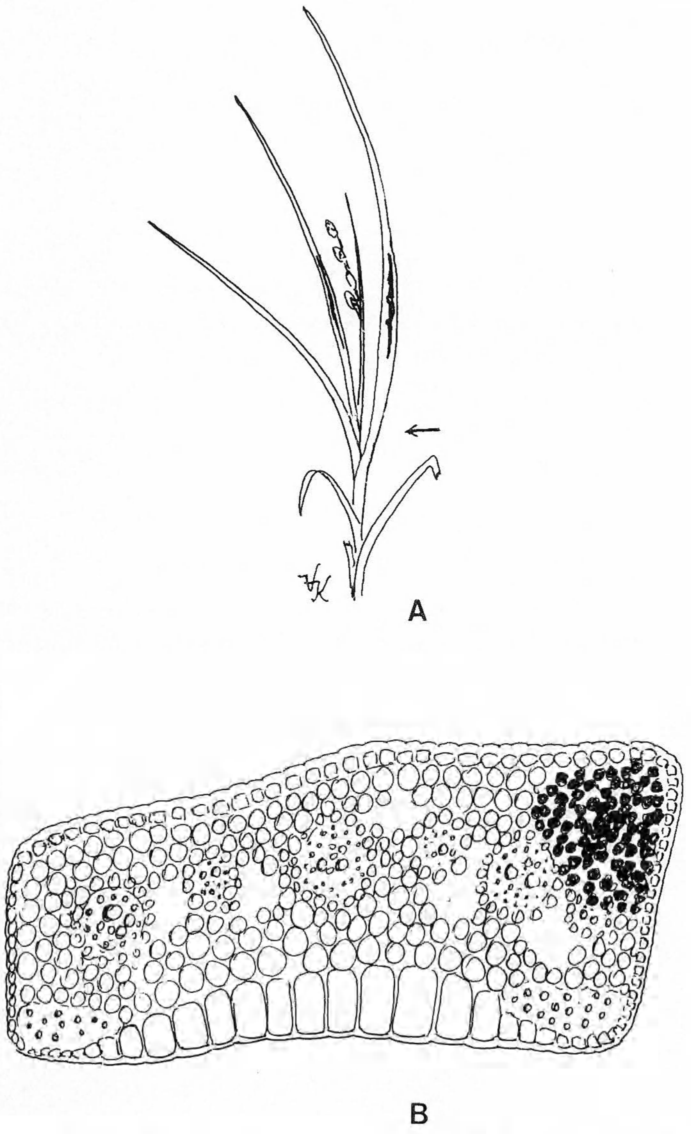

Fig. 3. A: *Urocystis lagerheimii* on *Juncus compressus*. – B: Cross section through a leaf.

holm, VII. 1896, G. Lagerheim (!); Syd. Ustil. 247 (!); Vgr. M. rar. sel. 190. (!).

Sori (Fig. 3) as blister-like streaks in the stems and basal half or 3/4 of the leaves, 1–2 mm in breadth, several cm long, at first covered by a greyish epidermis, which ruptures irregularly disclosing the black, powdery mass of spore balls. *Spore balls* (Fig. 6 C) globose, ovoidal to irregular, 24–52(–72) µm in diam., composed of 1–7(–10) central, fertile spores completely invested by a layer of sterile cells. *Spores* globose to ovoidal, sometimes flattened on one side, yellowish-brown, (12–)12.8–17.6 × (14.4–) 16–24(–27.2) µm in diam., smooth. *Sterile cells* variable in shape and size, 4.8–12 µm long, with light yellowish-brown, smooth wall, collapsed by drying.

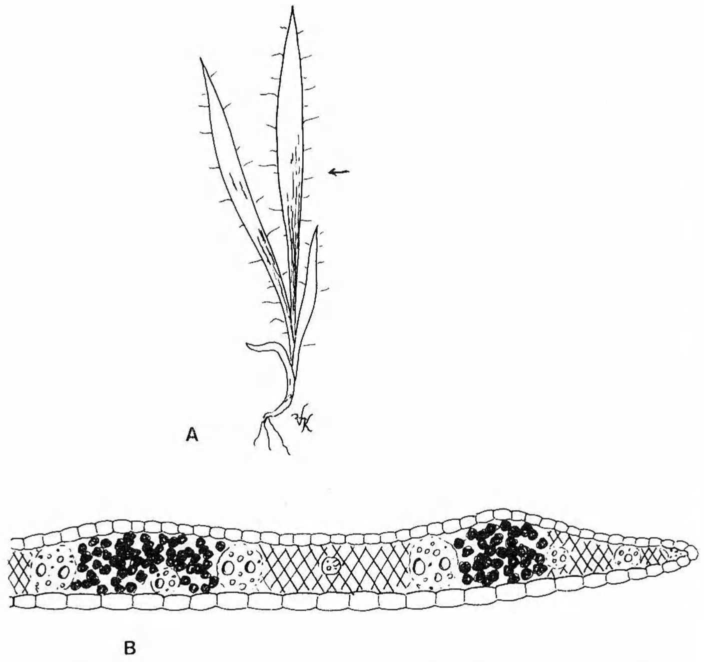

Fig. 4. A: *Urocystis luzulae* on *Luzula pilosa*. – B: Cross section through a leaf with sori.

Distribution: on *Juncus compressus* Jacq.: Europe (Finland, Sweden). – *J.* sp.: Europe (Soviet Union, n. v.), Asia (Soviet Union, n. v.).

Specimens studied. On *Juncus compressus:* (1) Sweden, Öland, Borgholm, VII. 1896, G. Lagerheim (sub *Urocystis junci* Lgh.) (S) – (2) Vgr. Micr. rar. sel. 190 (idem No. 1) (M, S) – (3) Syd. Ustil. 247. Suecia, Borgholm, VIII. 1896, G. Lagerheim (sub *Urocystis junci* Lgh.) (BP, HUV, LE, M, S, UPS) – (4) Fennia, Al., Föglö, Bärö, 17.VII. 1919, T. Putkonen (HUV).

4. **Urocystis luzulae** (Schröter) Winter

Winter, Rbh. Krypt. Fl. 1(1): 120, 1881. – *Polycystis luzulae* Schröt. in Cohn, Beitr. Biol. Pfl. 2: 380, 1877. – *Urocystis luzulae* (Schröt.) Schröt. in Cohn, Krypt.-Fl. Schles. 3(1): 279, 1889. – *Tuburcinia luzulae* (Schröt.) Liro, Ann. Univ. Fenn. Abo. A. 1(1): 36, 1922. – *Type* on *Luzula pilosa* (L.) Willd., Germany, Silesia, Jauer: Buschhäuser auf den Hessbergen, leg. Gerhardt.

Sori (Fig. 4) in the leaves as several cm long greyish-black striae between the veins, often confluent, at first covered by the epidermis which ruptures revealing the black, powdery mass of spore balls. *Spore balls* (Fig. 6 E) globose to ovoidal, 18–44 × 20–56 µm in diam., composed of 1–7(–12) central spores surrounded by a continuous layer of peripheral sterile cells. *Spores* globose, subglobose to ovoidal, 8–13.6 × (11.2–)12–16 µm in diam., with chestnut-brown,

Fig. 5. A: *Urocystis tothii* on *Juncus compressus*. – B: Cross section through a leaf with sori.

c. 0.4–0.6 μm thick, smooth wall. *Sterile cells* variable in size and form, 4–12.8 μm long, with dark brown, thick wall (c. 1.5 μm laterally and 0.5–0.8 μm on the free surface), collapsed by drying.

Distribution: on *Luzula multiflora* (Retz.) Lej.: Europe (Denmark, n. v.). – *L. pilosa* (L.) Willd.: Europe (Czechoslovakia, Finland, Germany, Norway, Poland, Soviet Union, Sweden, Switzerland).

Specimens studied. On *Luzula pilosa:* (1) Syd. Ustil. 138. Marchia, Nauen, Bredower Forst., VI. 1897, P. Sydow (BP, HUV, LE, S, UPS) – (2) Syd. Mycoth. Marchica, 4720. Berlin, Jungfernheide, V. 1898, P. Sydow (BP, HUV, S) – (3) Suecia, Öland, Stora Rör, VII. 1908, G. Lagerheim (sub *Tuburcinia luzulae* (Schröt.) Liro) (HUV, S) – (4) Kochman, Ustil. Poloniae, 44. Bronowice pr. Pulawy, 21.VI. 1933, K. Jankowska-Barbacka (sub *Tuburcinia luzulae* (Schröt.) Liro) (S).

5. **Urocystis tothii** Vánky sp. nov.

Type on *Juncus compressus* Jacq., Hungary, Hortobágy, Zámpuszta near the village Nagyiván in Heves county, alt. c. 90 m, 19.VI. 1974, coll. S. Tóth (BP holotype, BPI, HUV, IMI, S, UPS isotypes).

Tuburcinia lagerheimii (Bub.) Liro var. *obscura* Liro, Ann. Univ. Fenn. Abo. A. 1(1): 35, 1922. – *Urocystis lagerheimii* Bub. var. *obscura* (Liro) Zundel, Ustilag. of the World: 323, 1953. – *Type* on *Juncus gerardii* Lois., Finland, Nyland, Helsinki, Lill-Bådö, VIII. 1915, J. I. Liro (!).

Soris in foliis culmisque immersis, striiformibus, saepe confluentibus, brunneo-griseis, initio epidermide tectis, dein erumpentibus, atris, pulveraceis. *Glomerulis* ± globosis, elongatis vel irregularibus, rufo-brunneis, 20–50 μm diam., e 1–8(–10) sporis fertilibus et numerosis cellulis exterioribus, plerumque stratum continuum efformantibus. *Sporis* ± globosis, ovoideis vel angularis, dilute usque profunde rufobrunneis, (8–)10.4–13.6 × (10.4–)11.2–16.8 μm diam., episporio levi, 0.5–1.0 μm crasso. *Cellulis sterilibus* globosis, ovoideis vel irregularibus, dilute brunneis usque brunneis, 4–12 μm longis, episporio levi cca. 1 μm crasso. Habit. in *Junci compressi* Jacq., Hungaria, leg. S. Tóth, 19.VII. 1974. Holotypus depositus in BP, isotypus in BPI, IMI, S et UPS.

Sori (Fig. 5) embedded in the leaves and culms as long, brownish-grey striae between the veins, often confluent, covered by the epidermis, which when rupturing discloses the granular powdery, blackish mass of spore balls. *Spore balls* (Fig. 6 F) globose, subglobose to elongate or irregular, reddish-brown, chiefly 20–50 μm in diam., composed of 1–8(–10) central spores and a more or less completely investing layer of sterile cells. *Spores* globose, subglobose, ovoidal or somewhat angular in the interior of the spore ball, light to dark reddish-brown, (8–)10.4–13.6 × (10.4–)11.2–16.8 μm in diam., with a smooth, 0.5–1.0 μm thick spore wall. *Sterile cells* globose, ovoidal to irregular, light to medium reddish-brown, 4–12 μm long, with smooth, about 1 μm thick wall. The heavily infected plants often remain sterile, or have little developed flowers.

Note. According to Liro's description ("Mikroskopisch sind die Sporenballen, was Form, Grösse und Aufbau betrifft, denjeniger der Art *vollkommen gleich,* aber die Sporen haben konstant eine merkbar *dunklere* Membran." ... "Ausserdem scheint der Pilz etwas anders aufzutreten.") *U. lagerheimii* var. *obscura* should differ from *U. lagerheimii* s. str. in having darker spores and a somewhat different character of the sores. However, the type material (Fig. 6 D) is characterized by small spores (11.2–)12–16 μm against (14.4–)16–24 (–27.2) μm in *U. lagerheimii.* As to the colour there is no significant difference. This fungus is similar to *Urocystis tothii* and is here included in this taxon. The reason for the discrepancy between the description given by Liro and the type of *U. lagerheimii* var. *obscura* is not known. Could it have been a confusion of herbarium material, of slides, or was it something else?

Distribution: on *Juncus compressus* Jacq.: Europe (Hungary). – *J. gerardii* Lois.: Europe (Finland).

Specimens studied. On *Juncus compressus:* K. Vánky, Ustil. 194. Hungaria, comit. Heves, pr. pag. Nagyiván, Zámpuszta in Hortobágy, 19.VI. 1974, S. Tóth (BP, HUV, IMI, S, UPS).

On *J. gerardii:* Fennia, N. Helsinki, Lill-Bådö, VIII. 1915, J. I. Liro (sub *Tuburcinia lagerheimii* var. *obscura* Liro) (H).

Conclusion

Urocystis tothii and *U. lagerheimii* both parasitize *Juncus compressus,* but they are well distinguished by marked differences in spore size and also in the sorus characteristics. Morphologically *U. tothii* comes closest to *U. luzulae. U. johansonii* is characterised by the bulb-like sori and the low percentage of one-spored spore balls. *U. junci* is recognized,

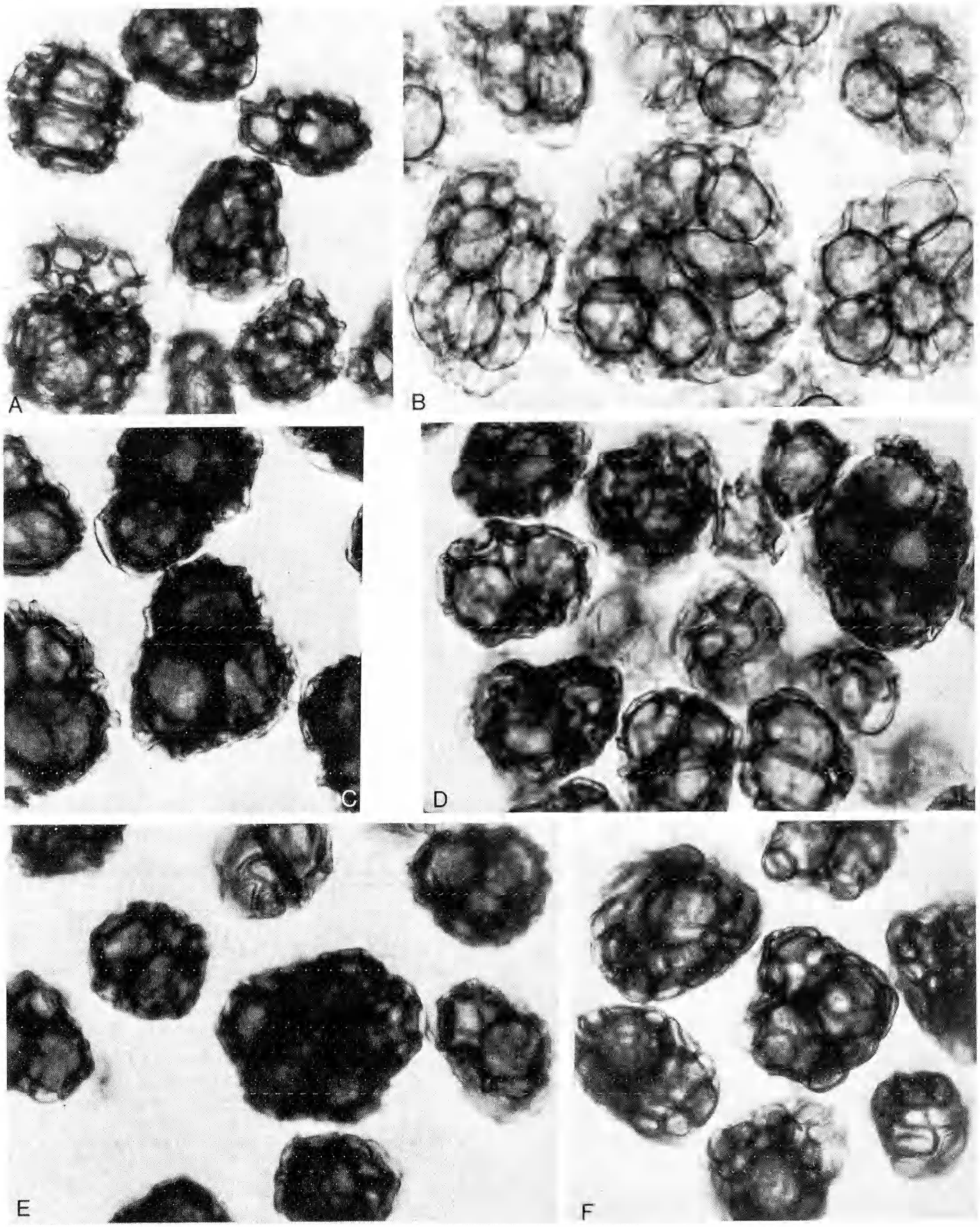

Fig. 6. Spore balls of *Urocystis* species. – A: *U. johansonii*. – B: *U. junci*. – C: *U. lagerheimii*. – D: "*U. lagerheimii* var. *obscura*". – E: *U. luzulae*. – F: *U. tothii*. – ×c. 800. Photo K. Vánky.

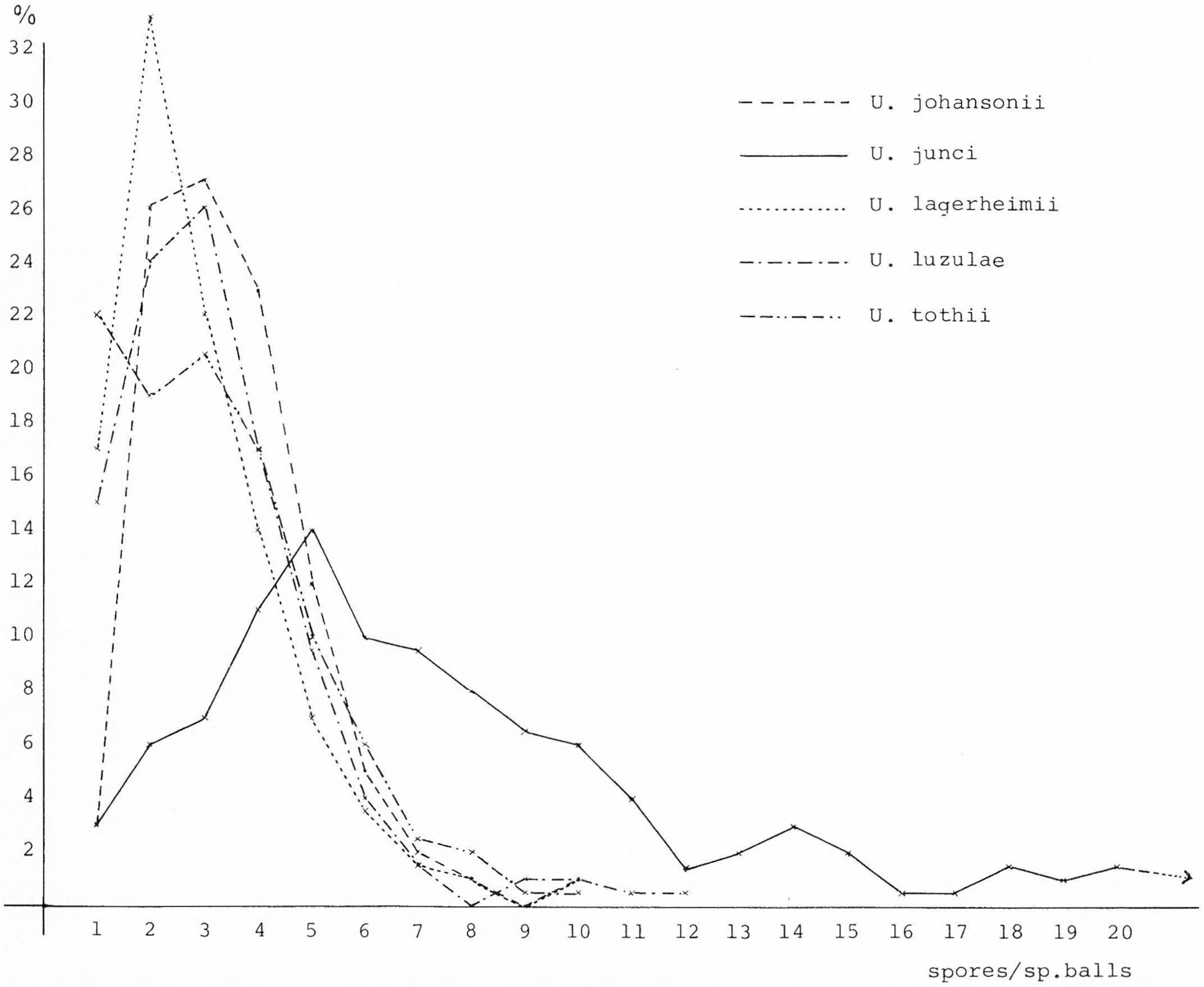

Fig. 7. Frequency of different kinds of spore balls of *Urocystis* species on Juncaceae.

i. a., by the multi-sporal glomerules. The description of *U. lagerheimii* var. *obscura* does not agree with the type material, and this fungus is here included in *U. tothii.*

Acknowledgements. The author expresses his sincere thanks to the Directors and Curators of herbaria from BP, BUCM, H, IMI, LE, LD, M, S and UPS for loans of the types and specimens, and to Professor J. A. Nannfeldt and Dr L. Holm for reading the manuscript.

Added in proof. The following additions to "Specimens studied" under the respective species should be made.

U. johanssonii: (1) also in BP and UPS; (3) the BP, HUV, S, UPS copies contain only *Tolyposporium junci;* (11) Mycoth. fenn. 49. Fennia, Ostrobottnia bor., Rovaniemi, Alaurokanen, 1.VIII. 1933, H. Roivainen & J. I. Liro (BP, S, UPS).

U. junci: Collection (2) on *Juncus balticus,* (2), (5), (7), (11) on *Juncus filiformis* also represented in BP.

U. lagerheimii: (1) also in UPS.

U. luzulae: (3) also in UPS.

Ecological notes on Amaurochaete Rost. (Myxomycetes)

Uno Eliasson

Eliasson, U. 1977 01 28: Ecological notes on Amaurochaete Rost. (Myxomycetes). *Bot. Notiser 129:* 419–425. Stockholm. ISSN 0006-8195.

Amaurochaete comata G. Lister & Brândză, previously known from Rumania and France, is reported from Sweden. Although there have been very few collections of *A. comata* and *A. trechispora* Macbr. & Martin, interesting differences in the choice of substrate between species of *Amaurochaete* can be traced. While *A. atra* (Alb. & Schw.) Rost. and *A. tubulina* (Alb. & Schw.) Macbr. occur predominantly on *Pinus,* the three existing records of *A. comata* were from *Abies* and *Picea. A. trechispora,* known only from a few localities in the U.S.A., has been found on *Sphagnum,* leaves and herbaceous stems.

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Amaurochaete comprises aethalioid, sometimes on the verge of pseudoaethalioid, species with black spore mass. The genus is closely related to *Stemonitis* and *Symphytocarpus,* and the delimitation of the three genera does not appear altogether satisfactory.

Besides the four black-spored taxa *A. atra* (Alb. & Schw.) Rost., *A. comata* G. Lister & Brândză, *A. trechispora* Macbr. & Martin and *A. tubulina* (Alb. & Schw.) Macbr., the brown-spored *A. ferruginea* Macbr. & Martin was also included in this genus by Martin & Alexopoulos (1969 p. 173), apparently with reservations. There have been different opinions concerning the generic affinity of the last-named species and specimens have been referred to *Stemonitis* as well as to *Comatricha.* Species intermediate between *Amaurochaete* on the one hand and *Stemonitis* and *Comatricha* on the other were referred by Ing & Nannenga-Bremekamp (1967) to the new genus *Symphytocarpus. A. ferruginea* was regarded as conspecific with *Comatricha flaccida* Morgan, for which the new combination *Symphytocarpus flaccidus* (Morgan) Ing & Nann.-Brem. was proposed. I agree with these authors that *A. ferruginea* has more in common with the taxa in *Symphytocarpus* than with the species of *Amaurochaete* mentioned above. Species of *Amaurochaete* s. str. have a black spore mass and the spores are generally 12–15 μm in diameter, whereas *A. ferruginea* has a brown spore mass and the spores are generally 8–10 μm in diameter.

The poorly known *A. trechispora* has reticulate-banded spores, while the spores in *A. atra, A. comata* and *A. tubulina* are warted or spinulose. The three last-named species are distinguished from one another by the different structure of their capillitia (Fig. 1).

Most of the observations on which the present paper is based were made during four years (1971–1974) of field studies carried out in a specially selected investigation area in the parish of Töllsjö, the province of Västergötland, S Sweden, but observations from other parts of S Sweden have also been taken into consideration. Previous reports in the literature on the ecology of *Amaurochaete* are cited.

A. atra and A. tubulina

Diagnostic characters of *A. atra* and *A. tubulina* are the appearance and mode of branching of the capillitium. In *A. atra* (Fig. 1 A) this consists of relatively broad membranous strands, the branching system of which is ir-

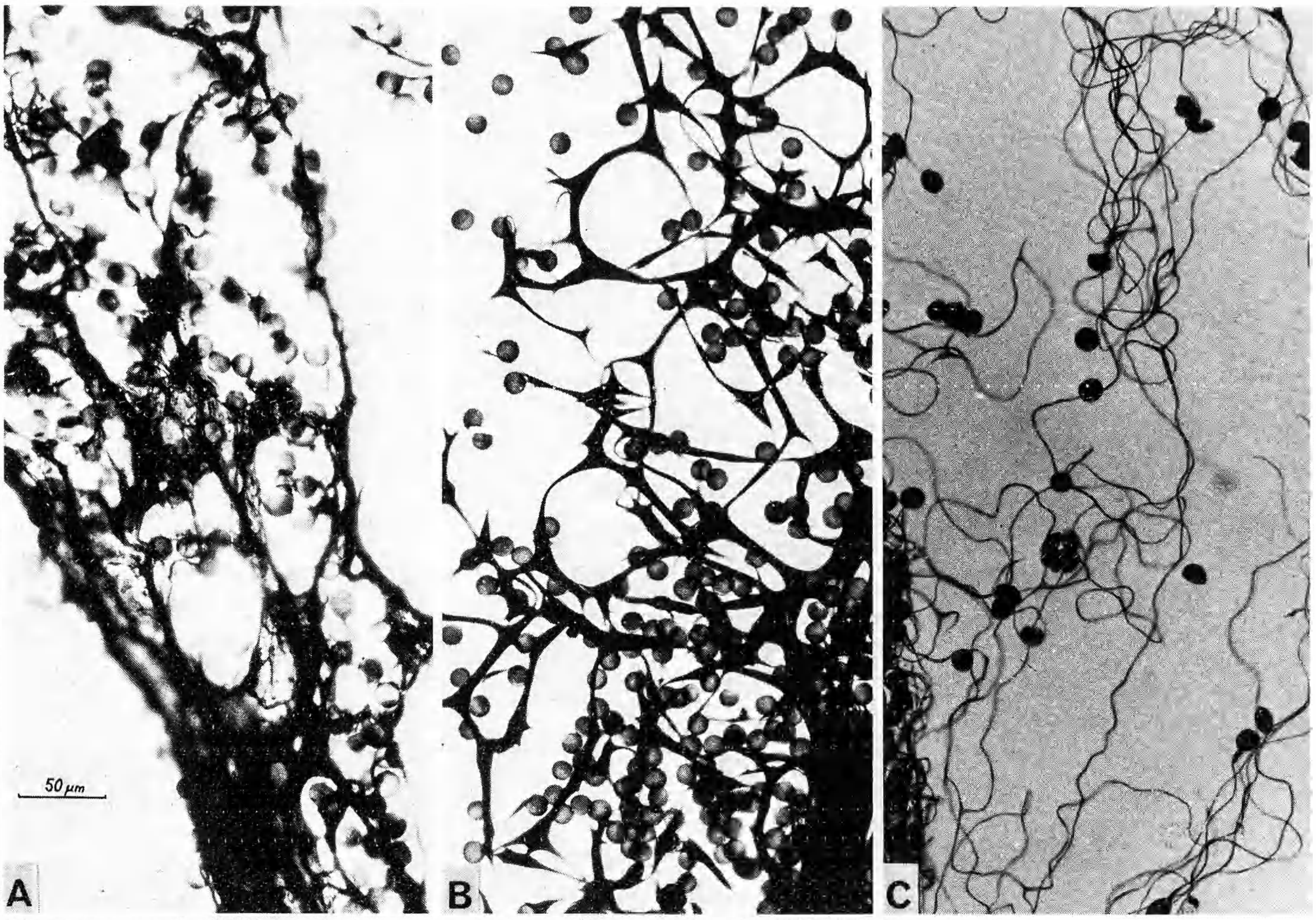


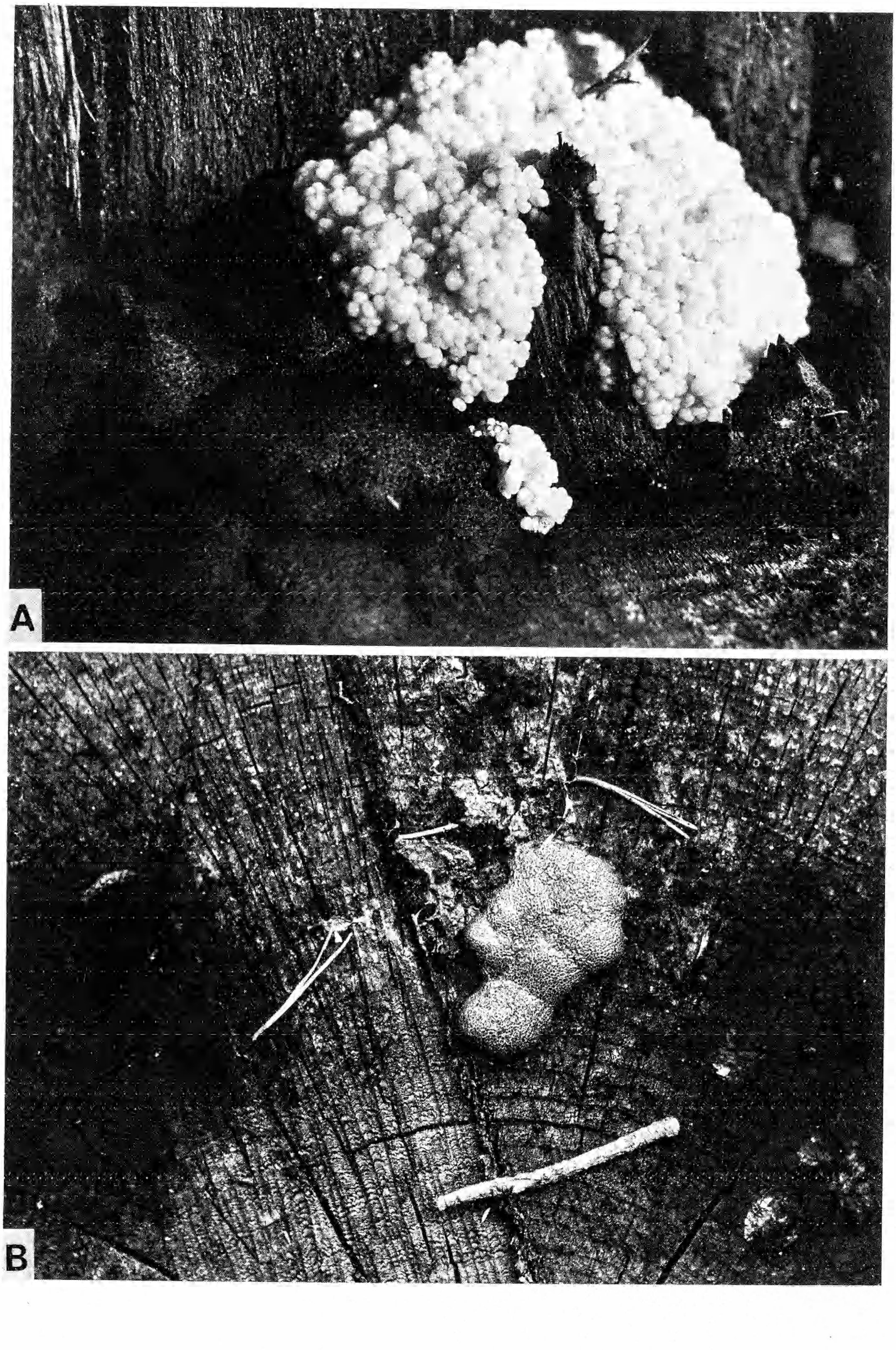
Fig. 1. Capillitium and spores of different species of *Amaurochaete*. – A: *A. atra* (Eliasson 2890). – B: *A. tubulina* (E. 2601). – C: *A. comata* (E. 2847).

regular but principally fan-shaped; the branches become thinner towards the periphery and may anastomose and form a net-work in the outer part. In *A. tubulina* (Fig. 1 B) the capillitium is normally more delicate with circinate, anastomosing strands forming a net-work, often with membranous expansions at the junctions.

A. atra and *A. tubulina* have a similar ecology and may occur together on the same substrate, as previously noted by Nannenga-Bremekamp (1960 p. 81, 1974 p. 181). She has reported one case (Ing & Nannenga-Bremekamp 1967 p. 224) where fructifications of the two species were found in intimate contact with one another. As has been noted previously by several authors, both species occur mainly on coniferous bark and wood, but it should be noted that Kowalski & Curtis (1968 p. 248) have reported *A. atra* (sub nomine *A. fuliginosa*) from California on the bark of *Quercus lobata* Neé.

During four years of field work I made altogether ca 45 records of *A. atra* and *A. tubulina*. Most of the records comprised several aethalia occurring together on the same substrate. In all cases recorded the species were found on the

Fig. 2. A: *Amaurochaete tubulina*. Plasmodium developing in immediate contact with a mature aethalium (the black mass to the left) of the same species on a stump of *Pinus sylvestris*. The plasmodium is ca 30 mm in extent from left to right. Töllsjö parish, 1973-06-20. Two days later the plasmodium had developed into a mature fructification covering a large part of the first one. – B: *A. atra*. Aethalium on the cut surface of a *Pinus* stump. The dark patches on both sides of the aethalium are black spore mass deliberated from disintegrating fructifications of the same species. The stick in the lower part of the picture is 5 cm long. Kullings-Skövde parish, 1971-06-11. – Photo: Uno Eliasson.


A
B

wood and bark of pine (*Pinus sylvestris* L.), although spruce (*Picea abies* (L.) Karsten) was the dominant tree species in the area and several species of deciduous trees were also present. Typical habitats for the two *Amaurochaete* species were fallen or erect dead pine stems, pine stumps, and cut surfaces of pine logs. The species can also be found on e. g. fresh and unimpregnated pine boards. The occurrence on fresh and undecayed wood is an uncommon phenomenon among Myxomycetes with large fructifications, *Symphytocarpus flaccidus* being an exception. My observations on the preference of the two *Amaurochaete* species for *Pinus* as substrate agree well with those of Macbride (1922 pp. 150, 151), who remarked that *A. atra* (sub nomine *A. fuliginosa*) is probably not uncommon in North America "wherever pine forests occur" and that *A. tubulina* developed abundantly "on the recently decorticated logs of *Pinus ponderosa*". In this connection it may be pointed out that Nannenga-Bremekamp (1974 p. 181) has recorded an undescribed species of *Amaurochaete* from the Netherlands, collected together with *A. atra* on a newly felled pine.

Within and in the vicinity of the investigation area I have recorded the two species from the middle of May to the first half of October. The latest observation of a plasmodium is from the first half of September, but since mature aethalia are fragile and soon disintegrated by beetles or heavy rain the aethalia found in October can be presumed to have developed a few days before they were found. Although the species may be found during a relatively long vegetation period most fructifications develop in May and June, often in open localities such as sun-warmed stumps and logs of *Pinus*. In choice of substrate as well as in time of appearance the two species have much in common with *Symphytocarpus flaccidus,* as noted by Fries (1912 p. 771).

In their growth and development, the plasmodia much resemble those of *Reticularia lycoperdon* Bull., as described by Sunhede (1973). The plasmodium, or at least early stages of it, seems to develop mostly in cavities in the wood, or between the bark and the wood. The plasmodial mass then moves on to the surface of the substrate. Fissures or insect tunnels are generally found when the substrate under a developing plasmodium or a fructification is examined. Plasmodia sometimes develop in intimate contact with mature fructifications (Fig. 2 A), sometimes partly covering these.

A plasmodium emerging between the wood and the bark on a *Pinus* stump is shown in Fig. 3 A. This plasmodium developed on the same stump as and simultaneously with that in Fig. 2 A. When the bark was loosened from the wood a large plasmodial mass was found on the wood behind the bark (Fig. 3 B) as well as on the inner surface of the bark. For experimental purposes the plasmodial mass was removed from the wood, but small remnants were still present in cracks and hollows (Fig. 3 C). One hour later a plasmodial mass ca 2 cm across and ca 1 cm in maximum thickness had emerged on to the wood (Fig. 3 D). This plasmodium did not produce fructifications but developed into a black and brown, shrunken, asporogenic structure. This structure developed quite exposed to the sun during a dry period. It is not possible to decide whether this structure was due to desiccation or whether it was due to the disturbances caused by my observations.

As long as the plasmodium increases in size it is coralloid in appearance and the surface is in the form of rounded papillae (Fig. 2 A). Before the fructification the surface becomes smooth. A plasmodium normally develops into a mature aethalium in a couple of days during favorable field conditions, but the maturation is easily disturbed by unsuitable weather. Heavy rain spoils the plasmodium. As mentioned previously mature aethalia are very fragile and are easily smashed to pieces by heavy rain. This is probably an important factor in the dispersal of the species. Small beetles are often seen in mature fructifications, making holes and tunnels in the fruiting body. The insects are probably important for the dispersal of the species, not only by serving as dispersal agents for the spores, but also indirectly by disintegrating the fruiting body so that the spore mass becomes exposed to the wind. During periods with little or no precipitation the capillitium or other remnants of the fruiting body can be seen on the substrate for days and even weeks (Fig. 2 B).

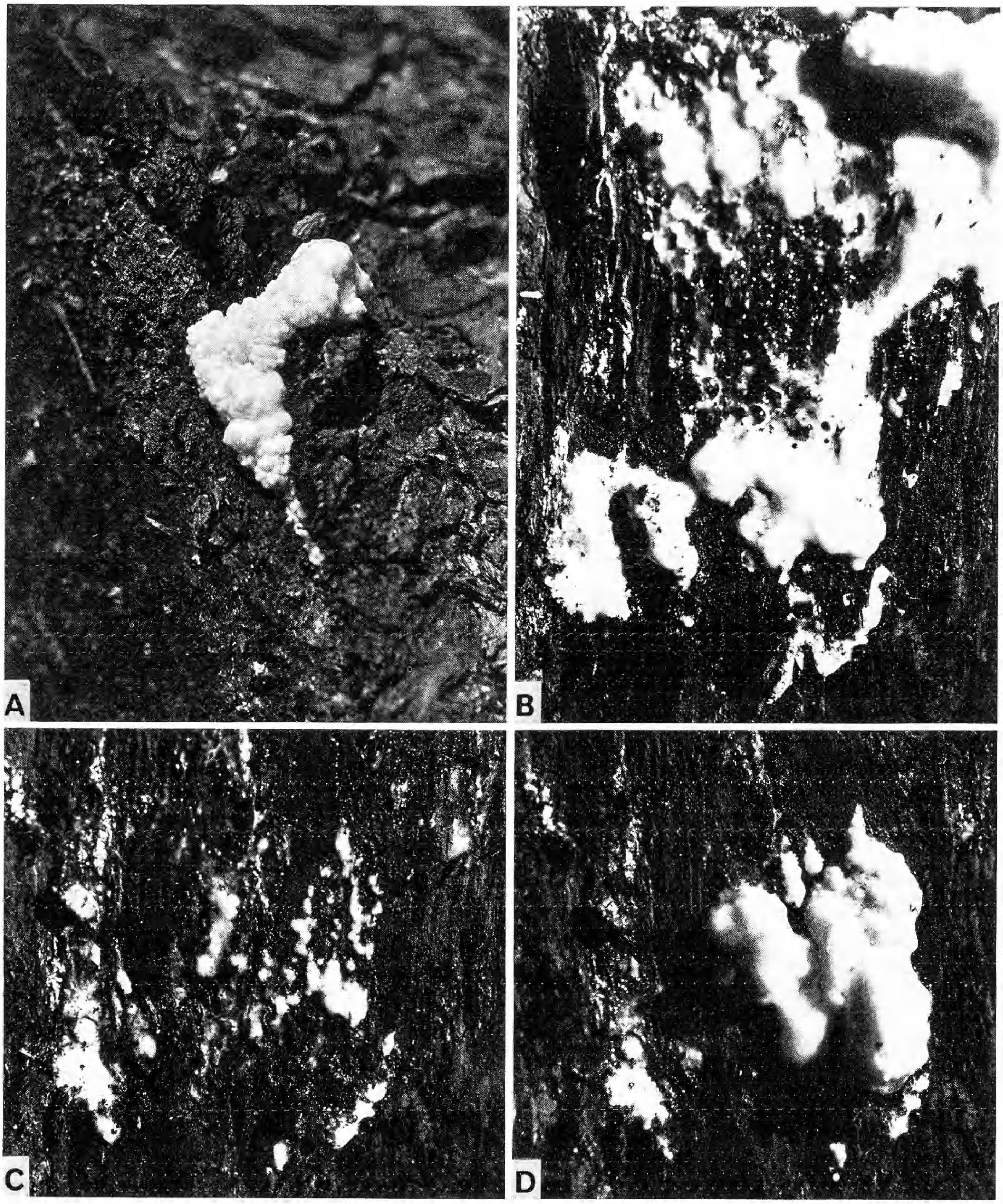


Fig. 3. *Amaurochaete* sp. Most probably this species is *A. tubulina*, but the plasmodium never developed into a mature fructification (see text). – A: Plasmodium pouring out between the wood and the bark on the same *Pinus* stump as that in Fig. 2 A and ca 10 cm from the plasmodium shown in that figure. Töllsjö parish, 1973-06-20, at 20.30. – B: Parts of the same plasmodium on the vertical wood surface exposed by removal of the bark. Same date, at 21.00. – C: The wood surface after most of the plasmodial mass has been taken away. Plasmodial mass is still present and pouring out from cavities in the wood. Same date, at 21.05. – D: The same wood surface photographed at 22.05. A plasmodial mass ca 2 cm across and ca 1 cm in maximum thickness has poured out from the wood. – × 1.3. Photo: Uno Eliasson.

A. comata

A. comata is apparently a rare species. It was described by Lister & Brândză (1926 p. 225) on material from Rumania and for nearly five decades was known only from the type locality. In 1973 Keller & Candoussau (1973 p. 118) reported it from France. A Swedish find is here reported: Sweden, Västergötland, Töllsjö parish, Bohult, on log of *Picea abies,* 24 July 1971, Eliasson 2847 (GB).

A. comata resembles *A. atra* and *A. tubulina* in the size and ornamentation of the spores, but differs from the two last-named species in its different capillitium, which consists of narrow, slender, circinate threads. The differences in the capillitial structure appear quite clearly when capillitia of the three species are seen under the same magnification (Fig. 1). The capillitial threads in the Swedish collection of *A. comata* are ca 1 µm thick (0.5–1.5 µm) (Fig. 1 C) with wider membranous expansions at the joints. The spores are 12–13 µm in diameter.

While *A. atra* and *A. tubulina* predominantly form fructifications on *Pinus,* the three collections of *A. comata* known so far have been made on *Abies* and *Picea.* The type collection from Rumania and the French collection were made on the trunk of storm-felled *Abies alba* Miller (=*A. pectinata* (Lam.) DC) (Keller & Candoussau 1973 p. 118). My Swedish specimen was collected on a log of *Picea abies* felled about two years before the collection was made. Whitish-yellow plasmodia of coralloid appearance were seen on the bark and in fissures in the bark on the upper side of the log on July 17, 1971. When the locality was visited one week later a single rather scanty fructification was found. The specimen was inconspicuous against the dark bark and would no doubt have been overlooked if the position of the plasmodia had not been marked.

Professor Harold Keller kindly examined a piece of my collection and agreed with my determination. He commented upon my specimen: ''... The capillitium and spores are identical to our specimen from France. ... I would predict that this tree was recently blown down and not well decayed. This species is a true corticolous Myxomycete'' (Keller in litt.).

A. trechispora

A. trechispora Macbr. & Martin differs from other known species of *Amaurochaete* in its reticulate-banded spores. It was regarded by Hagelstein (1944 p. 146) as a phase of *Stemonitis trechispora* (Torrend) Macbr. Brooks & Kowalski (1965 p. 136) noted the differences in size and colour of spores from an aethalium of *A. trechispora* on the one hand and from fructifications of *S. trechispora* on the other, but remarked that ''*S. trechispora* was fruiting abundantly in the area at the time, and it is quite possible that this specimen [*A. trechispora*] represents merely a phase of the latter species [*S. trechispora*]''. However, Ing & Nannenga-Bremekamp (1967 p. 219, p. 221 Fig. 3 D, E) have shown the striking difference in the spore ornamentation between *A. trechispora* and *S. trechispora* (sub nomine *Symphytocarpus trechisporus*), the former species having large-meshed spores with 3–4 meshes across the diameter, the latter having small-meshed spores with about 12 meshes across the diameter.

A. trechispora seems to differ from the other species in the genus in its choice of substrate. While the latter occur predominantly on coniferous bark and wood, *A. trechispora* has been recorded on *Sphagnum,* leaves and herbaceous stems (Macbride & Martin 1932 p. 89, Martin 1949 p. 69). The species is known only from Ontario and Massachusetts (Martin & Alexopoulos 1969 p. 174), and Michigan (''on moss''; Brooks & Kowalski 1965 p. 136).

Acknowledgements. I am indebted to Professor Harold Keller, Wright State University, Dayton, Ohio, for confirming my determination of *Amaurochaete comata.* Professor Ian Thornton, La Trobe University, Bundoora, Victoria, Australia, kindly checked the English.

References

Brooks, T. E. & Kowalski, D. T. 1965: New reports of Myxomycetes from Michigan. *Pap. Mich. Acad. Sci. Arts Lett. 50:* 135–138.

Fries, R. E. 1912: Den svenska myxomycet-floran. *Svensk Bot. Tidskr. 6:* 721–802.

Hagelstein, R. 1944: *The Mycetozoa of North America.* Mineola, New York.

Ing, B. & Nannenga-Bremekamp, N. E. 1967: Notes on Myxomycetes XIII. Symphytocarpus nov. gen. stemonitacearum. *Proc. Kon. Nederl. Akad. Wet. Ser. C, 70 (2):* 217–231.

Keller, H. W. & Candoussau, F. 1973: Quelques récoltes rares de Myxomycètes en France. *Revue Mycologie 38:* 114–123.

Kowalski, D. T. & Curtis, D. H. 1968: New records of Myxomycetes from California III. *Madroño 19:* 246–249.

Lister, G. & Brândză, M. 1926: Amaurochaete comata. *In* G. Lister, New species of Amaurochaete, and some other Mycetozoa. *J. Bot. 64:* 225–227.

Macbride, T. H. 1922: *The North American slime-moulds. Ed. 2.* New York.

– & Martin, G. W. 1932: Amaurochaete trechispora. *In* G. W. Martin, New species of slime molds. *J. Wash. Acad. Sci. 22:* 88–92.

Martin, G. W. 1949: Myxomycetes. *North American Flora 1 (1).*

– & Alexopoulos, C. J. 1969: *The Myxomycetes.* Iowa.

Nannenga-Bremekamp, N. E. 1960: An annotated list of Myxomycetes found in the Netherlands, mostly in the vicinity of Doorwerth. *Acta Bot. Neerl. 10:* 80–98.

– 1974: *De Nederlandse Myxomyceten.* Hoogwoud.

Sunhede, S. 1973: Studies in Myxomycetes I. On the growth and ecology of the Myxomycete Reticularia lycoperdon Bull. *Svensk Bot. Tidskr. 67:* 172–176.

Scyphopappus B. Nord. is Argyranthemum Webb ex Sch. Bip. (Compositae–Anthemideae)

Bertil Nordenstam

Nordenstam, B. 1977 01 28: Scyphopappus B. Nord. is Argyranthemum Webb ex Sch. Bip. (Compositae–Anthemideae). *Bot. Notiser 129:* 427–428. Stockholm. ISSN 0006-8195.

The recently described monotypic genus *Scyphopappus* B. Nord. (Compositae–Anthemideae) was based on a single collection allegedly from South Africa. This specimen has now been identified as *Argyranthemum frutescens* (L.) Sch. Bip. from the Canary Islands. *Scyphopappus* B. Nord. becomes a synonym of *Argyranthemum* Webb ex Sch. Bip., a genus restricted to Macaronesia. A parallel is drawn with the likewise monotypic genus *Pachyrhynchus* DC. (Compositae–Inuleae). The single specimen of supposed South African origin has proved identical to the South American *Lucilia acutifolia* Cass.

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In my recent revision of *Chrysanthemum* in South Africa (Nordenstam 1976) five new genera were established, including the monotypic *Scyphopappus* B. Nord. The latter was based on a single collection allegedly made by Thunberg in South Africa. In spite of the meagre material the detailed morphological study clearly showed that it was not congeneric with any known African genus of the tribe Anthemideae. To accommodate the species, which was known as *Chrysanthemum thunbergii* Harv., it was deemed necessary to establish a new genus, partly in the hope that new material would emerge and help clarify the affinities.

For macro-morphological and geographical reasons a relationship with the Macaronesian *Argyranthemum* was not seriously considered. The slender unbranched peduncles and the leaf shape of *Scyphopappus* seemed to make a closer comparison unnecessary. However, some striking micro-morphological similarities induced me to a renewed scrutiny with unexpected results. The type of *Scyphopappus frutescens* (Less.) B. Nord., likewise type of *Chrysanthemum thunbergii* Harv., proved to be a somewhat atypical specimen of *Argyranthemum frutescens* (L.) Sch. Bip. Among the seven subspecies recognized by Humphries (1976) ssp. *frutescens* seems to fit best.

Argyranthemum frutescens is normally a richly branching plant with bipinnatisect leaves and corymbose inflorescences. Harvey (1865) in his description of *Chrysanthemum thunbergii* specifically excluded from the synonymy the basionym of *A. frutescens* by citing, ''C. frutescens, Thunb.! Cap. 693 (non Linn.)'', and he described the peduncles as ''terminal, very long, naked, 1-headed''. However, forms of *A. frutescens* with unbranched peduncles do occur, and a close examination of the type of *Scyphopappus frutescens* revealed at least one leaf with secondary leaf-lobes. Of greater importance are similarities in involucre, receptacle, and achenes (heteromorphy, three wings, no secretory canals).

The identity of *Scyphopappus frutescens* with *A. frutescens* was further confirmed by a study of micro-morphological floral characters. Both have the same type of floral glands with a large terminal cell on a multicellular stalk, rays with a colliculate upper surface, a swollen style base partly immersed in a broadly cylindric nectary, filament collars with enlarged basal cells, non-polarized endothecial tissue, and perfectly similar pollen grains (studied on acetolysed material of both taxa).

In conclusion *Scyphopappus* B. Nord. is reduced to a synonym of *Argyranthemum* Webb ex Sch. Bip. Since the latter is strictly Macaronesian, Thunberg's specimen was either introduced into South Africa or, more likely, its stated origin is false.

A parallel case is afforded by the monotypic genus *Pachyrhynchus* DC. *P. xeranthemoides* DC. was based on a single collection allegedly from South Africa, and the capitula were described as homogamous (De Candolle 1837 p. 255). A few years ago I identified the specimen as *Lucilia acutifolia* Cass., a South American species with heterogamous flowerheads. This reduction of another monotypic South African genus to synonymy remained unpublished, until it was incidentally mentioned by Hilliard & Burtt (1973 p. 308) and recently recorded by Dyer (1975 p. 681) without reference to any source, however.

References

De Candolle, A. P. 1837: *Prodromus systematis naturalis regni vegetabilis 6.* Paris.

Dyer, R. A. 1975: *The genera of Southern African flowering plants. Vol. 1. Dicotyledons.* Pretoria.

Harvey, W. H. 1865: Compositae. *In* W. H. Harvey & O. W. Sonder, *Flora Capensis 3:* 44–530.

Hilliard, O. M. & Burtt, B. L. 1973: Notes on some plants of Southern Africa chiefly from Natal: III. *Notes R. B. G. Edinb. 32:* 303–387.

Humphries, C. J. 1976: A revision of the Macaronesian genus Argyranthemum Webb ex Schultz Bip. (Compositae–Anthemideae). *Bull. Brit. Mus. (Nat. Hist.) 5:* 145–240.

Nordenstam, B. 1976: Re-classification of Chrysanthemum L. in South Africa. *Bot. Notiser 129:* 137–165.

New records of pteridophytes from the Galápagos Islands

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Lycopodium phylicaefolium Desv., *Ophioglossum palmatum* L., *Grammitis delitescens* (Maxon) Proctor and *Woodsia montevidensis* (Spreng.) Hieron. are reported as new to the Galápagos Islands. New finds expand the known range of *Equisetum bogotense* HBK and *Lycopodium setaceum* Lam. subsp. *galapagense* O. Ham. The spore morphology of the latter is discussed.

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The collections and observations reported below were made in 1974 during my stay as UNESCO Associate Expert in plant ecology at the Charles Darwin Research Station, Islas Galápagos, Ecuador. The nomenclature is in accordance with Wiggins & Porter (1971).

Equisetum bogotense HBK

Collections studied: Isla Fernandina, Adsersen 577 (C, CDS); Hamann 2367, 2451 (C).

This species has previously been reported from Isla Isabela only. It also occurs on Isla Fernandina. Our collection was made at 900 m on the main SW slope (inclination c. 20°) in a *Darwiniothamnus*-fern pioneer vegetation on fine volcanic ash. D. Weber observed it on the SE slope in 1972, and according to Hamann (pers. comm.) it is common on the S–SW slope of Cerro Azul at altitudes from 500 to 920 m and on the E slope at 900 m.

Grammitis delitescens (Maxon) Proctor – Fig. 2 C–D

Proctor, Bull. Inst., Jamaica, Sci. Ser. 5 p. 36 (1953) – *Polypodium delitescens* Maxon, Bull. Torr. Bot. Club 32 p. 74 (1905). – *Xiphopteris delitescens* (Maxon) Copeland, Amer. Fern J. 42 p. 51 (1952).

Polypodium myosuroides sensu Jenman, Bull. Bot. Dept. Jamaica 2 (4) p. 112 (1897), non Swartz 1788. – *Grammitis myosuroides* sensu Schkuhr, Krypt. Gew. Pl. 7 (1804).

For a detailed discussion of the identity of the taxon see Maxon (1914), and for a recent discussion of the taxonomic rank of the name *Grammitis,* see Morton (1967).

Collections studied: Santa Cruz, Coralon Valley, Adsersen 146 (C, CDS), 973 (C); Little Puntudo Crater, Adsersen 147 (C).

Small epiphytic fern, with short ascending–erect rhizome, up to 1 cm long, c. 1 mm thick, densely invested with dark brown fibrous roots, 0.2 mm in diameter, with numerous lustrous tan acicular hairs, up to 0.6 mm long. Root and fronds appearing between nearly imbricate scales, these narrow deltoid to lanceolate, c. 1 mm long, 0.3 mm wide; joining cell walls thickened, black; cell lumina translucent. Fronds many, fasciculate, up to 10 cm long, stipes short, less than 1.5 cm long, c. 0.2 mm broad, stipe and rachis dark brown to black with scattered hyaline to lustrous tan setae, 0.20–0.25 mm long.

Lamina green, linear, slowly attenuating basally and apically, pinnatifid–pinnatisect, width 1.5–3 mm; segments alternate to sub-opposite, obtusely unevenly deltoid, dorsaldistally often with a somewhat darker chondroid trace.

Most fronds fertile on the upper 1/3 to 2/3 of length, morphology of fertile part little or not at all different from sterile part, indusia absent, sori dark orange to brown, more or less confluent axially on ventral side of lamina; distal third of fertile segments sterile. Sporangia about 0.2 mm in diameter, on thin stalk 0.1–0.2 mm long, hyaline except for brown thickened walls of annulus cells, these 11–13 in number. Spores green, spherical with a finely verrucous surface, 35–41 μm in diameter.

Habitat: The plant was first found in a valley immediately S of Cerro Coralon, Isla Santa Cruz, in a lush 2–3 m tall scrub covering the lower parts of the slopes (c. 650 m). Dominant ligneous plants are *Acnistus ellipticus* (>50 % cover), *Psychotria rufipes* (c. 20 %), *Tournefortia pubescens* (c. 10 %) and *Cyathea weatherbyana* (few specimens). The herb cover was very dense and composed mainly of *Jaegeria crassa, Eupatorium pycnocephalum, Alternanthera halimifolia, Pilea baurii, Commelina diffusa, Ageratum conyzoides, Elaterium carthagenense, Ctenitis pleiosora* and *Hypolepis hostilis.*

All woody branches were densely invested with epiphytic mosses, liverworts and vascular plants *(Epidendrum spicatum, Peperomia galapagensis, Asplenium auritum, A. praemorsum, Polypodium angustifolium, P. steirolepis* and *Hymenophyllum lehmanii).*

G. delitescens was growing on *Acnistus* and was often half-covered by the bryophyte mats. Despite careful search we did not find it on branches of other species. *Acnistus ellipticus* is generally a very good substrate for epiphytes in the Galápagos Islands.

The presence of *Acnistus* scrub in this locality is remarkable. Although it lies within the altitudinal range of the important humid-zone woody species *(Scalesia pedunculata, Zanthoxylum fagara, Miconia robinsoniana* and *Psidium galapageium),* they are virtually absent. Two explanations seem to be applicable. (1) Relative humidity may be kept constantly high due to the protection from the high surrounding cones (Coralon c. 750 m). This may stimulate the epiphytic growth to such an extent that it becomes serious for the phorophytes. *Acnistus* seems to be able to survive due to lateral twigs penetrating the epiphyte cover on the thick branches (NB: the drawing of *A. ellipticus* in Wiggins & Porter (1971) is misleading with respect to habit). – (2) The presence of *Acnistus* scrub may be due to edaphic conditions. While pH is low (4–5) in the fern zone and *Miconia* scrub and high (7–8) for *Scalesia* forest, the *Acnistus* scrub has an intermediate value (6). Phosphorus content is very high in the *Acnistus* scrub (962 ppm; extraxted with 0.2 N H_2SO_4). This is the highest value recorded on Santa Cruz, except for sites influenced by fire or birds. Corresponding values for *Miconia* scrub: 200 ppm; fern zone and *Scalesia* forest show 200–500 ppm.

Another locality for *G. delitescens* is a small crater c. 500 m N of the Puntudo pass. The crater has a very lush vegetation with large ferns *(Hypolepis, Dennstaedtia, Pteridium, Ctenitis, Cyathea, Thelypteris* and *Diplazium)* and scattered trees *(Scalesia pedunculata, Zanthoxylum, Tournefortia* spp. and *Acnistus).* The lower parts of this crater may have a local climate similar to that of the other locality. Here, too, *G. delitescens* grows exclusively on *Acnistus* branches among bryophytes.

Almost pure stands of *Acnistus* with the branches covered with epiphytes have also been observed along the trail from Santa Rosa to La Casita on the main SW slope of Isla Santa Cruz. No *Grammitis* was found, but I have examined the locality only very superficially.

Distribution: Jamaica, Cuba, Mexico, Guatemala, Honduras and Colombia.

The only *Grammitis* species previously recorded from the Galápagos Islands is *G. serrulata* (Sw.) Sw. (Eliasson 1970). It is easily distinguished from *G. delitescens* by the strong differentiation between the sterile and fertile part of the frond.

Illustrations (Maxon 1914) and a description (Jenman 1897) of this taxon fit our collections extremely well, and the key in Copeland (1952) also leads to this species. Therefore I do not hesitate to identify our collections with *G. delitescens,* although I have seen no other herbarium specimens of this taxon.

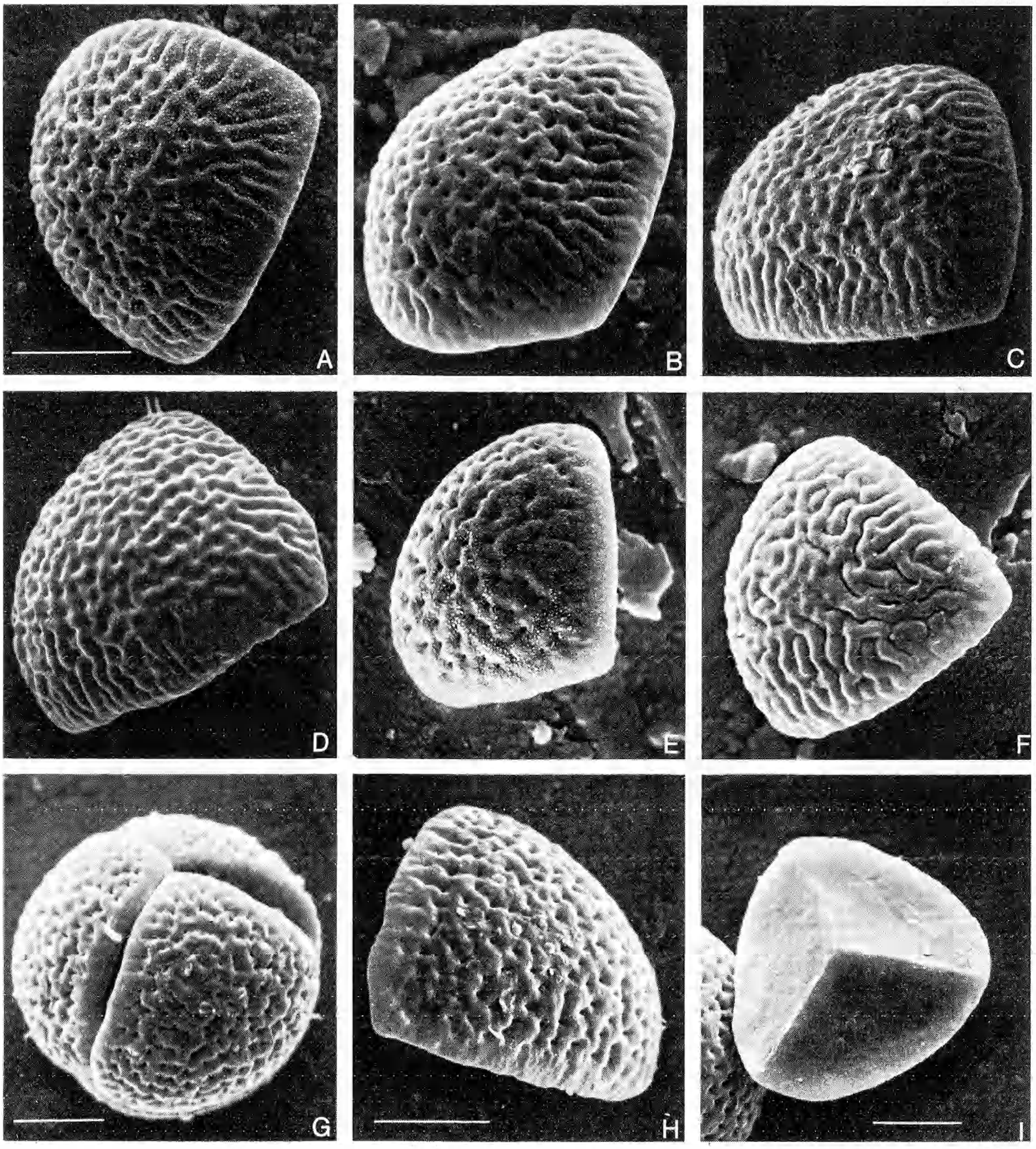


Fig. 1. SEM microphotographs of *Lycopodium* spores. – A–D: *L. setaceum* subsp. *galapagense*. – E: *L. reflexum*. – F: *L. dichotomum*. – A: Adsersen 972 (Santa Cruz). – B: Eliasson 1245 (Alcedo, Isabela). – C: Adsersen 1255 (Pinta). – D: Adsersen 1069 (San Salvador). – E: Adsersen 1312 (Santa Cruz). – F: Adsersen 733 (San Cristóbal). – G–I: *L. phylicaefolium* (Adsersen 731). – G: Spore tetrad. – H: Distal side of spore showing foveolate ornamentation. – I: Proximal side of spore. – Scale units 10 μm. A–F are of equal magnification.

Table 1. Spore diameter (μm) of *Lycopodium setaceum* subsp. *galapagense*. – N number of collections examined, n number of measurements.

Origin	N	n	Mean	SD	Max	Min
Galápagos	8	43	38.5	3.1	46.2	33.7
Santa Cruz	3	11	35.8	1.8	40.3	33.7
San Salvador	3	14	37.4	1.8	39.5	33.7
Pinta	1	6	39.2	1.8	42.3	37.5
Isabela: Alcedo	1	12	42.0	2.8	46.2	38.7

Lycopodium setaceum Lam. subsp. **galapagense** O. Ham.

Collections studied: Isla Santa Cruz, Adsersen 178, 626, 972 and 1297 (all in C) – Isla Pinta, Adsersen 1255 (C) – Isla San Salvador, Adsersen 1023, 1035, 1061 and 1069 (all in C); Hamann 2021, 2045 and 2107 (all in C) – Isla Isabela, Volcán Alcedo, Eliasson 1245 (S).

This taxon was described from Isla San Salvador by Hamann (1974 b). It occurs, however, also on other islands within the archipelago. We found it at several places on Isla Santa Cruz in the upland *Scalesia* forest from 600 to 700 m, growing on *Scalesia pedunculata* and *Acnistus ellipticus*, and at one locality on Isla Pinta in an upland *Zanthoxylum fagara* forest (550–600 m). We have also observed it at 800–1000 m on Volcán Alcedo, and it has been collected there by H. van der Werff (pers. comm.) and Eliasson (Eliasson 1245). However, its richest occurrences are on Isla San Salvador, where it occurs from 750 to 900 m on the main S slope in a *Scalesia pedunculata–Zanthoxylum fagara* forest.

The reason why it has not previously been reported from islands other than Isla San Salvador may be that young specimens are fairly similar to depauperate specimens of *L. dichotomum* or *L. reflexum*. These have initially erect growth, while *L. setaceum* subsp. *galapagense* is initially ascending or decumbent, and later on becomes pendant.

SEM photographs of spores reveal other differences. The spores of *L. dichotomum* are completely fossulate and those of *L. reflexum* foveolate, while the spore surface in my material of *L. setaceum* subsp. *galapagense* shows a fossulate marginal zone and a foveate central part (Fig. 1 A–F).

Hamann (1974 b) states that spores from *L. setaceum* subsp. *setaceum* show a variation from typically foveolate ornamentation to patterns similar to those seen in our specimens, whereas in his specimens of subsp. *galapagense* the ornamentation is more fossulate. Our material is morphologically identical with Hamann's collections of subsp. *galapagense* and it is collected over a wider geographical and phenological range. My observations together with Hamann's statement lead to the conclusion that spore ornamentation in *L. setaceum* subsp. *galapagense* is variable. The spore surface may be described as almost entirely fossulate to fossulate in the margins and foveolate in the central parts. Thus the ranges of spore ornamentation in subsp. *setaceum* and subsp. *galapagense* overlap.

SEM studies of *Lycopodium* spores were made with a Cambridge Stereoscan MK II A at the Geological Central Institute, Copenhagen. Samples of spores were placed without any fixative on specimen stubs and covered with a gold layer.

Spore measurements have been taken from SEM photographs in two ways: (1) Direct measurement on single spores, where the photographs apparently show a projection of the largest dimention. (2) Measurement of tetrad diameters D and calculation of the basal side K in the tetrahedron included in the spore, by the formula $K = D \cdot \sin 54.735$ (54.735 being half the top angles in the spore). This side closely approximates the maximum diameter in single spore projection, and as the tetrad diameter is unchanged by projection in the plane, this method may be advantageous to the first one. However, there was no significant difference between results obtained by the two methods.

Spores from two collections were measured also in a light microscope. These measurements were used to adjust SEM measurements to μm. This was necessary since magnification factors of the SEM photographs were only approximate.

Spore measurements from our collections are presented in Table 1. The spore sizes fall within the lower half of the range (35–47 μm) presented by Hamann (1974 b). The spores from the Pinta and Alcedo specimens seem to be somewhat larger that than those from the Santa Cruz and San Salvador collections.

Lycopodium phylicaefolium Desvaux – Fig. 2 E–G

Desvaux in Lam., Enc. Méth. Bot. Suppl. III p. 546 (1813). – *Urostachys phylicaefolius* (Desv.) Nessel, Bärlappgew. p. 246 (1939).

Collection studied: Isla San Cristóbal, El Junco, Adsersen 731 (C).

Small pendant epiphyte. Branches several times dichotomous, 5 cm long, 0.8 mm in diameter, sterile ones reddening apically; leaves ovate to lanceolate, attenuate, 1.2–1.6 mm wide, 3.5–5 mm long, light olive-green, twisted at base so that the shoot has a dorsiventral flattened appearance, stalk slightly decurrent.

Fertile parts spike-like, stout, branched several times dichotomously, terete to subtetragonous, up to 3 cm long, 1.7–2 mm wide; sporophylls dense, apically broadly cordate, aciculate, midrib prominent, almost forming a keel, about 1 mm long and 1 mm wide, towards sterile part gradually becoming longer, nearly lanceolate, 2–3 mm long, resembling sterile leaves. Sporangia lenticular, pale yellow, 1 mm in diameter.

Spore tetrads globular, dividing into rounded tetrahedral spores; spores with distal faces rounded, foveolate, proximal faces plane, smooth without ornamentation; largest spore diameter 37 (35–40) μm (measured on SEM photographs as described above), spores of the *Phlegmaria* type (Wilce 1972). Fig. 1 G–I.

It is with some hesitation that I refer this collection to *L. phylicaefolium*. It fits quite well the descriptions by Desvaux in Poiret (1813 p. 546) and Nessel (1939), but it might be a depauperate *L. subulatum* Desv. The reason why I prefer to call it *L. phylicaefolium* is the 90° distortion of the leaf blade and the stout appearance of the spike.

Spring (1849) included *L. phylicaefolium* in *L. subulatum*, a widespread and very variable South American species. B. Øllgaard, who is working on Ecuadorian *Lycopodium*, considers *L. phylicaefolium* to be distinct from *L. subulatum*, and refers my collection to the former.

Habitat: L. phylicaefolium was found in *Psidium guajava* scrub on the W part of the outer El Junco crater rim on Isla San Cristóbal (c. 650 m). We found only two specimens, one fertile and one sterile, on a branch of *Psidium guajava*, closely invested by brown epiphytic mosses and liverworts. Other epiphytes were *Lycopodium dichotomum*, *L. passerinoides*, *Grammitis serrulata*, *Asplenium auritum*, *Nephrolepis cordifolia*, *Polypodium angustifolium*, *Trichomanes reptans* and *Peperomia galapagensis*.

Distribution: Ecuador, Peru (Nessel 1939). Revised concepts of *L. phylicaefolium* and *L. subulatum* may expand the distribution range considerably.

Ophioglossum palmatum L. – Fig. 2 H

L., Sp. Pl. 2 p. 1063 (1753) – *Cheiroglossa palmata* (L.) Presl, Suppl. Tent. Pterid. p. 57 (1845) – *Ophioderma palmata* (L.) Nakai, Bot. Mag. Tokyo 39 p. 193 (1925).

Collection studied: Isla Pinta, Adsersen 1250 (C, CDS).

Rhizome fleshy, ascending, up to 1 cm long, 5 mm thick, with many yellowish fleshy roots, at frond bases densely invested with long, white, multicellular hairs. Fronds several from each rhizome, total length up to 40 cm, of which 3/4 is stalk; stalk fleshy, glabrous, about 3 mm thick; blade gradually dichotomously dividing into lobes, finally 6–10 cm wide, 10–15 cm long, irregularly palmate with 4 lobes, first dissection to about 2/3 of blade length and the second ones to about 1/2 the blade length. Blade dark green, glabrous, glossy, somewhat fleshy; venation areolate with elliptic-oblong areoles.

Fertile spikes (0–)1–5 borne near the blade base, one-sided and opposite blades, or sometimes at lower blade margin, semierect, forming an angle of about 45° with stalk, 3–5 cm long, lower tenth of spike without sporangia, upper part 3–4 mm wide, carrying sporangia in two rows, dark olive-green; sporangia 0.6–1.0 mm in diameter; spores yellow-green, finely verrucous, 40–52 μm in diameter.

Habitat: O. palmatum was growing on the ground on the SW slope of the highest cone in the summit area at c. 640 m (Adsersen 1976 b). The cone rises c. 25 m above the rather plane summit area, where there is a dense *Pteridium aquilinum* var. *arachnoideum* vegetation with scattered clusters of *Zanthoxylum fagara* (further description see Hamann 1974 a, 1975).

Ophioglossum palmatum is referred to as an epiphyte; thus this terrestrial occurrence may seem puzzling. However, the species composition is not at all typical for low exposed vegetation. The species with one asterisk in the list below are in Galápagos most often found as epiphytes or in bogs (i.e., in ombrotrophic localities), those with two asterisks are encountered in shaded habitats. The slope is exposed to the humid SW winds. The vegetation is completely dominated by pteridophytes: *Asplenium feei*, *A. praemorsum**, *A. serra* var. *imrayanum*, *Blechnum polypodioides*, *Dryopteris pedata* var. *palmata***, *Elaphoglossum firmum**, *E. minutum*, *Histiopteris incisa**, *Hypolepis hostilis*, *Lycopodium cernuum*, *Nephrolepis cordifolia**, *Ophioglossum palmatum**, *Polypodium aureum* var. *areolatum**, *P. tridens*, *Pteridium aquilinum* var. *arachnoideum*, *Pteris quadriaurita***, *Rumohra adiantiformis** and *Thelypteris pilosula***.

The only seed plants observed are *Commelina diffusa*, *Erythrodes* cf. *weberiana*, *Peperomia galioides*, *Pilea baurii* and *Solanum nodiflorum*.

Soil samples consistently show that contact with mineral soil is sparse. High content of organic matter (75 %, wet combustion) and low pH (4.16) and base saturation (20 %) indicate that the soil is best characterized as a fern peat.

The locality is not greatly influenced by goats and may have remained unchanged for a very long time (for dating of fern peats from Isla Pinta see Adsersen 1976). There is no reason to believe that *O. palmatum* has been introduced by man or feral animals.

Distribution: Tropical America from Uruguay and Peru to Yucatan, the Caribbean area and Florida; Viet Nam; Reunion (Clausen 1938).

Ophioglossum palmatum has not previously been reported from the Galápagos Islands. It differs from *O. reticulatum*, the only other *Ophioglossum* species known from the archipelago, in its palmately lobed sterile part of the frond and its several spikes borne at the base of the frond blade. It should be expected elsewhere in the archipelago on fern or *Sphagnum* peat.

Woodsia montevidensis (Sprengel) Hieron. – Fig. 2 A–B

For synonymy and illustrations see Brown 1964.

Collections studied: Isla Fernandina, Adsersen 561 (C, CDS), 933 (C, CDS).

Rhizome ascending, 3–4 mm thick, blackish brown, invested with narrow deltoid, almost entire scales, these 3–6 mm long, at base 0.3–0.5 mm broad, lustrous brown with hyaline margin, this broader on younger scales; fronds fasciculate, 2–16 fertile photosynthetic ones together with several persistent stipe bases, the latter of uneven length, 2–20 cm, dull grey to brown. Fronds all fertile, 5–25 cm long, stipes and rachis light brown, 1–1.5 mm thick, at base with a few tan, lanceolate scales of 3–7 mm length, above with few scattered, similar but smaller scales, scattered glands and numerous hyaline several-celled hairs of different lengths, the longest being c. 1 mm, the cells in these about 100 μm long. Blade 5–20 cm long, up to 5 cm wide, lanceolate or oblong, bipinnate or pinnate-pinnatifid, pinnae sessile to subsessile, 10–20-paired. Central pinnae oblong-lanceolate, pinnatifid, 2.5 cm long, at base 1–1.2 cm wide; basal pairs more deltoid, shorter and more remote; apical pairs generally reduced in size. Pinnulae suborbicular to obtusely oblong, crenulate and denticulate, lamina chartaceous to subcoriaceous, olive-green, both surfaces and margin with several-celled hairs and glands. Sori discrete, sometimes confluent; indusium composed of hyaline plate-like lobes, sometimes with marginal teeth.

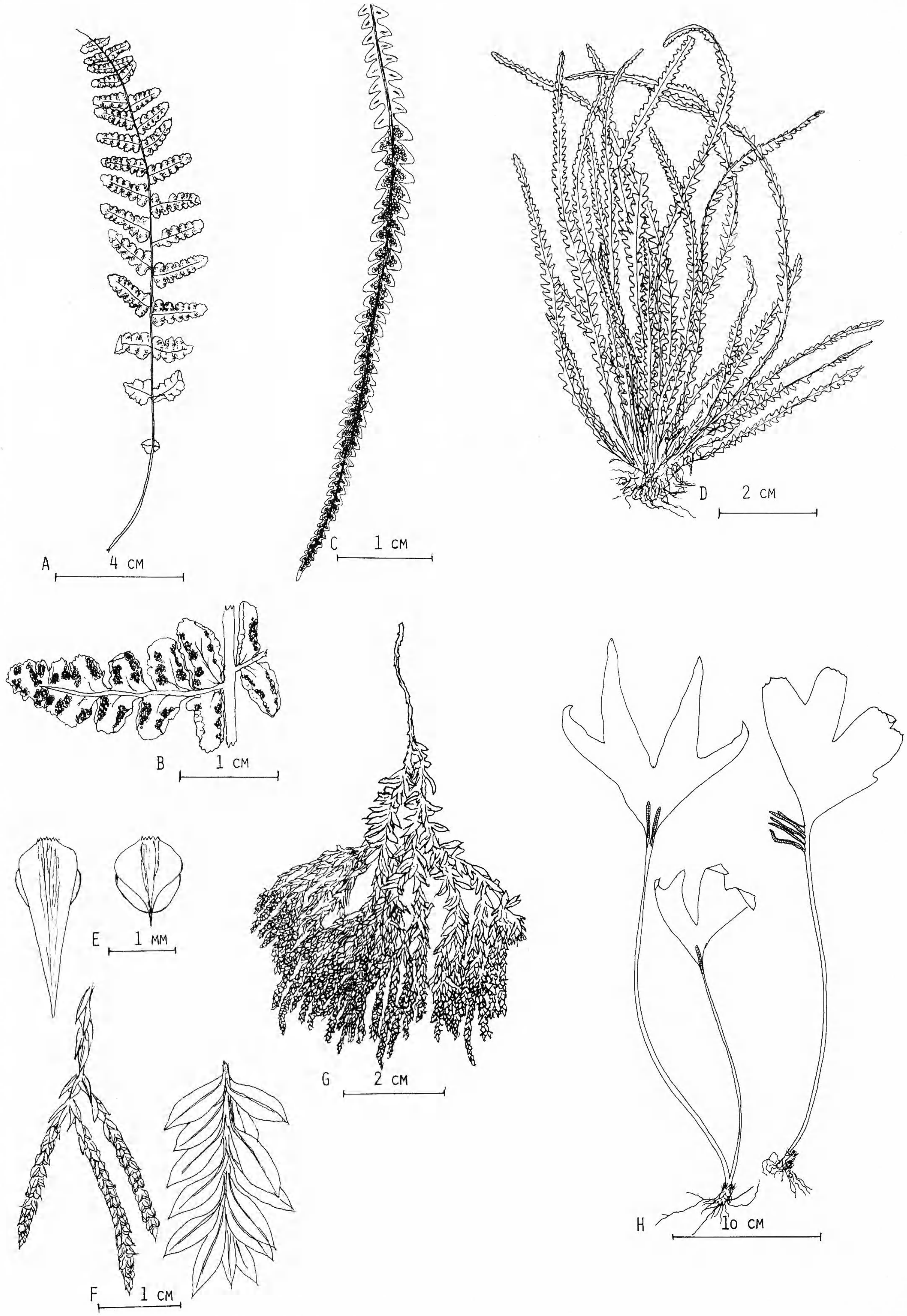
Spores monolete, with irregularly reticulate sculptured epispore, 40–50 μm wide and 60–70 μm long.

Habitat: On steep rock walls or slopes. We found it at 1400 m on S-facing slopes in faults on the S part of the caldera rim of Isla Fernandina. van der Werff (pers. comm.) found it on the E caldera rim of Volcán Alcedo at 1030 m (van der Werff 1160), and on the top of Cerro Azul at 1604 m (van der Werff 2250). It is almost certainly indigenous.

Distribution: Argentina to Colombia and Hispaniola; uplands of Brazil; South Africa.

The genus *Woodsia* has not previously been reported from Galápagos. The key in Wiggins & Porter (1971) will place the species in the

Fig. 2. A–B: *Woodsia montevidensis* (Adsersen 561). – A: Single frond. – B: Pinna from central part of frond. – C–D: *Grammitis delitescens* (Adsersen 146). – C: Single frond. – D: Habit. – E–G: *Lycopodium phylicaefolium* (Adsersen 731). – E: Sporophylls and sporangia from basal part (left) and central part (right) of spike. – F: Fertile (left) and sterile (right) shoot. – G: Habit (fertile plant). – H: *Ophioglossum palmatum* (Adsersen 1250).


A 4 cm
C 1 cm
D 2 cm
B 1 cm
E 1 mm
G 2 cm
H 1o cm
F 1 cm

Tectarioideae. It is easily distinguished from all other ferns known from the archipelago by its hairy and glandular leaf margins and the indusium which is composed of hyaline plate-like lobes, sometimes with marginal teeth.

Acknowledgements. My thanks are due to Lektor Ole Hamann, Copenhagen and Dr H. van der Werff, Utrecht, who permitted me to publish some of their records. Lektor B. Øllgaard, Århus, gave valuable help in the identification of the plants.

References

Adsersen, H. 1976: A botanist's notes on Pinta. *Noticias de Galápagos 24:* 26–28.

Brown, D. F. M. 1964: A monographic study of the fern genus Woodsia. *Beih. Nova Hedwigia 16.*

Clausen, R. T. 1938: A monograph of the Ophioglossaceae. *Mem. Torrey Bot. Club 19 (2).*

Copeland, E. B. 1952: The American species of Xiphopteris. *Am. Fern Journ. 42:* 41–52.

Eliasson, U. 1970: Studies in Galápagos plants IX. New taxonomical and distributional records. *Bot. Notiser 123:* 346–357.

Hamann, O. 1974 a: Contribution to the flora and vegetation of the Galápagos Islands. I. New floristic records from the archipelago. *Bot. Notiser 127:* 245–251.

– 1974 b: Contribution to the flora and vegetation of the Galápagos Islands. II. A new subspecies of Lycopodium from the archipelago. *Bot. Notiser 127:* 252–255.

– 1975: Vegetational changes in the Galápagos Islands during the period 1966–73. *Biol. Conserv. 7:* 37–59.

Jenman, G. S. 1897: Ferns: Synoptical list XLVI. *Bull. Bot. Dep. Jamaica, New Ser. 4:* 112–113.

Maxon, W. R. 1914: Studies of tropical American ferns no. 5. *Contr. U.S. Nat. Herb. 17(4).*

Morton, C. V. 1967: The genus Grammitis in Ecuador. *Contr. U.S. Nat. Herb. 38 (3).*

Nessel, H. 1939: *Die Bärlappgewächse.* Jena.

Poiret, J. L. M. 1813: *Encyclopédie méthodique. Botanique. Suppl. 3.* Paris.

Spring, A. 1842, 1849: Monographie de la famille des Lycopodiaceés. *Mém. Acad. Roy. Belg. 15, 24.*

Wiggins, J. & Porter, D. (eds.) 1971: *Flora of the Galápagos Islands.* Stanford.

Wilce, J. H. 1972: Lycopod spores. I. General spore pattern and the generic segregates of Lycopodium. *Am. Fern Journ. 62:* 65–79.

The amphicarpic species Lathyrus ciliolatus

Jacob Mattatia

Mattatia, J. 1977 01 28: The amphicarpic species Lathyrus ciliolatus. *Bot. Notiser 129:* 437–444. Stockholm. ISSN 0006-8195.

Lathyrus ciliolatus Sam. ex Rech. f., an amphicarpic species described from limited herbarium material and considered as an endemic of Syria and Lebanon, is recorded from many localities in Israel. A complementary description is given and the local distribution and ecology are discussed. Biosystematic studies have shown that amphicarpy is a constant character in this species. *L. ciliolatus* is compared with *L. blepharicarpus* Boiss., a species regarded as related to it. They differ in the flower and fruit morphology, as well as in amphicarpy. Crossing experiments show that the two sympatric species are reproductively isolated. Chromosome numbers of *L. ciliolatus* and *L. blepharicarpus* are 2n = 14. *L. ciliolatus* is further compared with two other species of *Lathyrus* in which amphicarpy occurs: *L. amphicarpos* L., which has been confused with *L. blepharicarpus* and *L. setifolius* L. var. *amphicarpos* DC.

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In the course of a study on amphicarpic plants from Israel (Mattatia 1976) many specimens of *Lathyrus ciliolatus* Sam. ex Rech. f. were collected. This species has so far been considered as an endemic to Syria and Lebanon (Mouterde 1970). Despite some discrepancies, mainly in variable quantitative characters, our material agrees both with the original diagnosis (Rechinger 1949) and the type, and are similar to some herbarium specimens from Syria and Lebanon. The following description is based on a wide range of material, both collected and grown, and is complementary to Rechinger's original diagnosis (1949), which was based on limited herbarium material.

Lathyrus ciliolatus Sam. ex Rech. f.

Rech. f. in Ark. Bot. Ser. 2, 1 (5): 311 (1949)

Amphicarpic winter annual, sparsely hairy to subglabrous or glabrescent, branching from base, with decumbent to ascending branches bearing chasmogamous flowers, and subterranean diageotropic to plagiogeotropic stolons bearing cleistogamous flowers. *Aerial branches* angular, up to 50 cm long. *Leaves* variable in shape and size; stipules 4–18 mm, longer than petiole, lanceolate, semi-sagittate; petioles 2–8 mm, shorter than leaflets; leaflets 1-paired, lanceolate to narrowly elliptical or linear, 5–50 × 1.5–6 mm; tendrils simple, up to 5 cm in the upper leaves, small and awn-like in the lower leaves. *Stolons* arising from cotyledonary buds and from subterranean axillary buds at the nodes of the main axis between the cotyledons and ground level, subangular to terete, achlorophyllous, simple or branched, with small lobed scales at the nodes, varying in length from a few cm up to 40 cm, apically hooked. *Flowers* solitary; subterranean flowers contain all the floral organs but are smaller than the aerial flowers (Table 1). *Style* dilated towards apex, adaxially puberulent, not contorted (contrary to the original diagnosis). Aerial *pod* somewhat compressed, short-beaked, ciliolate along margins, ventral suture canaliculate, 2-keeled. Subterranean pod similar to the aerial one, but often with indistinct cilia and of irregular shape due to mechanical pressure underground. *Seeds* subglobular, brownish grey, sometimes punctate

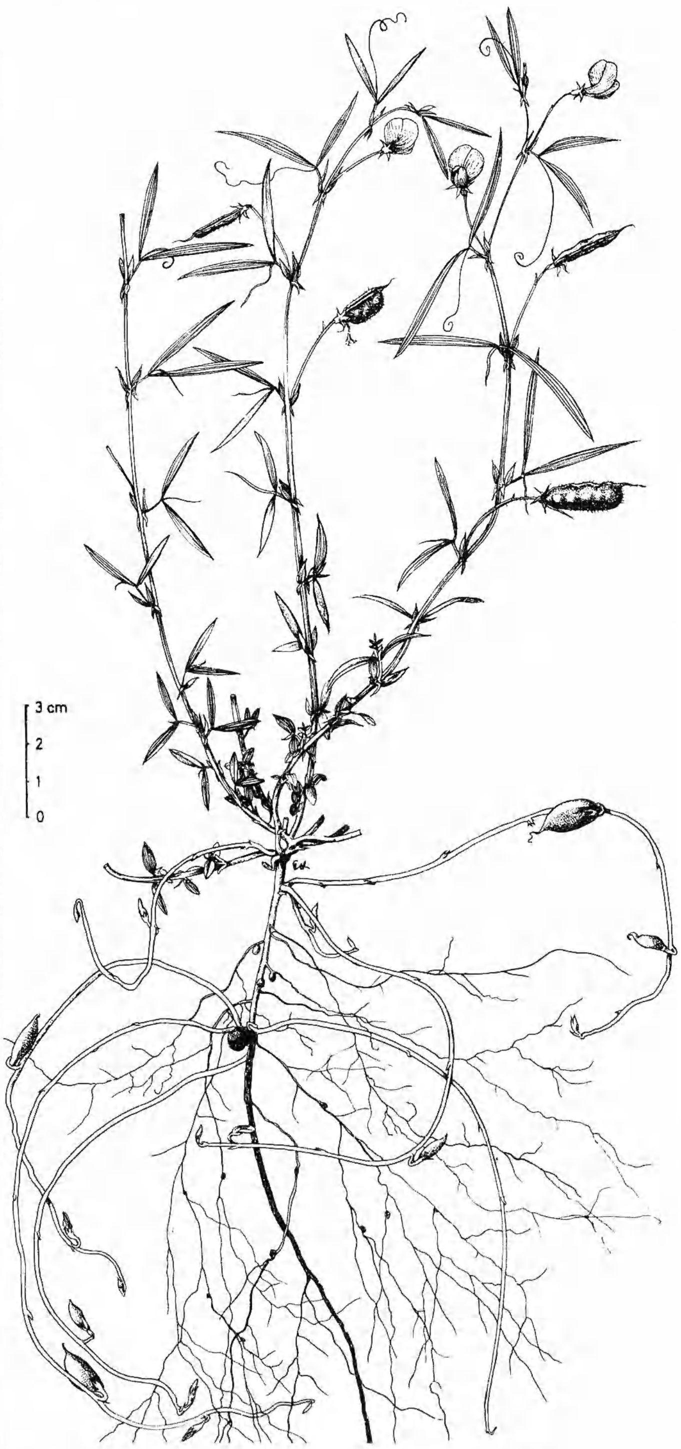

Fig. 1. *Lathyrus ciliolatus* Sam. ex Rech. f.

or mottled; ratio of hilum to seed circumference 1/11–1/15. 2n = 14. Flowering March–April.

Holotype: Lebanon: Djebel el Kenisseh, solo plus minus calcareo, in glareosis c. 1800 m, 5.6. 1933, G. Samuelsson, It. pal.-syr. sec. 5740 (S!).

Selected specimens: Lebanon: Ksara, 16.5.1937, Gombault, Pl. Syr. Liban. etc. 5941 (P). – Syria: Inter urbem Aleppo et opp. Antakieh (Antiochia), in rupestribus calc. prope pagum Tell Akibrin c. 430 m, 24.4. 1933, Samuelsson 3952 (W). – Israel (all J. Mattatia, HUJ): Mt Hermon, rocky batha, 1500 m, 15.7. 1971; Upper Galilee, 7 km NW of Zefat, batha, brown-red lithosol on vesicular basalt, 870 m, 15.4. 1970; Judean Mts, 4 km NE of Bethel, rocky batha, gravelly terra-rossa, grazing area, 800 m, 5.4. 1973; Judean Desert, Khashm-el-Karm, 18 km SE of Hebron, heavily grazed area (plants with subterranean fruits only), 7.4. 1973.

Distribution and ecology

According to Mouterde (1970), *L. ciliolatus* occurs in Lebanon and in the western and southern parts of Syria. The Israelian collections are mainly from the higher mountainous part of the Mediterranean phytogeographic territory (Zohary 1972): in the Upper Galilee, Mt Hermon (up to 1800 m), the Golan Heights, mainly in the higher northern part, and the Judean Mts (Fig. 2). In the eastern escarpments it extends to the margins of the Judean Desert, to sub-Mediterranean bathas with average annual rainfall of 200–400 mm. It extends not so far into the Irano-Turanian territory as does *Vicia sativa* ssp. *amphicarpa,* a taxon having similar ecological requirements (Plitmann 1973). At the margins of the Samarian and Judean Deserts, where these two species are sympatric, *L. ciliolatus* usually occupies more humid niches than the amphicarpic *Vicia* (Mattatia 1976).

L. ciliolatus occurs usually in rocky batha, sometimes in margins or clearings of garigue and maquis. It grows on well drained and aerated gravelly soils of various types, as terra-rossa and rendzina. In the eastern Galilee and northern Golan it grows on basalt, particularly on the lighter soil types originating from or mixed with vesicular pyroclastic basalt, as scoria or tuff. In the eastern and south-eastern parts of the Hebron Mts, bordering the Judean Desert and Negev, it grows on xeric brown rendzina and on dry brown lithosol. Characteristically it is absent from heavy alluvial soils, as grumosols. Like the amphicarpic *Vicia,* it prefers loose soils with well aggregated structure. But provided soil aeration is adequate, it grows also in places where soil is relatively compact.

When not in flower this plant is difficult to discover because of its low decumbent habit and its similarity in vegetative characters to other *Lathyrus* species. It is particularly difficult to discern it under grazing and dry conditions,

Table 1. Comparison of aerial and subterranean flowers and fruits of *Lathyrus ciliolatus*.

Character	Aerial	Subterranean
Type of flower	chasmogamous	cleistogamous
Length of peduncle (mm)	20–50	2–3
Length of calyx (mm)	5–7	4–6
Calyx, ratio tube/teeth	tube shorter than teeth	tube longer than teeth
Colour of corolla	showy, reddish-orange (7 A6–7 in Kornerup & Wanscher 1967)	colourless to slightly tinged with pale pink-orange
Size of standard (mm)	12–15 × 9–12	5–9 × 1.5–2.5
Ratio calyx/corolla	less than 1/2	2/3 or more
Secretion of nectar	present	absent
Average ratio staminal tube/filaments	1.4	0.5
Size of anthers (mm)	0.6–1.0	0.3–0.6
Number of ovules	3–5	2–3
Size of pod (mm)	(15–)20–30 × 7–8	7–15(–20) × 7–8
Dehiscence of pod	dehiscent	non-dehiscent
Number of seeds per pod	2–4(–5)	1–2(–3)
Seed diameter (mm)	3.5–4.5	4.5–6
Average seed weight (mg; n = 250)	37.8 ± 0.5	59.4 ± 1.1

when its aerial branches are few and short and seldom bear flowers and fruits. Moreover, the flowering season is very short. These facts may explain why this species, which is quite abundant in some localities, was so recently discovered in an area that has been so intensely explored by botanists. Probably *L. ciliolatus* has a wider distribution than presently known.

Survey of the literature

Lathyrus ciliolatus was recorded only in the local floras of Syria and Lebanon (Mouterde 1953, 1970). No amphicarpic *Lathyrus* is mentioned in the list of the amphicarpic plants of Palestine (Zohary 1962). An amphicarpic form of *L. blepharicarpus* Boiss. was recorded by Zohary (1972) among other forms of uncertain constancy, which were not given a taxonomic status. It is mentioned by Plitmann (1973) as *L. blepharicarpus* var. *amphicarpus,* although such a combination has never been formally published, and although Rechinger (1949) pointed out the difference between his new species and *L. blepharicarpus*. The amphicarpic *Lathyrus* is not commented upon in Zohary 1976.

The taxonomic study of *L. ciliolatus* focussed particularly on its contended relationship with *L. blepharicarpus* and with *L. amphicarpos* L., which has a confused taxonomy, and for which Linnaeus (1753) stated "Habitat in Syria".

One of the reasons for relating *L. ciliolatus* with *L. blepharicarpus* (Zohary 1972, Plitmann 1973) is the occurrence of cilia along the legume sutures in both taxa. Another probable reason is the nomenclatural confusion between *L. blepharicarpus* and *L. amphicarpos* L. and notes in the literature on amphicarpic forms in *L. blepharicarpus*. It is possible that specimens of *L. ciliolatus,* which has characters in common with each of these two species, were also involved.

The plant known today as *L. blepharicarpus* Boiss. was first discovered on Rhodos and Cyprus and identified with *L. amphicarpos* L. by Sibthorp & Smith (1832). However, it is clear that the plant described and depicted has 2-winged ciliate pods and was not amphicarpic. Boissier (1872) remarked that he had not seen amphicarpic forms of *L. blepharicarpus,* but thought, following Sibthorp & Smith, that they might occur in the Greek flora. Although he believed that the two names probably pertained to the same plant, he suggested to neglect the name *L. amphicarpos* in order to avoid confusion between amphicarpic forms of various *Lathyrus* species. Notes alluding to the possible identity of *L. blepharicarpus* Boiss. and *L. amphicarpos* L. appear also in Chaubard (1838), Post (1932) and

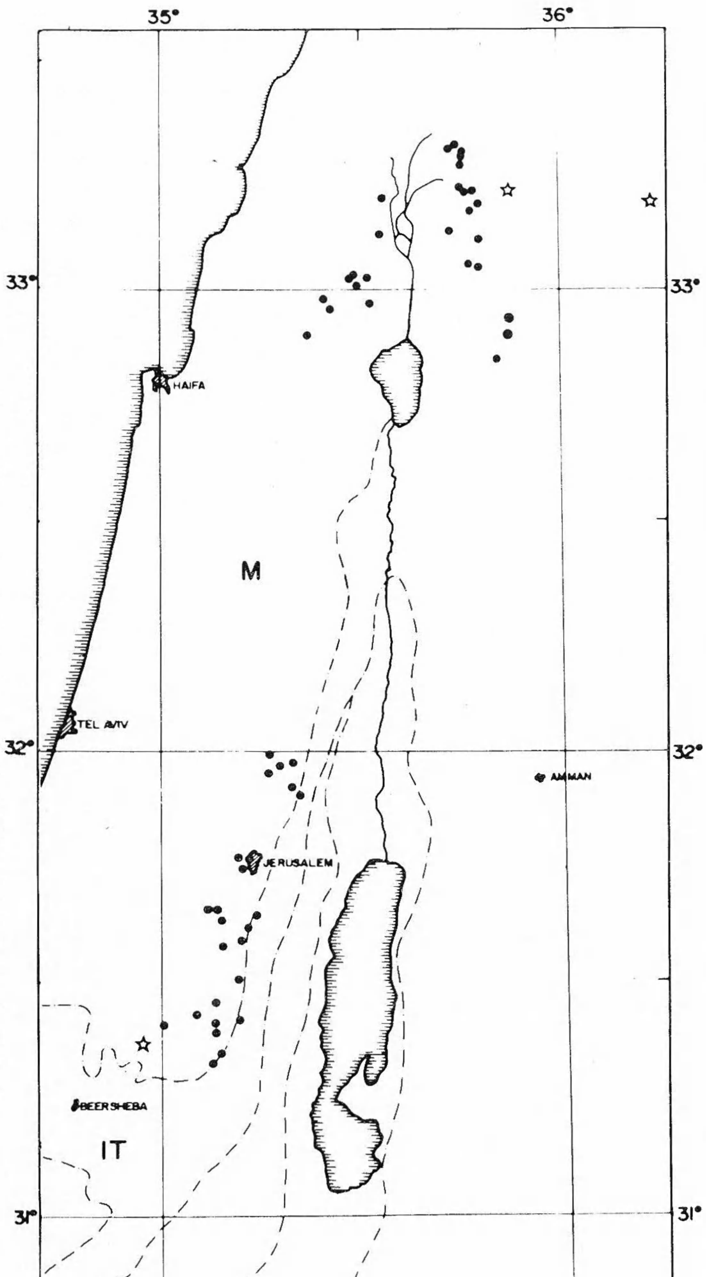

Fig. 2. The distribution of *Lathyrus ciliolatus* in Israel. – M, IT: the Mediterranean and Irano-Turanian phytogeographic territories of Israel according to Zohary (1972). – Dots: Populations observed in the field and collected. – Rings: Herbarium specimens. – Stars: Data from literature.

Zohary (1972). Halácsy (1901) stated that the pod is ciliate along its margins in *L. amphicarpos*, probably using this name in the sense of Sibthorp & Smith (1832). A note on the occurrence of facultative amphicarpy in *L. blepharicarpus* is found in Greuter & Rechinger (1967 p. 74). A doubtful specimen from Rhodos, belonging to *L. blepharicarpus* or *L. amphicarpos* is mentioned by Davis (1970).

Lathyrus ciliolatus and L. blepharicarpus

Biosystematic studies, in which plants of *L. ciliolatus* from different localities in Israel were grown under equal conditions, some of them up to five successive generations, have shown that amphicarpy is a constant character in this species, and occurs to an equal degree in different populations. Plants of *L. blepharicarpus* were also grown, but never showed signs of amphicarpy under conditions that enabled or stimulated amphicarpy in *L. ciliolatus*.

In an experiment with plants grown in well aerated soil mixture (terra-rossa and sand), aerial branches of *L. ciliolatus* were artificially buried. The green leaves of the buried branches usually withered, but some of their axillary buds developed to form stolons, bearing typical subterranean flowers and fruits. The same treatment did not bring about similar results in *L. blepharicarpus*. This shows that amphicarpy in *L. ciliolatus* is an inherent character, not a facultative one that may be induced merely by external conditions.

Lathyrus blepharicarpus and *L. ciliolatus* may overlap in the range of variability of vegetative characters (e.g. shape and size of leaflets, stipules, tendrils, etc.). These characters are also common of other related *Lathyrus* species of section *Cicercula*, as *L. cicera*, *L. pseudocicera*, *L. marmoratus*, and are, therefore, of limited diagnostic value. However, when grown under equal conditions, *L. ciliolatus* shows a slower rate of vegetative growth, fewer and shorter branches, smaller leaves and a lower fruit yield as compared with *L. blepharicarpus* and other non-amphicarpic species (Fig. 3 E). A similar phenomenon was found in experiments in *Vicia sativa* ssp. *amphicarpa* and in *Pisum fulvum* var. *amphicarpum* (Mattatia 1976), and was also noted on herbarium specimens of *L. amphicarpos* L. This

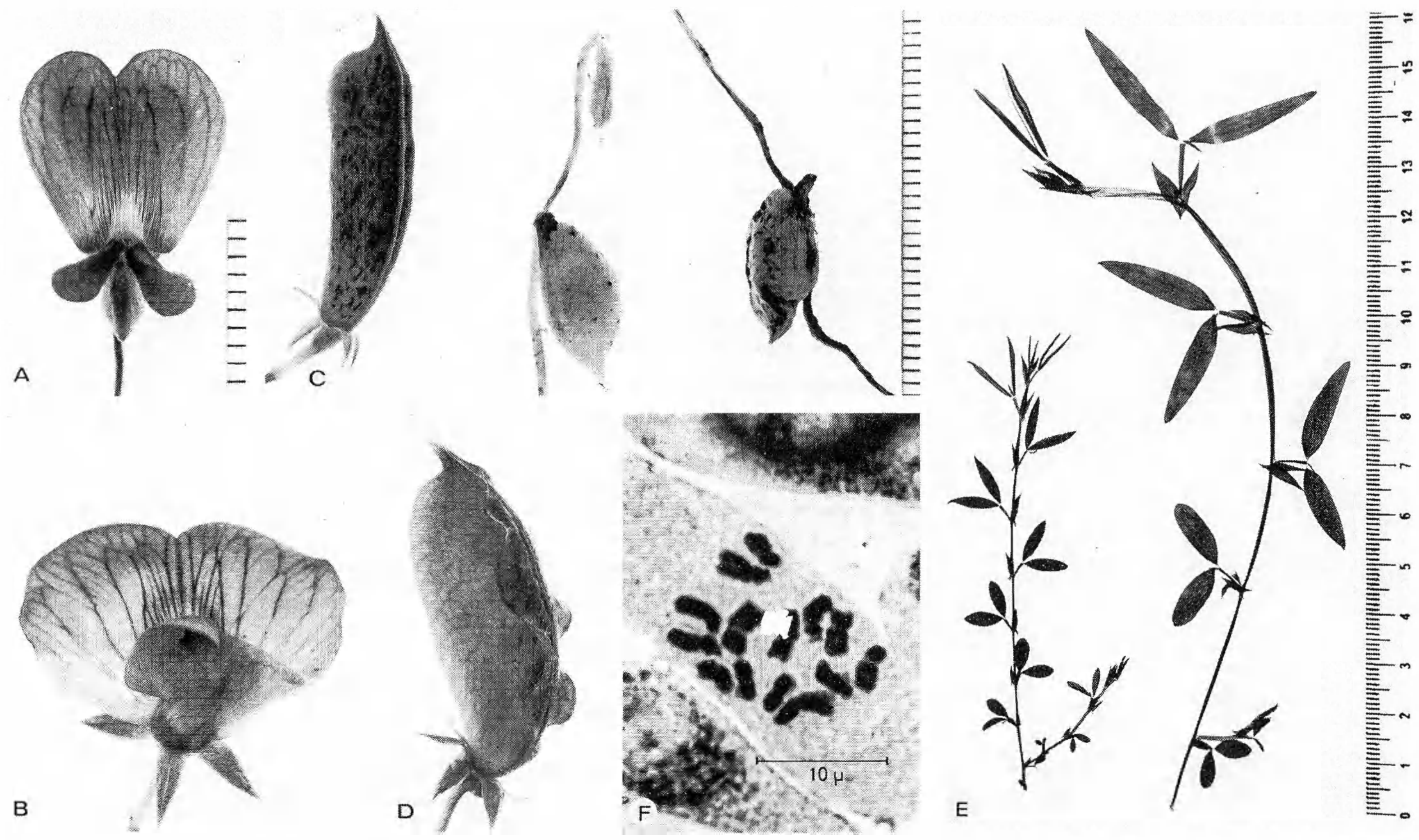

Fig. 3. A–E: Comparison of *L. ciliolatus* and *L. blepharicarpus,* grown under equal conditions in a greenhouse, from seeds collected in adjacent localities in the Upper Galilee. – A: Flower of *L. ciliolatus* (scale units are mm). – B: Flower of *L. blepharicarpus* (same magnification as A). – C: Aerial and subterranean fruits of *L. ciliolatus* (scale units are mm). – D: Fruit of *L. blepharicarpus* (same magnification as C). – E: Branches of *L. ciliolatus* (left) and *L. blepharicarpus* (right) at the same age, showing different growth rates (scale units are cm and mm). – F: Metaphase of root-tip mitosis of *L. ciliolatus,* pretreated with paradichlorobenzene, squashed in aceto-orcein (2n = 14).

phenomenon, associated with amphicarpy, is attributable to the fact that a considerable part of the photosynthetic resources are diverted to the stolons, which start to develop at a relatively early stage. Since they are subterranean organs, specialized in reproduction, they are consumers of products of photosynthesis without being their producers (Mattatia 1976).

Apart from amphicarpy and the characters associated with it, the two species differ in the morphology of the flower and fruit. The main differences between them are summarized in Table 2 and shown in Figs. 3 and 4. The most important differences are in the morphology of the gynoecium and fruit. The style of *L. ciliolatus* is straight, its dilated sub-apex being adaxial, whereas in *L. blepharicarpus* it is always twisted sinistrally (Fig. 4 E). This difference can be discerned even without dissection of the flower, as it is reflected in the shape of the keel (Figs. 3 A, B, 4 A). Extensive field observations have shown that these characters are constant in both species in their whole range of distribution in Israel. The different angle between the ovary and style (Table 2, Fig. 4 E) and the different plane of the pollen-presenting part of the style and stigma, seem to indicate different behaviour of the pollinating agent, and probably also different pollinators. These are important, though sometimes neglected, floral characteristics in *Lathyrus.*

The ventral wings on the pod of *L. blepharicarpus* may vary in breadth in various populations, but they are always broad, wavy and leaf-like, whereas in *L. ciliolatus* the ventral ridges are narrow, not exceeding 0.5 mm, and can hardly be termed as wings. This difference should be regarded as more significant than the similarity in having ciliate pod margins. The pod of *L. ciliolatus* resembles that of *L. cicera* in general shape and in the structure of the

Table 2. Comparison between *Lathyrus ciliolatus* and *L. blepharicarpus*.

Character	*L. ciliolatus*	*L. blepharicarpus*
Plant indumentum	plants sparsely hairy to mostly subglabrous or glabrescent	plants patulous pubescent to sparsely hairy
Calyx indumentum	teeth sparsely ciliate or mostly glabrous	teeth ciliate
Standard	length usually exceeding breadth (Figs. 3 A, 4 B)	breadth usually exceeding length or equal to it (Fig. 3 B)
Wings	approx. as long as keel	longer than keel
Keel	adaxial (upper) margin smooth	adaxial margin minutely ciliolate
Angle between ovary and style (Fig. 4 E)	approx. 130°	approx. 90°
Style (Fig. 4 E)	not contorted	contorted approx. 90°
Breadth of pod	up to 8 mm	up to 12 mm
Ventral suture of pod	canaliculate, 2-keeled	broadly 2-winged
Seed diameter (mm)	(aerial) 3.5–4.5	4.0–6.0
Average seed weight (mg)	(aerial) 37.8 ± 0.5	43.7 ± 2.1

ventral suture. However, it differs from it in being ciliolate, smaller, and in usually having fewer seeds.

In both species the chromosome number was found to be $2n=14$ (*L. ciliolatus:* Upper Galilee, Dalton Plateau, 7 km NW of Zefat, 5.5. 1970; Fig. 3 F. *L. blepharicarpus:* Upper Galilee, between Alma and Ramot-Naftali, 12 km N of Zefat, 10.4. 1970; voucher specimens HUJ). This is the predominant number in *Lathyrus,* found in 54 out of 61 species listed by Fedorov (1969).

Two-directional crosses were attempted between *L. ciliolatus* and *L. blepharicarpus* in plants grown from seeds in a greenhouse. In the majority of the pollinated flowers the ovary failed to develop. In 16 out of 37 crosses when the female parent was *L. ciliolatus* and in 7 out of 27 reciprocal crosses, the ovary started to develop, but its development was arrested at some stage. In 9 of the crosses the ovary approached the full size of a mature pod, but no seeds were set. It therefore seems that these two species are reproductively isolated. This may account for the fact that although they are partly sympatric, no spontaneous hybrids with intermediate characters could be found.

Further amphicarpic Lathyrus

Lathyrus ciliolatus was compared with two other species of *Lathyrus* in which amphicarpy is known to occur, viz., *L. amphicarpos* L. 1753 (syn. *L. quadrimarginatus* Bory & Chaub. 1832), and *L. setifolius* L. var. *amphicarpos* DC. (de Candolle 1805; syn. *L. amphicarpos* sensu Gouan 1762, non L.).

Lathyrus amphicarpos occurs in S Greece, Sicily, the Iberian Peninsula (Ball 1968), and N Africa (Quézel & Santa 1962). The study included examination of the type specimen (No. 905/3 in the Herbarium of the Linnean Society, London; personal information by Dr W. T. Stearn), the specimen No. XIX 98 bis in the Burser Herbarium, Uppsala, and herbarium material from S Europe and N Africa. This species differs from *L. ciliolatus* mainly in having a red corolla, glabrous ovary and pod, usually wider pods and two-winged margins on both ventral and dorsal sutures. In both species the mature pod is prominently veined. In *L. ciliolatus* some of the more prominent veins diverge from the dorsal suture and run more or less obliquely along the pod, whereas in *L. amphicarpos* all the veins anastomose, forming a network of polygonal structures.

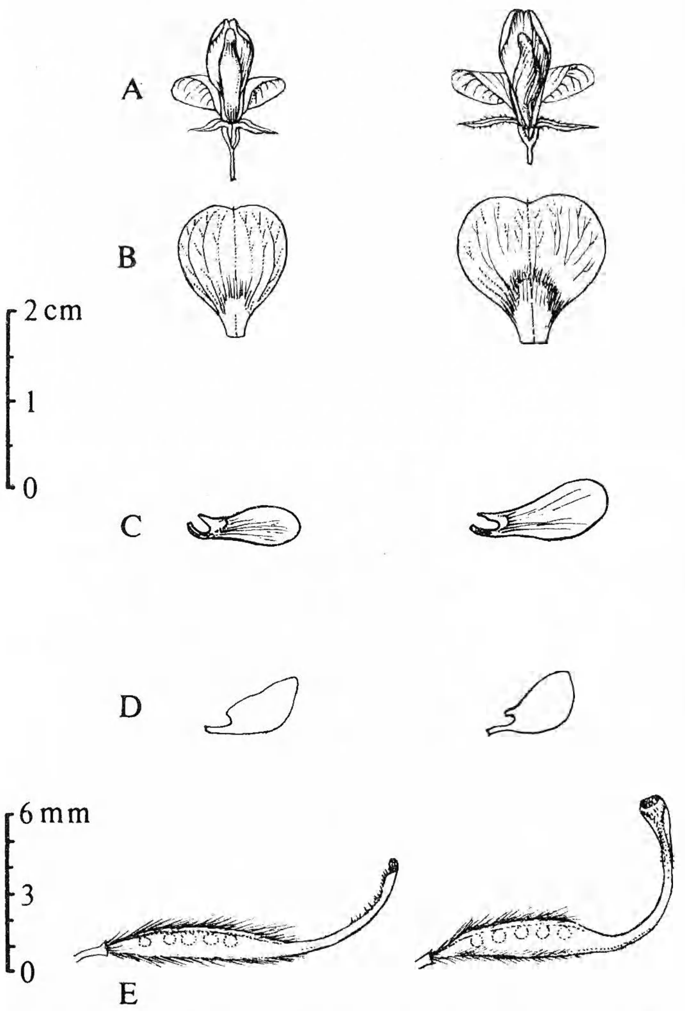

Fig. 4. Floral parts of *L. ciliolatus* (left) and *L. blepharicarpus* (right). – A: Flower. – B: Standard. – C: Wing. – D: Keel. – E: Gynoecium.

These two species are very similar in the general morphology of the stolons and subterranean reproductive organs. They present a very fine example of parallel evolution.

Lathyrus setifolius var. *amphicarpos* is known from S France and S Tyrol (Ascherson & Graebner 1909), Yugoslavia (Hayek 1926) and Spain (Willkomm & Lange 1877). Material from Montpellier was examined. This species can be distinguished from *L. ciliolatus* mainly in having a smaller flower, a densely hairy ovary, which is usually glabrescent in the fruit except for the margins, stipitate pods and tuberculate seeds. Amphicarpy here is generally less pronounced than in the two above mentioned species.

A third amphicarpic *Lathyrus, L. sativus* L. f. *amphicarpa* Coss. ex Beck, is known to me only from literature (Beck 1903), as no herbarium material was available for comparison. It may be synonymous with *L. amphicarpos* L., which resembles *L. sativus* in vegetative characters and in the general morphology of the pod.

From the present evidence it seems that amphicarpy has arisen independently at least three times in the genus *Lathyrus*.

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References

Ascherson, P. & Graebner, P. 1909: *Synopsis der mitteleuropäischen Flora 6(2)*. Leipzig.
Ball, P. W. 1968: Lathyrus L. *In* T. G. Tutin et al. (eds.), *Flora Europaea 2:* 136–143. Cambridge.
Beck, G. 1903: Lathyrus sativus. *In* H. G. L. Reichenbach & H. G. Reichenbach, *Icones florae germanicae et helveticae 22:* 165, Pl. MMCCL (199) Fig. 3. Leipzig.
Boissier, E. 1872: *Flora Orientalis 2*. Genevae et Basileae.
Bory de Saint-Vincent, J. B. G. M. & Chaubard, L. A. 1832: Lathyrus quadrimarginatus. *In* J. B. G. M. Bory de Saint-Vincent et al., *Expédition scientifique de Morée 3(2):* 205, t. 25. Paris.
Candolle, A. P. de 1805: Lathyrus setifolius var. amphicarpos. *In* J. B. A. P. M. de Lamarck & A. P. de Candolle, *Flore française (ed. 3) 4:* 581. Paris.
Chaubard, L. A. 1838: Lathyrus quadrimarginatus. *In* J. B. G. M. Bory de Saint-Vincent & L. A. Chaubard, *Nouvelle flore du Péloponnèse et des Cyclades:* 47, t. 27. Paris and Strasbourg.
Davis, P. H. 1970: *Flora of Turkey and the East Aegean Islands 3*. Edinburgh.
Fedorov, A. A. (ed.) 1969: *Chromosome numbers of flowering plants*. Leningrad.
Gouan, A. 1762: *Hortus regius monspeliensis*. Lyon.
Greuter, W. & Rechinger, K. H. 1967: Chloris Kythereia. Flora der Insel Kythera. *Boissiera 13*.
Halácsy, E. von 1901: *Conspectus Florae Graecae 1*. Leipzig.
Hayek, A. von 1926: Prodromus Florae Peninsulae Balcanicae 1. *Feddes Repert. Beih. 30*.

Kornerup, A. & Wanscher, J. H. 1967: *Methuen handbook of colour*. Ed. 2. London.

Linnaeus, C. 1753: *Species plantarum*. Stockholm.

Mattatia, J. 1976: *The relationships between amphicarpic plants and their environment*. Ph. D. thesis, The Hebrew University of Jerusalem (in Hebrew, with an English summary).

Mouterde, P. 1953: *La flore du Djebel Druze*. Paris.

– 1970: *Nouvelle flore du Liban et de la Syrie 2*. Beyrouth.

Plitmann, U. 1973: Vicia sativa subsp. amphicarpa (Dorth.) Aschers. & Graebn. *Israel J. Bot. 22:* 178–194.

Post, G. E. 1932: *Flora of Syria, Palestine and Sinai 1. Ed. 2.* Beirut.

Quézel, P. & Santa, S. 1962: *Nouvelle flore de l'Algérie et des régions désertiques méridionales 1.* Paris.

Rechinger, K. H. 1949: Reliquiae Samuelssonianae I. *Ark. Bot. Ser. 2, 1 (5).*

Sibthorp, J. & Smith, J. E. 1832: *Flora Graeca 7.* London.

Willkomm, H. M. & Lange, J. 1877: *Prodromus Florae Hispanicae 3*. Stuttgart.

Zohary, M. 1962: *Plant life of Palestine*. New York.

– 1972: *Flora Palaestina 2*. Jerusalem.

– 1976: *A new analytical flora of Israel.* Tel-Aviv (in Hebrew).

Observations on the Elleanthus linifolius alliance (Orchidaceae) in S America

Bernt Løjtnant

Løjtnant, B. 1977 01 28: Observations on the Elleanthus linifolius alliance (Orchidaceae) in S America. *Bot. Notiser 129:* 445–453. Stockholm. ISSN 0006-8195.

The systematic relationships within the *Elleanthus linifolius* alliance in S and C America and the Caribbean area are discussed. *E. linifolius* Presl is restricted to S Ecuador and N Peru. *E. graminifolius* (Barb. Rodr.) Løjtnant comb. nov., formerly regarded to be conspecific with *E. linifolius,* is the correct name for the widespread species of tropical S America. *E. isochiloides* Løjtnant sp. nov. from W Ecuador, a close relative of *E. graminifolius,* is described. The original description of *E. fractiflexus* Schltr. is corrected.

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The plants belonging to the *Elleanthus linifolius* alliance have linear leaves and a distichous inflorescence with fractiflex rhachis. The inclusion of *Adeneleutherophora graminifolia* Barb. Rodr. in *E. linifolius* by Cogniaux (1901) started a tradition to refer uncritically most *Elleanthus* specimens with grass-like leaves to *E. linifolius* (e.g. Hoehne 1945, Schweinfurth 1958, Dunsterville & Garay 1961).

I came across the problems within the alliance when determining the orchid specimens collected by the 2nd Danish Botanical Expedition to Ecuador in 1973 (Holm-Nielsen et al. 1975). I have examined the material referable to this alliance in various Herbaria cited with the specimens. A complete list of the specimens studied is kept at AAU from where copies are obtainable.

The drawings of flowers and flower parts in Figs. 1–5 are from material preserved in FAA; those in Fig. 6 from dried material.

Elleanthus linifolius Presl

Presl, Rel. Haenk. 1: 97, 1827. – *Isochilus linifolius* (Presl) Lindl., Gen. and Sp. Orch. Pl. 113, 1831. – Lectotype (here selected): Peru, hab. in montanis Peruviae ad Huanocco, Haenke s.n.! (PR 25265).

Evelyna graminifolia Poepp. & Endl., Nov. Gen. ac Sp. Pl. 1: 33, 1836, excluding Plate 58. – Lectotype (here selected): Peru, crescit in Peruviae sylvis supra arbores altiores ad Pampayaco, floret Dec.–Jan., Poeppig 1641 (W).

This species is easily recognized by the short linear leaves and rather elongate terminal spike which is longer than the subtending leaves (Fig. 1). It generally grows on the rather dry and exposed areas confined to the tropical and subtropical mountain regions of S Ecuador and N Peru. *E. linifolius* is a rare and not very variable plant, closely related to the S American *E. fractiflexus* Schltr. and to *E. poiformis* Schltr. from C America.

Reichenbach (1862) after having examined the types of both species, concluded that *Evelyna graminifolia* was conspecific with *Elleanthus linifolius*. Reichenbach's conclusion is not surprising, for both types are from essentially the same area. Moreover, the descriptions are very similar in detail. However, despite having detected (Reichenbach 1852) that the original description and illustration of *Evelyna graminifolia* were at variance with each other, Reichenbach (1862) cited both the description and the illustration of *Evelyna graminifolia* under *Elleanthus linifolius.* This error must have influenced Cogniaux (1901) to include *Adeneleutherophora graminifolia* Barb. Rodr. under

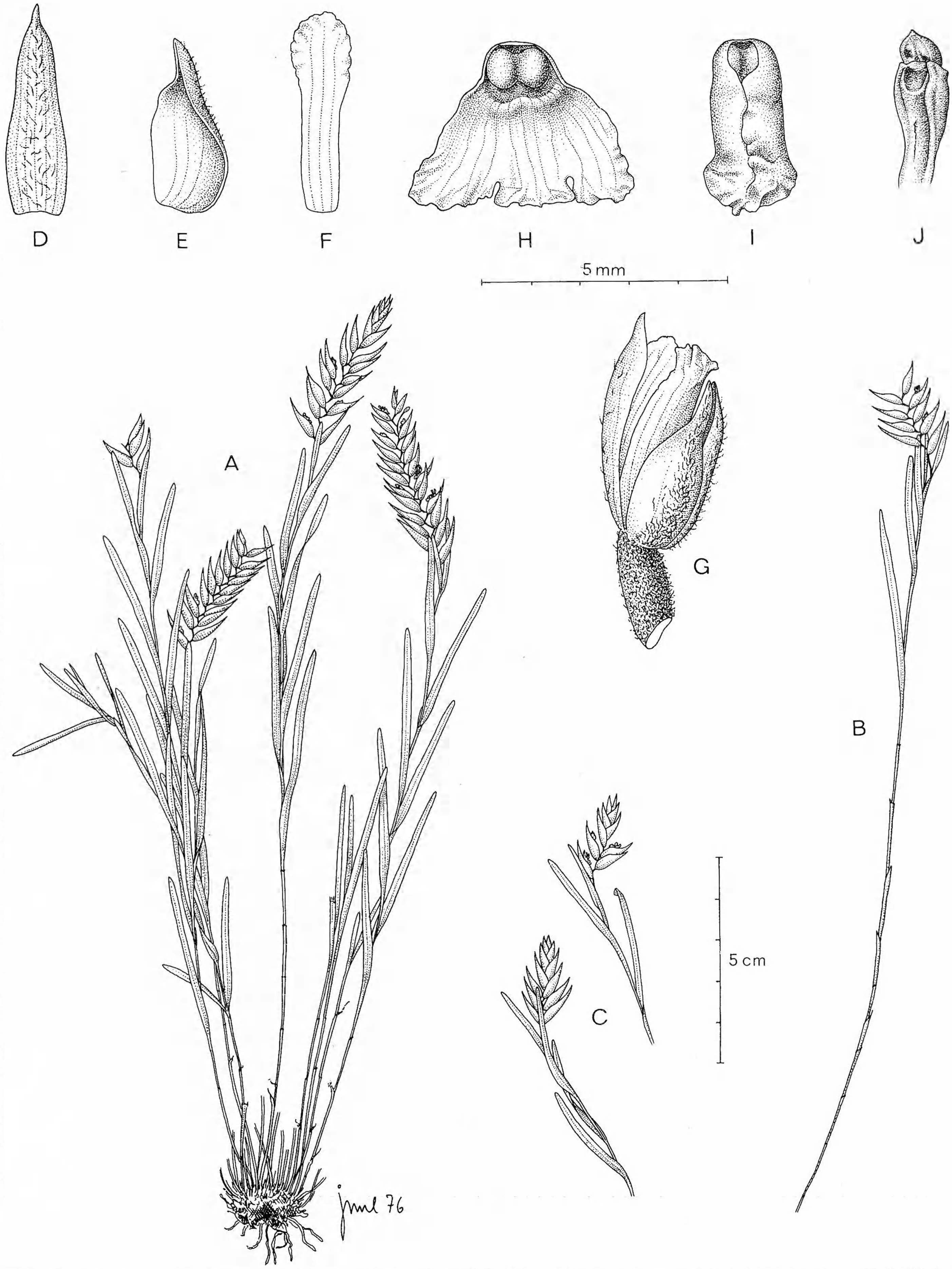

Fig. 1. *Elleanthus linifolius* Presl – A: Asplund 12584 (S). – B: Haenke s.n. (PR lectotype). – C–J: Holm-Nielsen et al. 3766 (AAU). – C: Inflorescences. – D: Dorsal sepal. – E: Lateral sepal. – F: Petal. – G: Flower. – H: Lip flattened out. – I: Lip in natural position. – J: Gynostemium.

Elleanthus linifolius. Cogniaux did not notice that Poeppig, under the same number as the type from Pampayaco, included mixed collections of *E. linifolius* and *E. graminifolius* some of which were even collected by him later in Cuchero. In actual fact the original drawings of *Adeneleutherophora graminifolia* and Poeppig's drawing of *Evelyna graminifolia* both portray plants belonging to the same species, *Elleanthus graminifolius*.

Specimens studied. Ecuador: Harling & Andersson 13845 (p.p., with *E. fractiflexus*, AMES, GB); Holm-Nielsen et al. 3766, 4038, 4047, 4118 (AAU). – *Peru:* Asplund 12584 (AMES, S); Haenke s.n. (PR 25265, PRC); Henschel 307 (M); Hutchinson 1874 (AMES); Kanehira 89 (AMES); Poeppig 1641 p.p., Cuchero 1829 (p.p., with *E. graminifolius*, W 51688); Poeppig 1641 p.p., Cuchero 1830 (p.p., with *E. graminifolius*, W s.n.); Poeppig s.n. (PR); Poeppig s.n. et loc. (P).

Elleanthus graminifolius (Barb. Rodr.) Løjtnant comb. nov.

Basionym: *Adeneleutherophora graminifolia* Barb. Rodr., Gen. et Sp. Orch. Nov. 2: 171, 1881. – Lectotype (here selected): Brazil, Minas Geraes, along river Parahybuna, Barbosa Rodrigues s.n.! The lectotype is Rodrigues' original watercolour drawing preserved in the Library of the Orchid Herbarium of Oakes Ames (AMES).

Elleanthus pusillus Schltr. in Notizbl. Bot. Gart. und Mus. Berlin-Dahlem 8: 117, 1922. – Orig. coll. (probably destroyed): Brazil, Parana, Dusen s.n.

Elleanthus graminifolius differs from *E. linifolius*, apart from the floral details, in having much longer leaves, and from *E. isochiloides* Løjtnant in the floral parts and in having considerably narrower leaves (Figs. 1, 2, 5). *E. graminifolius* is widely distributed in S America, perhaps throughout the neotropics.

I hesitate to include a form series from the Caribbean Islands, commonly identified as *E. linifolius*. These plants have leaves with mucronate tips which are longer than the bilobed apex. Moreover, the short broad spikes give the plants an appearance quite distinct from that of the S American material. The flowers have a tendency to be peloric and the lips seem to lack the diagnostic calli at the base. More material is needed for study before a final decision can be made.

Two well-defined form series from C America, hitherto included in *E. linifolius*, also need further investigation (Figs. 3, 4). Their general appearance is considerably different from *E. graminifolius* and *E. linifolius* as these taxa are understood in this paper. However, so far I have only seen non-flowering and fruiting material of these form series.

The illustration of *E. graminifolius* in Martius, Flora Brasiliensis 3 (5): t. 73, 1901 is an inaccurate reproduction of the original drawing by Rodrigues. The width of the leaves on the original, drawn from living material, is 2.6–3.2 mm whereas the leaves on the reproduction are up to 4.1 mm wide. Taking into consideration the shrinkage in dried specimens, the maximum width I observed is normally less than 2.8 mm (Fig. 2) which is in accordance with the lectotype.

No type material of *E. pusillus* Schltr. is known at present due to the destruction of Schlechter's herbarium during World War II. *Elleanthus pusillus* is known to me only through the original description and Schlechter's (1930) drawings of floral details. Schlechter distinguished *E. pusillus* from *E. linifolius*, as understood at that time, on the narrower leaves and differences in the floral parts. Obviously he had in mind the only reliable drawing published (Martius, Flora Brasiliensis) since he describes the leaves as being 2.5 mm wide. This measurement is well within the range of *E. graminifolius*, as explained above. *E. pusillus* seems to be within the range of *E. graminifolius* in all other respects as well.

Obviously Cogniaux (1901) intended to transfer *Adeneleutherophora graminifolia* to *Elleanthus* because the name *E. graminifolius* appears under Plate 73 in Mart. Fl. Bras. However, he did not make the transfer in the text. Hence the name is not validly published.

Specimens studied. Venezuela: Funck & Schlim s.n. et loc. (P); Steyermark 59436, 61427, 61719, 75062, 76018, 89415, 89955 (AMES); Steyermark 75061 (W); Wagener s.n. (W). – *British Guyana:* Aelsor 374 (K); Appun 593 (K); Jenman 824, 2387 (K); Lang 134 (AMES); Maguire & Fanshawe 23368 (AMES, K, P, S, W); Maguire & Fanshawe 23512 (AMES); Quelch & McConnel 301 (K); Sandwith 146 (K); Schomburgk s.n. et loc. (K, W). – *Surinam:* Granville 1242 (P); Lanjouw & Lindeman 2745 (AMES); Maguire 24523 (AMES). – *Brazil:* Barbosa Rodrigues s.n., Minas Geraes (AMES); Brade & Santos Lima 11772 (M); Burchell s.n. et loc. (K); Dusen 18117 Sao Paulo (S); Luetzelburg 14012 (M); Mosén 3695 (S, W). – *Colombia:* Pennel 3469 (AMES); Sprague

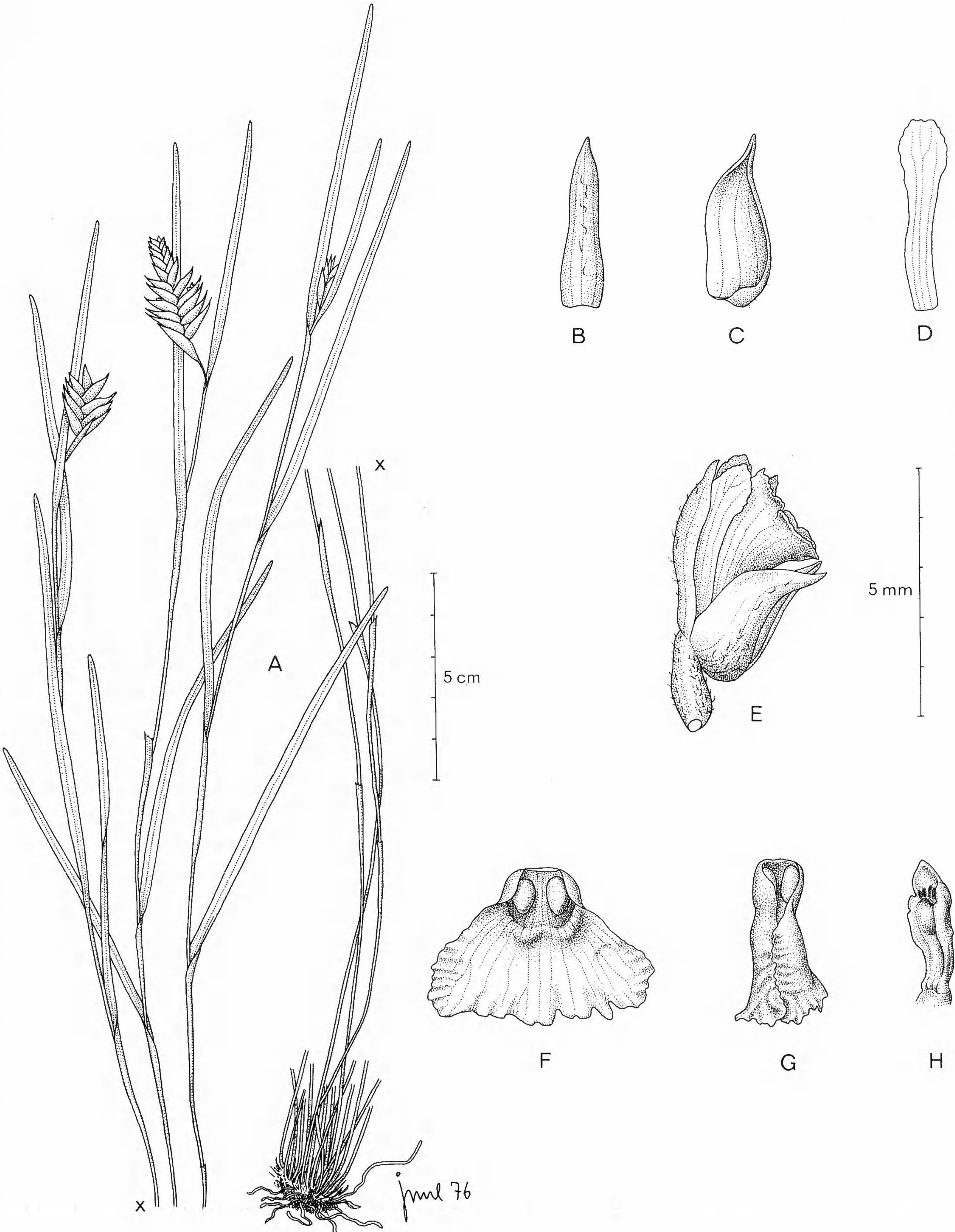

Fig. 2. *Elleanthus graminifolius* (Barb. Rodr.) Løjtnant – A: Holm-Nielsen et al. 4193 (AAU). – B–H: Holm-Nielsen et al. 4518 (AAU). – B: Dorsal sepal. – C: Lateral sepal. – D: Petal. – E: Flower. – F: Lip flattened out. – G: Lip in natural position. – H: Gynostemium.

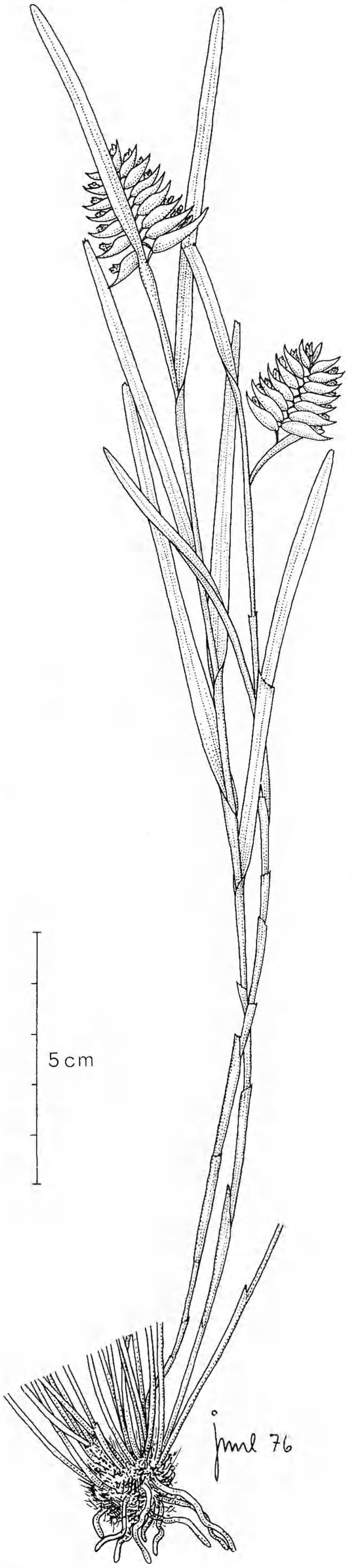

Fig. 3 (left). *Elleanthus* sp. – Jimenez & Lankester 2076 (AAU, AMES). This plant, which is closely related to *E. graminifolius,* is known from Costa Rica, Panama, N Colombia and Cuba.

Fig. 4 (right). *Elleanthus* sp. – Edwards 578 (AAU, AMES). This plant which resembles *E. graminifolius,* is known from Mexico, Br. Honduras, Guatemala and Costa Rica.

377 (K). – *Ecuador:* Holm-Nielsen & Jeppesen 431 (AAU); Holm-Nielsen & Jeppesen 520 (AAU, C); Holm-Nielsen et al. 4193, 4518 (AAU); Mexia 7103 (AMES, W); Sparre 16434, 19144 (S) – *Peru:* Haenke s.n. (W 51689 p.p.); Haenke 207 (M); Killip & Smith 22594, 22754, 23161, 24524, 24855, 25514 (AMES); Klug 3564 (AMES, S); Macbride 5720 (AMES); Poeppig 1641, Cuchero 1829 (W); Poeppig 1641 p.p., Cuchero 1830 (p.p., with *E. linifolius,* W s.n.); Poeppig 1641 p.p., Cuchero 1830 (p.p., with *E. linifolius,* W 51688); Poeppig s.n. et loc. (W); Schunke A50, 1334, 1679 (AMES). – *Bolivia:* Pearce s.n. (K); Pentland s.n. et loc. (K); Rusby 2166 (AMES).

Elleanthus isochiloides Løjtnant sp. nov.

Orig. coll.: Ecuador, prov. Cotopaxi, Quevedo-Latacunga road, alt. c. 700 m, 5.4. 1973, Holm-Nielsen, Jeppesen, Løjtnant & Øllgaard 2947! (AAU holotype, AMES).

Epiphytica, erecta, 20–35 cm alta; rhizomate valde abbreviato, radicibus filiformibus, crassiusculis, glabris; caulibus simplicibus, gracillimis, teretibus, bene foliatis, 1–1.5 mm diametro; foliis erecto-patentibus, oblongo-linearibus, obtuse bidentatis, dorsaliter breviterque mucronatis, glabris, 5–10 cm longis, 3–4.5 mm latis; inflorescentiis terminalibus, dense multifloris (16–24), in ambitu ovatis vel cylindraceis, usque ad 4 cm longis; floribus distichis, albis; bracteis ovatis, cymbiformibus, glabris, 1 cm longis, floribus subaequilongis; sepalo postico ovato-lanceolato, concavo, acuto, dorsaliter sparse pilosulo, 4 mm longo; sepalis lateralibus oblique ovato-lanceolatis, acutis, basin valde concavis, dorsaliter sparse pilosulis, 4.5 mm longis; petalis lineari-oblongis, apice subspathulatis, margine sub lente subcrenatis, 5 mm longis, 0.8 mm latis in basi, ad apicem 1 mm latis; labello in ambitu ovato, antice emarginato-bilobo, margine erosulo, basi valde excavato, in excavatione callis seu corpusculis didymis, ellipticis ornato, usque ad 5.5 mm longo, 3.5 mm lato; ovario cylindrico hispidulo.

This new species is related to *E. graminifolius* but the sepals and petals are smaller and differently shaped (Fig. 5) and the leaves are conspicuously broader. In general appearance, sterile specimens resemble *Isochilus linearis* (Jacq.) R. Br.

Hitherto this species is known only from the lowlands of W Ecuador.

Specimens studied. Ecuador: Drew E-543, E-639 (AMES); Holm-Nielsen et al. 2947 (AAU, AMES), 2948, 3002, 7012 (AAU); Jameson s.n. et loc. (W); Jativa & Epling 424, 2006 a (S); Lehmann 4335 (K); Sodiro s.n. et loc. (Q); Sparre 15134, 17138 (S).

Elleanthus fractiflexus Schlechter

Schltr. in Feddes Rep. Beih. 8: 35, 1921. – Lectotype (here selected): Ecuador, prov. Pichincha, in the valley of Nanegal, Sodiro 36! (Q).

Elleanthus tenellus L. O. Williams in Lilloa 6: 241, 1941. – Orig. coll.: Colombia, Dept. de Cauca, Torosa, Lehmann 2908! (US holotype, AMES, K, W).

The original description of *E. fractiflexus* is based upon fruiting material, hence the floral details were not given. Yet, as Schlechter (1921) emphasized, the general appearance of the plant is very characteristic (Fig. 6).

Upon examining specimens from the type collection of *E. tenellus* Williams in AMES, K and W, I find that Williams' (1941) description is inaccurate. The lip is neither pronounced three-lobed nor ecallose and the petals are surely not constricted in the middle. The floral details must be described as follows (from the holotype in US): Dorsal sepal linear-oblong, acute, 4 mm long, 1.25 mm wide; lateral sepals obliquely ovate-lanceolate, acute, deeply concave at base, 3.5 mm long, 1.5 mm wide; petals spathulate, rounded at apex with a long claw, 4–5 mm long, 1.5 mm wide; lip flabellate with a transverse thickening in middle in front of basal gibbosity which contains a pair of lenticular corpuscles, margin erose-denticulate in front, 4 mm long, 5 mm wide; ovary cylindric, hirsute, 3 mm long.

This species seems to be confined to the tropical and subtropical, moist mountainous areas of the Andes of Colombia and Ecuador.

Specimens studied: Colombia: André 2639 (K); Cuatrecasas 15175 (AMES); Lehmann s.n. (K); Lehmann 2908 (AMES, K, US, W). – *Ecuador:* Asplund 19178 (S); Drew E-581 (AMES); Harling & Andersson 13033 (AMES, GB), 13845 (p.p., with *E. linifolius,* AMES, GB); Holm-Nielsen & Jeppesen 373, 519 (AAU, C); Mexia 6953 (AMES); Penland & Summers 220 (AMES); Sodiro 36 (Q).

Comments on further species

The *Elleanthus linifolius* alliance is here outlined in a restricted sense including *E. fractiflexus, E. linifolius, E. poiformis, E. graminifolius* and *E. isochiloides*. Most probably it should be extended to encompass for example *E. muscicola* Schltr. and *E. cinnabarinus* Garay, to mention two extremes. Reichenbach (1852, 1862–63) used the name *Chloidelyna* for this alliance but without a rank.

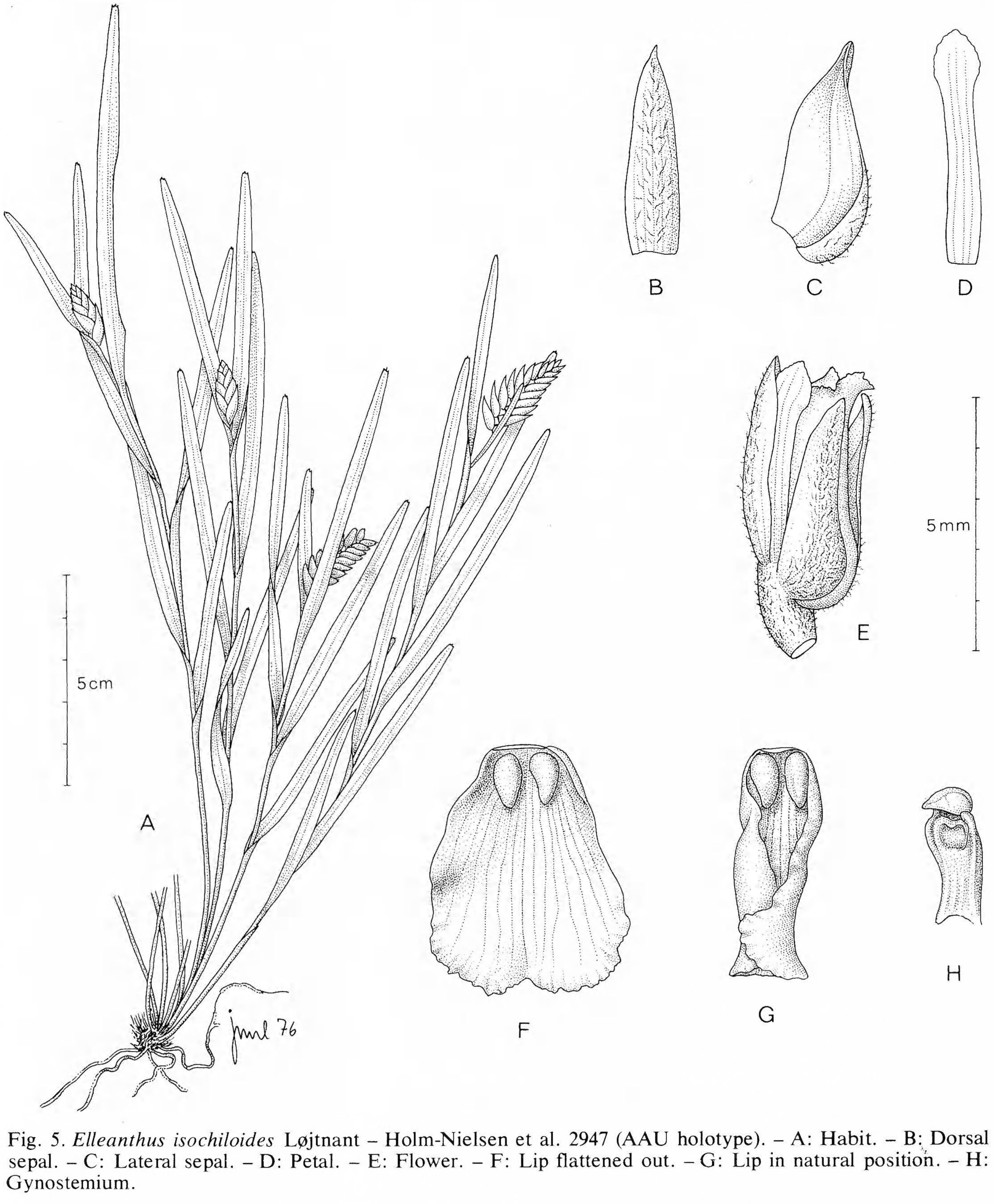

Fig. 5. *Elleanthus isochiloides* Løjtnant – Holm-Nielsen et al. 2947 (AAU holotype). – A: Habit. – B: Dorsal sepal. – C: Lateral sepal. – D: Petal. – E: Flower. – F: Lip flattened out. – G: Lip in natural position. – H: Gynostemium.

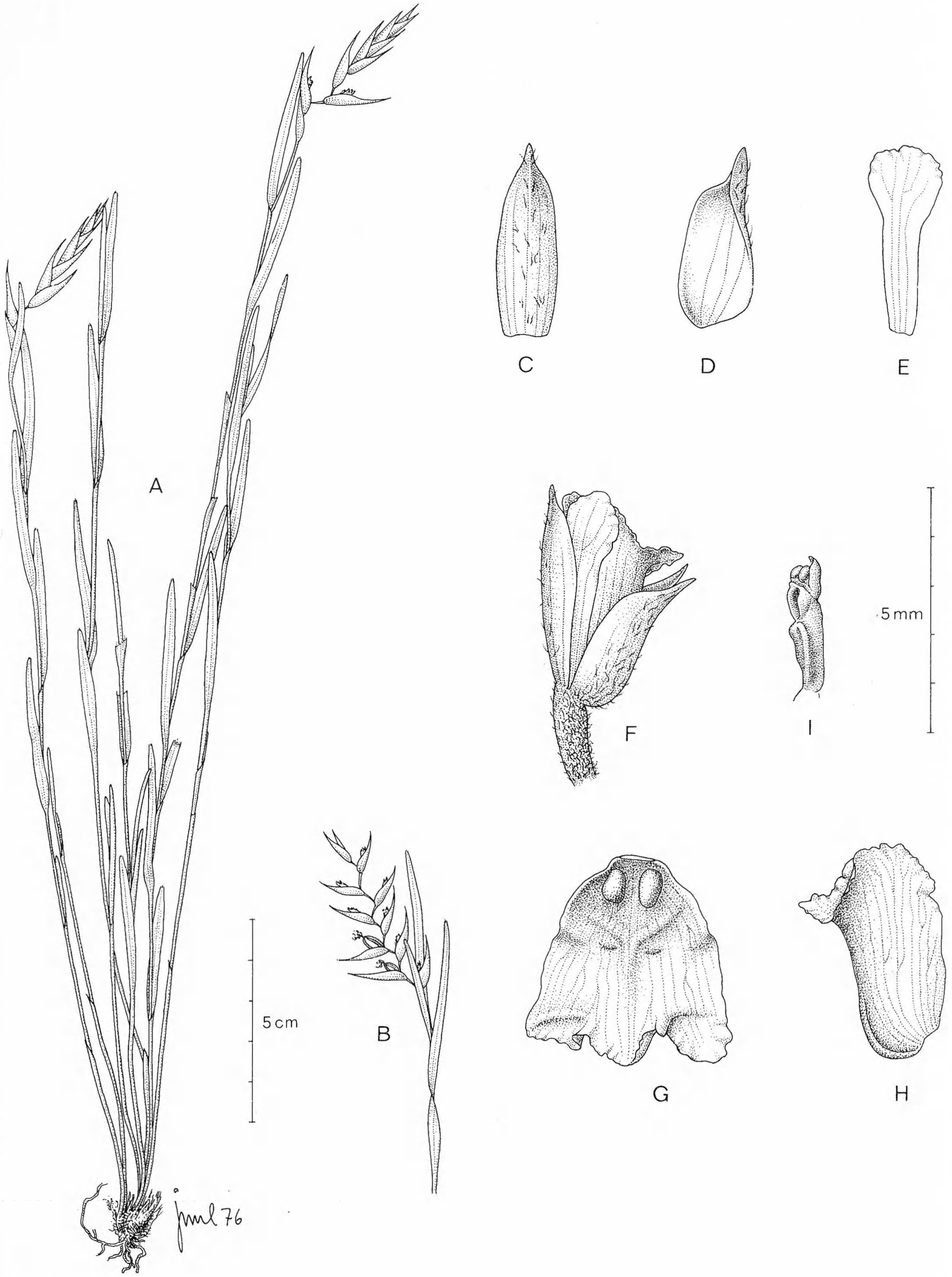

Fig. 6. *Elleanthus fractiflexus* Schltr. – A: Lehmann 2908 (K isotype of *E. tenellus*). – B: Holm-Nielsen & Jeppesen 373 (AAU). – C–I: Harling & Andersson 13033 (GB). – C: Dorsal sepal. – D: Lateral sepal. – E: Petal. – F: Flower. – G: Lip flattened out. – H: Lip seen from the side in natural position. – I: Gynostemium.

Elleanthus muscicola has the typical distichous inflorescence of the *E. linifolius* alliance, but the leaves are ovate-elliptic instead of linear. Although florally it is a true *Elleanthus*, most likely it represents an isolated survival of an evolutionary line which culminated in the morphologically striking *Epilyna jimenezii* Schltr. Whether or not the monotypic genus *Epilyna* Schltr. (Schlechter 1918) is to be united with *Elleanthus*, as was suggested by Schweinfurth (1937), requires deeper study than the mere examination of the few existing specimens.

Elleanthus cinnabarinus, closely related to *E. virgatus* (Rchb. f.) C. Schweinf., could easily be considered a member of the *E. linifolius* alliance. The few-flowered, straggly fractiflex inflorescence is, however, very distinct and this characteristic is shared only with *E. virgatus*. Garay (1969) proposed the section *Virgatae* for these plants. He informs me that *E. coriifolius* (Rchb. f.) Rchb. f. and *E. lancifolius* Presl, contrary to his publication, must be excluded from section *Virgatae*. *Elleanthus coriifolius* is a member of the *E. kermesinae* alliance of the section *Stachydelina* (Rchb. f.) Cogn., while *E. lancifolius*, the lectotype of the genus, represents its own alliance.

Garay (1968) united *E. laxus* Schltr. from Panama and *E. ampliflorus* Schltr. from Colombia with *E. lancifolius*, but I am not prepared at this point to accept his proposition. In our personal discussions of the problem, he has concurred with my views. The section *Elleanthus* may be characterized as having a big and markedly fractiflex rhachis, very loose inflorescence and rather narrow lanceolate leaves. In addition to the above-mentioned species, *E. grandiflorus* Schltr. and *E. vinosus* Schltr. from Colombia are also referable to this alliance.

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References

Cogniaux, A. 1901: Orchidaceae II. *In* C. F. P. von Martius (ed.), *Flora Brasiliensis 3 (5)*. Leipzig.

Dunsterville, G. C. K. & Garay, L. A. 1961: *Venezuelan orchids illustrated II*. London.

Garay, L. A. 1968: Studies in American orchids VII. *Caldasia 10:* 231–238.

– 1969: Orquideas colombianas nuevas o criticas I. *Orquideologia 4:* 14–21, 32–33.

Hoehne, F. C. 1945: *Flora Brasilica 12 (2)*. S. Paulo.

Holm-Nielsen, L. B., Jeppesen, S., Løjtnant, B. & Øllgaard, B. 1975: *Preliminary report on the 2nd Danish botanical expedition to Ecuador*. Aarhus.

Reichenbach, H. G. fil. 1852: Neue Orchideen der Expedition des Herrn J. de Warszewicz. *Bot. Zeit. 10:* 705–715.

– 1862–63: Orchides. *Walp. Ann. 6:* 472–485.

Schlechter, R. 1918: Kritische Aufzählung der bisher aus Zentral-Amerika bekanntgewordenen Orchidaceen. *Beih. Bot. Centralbl. 36:* 321–520.

– 1921: Die Orchideenfloren der südamerikanischen Kordillerenstaaten III. Ecuador. *Feddes Rep. Beih. 8.*

– 1930: Blütenanalysen neuer Orchideen I. Südamerikanische Orchideen. *Feddes Rep. Beih. 58.* [Hrsg. R. Mansfeld.]

Schweinfurth, C. 1937: Nomenclatorial notes V. *Bot. Mus. Leafl. 5:* 38–40.

– 1958: Orchids of Peru I. *Fieldiana: Botany 30 (1)*.

Williams, L. O. 1941: Orchidaceae austro-americanae. *Lilloa 6:* 241–246.

Botanical literature

Zeven, A. C. & Zhukovsky, P. M. 1975: *Dictionary of cultivated plants and their centres of diversity*. Excluding ornamentals, forest trees and lower plants. 219 pp. Published by Centre for agricultural publishing and documentation, P. O. Box 4, Wageningen, the Netherlands. ISBN 90 220 0549 6. Price DFl. 45.–.

(1) Take a map, (2) select important cultivated plants, (3) mark on the map the sites where recognizable botanical varieties and races of these cultivated plants are found. The identification of the botanical varieties was done by investigating the morphology, cytology, genetics and resistance to diseases, pests and unfavourable climatic conditions for the plants. (4) The place where these marks tend to collect is called a centre of origin. In such a centre the greatest diversity of the cultivated crop may be observed (Burkhill 1952 and cited by Zeven & Zhukovsky).

Among the methods used to identify botanical varieties a modern worker would have added a study of variation of different chemical compounds. As a matter of fact the method cited gives a centre of diversity which is not necessarily the same as the centre of origin.

Among the pioneer-workers in the field of finding centres of plant domestication was Vavilov. He presented his theory of centres of origin or gene centres in Berlin 1926. Since then many researchers have occupied themselves with this subject by trying to pinpoint the centres more exactly. In 1968 Zhukovsky published his idea about megagene centres and the present work by Zeven and Zhukovsky is based upon this idea. Zhukovsky found twelve megacentres which include most of the tropical and subtropical world and also part of temperate regions. A striking exception is the eastern part of the South American continent, where no cultivated plants were found to have centres of diversity.

The present book covers 2300 species which are listed under the twelve megacentres. However the plants are not simply listed for information concerning chromosome numbers (where possible), vernacular names in English, synonyms, habitat and use is given. Where groups are more carefully examined, information has been given which can be useful to plant breeders, e.g. genome formulas, frost hardiness and resistance to certain diseases. 109 maps of distribution or paths of distribution have also been presented.

A tremendous number of facts have been put together in this Dictionary, it comes as no surprise then, that we find some mistakes. For example all species of *Carum* have been placed under Compositae and *Pistacia vera* under Phytolaccaceae. Some of the authors cited in the introductory chapters cannot be found in the list of references, e.g. on p. 10 Churcher & Smith 1972, p. 12 Polunin 1960 and p. 18 Harlan 1961. In the copy studied the pages 34–35, 38–39, 42–43 and 46–47 were blank.

This book will probably form one of the main works of reference to cultivated plants and their centres of diversity and it is likely to remain so for a long time. It will be of great interest to people working with plant breeding and plant domestication and should be of value to everybody interested in cultivated plants. I trust that a new edition will also contain an index of vernacular names.

Lennart Engstrand

Rensing, L., Hardeland, R., Runge, M. & Galling, G. 1975: *Allgemeine Biologie. Eine Einführung für Biologen und Mediziner*. 411 pp. Uni-Taschenbücher 417, Verlag Eugen Ulmer, Stuttgart. ISBN 3-8001-2433-5. Price DM 23.80.

Allgemeine Biologie ("General Biology") is a comprehensive treatise on the physiology, genetics, development, functional organization and ecology of both plants and animals. The text is admirably condensed though sometimes so as to be difficult to understand if one has no previous knowledge of the subject. (Many students of botany will perhaps be reminded of the style of the classic Strasburger Lehrbuch der Botanik, but the present textbook is less difficult.) The illustrations are simple, diagrammatic and instructive. A somewhat generalized presentation is to be expected in view of the limited space.

There is perhaps a risk that after reading this book the student will feel he has covered the field of biology in its entirety. On the contrary, with its emphasis on molecular biology, physiology and to some extent ecology the book is lacking in structural and, in particular, taxonomic aspects. My opinion is that the informative value of the book would have gained much if these branches of botany and zoology had been included even if it had entailed increasing the number of authors from four to six. This criticism does not of course lessen the positive impression of the presentation of those branches of biology actually dealt with.

Gunnar Weimarck

Ettl, H. 1976: *Die Gattung Chlamydomonas Ehrenberg (Chlamydomonas und die nächstverwandten Gattungen II)*. 1122 pp., 168 pl., 67 fig. Beihefte zur Nova Hedwigia 49. J. Cramer Verlag, Vaduz. Price DM 300.–.

One of the rules of thumb for every freshwater phycologist is to keep currently informed about the publications of Czechoslovakian colleagues: Prof. Fott fostered many skilled first-rate research workers. The matter is well illustrated by the recent monograph on genus *Chlamydomonas* s. str. by Dr Hanuš Ettl. It is a bulky volume about the size of a brick. Doubtless this monograph will be of great use, not only for phycologists, but also for people working in various fields of experimental biology and cytology. *Chlamydomonas* is frequently used for experiments. However, the taxonomic position of the used material is often obscure, depreciating the value of such studies, sometimes even when strains from culture collections are used, cf. Lhotsky (1970). For students of freshwater algae this monograph, based on critical analysis and scrutiny of all described taxa by an experienced specialist, is almost a gift from above. *Chlamydomonas* species occur in every body of water, and they are especially abundant in smaller bodies of water.

The introductory chapters on morphology might seem too long, about 100 pages. However, the intimate knowledge of the morphology is prerequisite for identification of *Chlamydomonas* species. Many adequate illustrations, including a number of TEM photomicrographs, accompany the morphological descriptions. The methods for cultivation and investigation are discussed in detail. Most useful are the hints for investigation. These are, without any doubt, from the most experienced source and indispensable for the study of a great many other flagellates. One should have ample living material; identifications made on preserved plants are, for the most, of little value. Drawings of plants and their morphological details are essential for identification and documentation.

In this connection I will take the occasion to emphasize that the increasingly widespread use of Lugol's solution for preservation of algae has had a deteriorating effect on algal identifications. Due to its strong staining effect it is often impossible to study the internal morphology as well as the structure of cell wall, essential details for reliable identification.

The major part of the monograph, about 480 pages, is devoted to a comprehensive treatment of 459 species together with a number of varieties, thus far more than in the compilation of Huber-Pestalozzi (1961). At least I cannot recall any omitted taxon. Dichotomous keys are presented, it remains to make use of them.

The description of taxa is comprehensive and supported by figures, a large part of which are by the author. There are 168 plates altogether. The concluding chapter is an alphabetic inventory of synonyms and insufficiently described taxa with comments. There is also an imposing list of references.

Dr Ettl has provided us with an eminently suited tool for further studies. Our information about the distribution and ecology of *Chlamydomonas* species is very poor; may this book encourage many students to make a personal contribution to the knowledge of the genus.

Kuno Thomasson

Gradstein, S. R. 1975: *A taxonomic monograph of the genus Acrolejeunea (Hepaticae) with an arrangement of the genera of Ptychantoideae*. 164 pp., 24 plates and maps. Bryophytorum Bibliotheca 4. J. Cramer, Vaduz. Price DM 50.– (subscr. 40.–).

Uncritical description of hepatics of Lejeuneaceae type, particularly during the later half of the last century and the beginning of the present one has perhaps created more and greater problems to subsequent taxonomists than Nature itself. The revision work has been and is still troublesome and extensive and rather few of the limited group of hepaticologists have devoted their main scientific work to Lejeuneaceae during the period from World War I up to the middle of this century. It is therefore satisfactory now to find that for some decades several often young, well-trained hepaticologists have entered this field and with enthusiasm and success attacked various problems. Dr Gradstein's dissertation is devoted to those species of the family which have undivided underleaves (Ptychantoideae), and particularly to those which he has recognized and grouped in the genus *Acrolejeunea*.

The book includes two parts. The first one (c. 120 pp.) corresponds to the main title, and, hence, treats the genus *Acrolejeunea,* a name reintroduced by the author in an earlier paper. The introductory chapters give an excellent survey of the history and description of anatomy and morphology from which applied characters have been selected. Gametophyte characters are used entirely in the subdivision of the genus, since no differentiating characters could be found and ascribed to the sporophyte. Criteria applied to subdivision into species, subspecies and varieties are defined and discussed. The author accepts 15 species, 4 subspecies and 2 varieties which together with the recognized subgenera and sections are presented in a conspectus.

After having defined the genus and presented the key, the species and infraspecific taxa are described. Like the introductory sections, this representation is carefully done and exhaustive with – as far as the reviewer can decide – all information accessible included. Judging from the many (c. 30) heterotypic synonyms, one will remark that the reduction of species has been considerable.

The second and minor part (c. 15 pp.) deals with the arrangement of the genera of Ptychantoideae i.e. the holostipous Lejeuneaceae. Perhaps this section had been better considered as an appendix, since the common denominator with the main part is merely that Acrolejeunea is a part of Ptychantoideae. The reference list and the index of names which finish the text part of the book need no comments.

The illustrations at the back of the book are collected in 24 plates. They include instructive drawings of pertinent details from anatomy and morphology used as characters as well as shoots of the plants. Maps of total distribution and distribution types of the species complete here the discussion in the text. Two phenograms of classical type illustrate the phenetic relationship between the species of *Acrolejeunea* and between the genera of Ptychantoideae respectively.

Print, paper and the half-soft covers are those earlier adopted for this series. In the reviewer's opinion the outer margin of the pages could have been some millimeters broader (in some pages it is now only c. 5 mm), particularly when so much space has been devoted to the legends of the plates (which could have been placed below the figures). The reviewer notes with satisfaction that this book – like the preceding ones in this excellent series – is bound stitched and not issued with cut back. Printing errors and similar inadvertences met with are few and non-irritating.

Dr Gradstein's monograph is a comprehensive and impressive work. It will certainly prove to be of established value in present and future studies of the intricate group of mainly exotic hepatics which we call Lejeuneaceae.

Olle Mårtensson

Scott, G. A. M., Stone, I. G. & (illustrations) Rosser, C. 1976: *The mosses of Southern Australia*. 495 pp., 86 plates. Academic Press, London, New York, San Francisco. ISBN 0 12 633 850 7. Price bound £ 18.50.

It seems strange that Australia hitherto has lacked any comprehensive handbook or manual of bryophytes, covering a not too limited part of the continent (Tasmania has been favoured in this respect by Rodway's Tasmanian Bryophyta from 1913–16.) Much of the oldtime, basic material is scattered over many herbaria in several countries which has not stimulated to extensive work but rather invited to revisions of limited groups. Indeed, *The mosses of Southern Australia* is the first manual of this kind. Formally it treats only the S part of the continent (including Tasmania) up to a border approximately defined by a line from Sydney to Geraldton, but all species from Australia known to the authors are included. Species from the thus defined area which are more or less common there and/or are well known to the authors are treated in detail. Less known and established species from the area form a second category, being only briefly described. Australian species, known only from the remaining part, for instance, from the tropical N parts, are only listed. Of course, it is too much to expect the book to be complete as concerns the number of species from Australia in its entirety. The remarkable moss *Viridivellus pulchellum* Stone, described almost simultaneously (J. Bryol. 9 p. 13–15) on specimens from Queensland by one of the authors, is not listed.

The classification into families, genera, etc. is based on Sainsbury's *A handbook of the New Zealand mosses* from 1955 unless some recent work has given rise to modifications. Keys and descriptions are simple and non-sophisticated. For instance, the key to the 19 species of *Bryum* included does not utilize any peristome character. Synonyms, unless such names are especially needed, are excluded. The conspectus of genera which occurs in the introductory part is compiled from Index Muscorum. Genera of the area are numbered, and, in order to facilitate the seeking, these generic numbers occur (together with the title and the family name) as column (page) titles. After a slash following this number, an intrageneric paging is introduced. The main advantage with these generic numbers is probably that keys can be completed with references independent of the definite paging of the book.

All descriptions have references to illustrations. Unfortunately, in some cases the works referred to (such as W. J. Hooker's Musci Exotici and Wilson & J. D. Hooker's Musci Antarctici are so rare that they generally are absent even from the shelves of the working library of the specialists. The 86 authentic drawings by Celia Rosser are very beautiful and illustrative. The interesting technique of drawing which also involves the use of photography, is described in the introductory chapters. But could not some of the plates of species with a worldwide distribution and of which there are plenty of illustrations in easily available handbooks, such as *Ceratodon purpureus* and *Hedwigia ciliata,* have been replaced by drawings of species characteristic for the area?

The bibliography which, together with a glossary of terms and the index of names, finishes the volume, forms with the added comments a very valuable source of literature about Australian mosses. Herzog's Geographie der Moose from 1926 is missing. A reference to it could have been a complement to the short chapter of plant geographical relationships given in the introductory part. Herzog devotes about ten pages to the Australian and Australian-Antarctic flora areas.

Academic Press has created a magnificent volume with excellent print and reproduction of drawings. A beautiful coloured picture of *Hypnodendron comosum* introduces the book and decorates also the loose, protecting wrapper. On the green end-papers we find a contour map of Australia, including territory borders and abbreviations of territory names. The relevant area of Southern Australia is dotted. Perhaps the antipodal reviewer is ungrateful when he says that he had preferred an ordinary, more complete map, instead.

The binding in pale green cloth is excellent with intact, stitched signatures (the terrible manner of cutting the back of "long-lasting" books cannot be condemned enough!) Printing errors and inadvertences are rare (for instance, the "i" in the epithet of *Bartramia halleriana* has been dropped, and the contour picture of the *Buxbaumia* capsule on the end-pages is not convincing.

The mosses of Southern Australia will be a very useful and valuable source for everybody who asks for information about not only the relevant title but also of Australia in its entirety. As a pioneering work, the book will stimulate and accelerate the future research of Australian mosses.

Olle Mårtensson

Herklots, G. 1976: *Flowering tropical climbers.* 194 pp., 270 line drawings, 16 colour plates. Wm. Dawson & Sons Ltd., Folkestone, Kent. Price £ 17.50.

The present volume in large format is a very attractive presentation of climbers in a number of families which are arranged alphabetically. An introduction demonstrates, among other things, that the various types of tendrils correspond to leaf tips, leaf petioles, midrib extensions, terminal leaflets, stipules, flower peduncles and lateral branches. Within each family one or more genera are presented and exemplified by illustrations of species, showing leaves and inflorescences.

Climbers are found in many families, and even in some monocotyledons, such as in Alstroemeriaceae (treated under Amaryllidaceae) and Philesiaceae. Families such as Aristolochiaceae, Bignoniaceae, Convolvulaceae, Leguminosae and Passifloraceae are well represented and the reader will also find climbers in Compositae: within the genera *Hidalgoa, Mutisia* (a most spectacular genus), and even in *Senecio* some of which have pronouncedly *Hedera*-like leaves. It should be stressed that the book concentrates on groups with more or less showy or conspicuous flowers or inflorescences, while those with inconspicuous flowers are practically lacking (Dioscoreaceae, Smilaceae, Piperaceae, Menispermaceae). Thus it directs itself chiefly to a broad public, including gardeners and garden-lovers. But it is also of great interest to scientific botanists and botany teachers as a source of exemplification of life forms and specializations for climbing.

Rolf Dahlgren

Nooteboom, H. P. 1975: *Revision of the Symplocaceae of the Old World. New Caledonia excepted.* 352 pp., 21 plates, 5 phot. Leiden Botanical Series 1. Leiden University Press. ISBN 90-6021-242-8. Price Dfl. 93.60 (paperback).

A new botanical periodical has been given out by the Leiden University Press. In this series will be published papers of monographic nature from the entire field of botany which because of their length (100 printed pages or more) are unsuitable for publication in journals.

The paper and print are fine. Photographs are reproduced excellently. One would have expected that the text had been printed in two columns, but this is of course a matter of taste.

The first volume of the series contains a monograph of the Old-World-species of the genus *Symplocos* by H. P. Nooteboom. The monograph follows the normal pattern of a modern taxonomic study. It is interesting to notice that the keys were made with computer-aid, in such a way that after constructing the overall key the changing of one card was sufficient for constructing keys for the separate countries.

The species concept is broad, numerous taxa have been reduced to synonymy, of 500 described Old-World-species only 90 are left; 21 new species are proposed.

The work has not been an easy one, which is best seen by the treatment of *Symplocos cochinchinenses* with more than 100 synonyms; now it is subdivided into 3 subspecies, one of which is again subdivided into 34 varieties. I do not think that this treatment will stand for a long time. On page 153 the author has a "topodeme *'morobensis'*". It ought to have been described as a variety or left out and mentioned in a special note as a possible local variation. There are some peculiarities in his way of quoting specimens – the promised list of specimens studied should have been included in the work. It is just as important as all the local keys. The drawings are generally good, but it would have been easier if they had been included in the text.

Apart from this there is every reason for thanking Dr Nooteboom for giving us this monograph of a very difficult group.

Kai Larsen

Smitinand, T. & Larsen, K. (eds.) 1970–1975: *Flora of Thailand*. Vol. II. Parts 1–3. 280 pp. Applied scientific research corporation of Thailand. Printed at the ASRCT Press, Bangkok. Price US $ 2.50 + 3.00 + 7.00 (paperback). – Address for subscriptions: Thai National Documentation Centre, Applied Scientific Research Corporation of Thailand, 196 Phahonyothin Road, Bangkok 9, Thailand.

The "Flora of Thailand" is intended to be the first complete treatment of the vascular plants in Thailand. The Flora provides descriptions of families, genera and species. For each species the general distribution as well as the distribution in Thailand are given. Clear and legible keys are provided to genera and species. Species suspected to occur in Thailand although not yet recorded are often included in the keys. No collections are cited. A key to families is intended to be published in volume I.

Volume II is the only volume to appear so far. It has been published as three separate paperback parts with continuous pagination, comprising 92, 104 and 84 pages, respectively. The number of families in the three parts is 6, 23 and 8, respectively. The largest families treated are Rosaceae (incl. Chrysobalanaceae) (by J. E. Vidal, 61 species), Smilacaceae (by T. Koyama, c. 27 species), Theaceae (by H. Keng, 21 species), Icacinaceae (exkl. *Cardiopteris*) (by H. Sleumer, 18 species), Connaraceae (by J. E. Vidal, c. 16 species), Magnoliaceae (by H. Keng, c. 16 species), and Dilleniaceae (excl. *Saurauia*) (by R. D. Hoogland, 15 species). Ten of the 37 families treated hitherto are represented in Thailand by one single species each.

The sequence in which the families are treated appears to be quite at random, that is, apparently the contributions have been accepted as manuscripts have become ready for publication. This, of course, inevitably has as a consequence that closely related families may be placed far apart while families with no affinities at all may be found together. Thus, for example, the monocotyledonous family Apostasiaceae is found between the dicotyledonous families Connaraceae and Actinidiaceae. The gymnospermous families Cycadaceae, Pinaceae, Cephalotaxaceae, Cupressaceae, Podocarpaceae and Gnetaceae are grouped together, but the group is surrounded by angiospermous families.

Whether or not the families should be arranged in a systematic order is, of course, largely a practical question. From a scientific point of view a systematic arrangement is preferable. Comparison of related groups is facilitated if the groups are found near each other. An advantage of the practice in the present Flora is that families can be published as soon as a number of manuscripts are finished. Publication of a family does not have to await the completion of manuscripts on related families. Small and unrelated families can be grouped and published together. On the back cover of part three of the present volume there is an index to the families treated so far, giving volume, part and page number. It would be practical to publish in forthcoming volumes or parts thereof enlarged and completed indices to the families treated so far.

The volume published hitherto is relatively richly illustrated. The drawings have generally been satisfactorily reproduced. The quality of the black-and-white picture reproduced in part two insignificantly exceeds that of pictures in daily newspapers.

Volume I is in preparation. Besides a key to the families it is intended to include a general survey of the soils and plant geography of the country, an account of the botanical exploration and literature on Thai plant life, and an explanation of botanical terms used.

Starting a Flora of this kind is a big project that will extend over many years and require a large number of specialists. One of the editors, Professor Kai Larsen, has spent about three and a half years of field work in Thailand and has collected c. 20,000 numbers. He has worked up some of the minor families in volume II. His solid knowledge on the floristic regions in this part of the world will undoubtedly result in preparations of many families in forthcoming volumes. Professor Larsen and his collaborators are to be congratulated upon the initiation of this big project and its promising start.

Uno Eliasson

Grummann, V. (†) 1974: *Biographisch-bibliographisches Handbuch der Lichenologie*. Nach dem Tode des Verfassers für die Herausgabe durchgesehen von Oscar Klement. IX + 839 pp. 43 plates. J. Cramer, Lehre. ISBN 3 80 67 0358 2. Price DM 250:– (linen).

Dr Vitus Grummann, Berlin (1899–1967) was well known as a lichenologist, especially for his *Catalogus Lichenum Germaniae* (1963, cf. review in *Bot. Notiser* 117 (1964) p. 104) and a major work on the teratology of lichens (1941). During the last two decades of his life he collected material for a world-wide manual of biographies and bibliographies of past and present lichenologists.

After Grummann's death his extensive manuscript was taken over by Dr O. Klement (Kreutzthal-Eisenbach, W Germany). Sometimes, though to a limited extent, later data have been included, but the information does not claim to be up to date after 1967. Hence a considerable number of young lichenologists who started their career after that year have been omitted. Lichenologists in particular and botanists interested in biography and history in general are greatly indebted to Dr Klement and to the publisher who have solved the not so easy task of arranging this enormous material to form a publication of reasonable size.

No less than 3,865 authors from 40 countries have been recorded in this comprehensive volume. Under each entry we find important biographical data, including education and positions held, and a selected list of lichenological publications. As some authors, for instance Nylander and Magnusson, published hundreds of papers it has not been possible to cite all of them. In such cases further information can be found in, e.g. bibliographical works by Lindau & Sydow (covering the period up to 1910) and Ciferri (1911–1930), in obituaries which often contain lists of publications, or in the survey of lichenological literature published by W. L. Culberson (from 1951 on) in *The Bryologist*.

The arrangement of the material is somewhat unconventional. The authors are grouped according to the countries where they were born, not the countries where they spent most of their active life. The countries are arranged according to the number of authors recorded, starting with Germany and the U.S.A. and ending with the Philippines (only one author cited). Within each country we meet with three groups: (A) lichen taxonomists, (B) authors of works with a general botanical scope where lichens have been mentioned to some extent (not the least publications on plant ecology), and (C) authors of works dealing mainly with chemistry, pharmacology or economy. These subdivisions are obviously more or less arbitrary.

Some odd chapters could well have been omitted, e.g. a "Gedenk- und Festkalender" listing the birthdays (and deaths) of all authors recorded and a report (with photographs) on the present condition of the tombs of some great lichenologists.

The work concludes with a selection of portraits of 295 lichenologists mostly with their autographs. In some cases these can be difficult to read. An interpretation is given by K. Mägdefrau in *Herzogia* 4 (1976) p. 83. Grummann's collection of portraits is now in the Hunt Botanical Library in Pittsburgh.

The critical reader can easily find a number of misprints and shortcomings in Grummann's manual. We should bear in mind, however, that this is a posthumous work. In actual fact it is an indispensable mine of information for everyone interested in personalia, and it has few, if any, counterparts in other fields of botany.

Ove Almborn

Brown, D. H., Hawksworth, D. L. & Bailey, R. H. (eds.) 1976: *Lichenology. Progress and problems*. Proceedings of an International Symposium held at the University of Bristol. The Systematics Association, Special Volume No. 8. XII + 544 pp. 20 plates. Numerous figures, tables and maps in text. Academic Press, London, New York and San Francisco. ISBN 0 12 136750 9. Price £ 19.– (cloth).

Few subjects in scientific research have made such rapid progress in the last decade as that of lichenology. Many new and challenging problems have been recognized and modern techniques have been applied to topics already under investigation.

The last few years have seen several surveys of recent activities in lichenology, e. g. Hale, *The biology of lichens* (1974), reviewed in *Bot. Notiser* 127 (1974) p. 456, Ahmadjian & Hale, *The lichens* (1973) and Henssen & Jahns, *Lichenes* (1974), both reviewed l. c. (1975) p. 275.

The present volume reflects the proceedings of a symposium sponsored jointly by The Systematics Association and the British Lichen Society and held at the University of Bristol in April 1974. It covers some fields surveyed in the works quoted above, e. g. growth, developmental morphology, chemotaxonomy, metabolism and lichen symbiosis compared with other symbioses. On the other hand, we meet with some topics which are quite new or have not been reviewed for several years.

Among contributions to this last group the reviewer would especially mention the following articles. Hale, "Lichen structure viewed with the scanning electron microscope" (this technique has revealed new, previously unsuspected, structures, e.g. a pored epicortical layer in some genera, characters which certainly will prove to be important in taxonomy), James & Henssen, "The morphological and taxonomic significance of cephalodia" (with new and most interesting aspects of "*Dendriscocaulon*", a classical problem in lichenology), Tschermak-Woess, "Algal taxonomy and the taxonomy of lichens", Tschermak-Woess & Poelt, "*Vesdaea,* a peculiar lichen genus and its phycobiont" (a monotypic genus, the single species previously known as *Pachyascus byssaceus,* the phycobiont found to be *Leptosira obovata,* a species hitherto unknown in the lichenized state).

Some topics not treated by Ahmadjian & Hale, e.g. geographical distribution, have been dealt with here, for instance Coppins, "Distribution patterns shown by epiphytic lichens in the British Isles", and Seaward, "Performance of *Lecanora muralis* in an urban environment."

This well-organized volume is a valuable stimulus to future research and an important reference work not only for lichenologists but also for many mycologists, phycologists, plant physiologists and ecologists.

Ove Almborn

Smith, A. L. 1975: *Lichens*. Reprint with new introductory matter and supplementary index by D. L. Hawksworth. XI + XXVI + 464 + IV pp. 135 figures in text. The Richmond Publishing Co., Richmond. ISBN 85546 192 6. Price £ 11.50 (cloth).

Annie Lorrain Smith (1854–1937) was for many years an unofficial worker in the Cryptogamic Herbarium of the British Museum (Natural History) in London. She published several works on the taxonomy of lichens, e.g. *A monograph of British lichens 1–2* (1918, 1926), and *A handbook of British lichens* (1921). The latter is a condensed flora comprising keys to the British species.

In 1921 she published a major work called *Lichens* covering most aspects of lichenology. The diversity of its contents is reflected in the headings of its ten chapters: History of lichenology, Contents of the lichen thallus, Morphology, Reproduction, Physiology, Bionomics, Phylogeny, Systematic, Ecology, Economic and technical.

Fifty years ago this work was rightly considered as "a veritable mine of wealth" (review from 1922). After the dramatic upsurge of interest in lichens, in particular during the last two decades, and the corresponding increase of comprehensive literature on this subject (cf. review above), *Lichens* has become a rather out-of-date manual. Admittedly, it is an interesting historic document. The detailed account of the history of lichenology and the rich bibliography, especially concerning early literature, will remain useful to many students. Nevertheless the reviewer would question the need for a reprint of this book.

Dr D. L. Hawksworth, Kew, has written a foreword and added a useful list of literature references covering the last five decades. He is also responsible for a "Supplementary index" providing the currently accepted names of lichen genera and species in the many cases where these differ from the names employed in *Lichens*.

Ove Almborn

Heywood, V. H. (ed.) 1976: *Botanical systematics*. An occasional series of monographs. Vol. 1. Academic Press, London, New York, San Francisco. ISBN 0-12-346901-5. Price £ 24.–. Contains the following two major works.

Hanks, S. L. & Fairbrothers, D. E.: *Palynotaxonomic investigation of Fagus L. and Nothofagus Bl.: Light microscopy, scanning electron microscopy, and computer analyses* (pp. 1–142).

Polhill, R. M.: *Genisteae (Adans.) Benth. and related tribes (Leguminosae)* (pp. 143–368).

Botanical systematics is a new series of publications due to appear at irregular intervals. According to the editor "it will publish papers ... considered to be of especial merit". The format is convenient and both paper and typography are attractive. Moreover the quality of the illustrations is very high. The editor is to be congratulated on the first volume of this series.

The first paper, by S. L. Hanks & D. E. Fairbrothers, is an interesting presentation of a biometric and morphological study of 41 species of *Fagus* and *Nothofagus*. There are four pollen types in these genera, all represented in the material studied. The characters of the pollen grains were used with the help of a computer to construct a diagnostic key to the species and to construct a dendrogram based on similarity coefficients. In combination with other data, morphological, anatomical, cytological and paleobotanical, it was possible to outline probable phylogenetic relationships and the past history of the genera. The modus operandi is very interesting and methods such as these will probably be increasingly used in future investigations. The subjective element in a study of this type is reduced to a minimum.

The second paper, by R. Polhill, is of particular interest to fabologists all over the world. It represents a thorough study of all the genera referred to the tribe 'Genisteae' in the broad sense. The study includes the morphology of the vegetative and floral parts, as would be expected, but also a number of unconventional characters which refer to the seeds and chromosome numbers as well as chemical constituents. It is an extraordinary achievement and will certainly be looked upon as a model for similar revisions of other tribes of the c. 13,000 species of Leguminosae when this huge family is discussed at a conference at Kew in 1977. The present large-scope survey stands in sharp contrast to the rather inconsistent previous treatments of many genera of 'Genisteae'. Because of the extent of the survey it is possible for Dr Polhill to give an unbiased and sound judgement on circumscriptions of genera and of probable relationships and groupings of this partly heterogeneous group. The numerous excellent illustrations make it easy for the reader to visualize the appearance and variation of the genera. In the concluding chapter the accepted genera are presented according to a partly new system. They prove to be divisible into four natural tribes: Bossiaeae (10 genera), Liparieae (5 genera), Crotalarieae (16 genera) and Genisteae s. str. (14 genera). Especially thorough are the revisions of the formerly very split genera *Cytisus* and *Genista* (the later now including *Chamaespartium, Teline* and *Echinospartum*, for example). Having worked a great deal on the South African genera, I am personally very satisfied to see the present tribal division which gives a sound phytogeographical basis: Bossiaeae entirely Australian; Liparieae entirely South African; Crotalarieae mostly African, especially South African (but reaching to the Mediterranean and even to India and Australia; two genera in South America) and Genisteae chiefly Mediterranean. I wish to recommend this book on the 'Genisteae' not only to those who are interested in the legumes as such, but to anyone who wishes to make an intensive study of a normal-sized family or a subfamily of a larger family without aiming at making a revision at species level. Indeed such a study shows where the latter type of revision is best needed.

Rolf Dahlgren

Brenan, J. P. M., Ross, R. & Williams, J. T. (eds.) 1975: *Computers in botanical collections*. X + 216 pp. Plenum Press, London and New York. ISBN 0-306-30847-9. Price $ 30.–.

This book comprises the papers read at an international conference discussing the use of E.D.P. methods in handling taxonomic plant collections in European Herbaria (numerical taxonomy was not included). The conference was held at Kew in October 1973. A brief resumé was published in November 1973 in *Nature 246* p. 62, and a longer article with abstracts of the papers in *Taxon 23* pp. 101–107 (February 1974), so the book presents no surprises to the public. Still I think it will prove of great use to the undoubtedly many persons who are wondering whether E.D.P. would help them in handling large collections.

The papers do not presuppose any particular knowledge of E.D.P. They give examples of the use of E.D.P. in flora projects, for botanical gardens and other living collections and for making distribution maps, while other papers discuss international standardizations. The reports of the discussions that followed the lectures are not the least valuable, as they draw attention to, for example, the difficulties and the cost in money or man power, and draw comparisons with what has been achieved by using computers.

Even at the end of the conference several of the participants had retained the hope that it would be possible within a reasonable span of years to have coded the information from the labels of all the sheets in the important European Herbaria. Two years later I do not think anyone considers this thought to be realistic. Only to set up an international type register, as was recommended by the conference, might create too many problems in spite of its usefulness. The advantage of computer methods probably mainly applies to limited projects with less than 50,000 specimens.

Knud Rahn