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On the Fern Genera Acrophorus, Diacalpe, Lithostegia and Peranema

BY B. K. NAYAR and SURJIT KAUR

Pteridology Laboratory, National Botanic Gardens, Lucknow, India

Introduction

The early genera of COPELAND's *Aspidiaceae* (COPELAND 1947) are mostly of rather ambiguous phylogeny and relationships. The small genera *Acrophorus, Diacalpe, Peranema* and *Lithostegia* are no exceptions though morphologically they are a little better known than most others of this group. The supposed similarities of these ferns with the primitive family *Cyatheaceae* and the hypothesis of a cyatheoid origin of the aspidioid phylum possibly have attracted the attention of pteridologists to these small tropical genera and significant contributions towards an understanding of their morphology has been made in the recent past (DAVIE 1912, 1916, THOMPSON 1943, VERMA 1958, NAYAR & KAUR 1963). The present study is an attempt to evaluate the morphology of the sporophyte and the gametophyte of these ferns in considerations of phylogeny and relationship.

All the four genera included in this study are terrestrial ferns restricted to the oriental tropics from N-E. India to the Philippine Islands; only in N-E. India all are reported to occur together. Except *Peranema,* which includes two species, they are monotypic.[1] The present study is based on *Acrophorus stipellatus* (Wall.) Moore (*A. nodosus* Presl, *Lithostegia nodosa* Presl), a large handsome fern with delicate pinnules and huge deltoid leaves, growing restricted to dense forest tracts; *Diacalpe aspidioides* Blume (*Sphaeropteris hookeriana* Wall.,

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[1] Three species of *Diacalpe,* other than the type, are recognized by CHING (1949) and TAGAWA (1950) in the China-Japan region; ALSTON (1939) regards *Acrophorus loxoscaphoides* of New Guinea as distinct from *A. stipellatus.*

Peranema aspidioides (Bl.) Mett.), also restricted to dense humid forests; *Lithostegia foeniculacea* (Hook.) Ching (*Aspidium foeniculaceum* Hook., *Peranema foeniculacea* (Hook.) Nayar et Kaur), a comparatively shaggy small fern of rather open areas near forest tracts; and *Peranema cyatheoides* Don (*Sphaeropteris barbata* Wall.), an elegant fern with large spreading deep-green finely dissected rather coarse leaves and large reddish-brown often boat-shaped paleae clothing the stipes and rachises. All except *Lithostegia* are moisture-loving plants, often restricted to semi-marshy areas in dense forests, and near small streams and cascades in sandy or even gravelly soil. They never grow in exposed localities, whereas *Lithostegia* is rarely found in deep forests. A detailed taxonomic account of these ferns is presented elsewhere (NAYAR & KAUR 1963).

Material and Methods

Material for this study is collected solely from N-E. India, mainly from the K. & J. Hills of Assam. The usual techniques of study as are reported earlier (NAYAR & KAUR 1965 a, b) were followed. Spore morphology is studied mainly from acetolysed preparations and the methods used are the same as already described (NAYAR 1964). The development and morphology of the prothalli are studied from laboratory cultures raised on sterile nutrient agar medium in petridishes maintained at 24 ± 2°C (NAYAR 1962). Throughout the study, the cultures received light of ca. 600 f-c. intensity for 12 hrs each day, the light source being sets of 40 watt daylight flourescent lamps kept at a sufficient distance to avoid excessive heating of cultures. Observations on sporophyte morphology are based on material fixed in F.A.A. and preserved in 70 % Alcohol.

Spores

The spores of all the genera are monolete, bilateral, planoconvex to slightly concavo-convex in lateral view, ovate or oblong in polar view, and measuring on an average $20—25 \times 32—36\ \mu$ ($P \times E$, exclusive of the perine), *A. stipellatus* possessing the smallest ($20 \times 34\ \mu$) and *P. cyatheoides* having the largest spores. They swell markedly on acetolysis, the average size of the acetolysed spores being $26—32 \times 36—46\ \mu$, spores of *D. aspidioides* swelling proportionately more than those of the others (from 22×34 to $32 \times 46\ \mu$). The laesura is tenuimarginate. The exine is $1—2\ \mu$ thick, light-brown in colour and with a smooth surface. There is a prominent brownish thin perine forming a loose jacket around the spore. The perine bears a granulose ornamentation and is wrinkled into characteristic, thick, blunt, ridge-like, sharply demarkated folds which protrude about 8 μ from the exine surface, and are convoluted and often assuming irregularly oval or circular shapes (Fig. 6 I). The folds in *A. stipellatus* (Fig. 6 II) are comparatively thinner, irregular and less conspicuously convoluted, many of the folds being parallel to the equatorial axis of the spore. The folds are rather crowded in *D. aspidioides* and *P. cyatheoides*. Fresh spores contain many pale yellowish-green plastids and small oil globules.

Prothallial Development

On sowing, the spores germinate in a fortnight. The exine opens at the laesura and the germ filament emerges, usually preceded by the first rhizoid, but in some cases rhizoid formation is delayed. The germ filament becomes 4—6 cells long before the formation of a prothallial plate is initiated (Figs. 1 A, 2 G). The cells are barrel-shaped and densely chlorophyllous. Rhizoids are usually few (except in *Peranema*), nearly hyaline and non-chlorophyllous. The basal cell of the germ filament is short, but not bulbous. Under crowded conditions of growth and insufficient light, the basal cell and one or two cells next to it elongate markedly.

The development of a prothallial plate is initiated by longitudinal divisions in the terminal cell (Fig. 1 B), usually followed by similar divisions in the penultimate cell (Fig. 2 H, I). There is a good deal of variation in the pattern of development of the prothallial plate, even in the same species. An obconical apical meristematic cell is developed either early or rather late in development and this may in many cases be preceded by the formation of a terminal hair on the germ-filament. In all cases, however, the meristematic cell is developed in one of the daughter cells of the terminal cell. Soon after the longitudinal division of the terminal cell, the anterior region of the germ-filament expands, and an obconical meristematic cell may then be established by a wall formed oblique to the vertical wall separating the two daughter cells of the terminal cell (Fig. 1 C, D). In many cases, however, the development of a meristematic cell is delayed, the terminal and the penultimate cells of the germ-filament dividing several times and expanding to form an ameristic prothallial plate (Fig. 2 A—E). An obconical meristematic cell is later differentiated in one of the terminally placed marginal cells (Fig. 2 F). This condition is common in *Acrophorus* in which a meristematic cell is differentiated late in the

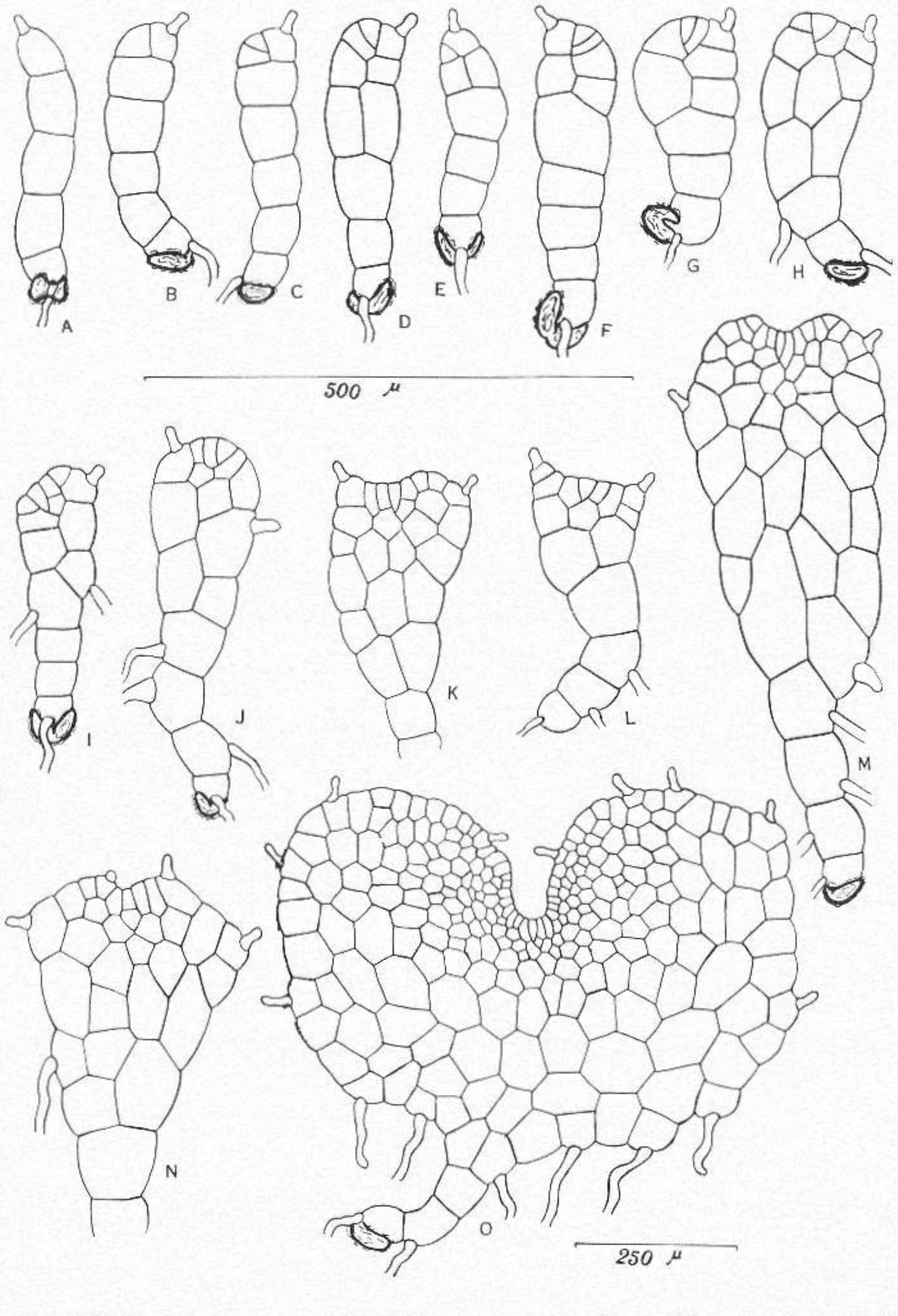


Fig. 1. Prothallial development in which meristematic cell is differentiated (D, J, K, M, N: *Peranema cyatheoides;* O: *Diacalpe aspidioides;* others: *Lithostegia foeniculacea*).

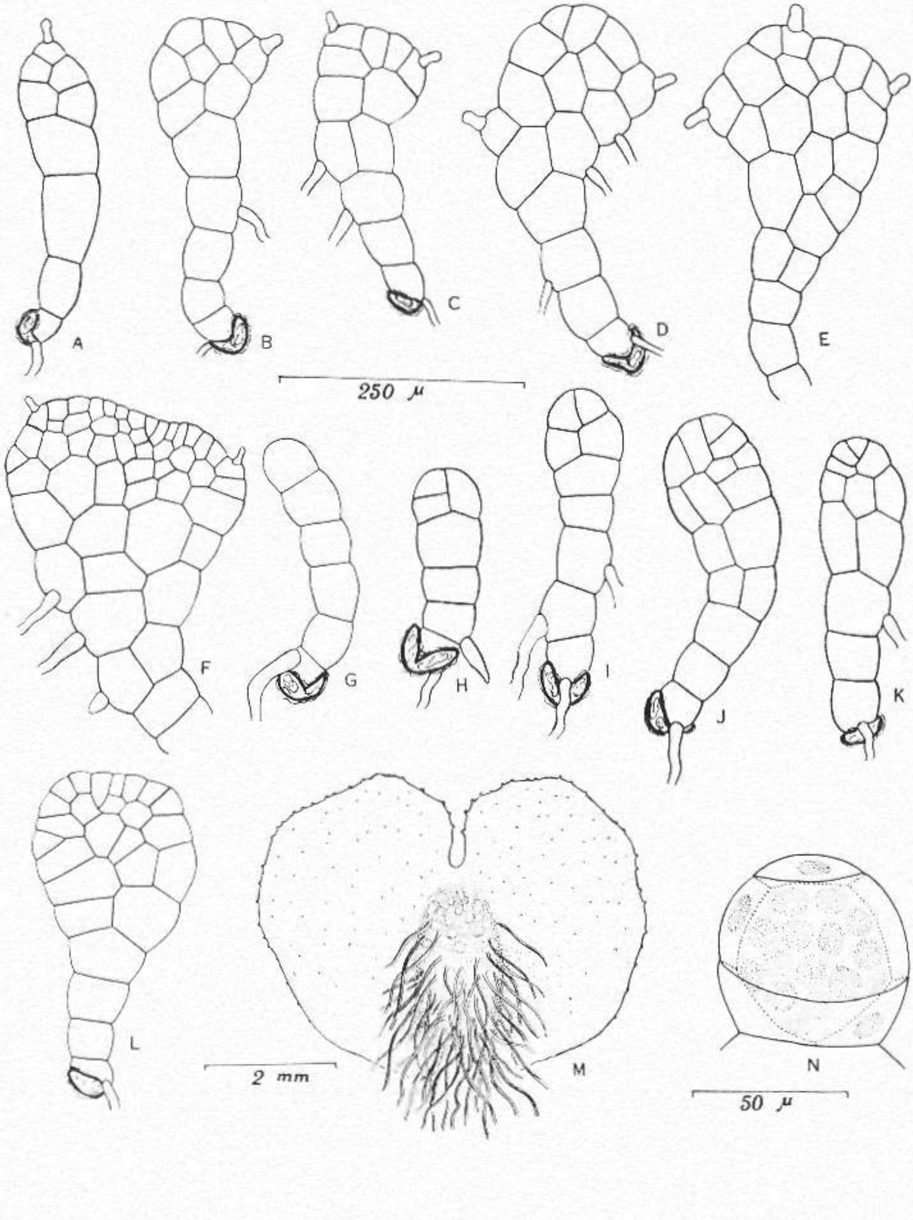


Fig. 2. A-F: Ameristic development of young prothalli (A: *Peranema cyatheoides*; F: *Acrophorus stipellatus*; others: *Lithostegia foeniculacea*). G-L: Young naked prothalli (K: *P. cyatheoides*; J, L: *A. stipellatus*; others: *L. foeniculacea*). M: Mature prothallus of *A. stipellatus*. N: Mature antheridium of *A. stipellatus*.

majority of prothalli. In *Peranema, Diacalpe* and *Lithostegia* the terminal cell of the germ filament often produces an apical, papillate hair before it divides longitudinally (Fig. 1 A). In such cases the terminal cell divides unequally (Fig. 1 B, E), the larger daughter cell bearing the hair. This hair-bearing cell sometimes divides transversely, and protrudes as a conical process, while the other daughter cell expands, pushing the hair-bearing cell to a lateral position. Usually an obconical meristematic cell is formed soon afterwards in the latter, by a wall formed oblique to the septum separating the two daughter cells of the terminal cell (Fig. 1 C, D). The first daughter cell cut off by the meristematic cell is on the side facing the hair-bearing cell (Fig. 1 G, H), but may rarely be on the opposite side in *Lithostegia* (Fig. 1 F). Often the sister cell of the meristematic cell develops a marginal papillate hair, soon after the meristematic cell is differentiated (Fig. 1 L). In some cases, the differentiation of a meristematic cell is delayed and the prothallial plate is ameristic for some time (Fig. 2 A-E). Rarely the division of the terminal cell of a germ-filament which has developed an apical hair, is so unequal that the sister cell of the hair-bearing daughter cell is narrowly wedge-shaped and resembles the obconical meristematic cell formed by young prothalli (Fig. 1 E). This cell, however, soon expands and divides in the usual way by a wall oblique to the septum separating it from the hair-bearing cell, thus establishing a meristematic cell. Rarely in young prothalli the meristematic cell is sluggish, and may later produce a marginal hair and stop growth. The thallus then continues growth ameristically and later develops a fresh obconical meristematic cell from one of the anterior marginal cells. Young prothalli are generally hairy, except in *Acrophorus;* in the latter, marginal hairs are produced only after a meristematic cell is differentiated (Fig. 2 J, L).

Young prothalli soon become spatulate and develop a notched apex, with the meristematic cell lodged at the bottom of the notch (Figs. 1 K, L, 2 L). The apical region broadens and the meristematic cell is replaced in the usual way (by a transverse division, followed by repeated longitudinal divisions in the outer daughter cell) by a multicellular meristem (Fig. 1 N). In *Diacalpe* the apical cell may persist till the prothallus is distinctly cordate with a deeply notched apex (Fig. 1 O); in the others it is replaced by a multicellular meristem soon after the apex of the thallus becomes notched. Rarely some of the ameristic young prothalli omit an apical cell stage, developing a multicellular meristem directly from the marginal cells. In *Peranema* and *Lithostegia* (more markedly in the latter) there is a tendency for the young prothalli to elongate, many thalli becoming elongate-oblong in outline (Fig. 1 M).

In *Diacalpe* and *Acrophorus* the prothallus is generally broader than long (Figs. 1 O, 2 F), with an expanded anterior region tapering on to a uniseriate posterior region. Young cordate prothalli in all the genera bear papillate marginal hairs rather profusely. Similar superficial hairs are produced on the lower surface as the thallus becomes distinctly cordate.

Mature Prothalli

Prothalli become full-grown in 6—8 months after spore germination. The mature prothallus (Fig. 2 M) is cordate, often broader than long, large and with a heavy (6—8 cells thick), broad midrib and flat, unruffled wings. The wing cells are uniformly thin-walled. The prothalli are profusely hairy, bearing both marginal and superficial (on both surfaces), unicellular, papillate or culb-shaped, chlorophyllus hairs devoid of any extracellular secretion: hairs, however, are more profuse on the margin and on the lower surface of the midrib than elsewhere. The superficial hairs are comparatively larger than the marginal ones. Multicellular hairs, as reported by SCHLUMBERGER (1911), are not observed in any of the species studied. Sex organs are of the usual type reported in advanced leptosporangiate ferns. The antheridia (Fig. 2 N) are sub-globose or oblong and are produced by prothalli from early spatulate stages onwards. The upper wall of the basal cell of the mature antheridium is prominently curved and touching the basal wall so that the basal cell is funnel-shaped. The opercular cell is single. In *Acrophorus* the antheridia are markedly larger than in the other genera studied. Archegonia begin to be produced when the prothalli are 5—6 months old. The archegonial neck is elongated, curved away from the apex of the prothallus and composed of 4 rows of 4—5 cells each. At maturity the basal tier of neck cells is divided longitudinally. The neck canal cell is slightly swollen at the apex and is bi-nucleate at maturity.

Juvenile Sporophytes

The first juvenile leaf is with a cuneate lamina having a deeply dissected anterior margin (Fig. 5 E). The simplest leaf observed in cultures had a forked apex with the lobes forked again. The single vascular strand entering the lamina is forked at the base, each of the branches being forked again. Usually the vein is forked 3 or 4 times and the lamina is dissected correspondingly, each ultimate veinlet entering a lobe. A midrib is developed in the 3rd or 4th leaf and originates near the first dichotomy of the vascular bundle entering the lamina. Soon the lamina becomes 3-lobed (Fig. 5 F, G), the midrib entering the median lobe. The midrib as well as the basal lateral veins are pinnately branched. The apex of the leaf becomes pronounced and the leaf becomes pronouncedly lobed. In succeeding juvenile leaves (Fig. 5 H), the lamina is progressively larger and gradually becomes pinnate and then decompound.

The juvenile leaves are profusely hairy. Unicellular papillate hairs resembling the prothallial hairs, but more elongated, are borne profusely over the margin and both surfaces (Fig. 5 Q). The marginal hairs are thin-walled and usually non-chlorophyllous. In *Peranema* the hairs are comparatively longer than in the other genera, and in many cases some of the hairs are much prolonged and flagellate especially on the earlier juvenile leaves (Fig. 5 R). In addition to the unicellular hairs the juvenile leaves bear larger club-shaped, densely chlorophyllous, thin-walled hairs composed of 2—4 short barrel-shaped cells (Fig. 5 P). These hairs are mostly restricted to the veins. Similar, but sparsely cholorophyllous, elongated hairs are found on the stipe and leaf base also. The hairs on the stipe and leaf base become progressively elongated in successive juvenile leaves, their anterior region being slender and much elongated. Multiseriate hairs resembling paleae are borne towards the leaf base by the 5th to 8th leaf onwards.

The Adult Sporophytes

Rhizome: The rhizome of the adult sporophyte of all the genera is short, unbranched and erect (or suberect in early stages, as in *Diacalpe*). It is densely covered by roots and closely set, persistent, hard leaf-bases clothed by large (up to 3.0×0.5 cms. in *Peranema*), dark-brown, basally attached paleae. Hairs occur mixed with the paleae; they are unicellular, short, club-shaped and with dense brown contents except in *Acrophorus* in which they are elongated, slender, and multicellular. The roots are thick, black, sparsely branched and covered by persistent, light brown root hairs. The cortex of the root is clearly demarcated into an outer parenchymatous region of radially arranged large cells (6—10 cells thick) and an inner sclerenchymatous region of smaller, dark-brown thick-walled cells (4—8 cells thick) with lamellated walls

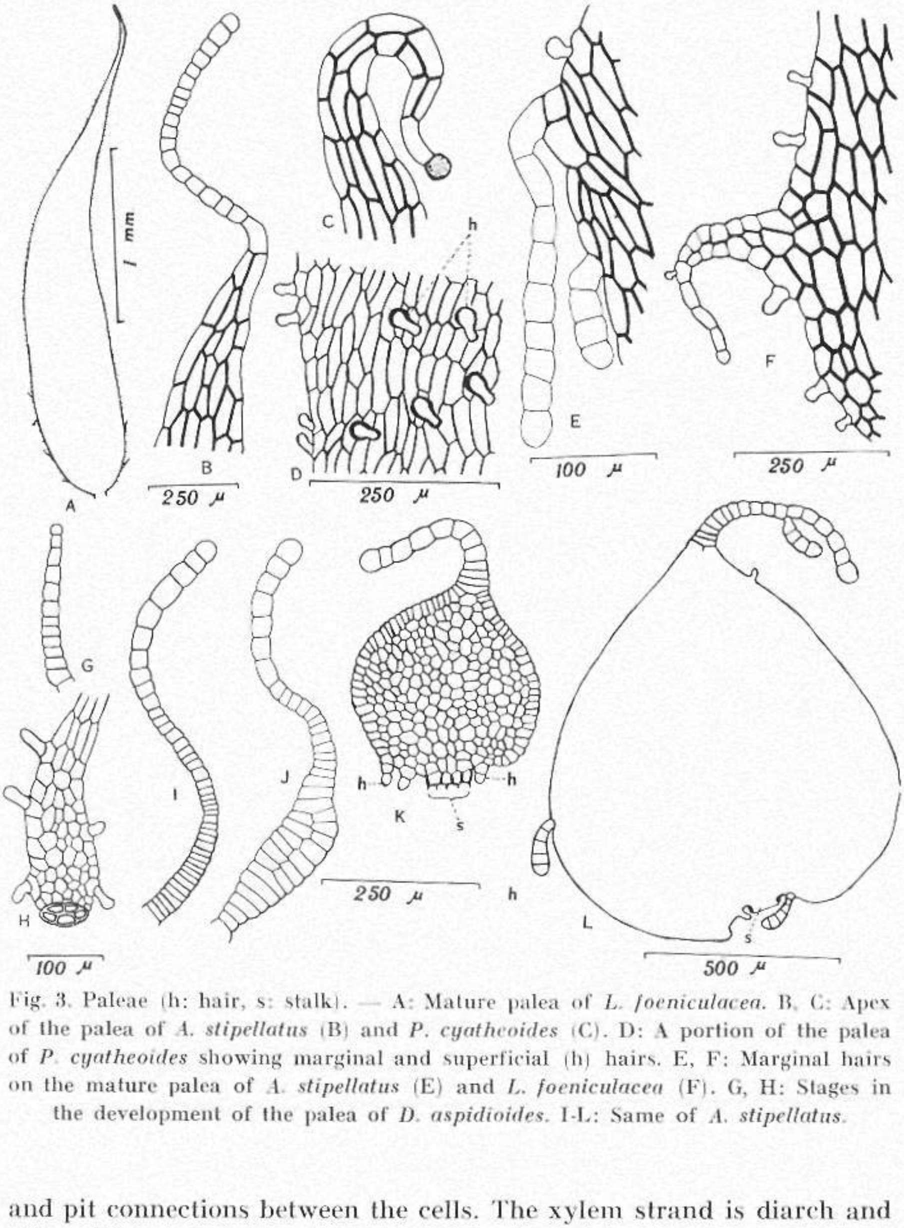


Fig. 3. Paleae (h: hair, s: stalk). — A: Mature palea of *L. foeniculacea*. B, C: Apex of the palea of *A. stipellatus* (B) and *P. cyatheoides* (C). D: A portion of the palea of *P. cyatheoides* showing marginal and superficial (h) hairs. E, F: Marginal hairs on the mature palea of *A. stipellatus* (E) and *L. foeniculacea* (F). G, H: Stages in the development of the palea of *D. aspidioides*. I-L: Same of *A. stipellatus*.

and pit connections between the cells. The xylem strand is diarch and ribbon-like.

The paleae (Fig. 3 A, L) are clathrate, basally attached, and ovate-lanceolate to ovate in shape. The stalk is broad, short (often over 10 cells broad and 2 or 3 cells long) and clearly demarcated from the body of the palea. The apex of the palea (Fig. 3 C) tapers to an attenuated uniseriate tip which bears a rather swollen probably glandular cell; in *Acrophorus* the uniseriate region is much prolonged (Fig. 3 B) and the terminal cell is non-glandular though sometimes slightly swollen. The margin of the paleae is hairy; hairs are very sparse in *Acrophorus* and rather profuse, especially on the basal half of the paleae, in *Peranema* and *Lithostegia*. The hairs are unicellular, short and club-like; elongated, multicellular, uniseriate hairs, resembling the apical region of the paleae, are found in addition, usually restricted to the basal region of the palea in *Acrophorus* and *Lithostegia* (Figs. 3 E, F). Unicellular club-like hairs similar to the marginal hairs are found profusely on the outer surface of the palea in *Peranema* (Fig. 3 D). A few superficial multicellular hairs are sometimes found towards the base of the palea in *Acrophorus* but unicellular hairs are absent.

The paleae originate as cylindrical, uniseriate, elongated hairs (composed of small disc-shaped cells) close to the growing apex of the rhizome. In *Diacalpe, Lithostegia* and *Peranema,* when these hairs become 10—15 cells long, the basal region (except the basal cell) becomes more or less flattened and the hair curves towards the growing apex of the rhizome. The anterior cells elongate (Fig. 3 G), and soon the terminal cell becomes swollen and acquires dense protoplasmic contents. The cells of the basal half (except the basal cell) divide longitudinally, and by successive division and expansion of the daughter cells, develop into the broad, shield-like body of the palea. Meanwhile, the basal stalk cell divides and develops into a short flat stalk. Marginal and superficial hairs are developed only after the palea becomes broad and lanceolate (Fig. 3 H). In *Acrophorus* the palea originates as in *Peranema*, etc., but the uniseriate hair becomes very long, often composed of 50 or more disc-shaped cells. The cells of the anterior region are rather elongated, but those near the middle are very short (Fig. 3 I), due to active cell divisions in this region. The hair broadens in this region and longitudinal divisions set in (Fig. 3 J). Soon a broad ovate body is developed, tapering sharply on to the elongated (15—20 cells long) uniseriate anterior region (Fig. 3 K, L). Marginal multicellular hairs may be developed from this stage onwards. The marginal cells of the young palea are often regularly arranged, narrow and radially elongated.

The rhizome is parenchymatous and the cells of the ground tissue possess dense deposits of starch. Slender, cylindrical, dark-brown to blackish strands of sclerenchymatous cells are scattered throughout in

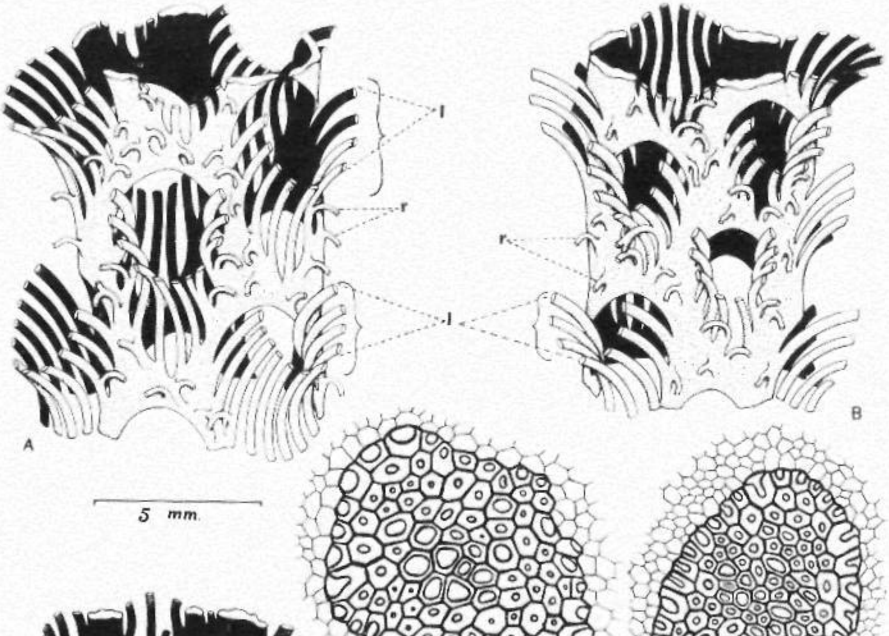


Fig. 4. Morphology of the rhizome (r: root trace, l: leaf trace, c: cortical parenchyma). — A-C: Stelar cylinders of a portion of the rhizome of *A. stipellatus* (A), *P. cyatheoides* (B) and *D. aspidioides* (C). D, E: T.s. of sclerenchymatous strand in the ground tissue of the rhizome of *A. stipellatus* (D) and *L. foeniculacea* (E). F: A portion of E showing nature of cells.

the ground tissue. These strands vary much in size but are usually 30—50 cells thick (some of the smaller strands are only 2 or 3 cells thick) and composed of narrow elongated cells. The strands have a nearly smooth contour (Fig. 4 E), except in *Acrophorus* (Fig. 4 D), and the peripheral wall of the outer layer of cells (adjacent to the surrounding parenchyma) is unthickened (Fig. 4 F), as described in some Polypodiaceous (NAYAR 1963 a, 1963 b), and Lomariopsidoid ferns (NAYAR & KAUR 1964 a). The cells of the sclerenchymatous strands are devoid of any contents and possess highly thickened, dark-brown, lamellated and pitted walls (Fig. 4 F). Except for the cells in the middle of the larger strands, which possess a wide lumen, the lumen is occluded. Towards the apex of the rhizome the sclerenchymatous strands in *Diacalpe* and *Lithostegia* are differentiated as uniseriate rows of elongated cells in the promeristem region. These cells divide and gradually develop into the multiseriate thick-walled strand as the rhizome grows.

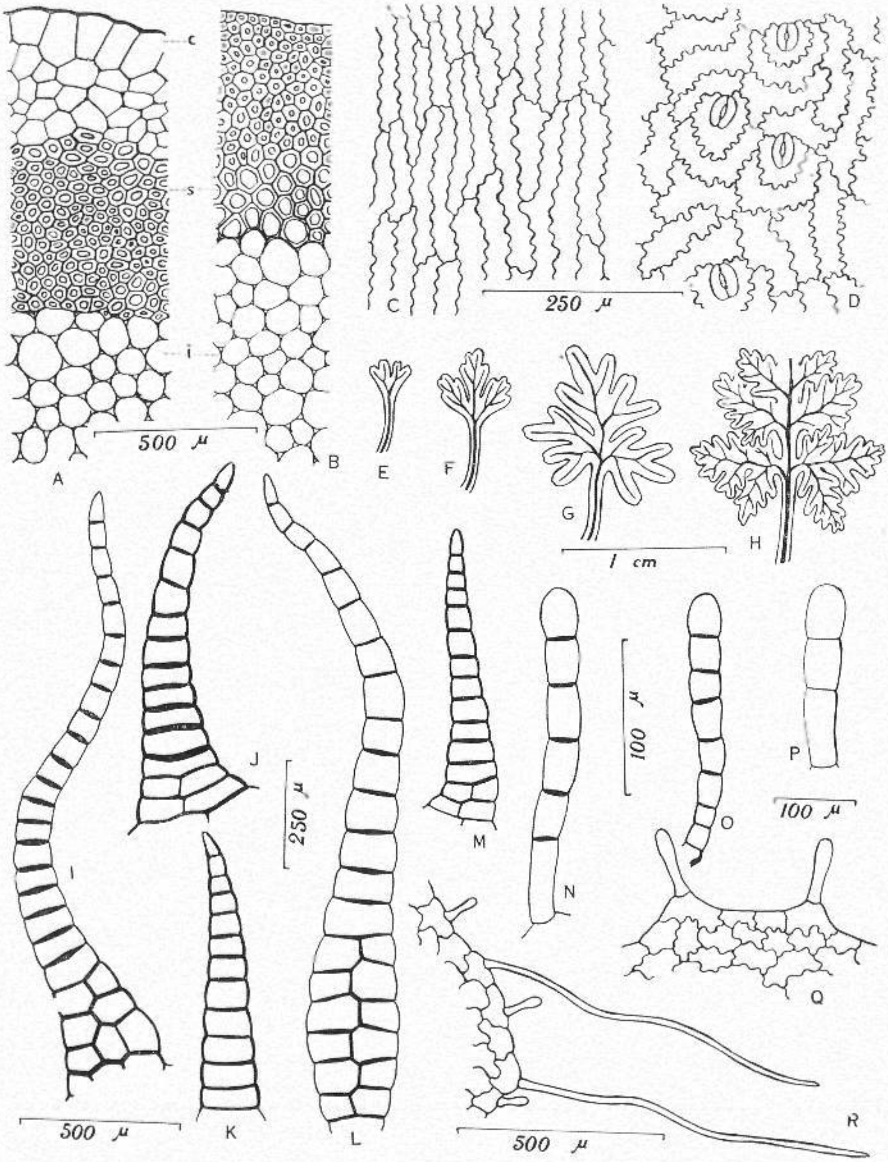
The vascular cylinder of the rhizome (Fig. 4 A-C) is a condensed dictyostele dissected by closely placed, spirally arranged, obovate leaf gaps and appearing in a t.s. as 5—9 strap-shaped meristeles arranged in a circle. The surface of the stelar cylinder is irregular, especially in *Diacalpe*, the stelar cylinder of which (Fig. 4 C) bears many irregular longitudinal ridges on both surfaces. The leaf gaps are comparatively very large in *Acrophorus* (Fig. 4 A) and are closely placed so that the meristeles are usually narrow and well separated from each other. They are in 3 or 4 closely placed spirals around the stelar cylinder in all the genera. Vascular connection to each leaf (Fig. 4 A-C, 1) consists of 5—8 (up to 12 in *Acrophorus*) slender cylindrical strands attached to the margins of the leaf gap. The adaxial pair of strands are larger than the others: in *Peranema* the abaxial strand of the leaf trace is often as prominent as the adaxial strands. The leaf trace bundles often have irregular vascular commissures between nearby bundles; in *Diacalpe* commissures are more common, sometimes forming a loose reticulum at the leaf base. Root traces are mostly associated with the leaf traces, the large majority of them originating close to the leaf gap, often at the base of the leaf trace bundles, so that there are clusters of roots around each leaf base. Some root traces originate along with the leaf trace bundles from the margin of the leaf gap, while a few originate as slender superficial or lateral branches of some of the leaf trace bundles themselves. Except in *Acrophorus* the first vascular strand originating at the posterior end of each leaf gap is often a root trace. Branching of the rhizome is uncommon. Where branches occur, they are unassociated with the leaves. The vascular cylinder forks unequally to supply the branch of the rhizome, the branch trace being a cylindrical, solenostelic strand.

Leaf: The leaves in all genera are large, decompound (see NAYAR & KAUR 1964, for detailed morphological descriptions), crowded and arranged spirally over the rhizome. The stipe is long, hard and cylindrical with a shallow median longitudinal groove on the adaxial side. Paleae similar to those on the rhizome, but often larger, cover the young stipe; in *Acrophorus* they are deciduous so that the stipe is ultimately naked and glossy. Superficial hairs as found on the paleae of the rhizome are generally absent. In all genera, except *Acrophorus*, small club-shaped unicellular hairs occur mixed with the paleae on the stipe; larger multicellular uniseriate hairs are found in addition in *Diacalpe* and *Lithostegia*. Prominent, slender aerenchyma bands, one on either side of the stipe, are found in all genera, but are more conspicuous in *Diacalpe* and *Lithostegia*.

The ground tissue of the stipe, except a few (10—14) layers of cells towards the periphery are parenchymatous. In *Acrophorus* and *Peranema* the epidermis and 4 or 5 layers of the hypodermal cells are thin-walled (Fig. 5 A), but in *Diacalpe* and *Lithostegia* (Fig. 5 B) the epidermis and a few layers of cells below it are thick-walled, forming a hard, peripheral sclerenchymatous sheath. The thickening of the wall is progressively less and the cells are gradually larger in size towards the centre of the stipe so that the thick-walled peripheral region merges imperceptibly with the parenchymatous central region of the stipe. In *Acrophorus* and *Peranema*, on the other hand, there is a cortical sclerenchymatous sheath sharply demarcated from the parenchymatous tissue on either side (Fig. 5 A). This sheath is often 10—15 cells thick, and consists of dark-brown, highly thick-walled cells which are markedly narrower than the parenchyma cells on either side, and elongated along the length of the stipe. Broad lateral bands of parenchymatous aerating tissue interrupt the sclerenchymatous sheath in all the genera. Towards the base of the stipe slender cylindrical sclerenchymatous strands similar to and continuous with those of the rhizome are present scattered in the parenchymatous ground tissue of the stipe. Further up the stipe these sclerenchymatous strands merge imperceptibly with the parenchymatous ground tissue. The rachis is similar to the stipe in structure; the dorsal groove is often more prominent. In *Acrophorus* the regions at which branches are borne by the rachis are prominently swollen and covered by a dense felt of persistent dark-brown hairs. These hairs are non-glandular, thick, often tortuous and with a broad multiseriate base (Fig. 5 I). Vascular strands are many (8—10) per stipe and arranged in the form of a gutter; the adaxial strands (and one abaxial strand in *Peranema*) are larger than the others. During their course up the rachis the lateral vascular strands progressively fuse with the adaxial strand on either side so that towards the apex there remain only 3 strands, 2 adaxial and 1 abaxial. Near the apex the two adaxials merge into one and later fuse with the abaxial one. The vascular connection to the secondary branches of the rachis originates as a solitary branch from the adaxial bundle on that side. In larger branches this vascular strand soon splits into two or three.

The leaf lamina is deltoid, decompound and finely dissected with small pinnately lobed ultimate segments. Venation is pinnate, each main lateral vein of the midrib supplying one lobe of the lamina. The main veins are pinnate in the larger lobes but may be only once forked in the smaller lobes, particularly of *Lithostegia*. The ultimate veinlets are free, possess slightly swollen apices and terminate below the margin of the lamina. The epidermis of the leaf (Fig. 5 C, D) is thin-walled, chlorophyllous and with highly sinuous contour (in surface view); the lateral walls of the upper epidermis are less sinuous compared to that of the lower epidermis. In both cases the epidermal cells are elongated parallel to the lateral veins of the pinna lobes. Stomata are restricted to the lower epidermis. They are ovoid in outline with the guard cells elongated nearly parallel to the veins of the lamina. The epidermal cell subtending the stoma (the sister cell of the stoma initial) is different from the other epidermal cells in being transversely elongated and nearly surrounding the guard cells except at the anterior end (Fig. 5 D). Often the epidermal cell next to it is also transversely elongated and surrounding the subtending cell half-way around. Often there is only a single epidermal cell anterior to the stoma (so that the stoma is surrounded by two cells: one subtending it and one anterior to it), and in such cases this cell is also transversely elongated. The mesophyll tissue of the leaf is undifferentiated and composed of large armed parenchyma cells. Hairs occur profusely over the lamina in all the genera, but are mostly shed as the leaves mature. On mature leaves the lamina is often nearly glabrous on both surfaces except for a few hairs over the veins.

Fig. 5. Morphology of the leaf (c: cortical parenchyma, s: sclerenchymatous sheath, i: inner ground tissue). — A, B: Portions of the cortical region of the stipe of *P. cyatheoides* (A) and *L. foeniculacea* (B). C, D: Upper and lower foliar epidermis of



P. cyatheoides. E-H: Juvenile leaves showing succession in form and venation in *A. stipellatus* (E, F, H) and *P. cyatheoides* (G). I: Hairs on the rachis of *A. stipellatus*. J-M: Acicular hairs over the veins of *A. stipellatus* (J, K), *D. aspidioides* (L), *L. foeniculacea* (M). N, O: Club-shaped foliar hairs of *P. cyatheoides* (N) and *A. stipellatus* (O). P: Hair on the juvenile lamina of *A. stipellatus*. Q, R: Portions of the margin of the juvenile leaf of *P. cyatheoides* showing unicellular hairs.

These hairs are characteristic in being large, stiff, dark brown, acicular, jointed, and uniseriate (except at the base where it is often 2 cells thick), composed of short disc-shaped thick-walled cells (Fig. 5 J-M). In *A. stipellatus* they are often brittle. In *D. aspidioides* some of the larger hairs resemble small paleae (Fig. 5 L). Similar hairs are found on the branches of the rachis, often mixed with reduced paleae; they are more numerous at the region where the pinnules are attached. In addition to the stiff acicular hairs the leaf lamina bears sparse uniseriate thin-walled light-brown multicellular club-shaped hairs in all the genera (Fig. 5 N, O). These are often 4—6 cells long, with the terminal cell slightly swollen, but apparently non-glandular.

Sori and Sporangia

Sori are borne on the lower surface of the ultimate pinnules and are superficial over the veinlets a little below their apices. A conspicuous indusium is found in all the genera. The indusium is a thin, ovate, scale-like flap attached by a broad base to the posterior side of the sorus in *Acrophorus* (Fig. 6 A). When young, it covers the sorus, but is later pushed backwards by the developing sporangia. It is one cell thick (except at the base) and has a flabellate outer margin. In *Diacalpe* (Fig. 6 B) and *Lithostegia* the indusium covers the young globose sorus completely and is attached all around the short cylindrical stalk on which the sorus is borne. It is one cell thick, chlorophyllous when young and becoming dark, glossy and shining towards maturity. As the sporangia mature, they force open the indusial cover from top downwards tearing it up irregularly into a few scale-like valves which are usually persistent. In *Peranema* (Fig. 6 C, D) the entire sorus is borne over an elongated cylindrical stalk (NAYAR & KAUR 1963). The indusium is zygomorphic, nearly ovoid and covering the sorus, with the narrower end tilted downwards and facing the margin of the lamina. It is attached to the stalk towards the middle of the broader end and possesses a narrow, slit-like, transverse opening on the narrower end, close to the stalk. The indusium is one cell thick and green when young, ultimately becoming nearly black and shining. As in *Diacalpe* it breaks open irregularly into a few scale-like valves to release the sporangia. In all the genera the sorus is supplied by a vascular strand originating as a superficial branch of the foliar vein. In *Acrophorus* the vascular supply is inconspicuous, but in *Peranema* it is a cylindrical, thick vascular strand forming a central shaft in the elongated stalk of the sorus.

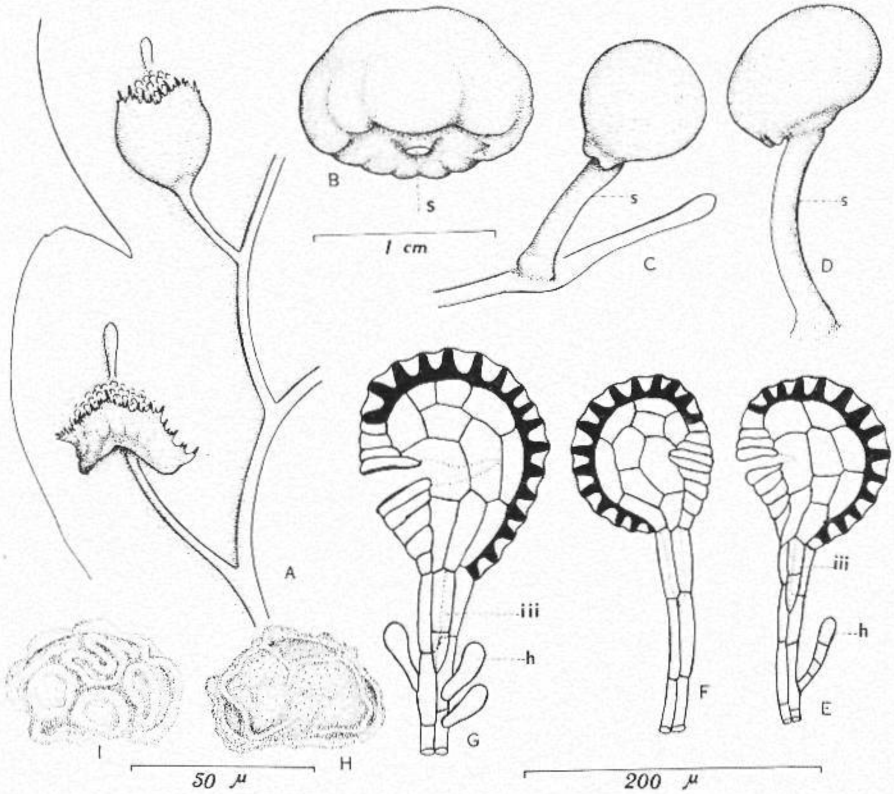


Fig. 6. Reproductory organs (h: hair, s: stalk, iii: 3rd row of stalk cells). — A: Sori of *A. stipellatus* (the lower one mature with the indusium reflexed). B: Unopened but nearly mature sorus of *D. aspidioides* showing the basal attachment. C, D: stalked sorus of *P. cyatheoides*. E-G: Lateral view of sporangia of *A. stipellatus* (E), *P. cyatheoides* (F) and *D. aspidiodes* (G). H, I: Lateral view of spores of *A. stipellatus* (H) and *D. aspidioides* (I).

The sporangia (Fig. 6 E-G) are typically of the common leptosporangiate type in all the genera, possessing a lens-shaped capsule and a slender elongated stalk. The annulus consists of 10—14 (up to 17) highly indurated cells and extends nearly 2/3 the circumference of the capsule abutting on the stalk on one side. The stomium is well developed, and the capsule wall is composed of a few elongated cells having a rather regular outline with nearly straight side walls. The sporangial stalk is 4—5 cells long and is 2 cells thick when young, the rows being continuous with the annular ring of the capsule. During sporangial development, a short third row of stalk cells (usually one or two cells long and extending less than half the length of the stalk) is formed secondarily from the basal wall cell on one side of the sporangial capsule. One of the basal wall cells protrude downwards and develop into the 3rd row. A few unicellular, highly vacuolated, club-shaped or balloon-like, thin-walled hairs are borne by the lower stalk cells in all genera except *Peranema*. In *Acrophorus* hairs are few, elongated and in many cases 2—4 cells long. Hairs similar to the sporangial ones are found sparsely distributed between the sporangia.

Discussion

The taxonomic history of *Acrophorus, Diacalpe, Lithostegia* and *Peranema* has already been presented in an earlier communication (NAYAR & KAUR 1963). These four genera of tropical ferns agree generally in frond form, habit and habitat, but differ in details of their soral morphology; even in soral morphology *Diacalpe, Lithostegia* and *Peranema* exhibit little difference among them, all possessing globose superficial sori covered by leathery basally attached indusia enveloping the sorus and splitting open irregularly at maturity. Also they agree in several fundamental features of external morphology, anatomy of the different organs, organisation of the stelar cylinder of rhizome, morphology of the spores and prothalli as well as cytology, that it appears unnecessary to recognize them as distinct genera. A genus is commonly accepted as a convenient group of related species, and relationships are commonly judged by total morphological comparison. The preponderance of similarities between *Diacalpe, Lithostegia* and *Peranema*, thus suggests close relationship, and, without violence to nature, it appears feasible to combine them as we have already suggested earlier (NAYAR & KAUR 1963). Taxonomic characterization of the combined genus (*Peranema* Don emend. Nayar et Kaur) is already presented (NAYAR & KAUR 1964 c).[2]

As to the affinities, most of the early workers regarded *Peranema* and *Diacalpe* as intermediate between the *Cyatheaceae* and the *Aspidiaceae*. BOWER (1928) considers them along with *Acrophorus* as a connecting link between the cyatheoid and the aspidioid ferns. The possession of

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[2] The following new combinations are suggested for species other than those included in this study: — *Peranema annamensis* (Tagawa) Nayar et Kaur comb. nov. (*Diacalpe annamensis* Tagawa 1950), *P. christensenae* (Ching) Nayar et Kaur comb. nov. (*Diacalpe christensenae* Ching 1949), *P. omeiensis* (Ching) Nayar et Kaur comb. nov. (*Diacalpe omeiensis* Ching 1949).

multicellular prothallial hairs, as reported by SCHLUMBERGER (1911) and their supposed resemblance to the characteristic "bristle-like" hairs (STOKEY 1930) of the *Cyatheaceae*, the presence of divided opercular cells of antheridia (SCHLUMBERGER 1911) in *Peranema* as well as the cyatheoid ferns, and the shape and probable evolution of the indusium in these ferns from the cup-shaped indusia of some of the *Cyatheaceae*, appear to have been the main considerations in ascribing a cyatheoid affinity to *Peranema* and *Diacalpe*. The large finely dissected leaves, bearing prominent superficial sori, might also have contributed to the superficial similarity to the cyatheoid ferns.

The sori of the cyatheoid ferns are morphologically much variable, and in some species bear a close resemblance to the sori of *Acrophorus*, *Diacalpe*, *Peranema* and *Lithostegia*. Other than this, it appears that there is morphogically little in common between these genera and the cyatheoid ferns to support a suggestion of any close relationship. The prothalli of *Acrophorus*, *Diacalpe*, *Lithostegia* and *Peranema* are strictly of the aspidioid type — cordate, bearing profuse unicellular papillate hairs (marginal and superficial), and following a pattern of development common in most *Aspidiaceae* (like the tectarioid ferns, the polystichoid ferns, etc.). Even the range of variation in the developmental history of the prothallus, is the same as in the polystichoid and tectarioid ferns (unpublished data). The cyatheoid prothallus, though of the cordate type, is markedly different in its developmental history as well as in the nature of its trichomes (STOKEY 1930). The characteristic bristle-like multicellular hairs, developing from special initials on the prothalli of the *Cyatheaceae*, have been held to be similar to the multicellular prothallial hairs reported by SCHLUMBERGER (1911) in *Peranema*. However, the present studies, as also detailed studies of DAVIE (1912, 1916) on *Diacalpe* and *Peranema*, have failed to corroborate SCHLUMBERGER's report: only the common aspidioid type of unicellular papillate hairs are borne by the prothalli of these ferns. Also, the supposed similarity of the divided opercular cell of the antheridium in these ferns and some of the *Cyatheaceae*, appear to be based on incomplete evidence. Under certain conditions of development the opercular cell in these ferns may be divided, but this is not of common occurrence. Occasional divided opercular cells are reported in several ferns, by no means closely related, and this feature seems to have little significance in assessing phylogeny and relationships. The spores of the *Cyatheaceae* are of the tetrahedral type devoid of any distinct perine (NAYAR 1964, HOLTTUM & SEN 1961) whereas in *Peranema*, etc., they are strictly of the bilateral type with a characteristic perine, closely resembling the spores of other *Aspidiaceae* (NAYAR & DEVI 1964).

The dermal appendages of the *Cyatheaceae* (HOLTTUM 1957, HOLTTUM & SEN 1961) are characteristic, the paleae being either of the flabelloid type or setiferous and terminated by an elongated, thick-walled, stiff, unicellular, acicular hair; the paleae of *Peranema*, etc., are distinctly different from these, and are similar to the paleae of the other *Aspidiaceae*. The superficial hairs on the paleae of *Peranema* are interesting in that superficial appendages on the paleae are unusual among ferns. Superficial hairs similar to those of the *Cyatheaceae* are reported in the thelypteridoid ferns, and this is often held as indicative of the cyatheoid affinity of this group. However, we have noticed superficial hairs quite similar to those of *Peranema* in quite unrelated genera like *Pyrrosia* (*Platyceriaceae*) and *Arthromeris* (*Polypodiaceae*).

The characteristic, stiff, multicellular, foliar hairs of *Acrophorus, Diacalpe, Lithostegia* and *Peranema* are interesting in that hairs somewhat similar to these occur in some of the aspidiaceous ferns (like some of the tectarioid group). They, however, do not indicate any resemblance to the foliar trichomes of the cyatheoid ferns. Many of the *Cyatheaceae,* as pointed out recently by HOLTTUM & SEN (1961), possess characteristic 'cubical cells' in the ground tissue and sometimes 'tangential cells' associated with phloem. Also, the meristeles possess a sclerenchymatous sheath. *Acrophorus, Diacalpe, Lithostegia* and *Peranema* lack these features, but like most other aspidiaceous ferns (the tectarioids, the polystichoids) possess slender strands of sclerenchyma scattered in the ground tissue. The tendency for the root traces to be associated with the leaf traces is another feature which these ferns have in common with tectarioid and polystichoid ferns. The chromosome count n=41 (VERMA 1958, MEHRA & SINGH 1955), typical of the aspidiaceous stock, is another important character in support of the aspidiaceous affinity of these genera of ferns. The basic chromosome number in the *Cyatheaceae* appears to be n=69. (ABRAHAM *et al* 1962, BROWNLIE 1954, 1958, 1961, MANTON & SLEDGE 1954, MEHRA & SINGH 1955).

On balance the genera *Acrophorus, Diacalpe, Lithostegia* and *Peranema* appear to be morphologically unrelated to the cyatheoid stock, but closely allied to the aspidioid stock, justifying the position allotted to them by COPELAND (1947).

Acknowledgement

We are indebted to the Director, National Botanic Gardens, Lucknow, for his encouragements.

Summary

The spores of the 4 species (*Acrophorus stipellatus, Diacalpe aspidioides, Lithostegia foeniculacea* and *Peranema cyatheoides*) studied are monolete, bilateral and with a smooth, thin exine enveloped by a loose granulose perine wrinkled into characteristic convoluted folds. The mature prothallus is of the cordate type, bearing profuse unicellular papillate hairs both on the margin and surfaces. The prothallus develops from a uniseriate germfilament, the anterior region of which develops a prothallial plate by longitudinal divisions in the terminal and the penultimate cells. A terminal hair is usually developed either before or after plate formation is initiated. An obconical meristematic cell is usually developed in one of the anterior cells of the prothallial plate and is eventually replaced by a multicellular meristem: several thalli, however, omit an apical-cell-stage. Young thalli are usually profusely hairy.

The rhizome is short, erect and clothed by basally-attached, clathrate paleae bearing marginal (also superficial in *P. cyatheoides*), club-shaped, unicellular hairs, and terminated by a swollen, probably glandular cell. Unicellular club-shaped hairs occur mixed with paleae. The ground tissue of the rhizome is parenchymatous, with scattered, slender strands of highly thick-walled sclerenchyma. The vascular cylinder is dictyostelic with large, closely placed leaf gaps arranged in 3 or 4 spirals around the cylinder. Each leaf is supplied by 5—8 slender vascular bundles. Root traces are mostly associated with the leaf-trace bundles. The leaves are decompound with free pinnately-branched veins in the ultimate pinnules. The stipe has a peripheral sclerenchymatous sheath, which is hypodermal and gradually merging with the inner ground tissue in *Diacalpe* and *Lithostegia*, and cortical and sharply delimitated in *Acrophorus* and *Peranema*. The leaf lamina bears multicellular hairs on both surfaces, and has an undifferentiated mesophyll. The sorus is superficial on the veins and is protected by a basally attached indusium which is flap-like in *Acrophorus* and globose (enveloping the sorus, and splitting open at maturity) in the others; in *Peranema* the sorus is borne on an elongated cylindrical stalk and the indusium has a slit-like lateral opening. The sporangia are of the common leptosporangiate type with the stalk composed of three rows of cells; a few unicellular (sometimes 2—4 cells long in *Acrophorus*) hairs are borne on the stalk.

It is concluded that there is little justification in regarding *Diacalpe, Lithostegia* and *Peranema* as separate genera; they are better merged under *Peranema* Don emend. Nayar & Kaur. *Peranema* as well as *Acrophorus* are evidently of aspidioid affinity; there is little morphological evidence to support a cyatheoid ancestry for these ferns.

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Meiotic Chromosome Numbers in Some Vascular Plants of Indus Delta II.

BY S. R. BAQUAR, AFAQ HUSAIN and SHAMIM AKHTAR

Central Laboratories, Pakistan Council of Scientific and Industrial Research, Karachi, Pakistan

Introduction

This investigation is a further contribution to the previous work of BAQUAR et al. (1965) on the plants of Indus delta. This area provides a good opportunity for cyto-taxonomic studies of the virgin endemic flora because of the presence of several kinds of habitat such as tidal swamps, sandy sea shore, saline and sandy land, dry and sandy region, low arid rocky and stony hillocks and cultivated areas. The present paper is second in a series designed to study the evolutionary course followed by the plants of local origin and to establish their genom pattern besides range of polyploidy occurring in endemic flora as this region has not been explored as yet. In this work chromosome counts for 20 indigenous species distributed over 12 families have been recorded.

Material and Method

Chromosome counts were made from pollen mother cell squashes. Buds, collected in the field from the plants growing in their natural environment were fixed in a solution of 6 parts alcohol: 3 parts chloroform: 1 part glacial acetic acid and were preserved in 75 % alcohol, till a convenient time to make temporary slides. Anthers were squashed in aceto-carmine. Camera lucida drawings were made at a magnification of approximately 2000 ×. For nomenclature and identification of plants HOOKER's "Flora of British India" (1872—1897) was consulted. Voucher specimens are deposited in the Herbarium of Central Laboratories, Pakistan Council of Scientific and Industrial Research, Pakistan.

Results

Capparidaceae

1. *Capparis cartilaginia* Decne. n=10

This species does not appear to have been studied before. The gametic number n=10 is a new record. The somatic numbers 18, 30, 38, 40 and ca 84 reported for other allied species of *Capparis* seem to represent a case of aneuploidy if 18 and 38 are not the counting error for 20 and 40 respectively. The basic number for this genus as recorded in DARLINGTON & WYLIE (1955) shows n=9, 10 and n_2=19. Our investigation suggests 10 to be the basic number.

2. *Gynandropsis gynandra* (L.) Briq. (Syn. *G. pentaphylla* DC.) n=17

This is a very common tropical herb distributed almost throughout West Pakistan. Previous somatic counts are 30 (SUGUIRA 1937), 32 (RAO 1936) and 34 (RAGHAVAN 1938). These counts suggest the presence of aneuploidy. Our report of n=17 is in accordance with that of RAGHAVAN. The basic number for this species is yet not known with certainty.

Malvaceae

3. *Abutilon graveolens* Wight et Arn. n=18

Chromosome count for *A. graveolens* has not been reported before but for other *Abutilon* species there are previous somatic records of 14, 16, 36 and 42 chromosomes. The gametic number n=18 is a new record for this species which falls in line with ROY & SINHA (1961) who reported 2n=36 for *A. indicum*. The basic numbers as reported in DARLINGTON & WYLIE (1955) are 7 and 8. Our investigation suggests the possibility of 9 being one of the basic numbers apart from the two mentioned above. However, *Abutilon* needs careful investigation for polyploidal analysis.

Tiliaceae

4. *Corchorus trilocularis* L. n=7

A common annual herb having elongated 3-angled capsules with entire beak. It is distributed almost throughout West Pakistan. MUKERJEE (1952) and RAO & DUTTA (1953) reported 2n=14 which is confirmed by our gametic record of 7 chromosomes.

5. *Corchorus tridens* L. n=7

This species is distinguished from *C. trilocularis* in having elongate cylindric capsules which end in 3-fid terminating points. It is quite variable in size and is found growing in waste shady places. Previous counts of 2 n=14 reported by MUKERJEE (1952) and ISLAM & QAIYUM (1961) agree to our finding of n=7.

Papilionaceae

6. *Indigofera oblongifolia* Forsk. (Syn. *I. paucifolia* Delile) n=7

A low unarmed shrub with copious woody branches. It is distributed throughout the dry arid region of West Pakistan specially in plains of Sind and Indus delta. Chromosome count for this species has not been reported before. Gametic number n=7 is a new record. The basic numbers recorded for the genus *Indigofera* are 6, 7 and 8.

7. *Astragalus fatmensis* Hochst. ex Blatter (Syn. *A. prolixus* Sieb.) n=8

The basic number n=8 is a new record as this species does not appear to have been studied before. The somatic numbers reported by various workers for other allied species of *Astragalus* from the old world are 16, 30, 32, 48, ca 56, 64, 72 and 96 which, except 30, are a multiple of 8 thus confirming 8 to be the basic number. It is difficult to ascertain whether 2 n=30, reported for *A. baeticus* L. by TSCHECHOW (1935) and LEDINGHAM (1960) displays a case of aneuploidy or a counting error for 32. Some American species of *Astragalus* have been reported to have 2 n=22, 24 and 36 chromosomes.

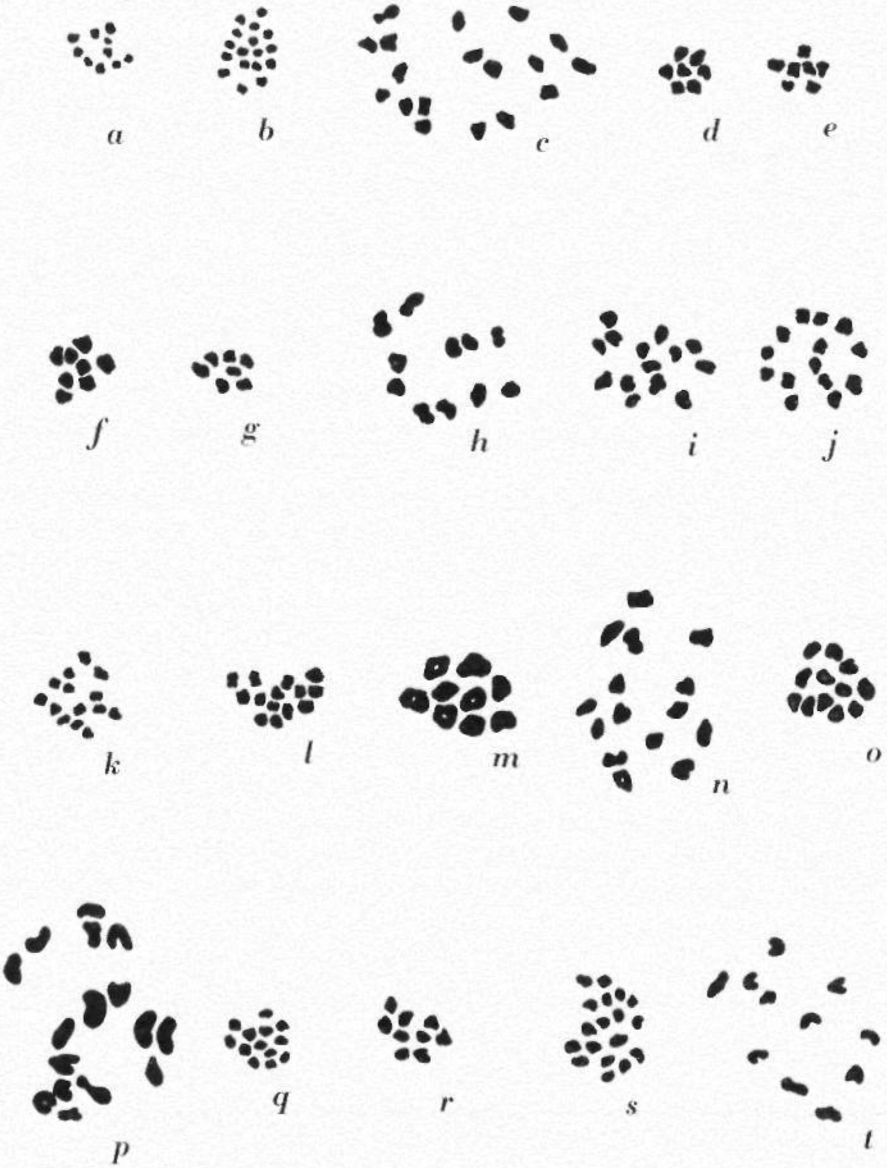
8. *Rhynchosia minima* (L.) DC. n=11

A predominently twining or wide-trailing annual herb extending throughout the plains of Sind and Indus delta ascending up to a height of 4000 ft. Our report of n=11 is a confirmation of the previous finding of 2 n=22 by SENN (1938) and MIEGE (1960) and n=11 by TURNER (1956 b).

9. *Cassia angustifolia* Vahl n=14

Very frequently occurring perennial undershrub with 10—16 oblong lanceolate acute leaflets and nearly straight oblong pods without crest.

Fig. 1. a. *Capparis cartilaginia* n=10 (Met II), b. *Gynandropsis gynandra* n=17 (Met II), c. *Abutilon graveolens* n=18 (Met I), d. *Corchorus trilocularis* n=7 (Met I), e. *Corchorus tridens* n=7 (Met I), f. *Astragalus prolixus* n=8 (Met II), g. *Indigofera paucifolia* n=7 (Met I), h. *Rhynchosia minima* n=11 (Met I), i. *Cassia obovata*



n=14 (Met I), j. *Cassia angustifolia* n=14 (Met I), k. *Cassia holosericea* n=14 (Met I), l. *Prosopis glandulosa* n=14 (Met I), m. *Limeum indicum* n=9 (Met I), n. *Ipomoea rumicifolia* n=15 (Met I), o. *Capsicum annuum* n=12 (Met I), p. *Ruellia patula* n=16 (Late diakinesis), q. *Blepharis sindica* n=13 (Met II), r. *Digera arvensis* n=9 (Met I), s. *Atriplex stocksii* n=18 (Met I), t. *Haloxylon recurvum* n=11 (Met I).

Our finding of n=14 is in accordance with that of SAMPATH & RAMANATHAN (1949) and FRAHM-LELIVELD (1960) who reported 28 as somatic number. MEHRA & SOBTI (1955) on the contrary reported a gametic number of 13 which is different to our finding.

10. *Cassia obovata* Collad. (Syn. *C. obtusa* Roxb.) n=14

This species differs from *C. angustifolia* in having characteristic obovate-oblong leaflets and flat oblong pods narrowed suddenly at both ends, with a crest on the middle of the valve opposite each seed. Our record of the gametic number of 14 is in line with the previous report of 2 n=28 by RAMANATHAN (1950) and FRAHM-LELIVELD (1957).

11. *Cassia holosericea* Fresen. n=14

C. holosericea resembles to a great extent *C. obovata* in general habitat specially leaf shape, but is distinguished in pod character which is without crest. This species does not appear to have been studied before, hence the gametic number of n=14 is a new record.

Mimosaceae

12. *Prosopis glandulosa* Torr. n=14

HOOKER in the Flora of British India (1879) reported only two species, namely: *Prosopis specigera* L. and *P. stephaniana* Kunth from the Indo-Pakistan Sub-continent out of which the first mentioned one was reported from the area under present study. A careful observation of the genus, which is under investigation, reveals some marked differential characters which identify the material from this area to *P. specigera* L. *P. juliflora* DC. and *P. glandulosa* Torr. All these species occur predominently throughout the dry, sandy and gravelly expanse of Sind and Indus delta. The chromosome count for *P. glandulosa* as reported by RAMANATHAN is 2 n=26 and for other allied species it has been reported to be 26, 28, 52, 56 and ca 112 by various workers. This variety of chromosome numbers suggests the presence of aneuploidy in this genus. CHERUBINI (1954) recorded 2 n=28 for *P. juliflora* var. *glandulosa.*

Ficoideae
(= *Aizoaceae*)

13. *Limeum indicum* Stocks ex T. Anders. n=9

The genus *Limeum* is represented by a single species, *L. indicum*, in the Indo-Pakistan Sub-continent. It is a prostrate, glandular-puberulous herb and is quite common in sandy and rocky areas. Our investigation of a gametic number n=9 is in accordance with the recent report of NARAYANA & JAIN (1962).

Convolvulaceae

14. *Ipomoea rumicifolia* Choisy n=15

This species has not been investigated before. The gametic number n=15 is a new record. The somatic counts reported for other *Ipomoea* species are 30, 60 and 90, on the basis of which DARLINGTON & WYLIE (1955) suggested 15 to be the basic number while LÖVE & LÖVE (1961) suggest 5 as the base number. It is difficult to say whether our material lies at the haploid or triploid level.

Solanaceae

15. *Capsicum annuum* L. (Syn. *C. frutescens* L.) n=12

Capsicum annuum has been studied by various workers as PAL et al. (1941), SINHA (1950), PICHENOT (1959) and OHTA (1962 a, b) who reported 2 n=24, while PAL et al. also recorded 36 and 48 as somatic number. Our report of a gametic number 12 is in line with the previous results. The basic number for this species is 6 which suggests our specimen to be a diploid one.

Acanthaceae

16. *Ruellia patula* Jacq. n=16

This is quite a common species in the area and its cytology seems to have been studied for the first time by the present authors. The gametic number n=16 is new record for this species. Previous somatic counts reported for other allied taxa show 32, 34 and 36 chromosomes which suggests the presence of aneuploidy in this genus.

17. *Blepharis sindica* T. Anders. n=13

A basic number n=13 is a new record as this species does not appear to have been studied before. This is a very common species, with toothed or subspinescent leaves, 6—10 cm long quadrifarious heads, and divaricate lanceolate, prickly-tipped bracts. It is found invariably on dry and stony hillocks of this region. MIEGE (1962) reported 2 n=24 for *B. linearaefolia* Pers. and 2 n=30 for *B. madraspatensis* Heyne. These counts do not fall in line with our findings thus suggesting the existence of aneuploidy in this genus. The basic number for this species is not yet known.

Amaranthaceae

18. *Digera arvensis* Forsk. n=9

The genus *Digera* is represented by a single species, *D. arvensis,* which is a very common annual herb, sometimes becoming perennial. It is found almost throughout West Pakistan, extending up to Arabia and N. Africa. PURI & SINGH (1935) reported 2 n=12, while MALIK (1960) recorded n=9 which is confirmed by our investigation. The specimen investigated by us appears to be a triploid as the basic number reported for this species is 6.

Chenopodiaceae

19. *Atriplex stocksii* Boiss. n=18

A very low common undershrub with whitish, woody, prostrate or suberect branches. It is found growing in sand or salt marsh along the coastal region of West Pakistan. This species has not been cytologically studied before. Previous counts for various other species of *Atriplex* show 18, 36 and 72 to be the somatic number while a gametic report of n=9 exists for *A. parviflora* by LARSEN (1960) which suggests 9 to be the basic number.

20 *Haloxylon recurvum* Bunge ex Boiss. n=11

This is a very predominently occurring shrub of salt range in Sind and Indus delta, with blackish long spreading branches ending in spikes about 6—12 cm long. Apparently no record exists in the literature on a cytological study of this genus from this region. The gametic number 11 is a new record for this species.

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Summary

This work, which is a continuation of previous report, presents the chromosome counts for 20 indigenous species of Indus delta. These include new records for 10 species (marked with*) while the remaining 10 are the confir-

mation of previous counts. The cytomorphological aberrations displayed by some of these species will be dealt with separately.

*_Capparis cartilaginia_ Decne.	n=10
Gynandropsis gynandra (L.) Briq.	n=17
*_Abutilon graveolens_ Wight et Arn.	n=18
Corchorus trilocularis L.	n= 7
Corchorus tridens L.	n= 7
*_Indigofera paucifolia_ Delile.	n= 7
*_Astraglus prolixus_ Sieb.	n= 8
Rhynchosia minima (L.) DC.	n=11
Cassia angustifolia Vahl	n=14
Cassia obovata Collad.	n=14
*_Cassia holosericea_ Fresen.	n=14
Prosopis glandulosa Torr.	n=14
Limeum indicum Stocks ex T. Anders.	n= 9
*_Ipomoea rumicifolia_ Choisy	n=15
Capsicum annuum L.	n=12
*_Ruellia patula_ Jacq.	n=16
*_Blepharis sindica_ T. Anders.	n=13
Digera arvensis Forsk.	n= 9
*_Atriplex stocksii_ Boiss.	n=18
*_Haloxylon recurvum_ Bunge ex Boiss.	n=11

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On Eudarluca caricis (Fr.) O. Eriks., comb. nov., a Cosmopolitan Uredinicolous Pyrenomycete

BY OVE ERIKSSON

Institute of Systematic Botany, Uppsala

Introduction

Darluca filum (Biv.-Bern. ex Fr.) Cast. is a well-known cosmopolitan parasite on rusts. It belongs to *Sphaeropsidales* in *Fungi imperfecti*. Its perfect state has hitherto been known as *Eudarluca australis* Speg. It has never been recorded from Europe, but in 1962 I collected this state at two separate localities in Sweden. Being a fungus that catches the eye, it seemed reasonable to conclude that it most probably had been collected several times in Europe, but that all collections were published and/or preserved under some name or names not assigned to the perfect state of *E. australis* before. This surmise could be verified. I found several earlier and later synonyms of this species, and the correct name now has to be *Eudarluca caricis* (Fr.) O. Eriks. comb. nov. (Basionym: *Sphaeria caricis* Fr. in Systema mycologicum 2 (2) : 435 (1823); list of synonyms on p. 35). Our knowledge of this species has been very incomplete and scattered. In this paper, which is no monograph on *E. caricis*, I have merely tried to bring together the most important new or already known facts on the taxonomy, nomenclature and distribution of this species.

Historical Survey

The literature on the imperfect states needs some brief introductory words. The literature on the perfect state, which turned out to be more extensive than was first expected, is treated more in detail. As mentioned above, this state has been known as *Eudarluca australis* Speg. It may be appropriate first to review the literature on this basionym and then to deal with the other basionyms in chronological order. None of the latter was earlier assigned to the perfect state of *Darluca filum*. In most cases these species were not even known to be uredinicolous. Having been so misinterpreted, almost any information in the literature on the perfect state is of interest and needs some comments. Thus, in this special case, I think there may be reasons for a fuller historical treatment.

The Imperfect States

The literature on the macroconidial state, *Darluca filum,* is large for several reasons. Its ecology is interesting, as very few fungi are known to be parasites on rusts. It is a common and widespread fungus. Moreover, as it is easy to recognize, macroscopically (fig. 4 d) as well as microscopically, it has very often been collected. Hence it is also often met with in lists of micromycetes from all over the world. There are several more comprehensive studies on this fungus too. Its physiology was studied by, e.g., KEENER (1933, p. 130) and NICOLÁS & VILLANUEVA (1965, p. 782). KEENER (1934, p. 475) also studied its biological specialization. Its possible economic importance was discussed by some authors and experiments are under way to test its utility for control of rust (PELHATE 1961, p. 32, SEBESTA 1963, p. 159). Some papers of taxonomical interest are mentioned on p. 52.

This fungus was described in 1815 by BIVONA-BERNARDI (p. 12, tab. 3: 3) under the name *Sphaeria filum.* Two of the hosts given for this species are rusts. In 1823 FRIES in Systema mycologicum (p. 547) transferred *S. filum* to the genus *Phoma.* By this the epithet "*filum*" is validly published. In 1845 CASTAGNE (p. 53) established the new genus *Darluca* for a fungus, which he had sent to other mycologists under the MS name *Darluca vagans* Cast. He considered *Sphaeria filum* Biv.-Bern. a synonym of his species. The legitimate epithet is however "*filum*" and the epithet "*vagans*" is superfluous. An original collection of "*Darluca vagans* Cast." (UPS) differs in one respect from other collections of *D. filum* I have seen. It yielded plenty of 3-septate conidia in addition to 1-septate. Normally the conidia in *D. filum* are only 1-septate. CASTAGNE correctly figured the conidia as 1—3-septate (op. cit., pl. VIII). His material is probably over-ripe.

When SPEGAZZINI in 1908 described *Eudarluca australis,* he assumed it to be the perfect state of a *Darluca.* There were several species in this genus, but most mycologists regarded it as more or less self-evident that this state is *D. filum*. The connection between *Darluca* and *Eudarluca* was not proved experimentally until 1951 by KEENER (p. 86—87). His paper is of interest also in another respect. It gives (l.c.) the first and as far as I know the only record of a microconidial state in *Eudarluca*, but the connection was not confirmed in any cultural experiment. There are some species commonly assigned to *Phyllosticta* which are uredinicolous. The fungus observed by KEENER may perhaps be identical with one (or several) of them. This possible microconidial state is also dealt with on p. 51.

The Perfect State

The synonymy of the perfect state is as follows (references to pages in this chapter are put in brackets):

Eudarluca caricis (Fr.) O. Eriks.

≡ *Sphaeria caricis* Fr., 1823. (p. 39)
≡ *Sphaeropsis caricis* (Fr.) Kickx, 1867.
≡ *Dothidea caricis* (Fr.) Cooke, 1871.
≡ *Phyllachora caricis* (Fr.) Sacc., 1883.
≡ *Phoma caricis* (Fr.) Sacc., 1884.
≡ *Macrophoma caricis* (Fr.) Berl. & Vogl., 1886.

= *Dothidea genistalis* Pers. ex Fr., 1823. (p. 43)
≡ *Sphaeria genistalis* Pers. in litt., vide Moug. & Nestl., 1815.
≡ *Darluca genistalis* (Pers. ex Fr.) Sacc., 1880.
= *Sphaeria caricis* Fr. var. *depauperata* Desm., 184?—1851.

= *Darluca filum* (Biv.-Bern. ex Fr.) Cast. var. *dothideaeformis* Fuck., 1870. (p. 45)
≡ *Darluca genistalis* (Pers. ex Fr.) Sacc. var. *dothideaeformis* (Fuck.) Sacc., 1880.

= *Darluca filum* (Biv.-Bern. ex Fr.) Cast. var. *stromatica* Fuck., 1868. (p. 45)
≡ *Darluca genistalis* (Pers. ex Fr.) Sacc. var. *stromatica* (Fuck.) Sacc., 1880.

= *Dothidella appendiculata* deLacr. ex Br. & Har., 1891. (p. 47)
≡ *Dothidea appendiculata* de Lacr. (nom. nud.), 1859.
≡ *Diplochorella appendiculata* (deLacr. ex Br. & Har.) Theiss. & Syd., 1915.

??= *Sphaerella pucciniophila* Sacc. & Syd. in Sacc., 1899. (p. 48)
≡ *Sphaerella parasitica* Fautr. in Roum., 1890 (non *Sphaerella parasitica* Wint., 1886).

= *Eudarluca australis* Speg., 1908. (p. 36)

?= *Didymella darluciphila* Speg., 1909. (p. 49)

?= *Didymella kariana* Sacc., 1914. (p. 49)

= *Leptosphaeria nigrificans* Bub. & Wróbl. in Bub., 1916 a. (p. 49)

= *Myrmaecium cannae* Dearn. & Barth. in Dearn., 1917. (p. 50)

= *Uleodothis paspali* Stev., 1924. (p. 50)

= *Eudarluca indica* Ramak., 1951. (p. 51)

Eudarluca australis Speg.

In **1908** SPEGAZZINI (p. 22) established the genus *Eudarluca* for a new pyrenomycete in the uredosori on *Canna* sp. (cult.) in the Botanical Garden in São Paulo (Brazil). The genus was described as follows:

> "Perithecia e globoso lenticularia parenchymatica glabra ostiolata; asci cylindracei paraphysati octospori; sporae cylindraceo-fusoideae hyalinae v. fumosae, 2-septatae.
>
> Genus pulchellum in *Uredinibus* (an semper?) parasiticum, statum ascophorum *Darlucarum* proferens.".

The only species, *Eudarluca australis,* was given the following description:

> "*Diag.* Characteribus generis praedita; contextu peritheciorum fusco fuligineo.
>
> *Hab.* In *Uredine cannae* Wint. ad folia viva *Cannae* cujusdam in hortis São Paulo.
>
> *Obs.* Perithecia 3—5-gregaria erumpentia nigra glabra (80—100 μ diam.) impresso-ostiolata, coriacella, contextu circa ostiolum atro opaco ambitu pellucido minute denseque parenchymatico fuligineo (noncyaneo!); asci antice obtuse rotundati crassiusculeque tunicati, postice breviter cuneati in pedicello brevissimo crassiusculoque producti, paraphysibus filiformibus longioribus obvallati (60 μ = 10 μ), octospori; sporae oblique distichae (16—20 = 4 μ) ad septa lenissime constrictulae, loculo medio saepius leniter tumidiore, primo hyalinae serius fumosae, utrinque acutiuscule rotundatae rectae v. lenissime inaequilaterales.".

His figure (op. cit., fig. E 1—6) gives a good idea about its habit and morphology. The most remarkable feature is the 2-septate ascospores. Ascospores with such a septation are on the whole very rare. Figs. 1 c and 4 b.

In **1926** SYDOW (p. 360) recorded two collections of *E. australis* from Costa Rica and described them carefully (fig. 3 c). He also studied an isotype of *E. australis,* which he, however, found to be over-ripe. Although his own collections only yielded 1-septate ascospores he considered them conspecific with this species. According to SYDOW, SPE-

GAZZINI had made an observational mistake and consequently he felt it necessary to redescribe the genus *Eudarluca*. His description runs:

> „Stromata in den Uredolagern von Rostpilzen parasitierend, durch ein meist sehr hell gefärbtes ± parenchymatisches, stark hervorbrechendes Basalstroma dem Mesophyll eingewachsen. Lokuli einzeln, meist zentral, seltener in geringer Zahl in Gesellschaft der zugehörigen *Darluca*-Konidien-lokuli dem Stroma mehr oder weniger tief eingewachsen, völlig geschlossen, ohne Ostiolum, durch einen rundlich eckigen Porus sich öffnend, mit zeimlich dicker, schwarzbrauner dothideal-parenchymatischer Wand. Aszi zylindrisch keulig oder fast zylindrisch, derbwandig, 8-sporig, fast sitzend. Sporen länglich spindelförmig, 2-zellig, in völlig reifem Zustande vielleicht 4-zellig, meist gerade, hyalin, mittelgross. Paraphysoiden sehr spärlich, undeutlich faserig zellig.".

This emendation of the genus has essentially been accepted by later authors. It is further discussed on p. 54.

In **1927** PETRAK (p. 301—302) after having examined type material of *Myrmaecium cannae* Dearn. & Barth. from Costa Rica stated that this species was a synonym of *E. australis*.

In **1929** PETRAK (p. 333) claimed that *Uleodothis paspali* Stevens from British Guiana was conspecific with *E. australis*.

In **1929** SYDOW (p. 426) reported a find of *E. australis* from China. This collection yielded 3-septate, pale honey-yellow ascospores and should, according to SYDOW, represent the fully mature state of *E. australis*.

In **1930** SYDOW (p. 71) recorded two collections of *E. australis* from Venezuela. One of them was issued in his "Fungi exotici exsiccati" as no. 807.

In **1932** PETRAK & CIFERRI (p. 190) recorded two collections of *E. australis* from the Dominic Republic.

In **1934** KEENER studied the biological specialization in *D. filum*. He isolated conidia from 11 collections of this fungus. KEENER (p. 477) also found an ascomycete on *Puccinia obscura* (on *Juncoides campestre*) and on *Puccinia Peckii* (on *Carex normalis*), in Pennsylvania, which he believed might be the perfect state of *D. filum*. Ascospores from these collections were isolated and used in his experiments.

In **1939** SYDOW (p. 378) recorded *E. australis* from Equador.

In **1941** DOIDGE (p. 208) recorded three collections of *E. australis* from South Africa. From her detailed description the following may be extracted: "Stromata developing in the uredo-sori of rust fungi; basal stroma growing into the mesophyll of the leaf, erumpent, more or less parenchymatous, consisting of light-coloured, thin-walled cells, which, immediately under the loculi, are often in vertical rows . . . Spores . . . usually with three cross walls of which only the central one is readily distinguishable". DOIDGE was sure that her South African fungus was conspecific with *E. australis.* I have not seen her collections, but probably she is right. These collections seem to agree at least with the stromatic fungus, that was described by, e.g., SYDOW and STEVENS (see above), and that in its turn probably represents *E. australis* (=*E. caricis*) in its normal state of development. DOIDGE also found the imperfect state in an empty or over-ripe condition on the edges of the stromata.

In **1946** HANSFORD (p. 58) claimed that *E. australis* was common in tropical Africa in its perfect as well as its imperfect state. Many later records indicate that he is right. He is wrong, however, when he states *E. australis* to be "aparaphysate". Those of HANSFORD's collections which I have seen do not differ in this respect from other collections of the species. Typical pseudoparaphyses are always present. HANSFORD's opinion that *E. australis* is Sphaeriaceous is not correct.

In **1949**, when describing the new uredinicolous fungus *Creonecte biparasitica,* PETRAK (p. 258), in passing, stated that this imperfect fungus was mixed with *D. filum* and young pseudothecia of *E. australis.* According to PETRAK, *C. biparasitica* has a stroma of a different type from that in *Darluca-Eudarluca,* and consequently he did not consider this species congeneric with his own species.

In **1949** WALLACE & WALLACE (p. 13 and 18) recorded *E. australis* from Tanganyika on two graminicolous rust species.

In **1951** KEENER (p. 86—87) reported that "culture and histological studies at various intervals over several years disclose that a fungus found colonizing uredinial and telial sori of *Puccinia extensicola oenotherae* (Mont.) Arth., on *Carex* sp. (=*C. straminea*?) at State College, and of *Puccinia obscura* Schroet., on *Luzula* sp. at Shingletown Gap, Pennsylvania, represents an ascus stage (*Eudarluca*) of the rust parasite, *Darluca filum* (Biv.) Castagne". These are probably the very collections that he used in his experiments on the biological specialization in this species already in 1934. He also recorded an immature collection of *E. australis,* observed in 1933 on *Frommea obtusa* (Str.) Arth. (on *Potentilla canadensis* L.) in Pennsylvania. KEENER's paper is of interest in two other respects as mentioned on p. 35.

In **1952** HUGHES (p. 35) recorded *E. australis* from "the Gold Coast". Two of his collections in Herb IMI are from this part of Africa, one from Togo and the other from Ghana.

In **1953** PETRAK (p. 105) recorded two collections of *E. australis* from Florida, U.S.A.

In **1953** in a paper on the rusts of "Nyasaland" (=Malawi), BISBY & WIEHE (p. 2) stated that "*Darluca* is often so abundant, sometimes also in the perfect state *Eudarluca,* that one may have to search to find a few good rust spores".

In **1954** PETRAK (p. 18) reported *E. australis* from North Borneo.

In **1960—1965** *E. australis* was recorded by many mycologists e.g., by JOHNSTON (1960 a, p. 24) from Malaya and (1961, p. 30) from Netherlands New Guinea, by NATTRASS (1961, p. 34) from Kenya, by LEATHER (1962, p. 30) from Jamaica, by PIENING (1962, p. 32) from Ghana, by KRANZ (1963, p. 179) from Guinea, by TARR (1963, p. 17) from Sudan, by KATUMOTO (1964, p. 361) from Japan and by KRANZ (1964, p. 126) from Libya. KATUMOTO obtained the perfect state in a rust infected with *D. filum* after several weeks deposition of the material in the laboratory. The fungus was stromatic and yielded 1-septate spores (op. cit., fig. 2).

Sphaeria caricis Fr.

In **1823** FRIES, in Systema mycologicum (p. 435), described the new species *Sphaeria caricis* as follows:

> "262. *S. Caricis*, tecta, inaequabilis, confluens, nigra, ex peritheciis prominentibus astomis tuberculosa.
>
> Praecedenti affinis, sed folii parenchyma in stroma non mutatum, perithecia eidem immersa, omnino genuina, globosa, majora sunt, prominentia, inter se distincta, sed epidermide nigrefacta tecta, unde habitus compositus. Raro reperiuntur individua solitaria. *In foliis Caricis Öderi & c. vere* (v.v., etiam a Cel. Kunz. miss.)".

There is one collection in Herb. FRIES (UPS) with the following text: "*Sphaeria Caricis* S.M. — *Car. Öderi.* Fries . .". This is obviously an original collection. The label is written by FRIES himself. His name and the first point after the name is written by him with darker ink on a later occasion. It replaces an earlier text, which has been impossible to decipher.

This collection consists of three fragments of a *Carex* sp. The leaves are heavily infested with fungi. About 50 % of the adaxial surfaces of the leaves are black from a pyrenomycete (fig. 2 a). Some stromata can also be seen on the abaxial surfaces of the leaves, which are ruptured by numerous uredosori of *Puccinia caricina* DC. In some sori the typical pycnidia of *Darluca filum* are to be found. The stromata are compact and ± pseudoparenchymatous. The outer layers are dark brown, while the inner parts consist of pale, thin-walled cells (fig. 2 b). Collapsed uredospores and fragments of the leaf-tissues are enclosed in the stromata (fig. 2 c). There are usually several loculi immersed in each stroma. Only the conical apices of the loculi protrude. Most loculi are immature. The mature ones contain asci and ascospores of exactly the same type as in the type collection of *Eudarluca australis* (fig. 1 a and 1 c). Besides 2-septate spores, a few 1- or 3-septate spores have been observed.

In **1830** DUBY (p. 695) recorded *S. caricis* "In foliis *Caricis depauperatae* in sylvis prope Beauvais".

In **1849** FRIES (p. 387) listed *S. caricis* and three other species immediately after the genus *Dothidea* under the heading: "Incerte generis, priori affinis". Several authors have incorrectly interpreted this as a transfer of these species to *Dothidea*.

There is in fact one collection on *Carex* sp. in Herb. FRIES (UPS) labelled "*Dothidea caricis*, — Getinge, Halland". This collection contains however a different fungus from that on *Carex oederi*. Macroscopically it looks ilke a *Phyllachora* sp. Most loculi are empty, but in some of them conidia of the *Stagonospora* type are to be found. The leaves are not infested by rust.

In **1849** KICKX (p. 24) recorded *S. caricis* from Gand (=Gent. Belgium). See also 1867!

In **1851** BERKELEY & BROOME (p. 187) recorded *S. caricis* from Scotland, "on leaves of *Caricis*, West Water, Forfarshire".

In **1854** WESTENDORP (p. 28) listed *S. caricis* in his "Les cryptogames classés d'après leurs stations naturelles" on *Carex oederi* only.

In **1857** RABENHORST published an exsiccatum of "*Phoma filum* Ces. Forma *Caricis*" in "Herbarium mycologicum" (ed. II, ser. 1, no. 448). This fungus is stromatic *Eudarluca* (in S). No loculi could be found in the stromata. *Sphaeria caricis* Fr. is not given as a synonym and is probably not the basionym to the name proposed by RABENHORST (see also 1863).

In **1863** RABENHORST distributed *S. caricis* in his "Fungi europei exsiccati" as no. 535. The matrix is given on the label as *Carex muricata*. This is not correct. It is a grass, probably a member of *Triticeae*. The fungus is a *Phyllachora*, most likely *Ph. graminis* (Pers. ex Fr.) Nits.

In **1863** GROGNOT (p. 103) in his "Plantes Cryptogames-cellulaires du departement de Saone-et-Loire" stated that *S. caricis* is uncommon on leaves of *Carex* in summer and autumn.

In **1866** in MORIÈRE's annotated list of the fungi collected by ROBERGE in the department of Calvados in northern France we find (p. 137): "*Sphaeria caricis*, var. B. *depauperata* (Desmaz.)! Sur les feuilles sèches d'un *Carex*, Été". The exclamation-mark means that a collection from Calvados had been distributed by DESMAZIÈRES in his "Plantes cryptogames du Nord de la France". According to OUDEMANS (1919, p. 1048) *Sphaeria caricis* var. *depauperata* is distributed in Ed. I as no. 2057 and in Ed. II as no. 1757. I have not had access to these numbers and do not know whether or not they are conspecific with *S. caricis*. I have however seen a sample (UPS) with this name, collected by ROBERGE at Caen in Calvados. The matrix is *Carex* sp., but it is difficult to say whether it is *Carex vulpina* as stated in DESMAZIÈRES exsiccata. Nevertheless it is very probable that the fungus distributed by DESMAZIÈRES was collected by ROBERGE and that part of his collection was sent to FRIES, perhaps for confirmation. The sample in UPS turned out to be mature *Eudarluca*. The spores are of the same type as in the original collection of *S. caricis*.

In **1867** KICKX (p. 403) transferred *S. caricis* to the genus *Sphaeropsis* Lév. among the "Athèques, Sphaeropsidées Lév.". He said, however: "Quelques spores nous ont paru avoir deux ou trois cloisons transversales, mais trop peu distinctement pour pouvoir l'affirmer. Si l'existence de ces cloisons était bien constatée, la plante devrait faire partie du genre *Hendersonia* et y être placée à côté de l'*H. graminicola* Lév.". The septa of 2-septate ascospores in *Eudarluca caricis* are often rather indistinct and according to the description of the habit of his fungus, KICKX may very well have studied the rust parasite, although he overlooked the asci.

In **1871** COOKE (p. 806) quoted BERKELEY & BROOME's record of *S. caricis* under the name "*Dothidea caricis* Fr.". In fact he seems himself to be the first one to publish it as a species of *Dothidea*.

In **1874** OUDEMANS (p. 316) recorded a collection of "*Dothidea Caricis* Fr." from Nijkerk (the Netherlands).

In **1883** BUCKNALL (p. 59) reported "*Dothidea caricis* Fr." from Blaise Castle Wood, Bristol district (England). Asci were "broadly oblong .0024 in." [=c. 60 μ] and the ascospores "oblong, apparently becoming 3 or 4 septate, .001 in. long" [=c. 25 μ]. BUCKNALL considered this collection immature, but he obviously discerned a faint septation in the ascospores. Thus he cannot have studied a *Phyllachora* species, possibly *Eudarluca caricis* with 2- (and/or 3-) septate ascospores. The habit of BUCKNALL's fungus is that of *Darluca filum* (op. cit., fig. 8).

In **1883** SACCARDO (p. 625) transferred *S. caricis* to *Phyllachora*. He annotated: "Ph. Graminis affinis". He had certainly not seen any material, as the description given by him is only a verbatim repitition of FRIES' diagnosis.

In **1884** SACCARDO (p. 164) made the new combination *Phoma caricis* (Fr.) Sacc. and considered *Sphaeropsis caricis* (Fr.) Kickx as synonymous. He did accordingly not discover that this species and *Phyllachora caricis* are both based on *Sphaeria caricis* Fr.

In **1885** COOKE (p. 63) described the asci and the ascospores of "*Dothidea caricis* Fr." as follows: "Asci clavatis. Sporidiis ellipticis, continuis, hyalinis". This description points to COOKE's having studied a *Phyllachora* species instead of a *Eudarluca*.

In **1886** BERLESE & VOGLINO (in SACCARDO, Sylloge Fungorum, Additamenta ad vol. I—IV, p. 314) assigned *Phoma caricis* to the genus *Macrophoma*. By writing "*Macrophoma Caricis* Berl. & Vogl. in Atti Soc. Veneto-Trentina, p. 195. — *Phoma Caricis* Sacc. Syll. III, p. 164." they indicated that this tranfer already had been done. This cannot be correct. The "Atti" of 1886 were not published until 1887, but evidently they had seen a printer's proof of their treatise on *Macrophoma* already in 1886. All references in "Additamenta" to this treatise are five pages too low. This is obviously due to a later insertation of a paper by BERLESE, which is of five pages.

In **1886** MASSEE (p. 36) quoted the known locality Forfarshire and also reported "*Phyllachora caricis* (Fr.) Sacc." from a new British locality, viz. Swanscombe Marshes.

In **1887** WINTER (in RABENHORST, p. 899) reduced *S. caricis* to a variety of *Phyllachora graminis*, which species he commented on as follows: "Eine sehr gemeine Art, die aber sowohl im Habitus, als in der Grösse der Asci und Sporen auf den verschiedenen Nährpflanzen kleine Unterschiede zeigt . . . Nur die Form auf *Carex* zeigt etwas bedeutendere Unterschiede". The ascospores were described as "elliptisch, bei voller Reife bräunlich, 14—16 μ lang, 7 μ dick". This description matches the spores of the fungus distributed in RABENHORST, F.eur., no. 535 (cf. above, 1863). This is the only collection cited by WINTER. In addition he gives the information "Auf lebenden *Carex*-Blättern".

In **1891** SACCARDO (p. 1026) quoted COOKE's complementary description of the ascospores of *Phyllachora caricis*.

In **1892** SACCARDO (p. 205) accepted the transfer of *Phoma caricis* (Fr.) Sacc. to *Macrophoma* (cf. 1884).

In **1892** ELLIS & EVERHART (p. 599) reported *Phyllachora caricis* from Albany (New York, U.S.A.) and like SACCARDO and WINTER, stated that it is allied to *Ph. graminis*.

In **1897** REHM (p. 373) described and figured (fig. XII: 10) a new variety of *Phyllachora caricis* from South America, viz. var. *brasiliensis* Rehm. The figure shows that REHM's fungus may be a *Phyllachora* but cannot be a *Eudarluca*.

In **1899** ALLESCHER (in RABENHORST, p. 360) accepted *Macrophoma caricis* as a good species. In all he dealt with eighty species of this genus.

In **1904** ROSTRUP (p. 13) reported *Ph. caricis* from Norway, on *Carex oederi*. This collection (0) proved to represent the stromatic from of *E. caricis*. Pycnidia, but no perfect state, were present. The vascular plant is the same as in FRIES' original collection of *S. caricis*.

In **1928** LIND (p. 63) recorded *Phyllachora caricis* on *Carex* sp. from Åreskutan (Jämtland, central Sweden). This collection is supposed to be in C or UPS, but I have searched for it in vain.

In **1934** LIND (p. 79) recorded *Phyllachora caricis* on "*Carex norvegica*" (=*Carex mackenziei* Krecz., non *Carex norvegica* Retz.) from Hudson Bay, Cape Eskimo, 61°05′ (Canada) and on *Carex rostrata* from Abisko (northern Sweden). I have seen the Swedish collection (C). Only immature stromata could be found. They do not belong to *Eudarluca*, as they are black throughout, nor was any rust present on the leaves.

Dothidea genistalis Pers. ex Fr.

In **1815** MOUGEOT & NESTLER issued fascicle V of their "Stirpes Cryptogamae Vogeso-Rhenanae" with "488. *Sphaeria genistalis* Pers. in Litt., — Ad folia exsiccata *Genistae sagittalis*".

In **1823** FRIES, in his Systema mycologicum (p. 552), transferred this species to the genus *Dothidea*, and gave it the following description:

> "10. *D. genistalis*, erumpens, tuberculosa, difformis, atra, intus alba, cellulis periphericis albis.
> Sphaeria. Pers.! (Moug.! & Nestl. exs. n. 448.).
>
> Primo tecta, dein epidermide lacerata erumpens, sordide nigra, tubercula sistens minuta, subconfluentia, Sphaeriae cuidam immaturae similia. Stroma compactum albidum. Cellulae minutae, subfarctae. *In foliis vivis & exsiccatis Genistae sagittalis*. (v.s.).".

FRIES, like many authors after him, incorrectly quoted the number in MOUGEOT & NESTLER as 448 instead of 488. This original collection of *Dothidea genistalis* turns out to be a *Eudarluca.* Unfortunately it is immature, but the stromata (fig. 3 d and 5 c) match those in the original collection of *Sphaeria caricis* perfectly (fig. 2 b). The pseudothecial loculi were obviously observed already by FRIES.

There is one collection in UPS labelled by FRIES: "*Dothidea genistalis.* Fr. — In *Spartio Scopario,* — Scaniae". This is certainly collected at a later date as it was not taken into consideration in Systema mycologicum. Otherwise he would have noted "v.v." (=vidi vivam) in stead of "v.s." (=vidi siccam) and added *Spartium scoparium* (=*Sarothamnus scoparius*) as a host. The fungus in this collection is not congeneric with *D. genistalis.* The stromata yielded muriform conidia. This is probably a member of the genus *Dichomera* Cooke.

Several mycologists paid attention to *Dothidea genistalis* during the immediately following years. As a rule, they gave no exact informations about localities and it is merely possible to state from which country the fungus was reported. *Dothidea genistalis* is listed:

in **1826** by CHEVALIER (p. 456) in his "Flore genéral des environs de Paris" (France),

in **1830** by DUBY (p. 713) in his "Botanicon Gallicum" (France),

in **1833** by SECRETAN (p. 693) in his "Mycographie Suisse" (Switzerland),

in **1833** by WALLROTH (p. 864) in his "Flora Cryptogamica Germaniae" (Germany).

In **1844** RABENHORST (p. 164) in his "Deutschlands Kryptogamen-Flora" wrote about *Dothidea genistalis*: "An lebenden und abgestorbenen Blättern und Stengeln der *Genistae sagittalis,* hier und da, nicht selten (bei Kreuznach 1841 im herbst, Rabenh.)".

In **1849** FRIES (p. 386) reported the above mentioned misdetermined collection of *Dothidea genistalis* on *Sarothamnus* from Scania (=Skåne, southern Sweden).

In **1855** KICKX (p. 17; also 1867, p. 298) recorded *Dothidea genistalis* from the Botanical Garden in Gand (=Gent, Belgium).

In **1863** GROGNOT (p. 123) in his "Plantes Cryptogames-cellulaires du departement de Saone-et-Loire" gave *Dothidea genistalis* as rather common.

In **1865** FUCKEL (p. 330) stated "dass die *Dothidea genistalis* Fr. gar keine *Dothidea* ist, sondern das *Phoma Filum* Fr. (*Darluca Filum* Berkl.), auf *Uromyces* smarotzend." and l.c.):

> „Die eigenthümliche der Entwicklung des *Phoma Fil.* auf *Cytisus sag.* besteht darin, dass sich die Perithecien desselben auf dem Mutterboden des *Uromyces* bilden, noch ehe die Sporen des letzteren die Oberhaut durchbrochen. Die Folge davon ist, dass sich nur wenige Sporen des *Uromyces* bilden und der Mutterboden desselben gleichsam monströs anschwillt. Sobald die Oberhaut zerreist, kommen die Perithecien des *Phoma* Vorschein, der früher grünliche Mutterboden des *Uromyces* wird schwarz und schwillt immer mehr an, so, dass die anfangs freien Perithecien halb eingesenkt erscheinen. In diesem Stadium hat der Pilz, oberflächlich betrachtet, einige Aehnlichkeit mit einer *Dothidea.* Ich habe nur die characteristischen Sporen von *Phoma Filum* finden können, niemals Schläuche. An den Exemplaren in Moug. und Nestlr. fand ich die Sporen des *Phoma* nicht, weil an den dürren Stengeln die Perithecien desselben schon entleert waren, wohl aber fand ich in allen untersuchten Häufchen derselben *die leeren Perithecien des Phoma Filum und die Sporen des Uromyces.* Es sind daher diese Specimina als veraltetes *Phoma Filum* Fr. zu betrachten. Hiernach ist die bisherige *Dothidea genistalis* Fr. als nicht existirend zu streichen.".

FUCKEL is the first author to point out that *Dothidea genistalis* is uredinicolous (on "*Uromyces*" = *Uromyces laburni* (DC.) Fuck., the only rust species on *Genista sagittalis* L. according to GÄUMANN 1959, p. 569), and that it is conspecific with *Darluca filum.*

In **1867** CROUAN & CROUAN (p. 35) listed "*Dothidea genistalis* Fr." in their "Florule Du Finistère". They had probably not seen FUCKEL's paper. They are the first and only authors who have described the ascospores in this species: "Epores à sporidioles uniseriées. Oblongues". It is possible that they had collected the form of *Eudarluca caricis* with 2-septate ascospores. I have not been able to examine their material, as loans from their herbarium are not admitted (by their will).

In **1870** FUCKEL (p. 378—379) recognized four varieties of *Darluca filum,* viz. var. *vulgaris* (575, 1030), var. *dothideaeformis* (1014), var. *stromatica* (2132) and var. *hypocreoides* (2131). The figures in brackets give the numbers in FUCKEL's "Fungi rhenani", where these varieties had been distributed. Var. *dothideaeformis* (syn. *Dothidea genistalis* Fr. according to FUCKEL) should not be uncommon on *Cytisus sagittalis* (= *Genista sagittalis*) in spring. The reason why FUCKEL never found mature perithecia is that this fungus was collected too early in the year.

Var. *stromatica* "wuchert ebenfalls im Anfang in Uredoräschen, später aber bildet sich ein weit verbreitetes, oft die ganzen Halme, unter der Oberhaut schwarzfärbendes Stroma. In wie weit dieses mit *Dothidea graminis* im Zusammenhang steht, lasse ich dahin gestellt sein, sowie auch den genetischen zusammanhang von *Darluca* und *Dothidea* überhaubt, bin aber sehr geneigt, erstere für die Pycnidien der letzteren zu halten". The original collection of this variety (Fungi rhenani, no. 2132) from near Hallgarten in Austria is on *Agrostis stolonifera*. Examination of an isotype (UPS) revealed that the stromata contain immature loculi of a pyrenomycete and collapsed uredospores. This is certainly immature *E. caricis*. It has nothing to do with *Phyllachora graminis* (="*Dothidea graminis*") as pointed out already by HÖHNEL (1927, p. 55).

In **1879** ROUMEGUÈRE distributed *Dothidea genistalis* from "Reliquae Mougetianae" in his "Fungi gallici exsiccati" (no. 94).

In **1880** the same species appeared in ROUMEGUÈRE's exsiccatum (no. 888) as "*Phacidium Cytisi* Rab.réuni au *Dothidea genistalis*". ROUMEGUÈRE probably got the name from JACK, LEINER & STIZENBERGER's exsiccatum "Kryptogamen Badens", no. 642, "*Phacidium Cytisi* Rab., Monogr. Peziz. ined.". RABENHORST never published the diagnosis. This fungus (UPS) is not conspecific with *Dothidea genistalis*, but possibly is with "*Phacidium Cytisi* Fuckel" (1871, p. 328). ROUMEGUÈRE's collection is, however, *Dothidea genistalis* and no "*Phacidium*" could be found mixed with it.

In **1880** SACCARDO (p. 108), contrary to FUCKEL, considered *Darluca filum* and *Dothidea genistalis* separate species and made the new combination *Darluca genistalis* (Fr.) Sacc. It should differ from *Darluca filum* by "peritheciis dense aggregatis, robustioribus etc.". FUCKEL's variety *dothideaeformis* of *Darluca filum* became merely a synonym of *Darluca genistalis*, and (in **1884**, p. 410) the other varieties distinguished by FUCKEL, except the main variety *vulgaris*, were also transferred to the latter species.

In **1899** ALLESCHER (in RABENHORST, p. 702—704) adopted SACCARDO's classification of *Darluca*.

In **1913** GROVE (p. 45) reported and described a collection of *Darluca genistalis* from Dublin (Ireland) on *Uromyces anthyllidis*. A more detailed description was given by GROVE in 1935 (p. 340). According to him *D. genistalis* is distinguished from *D. filum* almost solely by its densely clustered habit. GROVE's collection seems to correspond to FUCKEL's var. *hypocreoides* of *D. filum*.

There are rather few later publications on *Darluca genistalis*, but it is distributed in KABÁT & BUBÁK's "Fungi imperfecti exsiccati" as no. 462 from Böhmen (Bohemia) (the prominent stromata in this collection (S) do not contain any perithecial loculi) and reported from Thessaloniki (Greece) by KONSTANTINIA-SULIDU (**1939**, p. 291) and from India by CHONA & MUNJAL (**1950**).

Dothidella appendiculata deLacr. ex Br. & Har.

In **1859** DELACROIX (p. 404) published the nomen nudum *Dothidea appendiculata.* This name refers to a collection on *Chondrilla juncea* from St.-Romain-sur-Vienne. Part of this was distributed by SCHULTZ in his "Herbarium normale" (Fasc. 8, no. 799).

In **1891** BRIARD & HARIOT (p. 170) gave this species a diagnosis in the genus *Dothidella.* It runs as follows:

> "D. stromate rotundato, atro, epidermide tecto, saepius confluenti, plano vel prominulo, 1 mm. diam.; ostiolis granuliformibus, superficie rugulosa; ascis cylindraceo-clavatis, breviter stipitatis, 50—70 = 8—10 μ pro parte sporarum; paraphysibus filiformibus; sporis 8-nis, distichis, ovato-oblongis, utrinque attenuatis, 1-septatis, ad septum constrictulis, loculis 2-guttulatis vel non, dilute-olivaceis, subhyalinis, 12—14 = 4—5 μ, utrinque appendiculo brevi, hyalino praeditis.
>
> Ad caules Chondrillae junceae, Saint-Romain-sur-Vienne (Vienne) cl.ab. de Lacroix.".

In **1891** ROUMEGUÈRE issued an exsiccatum of *Dothidella appendiculata* (Fungi sel. exs., no. 5760). This collection is a part of "Reliquae Lacroixianae" and was communicated to ROUMEGUÈRE by HARIOT. Hence it can be regarded as type material.

In **1915** THEISSEN & SYDOW (p. 625) transferred *Dothidella appendiculata* to the genus *Diplochorella.* They considered it a doubtful species, as they could not find any perithecial loculi.

In **1941** PETRAK (p. 320) studied material of "*Dothidea appendiculata* deLacroix" from SCHULTZ's exsiccatum. He stated that this species had been misinterpreted by earlier mycologists:

> "Auf den dürren *Chondrilla*-Stengeln finden sich ganz verdorbene Teleutolager von *Puccinia chondrillina* Bub. et Syd. Auf und in diesen Lagern, von denen meist nur noch Spuren vorhanden sind, parasitiert eine durch kräftiger entwickeltes Stroma ausgezeichnete Form von *Darluca filum* (Biv.) Cast. mit länglich spindelförmigen, ca. 12—16 = 3—4 μ grossen, beidendig mit kurzen, schleimigen Anhängseln versehenen, mehr oder weniger stark verschrumpften und miteinander verklebten Konidien. Weil die Konidien in mehr oder weniger radiären Reihen nebeneinander liegen, kleben sie oft zu mehreren neben- und hintereinander zusammen. Derartige schmale, oft ziemlich langgestreckte Konidienklumpen können bei oberflächlicher Betrachtung in Quetschpräparaten leicht für Schläuche gehalten werden. So sind die irrigen Angaben von Hariot und Briard zu erklären. *D. appendiculata* mit allen darauf begründeten Synonymen ist daher nur eine schlecht entwickelte Form von *Darluca filum* (Biv.) Cast. und als ein Synonym davon zu betrachten.".

It is remarkable that PETRAK did not fancy the possibility that BRIARD & HARIOT had seen and described the perfect state of *Darluca filum*. This state is generally stromatic and the thorough description of the asci given by BRIARD & HARIOT points to their having seen real asci and not merely "miteinander verklebten Konidien". This does not preclude the possibility of their having described conidia instead of ascospores. I have studied material of this species from both exsiccata mentioned above. Asci and ascospores were met with in both cases. In ROUMEGUÈRE's material (UPS) the ascospores were in a very bad condition, but two septa could be discerned in some ascospores. In SCHULTZ's material (S) this septation was easy to see, although the spores did not readily leave the asci. Appendages could of course only be found in conidia, and BRIARD & HARIOT certainly mistook these for ascospores.

(Sphaerella pucciniophila Sacc. & Syd. in Sacc.)

In **1890** in ROUMEGUÈRE's "Fungi selecti exsiccati" (no. 5237; schedae also in Rev. Mycol. 1890, p. 61—69) FAUTREY described a new pyrenomycete under the name *Sphaerella parasitica* as follows:

> "Les groupes de *Puccinia,* nés sous la feuille forment, à la page supérieure une tache blanchâtre; sur cette tache, sont enfoncés, en grand nombre, les périthèces de *Phylloslosticla* [should be *Phyllosticta*] *destructiva,* puis, plus rares et plus gros, ceux de la nouvelle espèce de Sphaerella. Thèques cylindracées, 45, 60×15 de 4, 6 ou 8 spores distiques, inequilatérales, uniseptées, hyalines à plusieurs gouttes, 20, 25×5, 7. Pas de paraphyses.
>
> Sur *Puccinia Malvacearum* des feuilles sub-vivantes d'*Alcea rosea.* Noidan (Côte-d'Or).".

In **1899** SACCARDO & SYDOW (in Sacc., p. 533) replaced the epithet "parasitica" by "pucciniophila", as *Sphaerella parasitica* Fautr. was anticipated by an earlier homonym, *Sphaerella parasitica* Winter (1886, p. 19).

I have studied a part of the original collection in ROUMEGUÈRE's exsiccatum. Only the *Phyllosticta,* mentioned in the diagnosis, could be found in the leaf-spots. It is difficult to know whether or not the pyrenomycete has something to do with *Eudarluca.* Perhaps it is *Mycosphaerella* sp., as the asci are comparatively broad and there should be no paraphyses.

(Didymella darluciphila Speg.)

In **1909** SPEGAZZINI (p. 357) described *Didymella darluciphila,* an uredinicolous pyrenomycete from Argentina. The ascocarps were "amphigena hinc inde aggregata, 0.5—2 mm. long., 250—500 µ. lat." and the ascospores "fusoideo clavulatis, subcurvulis, 12—18=3 medio 1-septatis, hyalinis, biguttulatis v. non.". It was mixed with "*Darluca australis*" on leaves of *Andropogon condensata* infested with *Puccinia andropogonicola.*

In **1946** HANSFORD (p. 58) guessed that *D. darluciphila* could be a synonym of *E. australis.* He did never study any type material. Nor have I, but SPEGAZZINI's description and figure (op. cit., fig. 13) suggest *E. caricis.*

(Didymella kariana Sacc.)

In **1914** SACCARDO (p. 301) described this fungus from India. The following is quoted from the diagnosis:

> "Peritheciis epiphyllis, laxe gregariis, ... sporidiis distichis, fusoideis, utrinque obtusiuscule attenuatis, curvulis, 16—18×4.5, medio septatis, leviter constrictis, typice 4-guttatis, hyalinis.
>
> *Hab.* in foliis morientibus *Polygoni* sp. latifoliae, socia Uredine *Pucciniae Polygoni* (?) et *Darluca filo,* ...".

In **1946** HANSFORD (p. 58) proposed the possibility that *D. kariana* could be a synonym of *Eudarluca australis,* but he had not access to any type material and could not verify this surmise. It is possible that HANSFORD is right. I have seen one collection of *Eudarluca* (IMI, no. 62099 e) with unilocular ascocarps and 1-septate ascospores. However, most ascocarps were plurilocular and the unilocular ones were not "laxe gregaria".

Leptosphaeria nigrificans Bub. & Wróbl. in Bub.

In **1916** BUBÁK & WRÓBLEWSKI (in BUBÁK 1916 a, p. 329) described a new pyrenomycete, *Leptosphaeria nigrificans,* as follows:

> "Peritheciis singulis vel gregariis, immersis, epidermide tectis, globosis, vel parum applanatis, 150—200 µ in diam. apice subconico erumpentibus, atris, in pseudostromate sub epidermide atrobrunneo, intus flavobrunneo immersis.
>
> Ascis cylindricis vel cylindraceo-clavatis, 55—65 µ longis, 9—10 µ latis, rectis vel curvatis, supra rotundatis et incrassatis, basi attenuatis, breve pedicellatis, octosporis, paraphysibus filiformibus, crebris obvallatis.

> Sporidiis distichis, rarius tristichis, fusoideis, 13—19 μ longis, 3.5—4 μ latis, rectis vel curvatis, utrinque attenuatis, dilutissime olivaceis, biseptatis.
>
> Galicia: Werbiaž Nižny in foliis et culmis *Caricis* sp. (*C. leporinae*?), IX. 1912. leg. A. Wróblewski.".

The authors pointed out that this species is almost stromatic on account of "Schwärzung der oberen Mesophyllschichten und das Zusammenfliessen der Fleckchen". Mixed with this species they found uredosori of *Puccinia silvatica* Schröt. and *Darluca filum* (Biv.-Bern. ex Fr.) Cast. Already from this diagnosis and the appended notes it is reasonable to guess that *L. nigrificans* is identical with *E. caricis*. An isotype in S turned out to be a good material of this rust parasite (fig. 1 b and 4 d).

Except SACCARDO (1928, p. 982), where the diagnosis of *L. nigrificans* also is quoted, there is no later literature on this species. It is worth mentioning that SACCARDO (op. cit., p. 1415) indexed *L. nigrificans* as "*nigricans*" by mistake. This epithet refers to another species of *Leptosphaeria* (op. cit., p. 981).

Myrmaecium cannae Dearn. & Barth. in Dearn.

In **1917** DEARNESS & BARTHOLOMEW (in DEARNESS, p. 347) described a new pyrenomycete, "(?) *Myrmaecium cannae*", from Puerto Rico. From the diagnosis the following may be extracted:

> "Stromata minute, ... Perithecia black, one to several in a stroma, ... Sporidia hyaline, 1-septate, upper cell larger, 10—15×4—8 μ. Some of the perithecia filled with conidia and sporophores; conidia linear-oblong, obscurely 1-septate, 15×2.5—3 μ.
>
> On withered leaves of *Canna indica* L., ... Type collection, Fungi Columb. 5038.".

There is no diagnosis of this fungus in BARTHOLOMEW's exsiccatum "Fungi Columbiani".

In **1927** PETRAK (p. 301—302) stated that *M. cannae* is a synonym of *Eudarluca australis* Speg. PETRAK's opinions on *M. cannae* and *E. australis* are dealt with on p. 54.

Uleodothis paspali Stev.

In **1924** STEVENS (p. 181, fig. III: 20—23) described a new stromatic pyrenomycete, *Uleodothis paspali*. From his diagnosis of this fungus the following may be quoted:

"Stromata occupying the whole region between the upper and lower epidermis, . . . Perithecia 1 to 30 in a group on o single stroma, . . . Spores 14 to 18× 3.5 µ, fusiform, 1-septate, hyaline, guttulate.

On *Paspalum conjugatum*.

British Guiana: Coverden, August 8, 1922, 759.".

In **1929** PETRAK (p. 333) regarded *U. paspali* as a synonym of *E. australis*. I have not seen any type material of STEVENS' fungus, but everything in the diagnoses and the figure subjoined to it speaks in favour of PETRAK's opinion.

Eudarluca indica Ramakr.

In **1951** RAMAKRISHNAN (p. 158) described a new uredinicolous pyrenomycete, *Eudarluca indica,* from India. He stated that it comes close to *E. australis*. In fact, there are certainly no reasons for keeping them separate (see p. 58). *E. indica* (UPS, isotype) is typical *E. caricis* (=*E. australis*), with stromatic ascocarps and 1-septate ascospores.

Taxonomy

DANSER (1950, p. 118) has written: "Many false conceptions have arisen in systematics because living beings were treated as objects which the scientist proposed to classify. Once for all attention must be drawn to the fact that the systematist never classifies objects but life-cycles.". Most mycologists consider this opinion more or less self-evident. Classification within, e.g., the pyrenomycetes often requires a thorough knowledge of the imperfect states of the species to be classified. An illustration to this is the genus *Pyrenophora* Fr., in which several species are kept separate solely by their having different imperfect states. Concerning the genus *Eudarluca,* we may not preclude the possibility of several uredinicolous species. A cursory examination of the perfect state suggests that there are at least two such species, but in my opinion there is most likely only one species. This, however, must be demonstrated experimentally, taking the imperfect states into consideration.

As mentioned above (p. 35), besides the macroconidial state *Darluca,* there may be a microconidial state in *E. caricis*. I have seen micropycnidia mixed with macropycnidia in several collections (e.g., IMI, no. 79400 b). The texture of the wall is the same in both types of pycnidia. The habit is also the same. The microconidia are very small, only c. 2—3×1 µ, non-septate and hyaline. The macroconidia show a wider range of variation and are consequently of greater interest in the taxonomy than the microconidia. In general the individual collections of *Darluca* are comparatively homogeneous. No wonder there has been described a number of species in this genus, based on rather subtle morphological differences. This state of affairs has attracted the interest of several mycologists, e.g., DIEDICKE (1912, p. 150), HÖHNEL (1927, p. 27), SYDOW (1926, p. 417) and PETRAK (1929, p. 371). SYDOW and PETRAK considered *Darluca* a monotypical genus. HÖHNEL pondered this possibility, but he maintained, e.g., *Darluca genistalis* as a separate species. Thus, a fungus described by BUBÁK (1916 b, p. 151) as *Diplodothiorella Sadurneri* was placed as a synonym of *Darluca genistalis* by HÖHNEL (op. cit., p. 53). *D. genistalis* should differ from *D. filum* in being stromatic. They may, however, be modifications of one and the same species. The shape and the extension of the stromata depends largely on the morphology of the host of the rust. In one very aberrant collection of *Darluca* on *Sphaerophragmium artabotrydis* Doidge, Uganda (IMI, no. 79018), the pycnidia are clustered in moriform aggregates. Another collection (IMI, no. 5078), also from Uganda and on the same host, contains the perfect state. It has the same habit. The ascospores are 1-septate and do not differ from those in other collections of *Eudarluca* from Africa. This moriform habit is also represented in a collection from South Africa, described as *Botryella nitidula* Syd. & Syd. (1916, p. 95), but already shown by HÖHNEL (1918, p. 140) to be a *Darluca*. Examination of the type specimen (S) revealed that this is correct. The wall of the pycnidia is not as thick as in the African collection. The conidia have in both these cases the appendages, which are so typical of *Darluca*.

MÜLLER & ARX (1962, p. 314) transferred three pyrenomycetes to *Eudarluca*. These colonize fungi but not rusts. Only one of them, *E. connata* (Syd.) Arx, is apparently known to have an imperfect state. In this state, *Metabotryon connatum* Syd., the conidia, according to these authors, are coloured, non-septate and lacking appendages. It is doubtful whether this fungus is congeneric with *Darluca-Eudarluca*.

On the whole, the imperfect states do not yet give us any clue as to how many species there are in *Eudarluca*. First we have to study them comprehensively, morphologically as well as experimentally. The following considerations are entirely based on studies of the morphology of the perfect state.

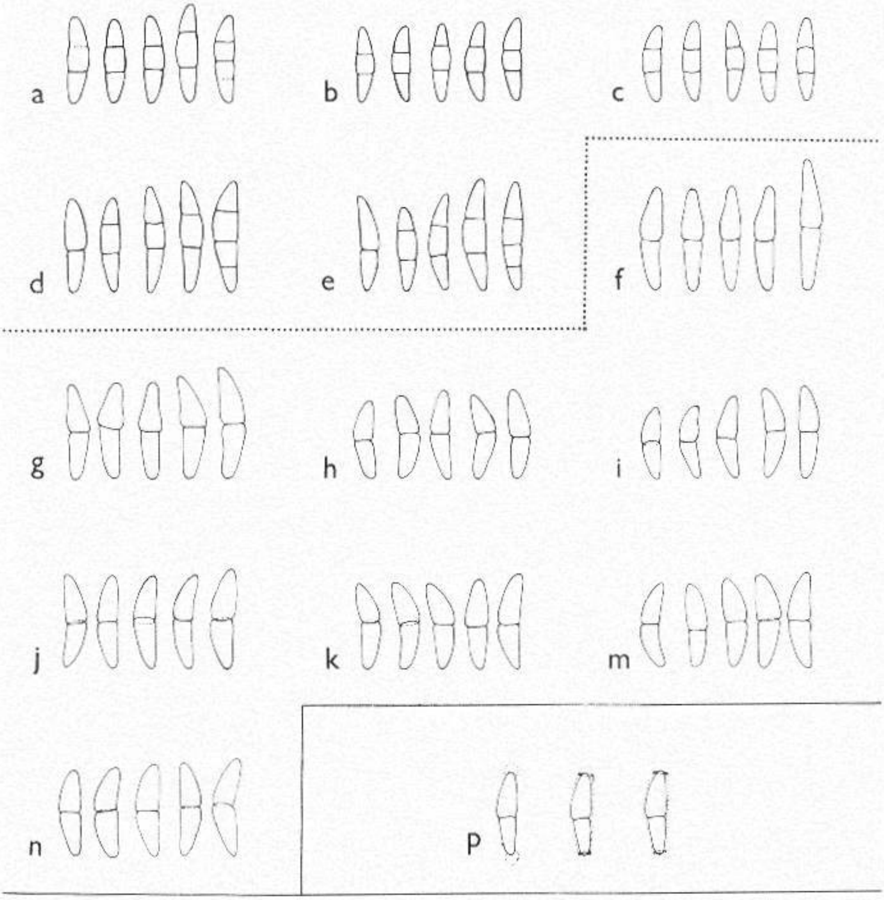

Fig. 1 *Eudarluca caricis.* a—e. Ascospores with (1—) 2 (—3) septa. f—n. Ascospores with 1 septum. p. Ascospores with gelatinous equipments in different stages. — References to "Collections Examined" (p. 62): a (36=*Sphaeria caricis* Fr., coll. orig.), b (40=*Leptosphaeria nigrificans* Bub. & Wróbl., Isotypus), c (12=*Eudarluca australis* Speg., Isotypus), d (39), e (37), f (38), g (21), h (24), i (7), j (4), k (17), m (18), n (2), p (—). — Magnification: all figures×780.

Morphology of the Ascospores

Features in ascospores are in general considered to be of the utmost moment in the taxonomy of *Ascomycetes*, especially on the species level, but sometimes also on the generic or taxonomically still higher levels. In *E. caricis* we are mostly interested in the septation of the ascospores, but their shape, colour and gelatinous equipments also merit attention.

Septation. As mentioned above, SYDOW (1926, p. 360) claimed that two collections from Costa Rica were conspecific with *Eudarluca australis* Speg., although the ascospores were 1-septate and not 2-septate as described by SPEGAZZINI. Concerning the septation of the ascospores SYDOW was however somewhat vague: "wohl mit drei Querwänden, von welcher aber fast immer nur die mittlere deutlich erkennbar ist" and some lines below on the same page:

> "Vergleicht man die vorstehende Beschreibung mit der Spegazzinischen Diagnose, so fällt, abgesehen von kleineren Differenzen, besonders auf, dass die Schlauchsporen nach Spegazzini 3-zellig sein sollen, wie sie auch von ihm abgebildet werden, während an dem vorliegenden Materiale 3-zellige Sporen nicht beobachtet worden. Trotzdem glaube ich, dass mein Pilz mit der *Eudarluca australis* identisch ist, indem ich annehme, dass dem Autor bei der Beobachtung ein Fehler unterlaufen ist. Ein Teil der Originalkollektion der *Eudarluca australis* stand zum Vergleich zur Verfügung, doch erwies sich dasselbe leider völlig unbrauchbar, da es nur leere Gehäuse enthielt.".

SYDOW's emendation of *Eudarluca* is compiled on p. 37. The ascospores were described as "2-zellig in völlig reifem Zustande vielleicht 4-zellig". In a later paper SYDOW (1929, p. 426) reported that he had found that the ascospores in a mature collection of *E. australis* were 3-septate.

SYDOW was never contradicted in this question, but supported by several other authors. As mentioned on p. 37, PETRAK (1927, p. 301) examined SYDOW's two collections from Costa Rica, an isotype of *Eudarluca australis* and one of *Myrmaecium cannae*. He was sure that these four collections belonged to one and the same species, *Eudarluca australis* Speg. The isotype of this species was "aber schon ganz alt, zeigt an der von mir gesehenen Exemplar keine Spur einer Fruchtschicht". Like the type material of *E. australis* the isotype of *M. cannae* was also collected on *Canna indica*. It was mature, and the ascospores were "zweizellig, bisweilen aber auch durch eine, in der oberen Hälfte entstehende Querwand dreizellig". The ascospores in the collections from Costa Rica were 1-septate, but in the largest spores PETRAK could discern two additional septa. He summarized his studies thus (p. 301):

> "Die Sporen dieser Art scheinen in Form und Grösse sehr veränderlich zu sein. In ähnlicher Weise scheinen ja auch die Konidien der Nebenfruchtform zu variieren, was zur Aufstellung verschiedener *Darluca*-Arten geführt hat, welche zweifellos alle mit einander identisch sind." and (p. 302) "Diese grosse Veränderlichkeit der Sporen dürfte vor allen darauf zurückzuführen sein, dass der Pilz auf allen mir vorliegenden Kollektionen gewiss noch nicht ganz reif ist, zum Teile auch deutliche Spuren von Entwicklungshemmungen zeigt.".

I have studied one of SYDOW's collections from Costa Rica, an isotype of *Eudarluca australis* and two isotypes of *Myrmaecium cannae*. The isotype of *E. australis* (from Herb. SYDOW, now in S) is certainly the very collection examined by SYDOW and subsequently also by PETRAK. Most of it is actually over-ripe, but in one small area of a leaf fragment mature pseudothecia were found. They contained ascospores coinciding very well with those figured by SPEGAZZINI. The other three collections yielded only 1-septate ascospores. The habit of all the specimens on *Canna indica* is largely the same, but in one case the ascospores are 1-septate (*Myrmaecium cannae*) and in the other they are 2-septate (*Eudarluca australis*).

In addition I examined 27 other collections with the perfect state in a mature condition. Of these 21 had 1-septate ascospores and 6 had 2-septate spores. In some cases 1-septate immature ascospores could be found together with 2-septate mature spores. The septum in these immature spores is very often not median as commonly is the case in "normally" 1-septate ascospores. Such a difference would in general be looked upon as a very fundamental one. For several reasons I feel we must not do so here:

1. Although the individual collections generally show either 1- or 2-septate ascospores, there is no sharp borderline between the two types of spores as to the location of the septa. It is in fact possible to find some "normally" 1-septate ascospores mixed with 2-septate spores (see fig. 1 d) although most 1-septate spores are ± apiosporous. Sometimes 3-septate spores are found in pseudothecia with 2-septate spores. In such spores the medium septum takes the same position as the single septum in the "normally" 1-septate spores.
2. As mentioned above 1- and 2-septate ascospores, respectively, occur in two otherwise similar collections on the same matrix (*Puccinia cannae* on *Canna indica*).
3. The type of septation described here is not unique. Other fungi with ascospores that are normally 1-septate, but occasionally have an additional septum, are, e.g., *Mollisia nigrescens* (Feltg.) LeGal & Mang. and *M. hydrophila* (Karst.) Sacc. (LEGAL & MANGENOT 1961, figs. 8 and 23 B) and *Massarina aquatica* Webster (1965, fig. 1 A-B). The cells in these 2-septate spores are of equal length.

Shape. The shape of the ascospores varies somewhat in 1- as well as in 2-septate spores. In some collections the 1-septate spores are distinctly swollen especially on one side of the septum. This feature is never seen in 2-septate spores, but as it is not prominent in all collections with 1-septate spores, it is most probably of no taxonomical value.

Colour. 1-septate ascospores are always hyaline, while 2- and 3-septate spores are pale honey-yellow. If they all belong to one species we may assume that the 1-septate spores are immature and that on maturing they turn coloured and get an additional septum (or septa). If they are immature this would be a case of neoteny, as 1-septate ascospores may germinate without further septation. This is shown in a figure that HANSFORD added to one of his collections in Herb. IMI (no. 13605). Another explanation is that the hyaline and 1-septate spores are mature, while the 2- or 3-septate, coloured spores are the results of a development under some extreme conditions, e.g. a spell of dry weather. I think this last interpretation is the most reasonable one, because in several collections with 2-septate spores the spores are in a comparatively bad condition and do not readily leave the asci. Also the ascocarps are for the most rather poorly developed in these collections (see below).

Gelatinous equipments. In almost all collections the ends of the ascospores are provided with mucous cushions (fig. 2 d). These seem to have been overlooked by earlier authors. This is probably due to the fact that they commonly dissolve very quickly in water, at least in their margins and thereby turn almost invisible. They are however very easy to see if, for instance, Congo red or Melzer's reagent is added immediately after the ascocarps have been placed in water and squashed under the coverslide. If for a later re-examination glycerine or lactophenol, respectively, is added to the mounts it will be very difficult to discern any cushions. In many collections each ascospore is enclosed in a mucous covering, which seems to be decapitated at the ends of the spores. In fact they are not. There is a mucous cupola at each end of the spore, but these cupolas dissolve very rapidly in water. I am sure there is no fundamental difference between these types of gelatinous equipments. They represent different stages of development instead (fig. 1 p). All these stages have been found in 1-septate spores, which can be regarded as normally developed in this respect also. In 2-septate spores only the first described type of gelatinous equipment have been met with. In this case the wall of the spore and the cushions are not so readily dissolvable as they are in mature 1-septate ascospores. This may be due to some infavourable conditions under the development.

The biological significance of the cushions is clear when HANSFORD's figure in the above mentioned collection from Herb. IMI is studied. In all he sketched 15 ascospores, which all germinated apically but never laterally. The same is true for three conidia figured by HANSFORD in the same collection. As is well-known, the conidia in this species are provided with apical appendages.

Morphology of the Ascocarps

At the beginning of my studies on *Eudarluca* it appeared to me as if the septation of ascospores and the morphology of ascocarps were correlated in this species. One-septate spores were generally found in "loculi" enclosed in very prominent stromata. The ascocarps which yielded 2-septate spores did not show such a stromatical aspect. In at lest two collections the fungus even seemed to belong to the genus *Phaeosphaeria* Miyake (see fig. 4 c).

This trend has persisted, but I have now seen collections in which the characters are not combined in the way described above. Thus in the original collection of *Sphaeria caricis* the ascocarps are stromatic and the spores 2-septate. These stromata match those which yield 1-septate spores in all details. One collection (IMI, no. 62099 e) shows stromata with 1-septate ascospores but also clusters of solitary pseudothecia, with exactly the same type of ascospores. From this it is reasonable to conclude that differences in the morphology of the ascocarps are of minor taxonomic significance.

STEVENS (1924, p. 181) observed a remarkable character in the stromata of his *Uleodothis paspali* (=*E. australis* fide PETRAK): "While the locules sometimes have a lining consisting of one or two rows of cells darker than the remainder of the stroma such a lining is not always present and I regard the fungus in the summation of its characters as Dothideaceous rather than Sphaeriaceous." Linings of this type ("stromata in stromata"??) can be seen in fig. 5 b. In fig. 5 c and 2 b they are not so distinct, but in fig. 5 a no compact stromatic tissue between the "linings" is to be found. In this case we have densely clustered pseudothecia with a common clypeus.

"Paraphyses" (=Pseudoparaphyses)

According to HANSFORD (1946, p. 58) *Eudarluca australis* Speg. should be devoid of paraphyses. Such were figured by SPEGAZZINI and described by e.g. SYDOW (1926, p. 361). When RAMAKRISHNAN (1951, p.

158) described his new species *Eudarluca indica,* he pointed out that the most important feature in this species was the presence of "paraphyses". He had obviously not examined any type material of *E. australis* as he referred to HANSFORD when stating that this species had no "paraphyses". I have found pseudoparaphyses in all collections of *Eudarluca* I have studied, and they certainly do not provide any useful criterion in this genus. *Eudarluca indica* is merely a synonym of *E. caricis.*

Distribution and Ecology

Data on all collection of *E. caricis* (also all reliable records in the literature) can be derived from Table 1 and under the heading "Collections Examined". (p. 62).

The collections with 1-septate ascospores have been called *Eudarluca australis* Speg. Most of them were published earlier. This form of the species has been found in all parts of the world. The single European collection is unpublished. The fungus was collected by me in an immature state in Dalecarlia (=Dalarna, Sweden) in June of 1962. The same locality was visited again in March, August and December of 1964. In March the fungus was immature, in August it was mature and yielded 1-septate spores and finally in December the perithecia were empty and new immature ascocarps were developing in the uredosori of this year's leaves. The host of the rust, *Puccinia caricina* DC., is *Carex diandra.* The tussocks in this locality are unusually tall. Several generations of leaves bend down and constitute a tunnel around the base of the tussock. This hollow is very humid and offers thereby an especially favourable milieu to *E. caricis.* It has been pointed out e.g. by RAMAKRISHNAN & NARASIMHALU (1941) and SEBESTA (1963) that *Darluca-Eudarluca* probably prefers high humidity. The more common occurrence in the Tropics also may indicate this.

The collections with 2-septate ascospores have been given several different names. One find is from Brazil, all the others from Europe. Except for one of the Swedish collections they were all published earlier. Two collections merit some further comments:

1. "*Leptosphaeria folliculata* Ell. & Ev." was collected by MÜLLER (1950, p. 269) in Switzerland. I have examined this material and found that it is well developed *E. caricis* (fig. 1 d). At a first glance no traces of a rust can be seen on the vascular plant (a grass). If, however, the

leaves are scrutinized under high magnification, some small empty cavities, typical for those caused by a rust, can be seen.

Leptosphaeria folliculata was described on material found by DEARNESS on *Carex* sp. in Canada. I have examined the holotype (NY) and an isotype (DAOM). According to the original description (ELLIS & EVERHART 1890, p. 237) the perithecia are situated on pale leaf spots. There were plenty of such spots in both samples, but of a perfect state only one single pseudothecium of *Mycosphaerella* sp. could be found. The spots seem to be caused by *Phyllosticta* (pycnidia c. 40—50 µ, conidia 3×1 µ). No 2-septate ascospores have been met with and *L. folliculata* remains a mystery.

2. A find of *Eudarluca* with 2-septate spores (fig. 1 e) was made by me in Västerbotten (northern Sweden) in June of 1962. The locality was a hollow in a compost heap, c. 10 meters from a rivulet. In this hollow the microclimate may certainly have been ± "tropical". *Eudarluca* grew on some old fragments of *Elytrigia repens*. In the summer of 1965 it was searched for in vain.

Darluca filum has been collected on a large number of rust genera, while the perfect state generally is found on *Puccinia* spp. on members of *Gramineae* and *Cyperaceae*. This is probably due to the fact that these plants often grow in and themselves make up a milieu, which is favourable for *Eudarluca*. Moreover, their tissues are in most cases comparatively resistant to decomposition. About two thirds of the collections studied by me are on species belonging to one of these families. The rust is commonly attacked in its uredinial stage, but in, e.g., the original collection of *Sphaeria caricis*, both uredo- and teleutosori are to be found.

It was stressed by HULEA (1939, p. 196) that *Darluca filum* and a number of other fungi found in connection with rusts should not be considered parasites but commensals. There is no doubt that *E. caricis* at least in its perfect state is parasitic. In general it is stromatic and in the stromata uredospores are enclosed and totally demolished. The problem is whether these compact stromata nourish exclusively on killed uredospores. We may not eliminate the possibility that *Eudarluca* to some extent may also feed directly upon the vascular plant, as a parasite or a saprophyte. This is conceivable especially in some cases were the fungus looks like species of the genus *Phaeosphaeria* Miyake, e.g., the collection from Västerbotten. In this collection the fungus is very similar to, e.g., *Phaeosphaeria rousseliana* (Desm.) Holm. The matrix of the latter, *Phleum phleoides* (L.) Karst., is blackened from a widely extended but thin clypeus. In the mentioned collection of *Eudarluca* the pseudothecia are not seated in the uredosori, but just opposite them on the other side of the leaf (figs. 4 c and 5 a), and this side is blackened from the fungus. In this connection some physiological studies on *Darluca filum*, performed by NICOLÁS & VILLANUEVA (1965, p. 782) are of interest. According to these authors, *D. filum* can utilize a large number of carbon compounds and probably does not need more than one nitrogenous compound. All amino acids required can then be synthetized by the fungus itself. These results suggest the possibility that *Darluca-Eudarluca* may also feed upon the vascular plants to some extent. It has never been found unless a rust has been present also. A wound on a vascular plant is certainly not enough for a successful attack by *Eudarluca*, but there must be some other factor, e.g., a specific substance from the rust, that is required for the development of this pyrenomycete.

Table 1. Distribution of the perfect state of E. caricis.

Country	Publ. coll.: author and year Unpubl. coll.: collector		Name of the fungus (note 1)	Number of coll. (note 2)	Septation of spores (note 3)	Reference to Coll. Exam. (note 4)
Africa						
Ghana	Hughes	1952	E.a.	1	1	1
Guinea	Kranz	1963	E.a.	2	?	—
—	Kranz	—	E.a.	1	1	2
Kenya	Nattrass	1961	E.a.	3	1	3
Libya	Kranz	1964	E.a.	1	?	—
Malawi	Bisby & Wiehe	1953	E.a.	×	?	—
Nigeria	Harris	—	E.a.	1	1	4
Sierra Leone	Deighton	—	E.a.	3	1	5, 6, 7
South Africa	Doidge	1941	E.a.	3	1—3	—
Sudan	Tarr	1963	E.a.	×	c	×
Tanzania	Wallace & Wallace	1949	E.a.	2	?	—
—	Pirozynski	—	E.a.	1	1	8
Togo	Hughes	1952	E.a.	1	1	9
—	Hughes	—	D.f.	1	i	10
Uganda	Hansford	1946	E.a.	×	1	11
America						
Argentina	Spegazzini	1909	*Di.d.	2	1	—
Brazil	Spegazzini	1908	*E.a.	1	2	12
British Guiana	Petrak	1929	E.a.			
	=Stevens	1924	*U.p.	1	1	—
Costa Rica	Sydow	1926	E.a.	2	1	13
Dominic Republic	Petrak & Ciferri	1932	E.a.	2	1	14.15
—	Petrak	?	E.a.	1	i	16

Table 1. Continued.

Country	Publ. coll.: author and year Unpubl. coll.: collector		Name of the fungus (note 1)	Number of coll. (note 2)	Septation of spores (note 3)	Reference to Coll. Exam. (note 4)
Ecuador	Sydow	1939	E.a.	1	?	—
—	Petrak	1949	E.a.	1	?	—
Jamaica	Hansford	—	E.a.	1	1	17
—	Leather	1962	E.a.	1	1	18
Puerto Rico	Petrak	1927	E.a.			
	=Dearn. & Barth.	1917	*M.c.a.	1	1	19
U.S.A.	Keener	1951	E.a.	4	1	—
—	Petrak	1953	E.a.	2	?	—
Venezuela	Sydow	1930	E.a.	2	1	20.21
Asia						
China	Sydow	1929	E.a.	1	3	—
India	Saccardo	1914	*Di.k.	1	1	—
—	Ramakrishnan	1951	*E.i.	1	1	22
Japan	Katumoto	1964	E.a.	1	1	—
North Borneo	Petrak	1954	E.a.	1	i	23
—	Forster	—	E.a.	1	1	24
—	Johnston	1960	E.a.	2	?	—
—	Johnston	—	E.a.	1	1	25
Sarawak	Johnston	—	E.a.	1	1	26
Australia						
New Caledonia	I.F.O.	—	E.a.	1	1	27
New Guinea	Johnston	1961	E.a.	1	1	28
Europe						
Belgium	Kickx	1855	Do.g.	1	?	—
Austria	Fuckel	1864	Do.g.	1	i	29
—	Fuckel	1868	*D.f.s.	1	i	30
Finland	Karsten	—	D.f.	1	i	31
France	Moug. & Nestl.	1815	S.g.	1	i	32
	=Fries	1823	*Do.g.			
—	Chevalier	1833	Do.g.	×	?	—
—	Grognot	1863	Do.g.	×	?	—
—	Morière	1866	S.c.d.	1	2	33
—	Crouan & Crouan	1867	Do.g.	×	?	—
—	Roumeguère	1880	Do.g.	1	i	34
—	Briard & Hariot	1891	*Dot.a.	1	2	35
Germany	Wallroth	1833	Do.g.	×	?	—
—	Rabenhorst	1844	Do.g.	×	?	—
Sweden	Fries	1823	*S.c.	1	2	36
—	Eriksson	—	—	1	1	37
—	Eriksson	—	—	1	2	38
Switzerland	Secretan	1833	Do.g.	×	?	—
—	Müller	1950	L.fo.	1	2	39
U.S.S.R.	Bubák & Wróblewski	1916	*L.n.	1	2	40

Note 1. The names of the fungi are abbreviated as follows:
D.f. =*Darluca filum*
D.f.s. =*Darluca filum* var. *stromatica*
Di.d. =*Didymella darluciphila*
Di.k. =*Didymella kariana*
Do.g. =*Dothidea genistalis*
Dot.a. =*Dothidella appendiculata*
E.a. =*Eudarluca australis*
E.i. =*Eudarluca indica*
L.fo. =*Leptosphaeria folliculata*
L.n. =*Leptosphaeria nigrificans*
M.ca. =*Myrmaecium cannae*
S.c. =*Sphaeria caricis*
S.c.d. =*Sphaeria caricis* var. *depauperata*
S.g. =*Sphaeria genistalis*
U.p. =*Uleodothis paspali*
*=the original description of the fungus in this paper.

Note 2. ×=the number of collections of the perfect state not given by the author.

Note 3. c=recorded as the perfect state, but only the imperfect state found.
i=immature perfect state.
?=septation unknown.

Note 4. ×=collection examined, but the perfect state not refound.

Collections Examined

The perfect state of *Eudarluca caricis* (Fr.) O. Eriks. was examined in the collections listed below. (If nothing else is stated, the collections were labelled *Eudarluca australis* Speg.).

Africa.

1. Ghana, Aburi, 13. XI. 1924, C. B. (no. 140) (IMI, no. 13605).
   On *Puccinia rufipes* Diet. (on *Imperata arundinacea* Cyrillo).
2. Guinea, IRF Kindia, 10. XII. 1963, (IMI, no. 105011 c), J. Kranz.
   On *Puccinia versicolor* Diet. & Holw. (on *Andropogon tectorum* Schumach.).
3. Kenya, Limuru, alt. 7000 ft, IV. 1950, R. M. Nattrass (no. 1365) (IMI, no. 41125).
   On *Puccinia kampalensis* Cumm. (on *Wedelia* sp.).
4. Nigeria, Zaria Province, Shika, 10. IX. 1958, E. Harris (IMI, no. 75759).
   On *Uredo* sp. (on *Hyparrhenia rufa* (Nees) Stapf).
5. Sierra Leone, 19. XII. 1936, F. C. Deighton (IMI, no. 43387 b).
   On *Uredo famelica* Arth. & Cumm. (on *Mucuna* sp.).
6. Sierra Leone, Musaia, 13. XII. 1946, F. C. Deighton (IMI, no. 11340).
   On *Puccinia* sp. (on *Hyparrhenia rufa* (Nees) Stapf).
7. Sierra Leone, 1. XI. 1956, F. C. Deighton (IMI, no. 68201 b).
   On *Puccinia polysora* Underw. (on *Zea mays* L.).
8. Tanzania, Kigoma, Kahombe, 4. I. 1964, K. Pirozynski (Mi 87 a) (IMI, no. 106009 a).
   On *Uromyces leptodermus* Syd. (on *Panicum maxicum* Jacq.).

9. Togo, Hohoe, 28. V. 1949, S. J. HUGHES (IMI, no. 39688 a).
On rust indet. (on *Andropogon* sp.).
10. Togo, Amedjofe Pass (on the top), 29. V. 1949, S. J. HUGHES (IMI, no. 39712).
On rust. indet. (on *Ctenium* sp.).
11. Uganda, Kazi near Kampala, XI. 1940, C. G. HANSFORD (IMI, no. 5078).
On *Sphaerophragmium artabotrydis* Doidge (on *Artabotrys nitida* Engl.).

America.

12. *Eudarluca australis* Speg. — TYPUS.
Brasilia, São Paulo, Botanical Garden, 10. VIII. 1905, A. USTERI (ISOTYPUS: S).
On *Puccinia cannae* (Wint.) Henn. (on *Canna indica* L.).
13. Costa Rica, La Caja near San José, 24. XII. 1924, H. SYDOW, [SYDOW, Fungi exot. exs., no. 636 (IMI, no. 13606; S; UPS)].
On *Puccinia conoclinii* Seym. (on *Eupatorium sinclairii* Benth. ex Oerst.).
14. Domonic Republic, Salcedo, VIII. 1929, R. CIFERRI (no. 3011) (S).
On rust indet. (on *Eleocharis geniculata* R. Br.).
15. Dominic Republic, Cordillera Central, Prov. de la Vega, at Rio Maimón, 17. XII. 1930, E. L. EKMAN (no. 3896) (S).
On rust indet. (on *Cyperus picardae* Boeck).
16. Domonic Republic, Santo Domingo, Lano Costero, IX. 1926, R. CIFERRI [PETRAK, Myc. gen., no. 639 (IMI, no. 30539; S; UPS)].
On rust indet. (on *Eleocharis* sp.).
17. Jamaica, Irinityville, 2. X. 1925, C. G. HANSFORD (no. 795) (IMI, no. 76473).
On rust indet. (on *Rottboellia exaltata* L.f.).
18. Jamaica, Mandeville, 23. VII. 1962, R. L. LEATHER (IMI, no. 95526).
On *Puccinia stenotaphri* (Syd.) Cumm. (on *Stenotaphrum secundatum* (Walt.) Kuntze).
19. *Myrmaecium cannae* Dearn. & Barth. — TYPUS.
Puerto Rico, Cabo Rojo, 30. X. 1912, F. L. STEVENS, [BARTHOLOMEW, Fungi Columb., no. 5038 (ISOTYPUS: IMI, no. 13608; ISOTYPUS: S)].
On *Puccinia cannae* (Wint.) Henn. (on *Canna indica* L.).
20. Venezuela, Caguita near Puerto La Cruz, 29. XII. 1927, H. SYDOW [SYDOW, Fungi exot. exs., no. 807 (IMI, no. 13607; S; UPS)].
On *Schroeteriaster crotonis* (Burr.) Diet. (on *Croton currani* Blake).
21. Venezuela, Caguita near Puerto La Cruz, 27. XII. 1927, H. SYDOW (S).
On rust indet. (on *Chaetochloa sulcata* (Aubl.) Hitchc.).

Asia.

22. *Eudarluca indica* Ramakr. — TYPUS.
India, Anamalais, 22. IX. 1950, T. S. RAMAKRISHNAN. (ISOTYPUS: UPS).
On *Uredo amomi* Petch (on *Amomum* sp.).
23. North Borneo, Tuaran ("Tauran"), 24. VII. 1931, J. & M. CLEMENS (IMI, no. 94660).
On *Uredo* sp. (on a Cyperacea).
24. North Borneo, Keningau, IV. 1955, R. H. FORSTER (IMI, no. 62099 e).
On *Puccinia polysora* Underw. (on *Zea mays* L.).

25. North Borneo, Keningau, 15. IX. 1959, A. JOHNSTON (IMI, no. 79341 b).
On *Puccinia polysora* Underw. (on *Zea mays* L.).
26. Sarawak, Miri, 21. IX. 1959, A. JOHNSTON (IMI, no. 79400 b).
On *Puccinia nakanishikii* Diet. (on *Cymbopogon citratus* (DC.) Stapf).

Australia.

27. New Caledonia, Nouméa, 21. IX. 1964, I. F. O. (IMI, no. 113453).
On *Uromyces* sp. (on *Heteropogon contortus* (L.) Beauv. ex Roem. & Schult.).
28. New Guinea, Biak, Kambong Landbouw, 12. VI. 1959, A. JOHNSTON (IMI, no. 77479).
On *Puccinia rufipes* Diet. (on *Imperata cylindrica* (L.) Beauv.).

Europe.

29. *Dothidea genistalis* Pers. ex Fr. (=*Darluca filum* (Biv.-Bern. ex Fr.) Cast. var. *dothideaeformis* Fuck. — COLL. ORIG.).
Austria, L. FUCKEL [FUCKEL, Fungi rhenani, no. 1014 (S)].
On *Uromyces laburni* (DC.) Fuck. (on *Genista sagittalis* L.).
30. *Darluca filum* (Biv.-Bern. ex Fr.) Cast. var. *stromatica* Fuck. — COLL. ORIG.
Austria, L. FUCKEL [FUCKEL, Fungi rhenani, no. 2132 (S; UPS)].
On *Puccinia* sp. (on *Agrostis stolonifera* L.).
31. *Darluca filum* (Biv.-Bern. ex Fr.) Cast.
Finland, Turku (Åbo), 6. IV. 1861, P. A. KARSTEN (HEL).
On *Puccinia* sp. (on *Anthriscus silvestris* (L.) Hoffm.).
32. *Dothidea genistalis* Pers. ex Fr. — COLL. ORIG.
France [MOUG. & NESTL., no. 488, "*Sphaeria genistalis* Pers. in litt." (UPS)] [ROUMEGUÈRE, Fungi gall. exs., no. 94, (UPS)].
On *Uromyces laburnei* (DC.) Fuck. (on *Genista sagittalis* L.).
33. *Dothidea genistalis* Pers. ex Fr.
France, Aude, Narbonne, IX. 1879 [ROUMEGUÈRE, Fungi gall. exs., no. 888 (UPS)].
On *Uromyces laburnei* (DC.) Fuck. (on *Genista sagittalis* L.).
34. *Darluca filum* (Biv.-Bern. ex Fr.) Cast. var. *depauperata* Desm.
France, Caen, ROBERGE (UPS).
On *Puccinia* sp. (on *Carex* sp.).
35. *Dothidella appendiculata* deLacr. ex Br. & Har. — COLL. ORIG.
France, Vienne, St.-Romain-sur-Vienne, IV. 1855, DELACROIX [SCHULTZ, Herb. norm., fasc. 8, no. 799, "*Dothidea*" *app.*, (S)] [ROUMEGUÈRE, Fungi gall. exs., no. 5760 (S; UPS)].
On *Puccinia chondrillina* Bub. & Syd. (on *Chondrilla juncea* L.).
36. *Sphaeria caricis* Fr. — COLL. ORIG.
Sweden (UPS).
On *Puccinia* sp. (on *Carex oederi* Retz.).
37. Sweden, Västerbotten, Bygdeå, 21. VI. 1962, O. Eriksson (no. 1386 b) (UPS).
On *Puccinia* sp. (on *Elytrigia repens* L.).
38. Sweden, Dalarna, Säter, Nordalen, 5. VI. 1962, 29. III. 1964, 27. VIII. 1964, 8. XII. 1964, O. ERIKSSON (nos. 1214 a, 2457 a (mature), 2537 a) (UPS).
On *Puccinia caricina* DC. (on *Carex diandra* Schrank.).
39. *Leptosphaeria folliculata* Ell. & Ev.
Switzerland, Kt. Graubünden, Bergün, Val-Plaz-bi, 30. VII. 1949, E. MÜLLER (UPS, ZT).
On rust indet. (on *Calamagrostis villosa* (Vill.) Gmelin).

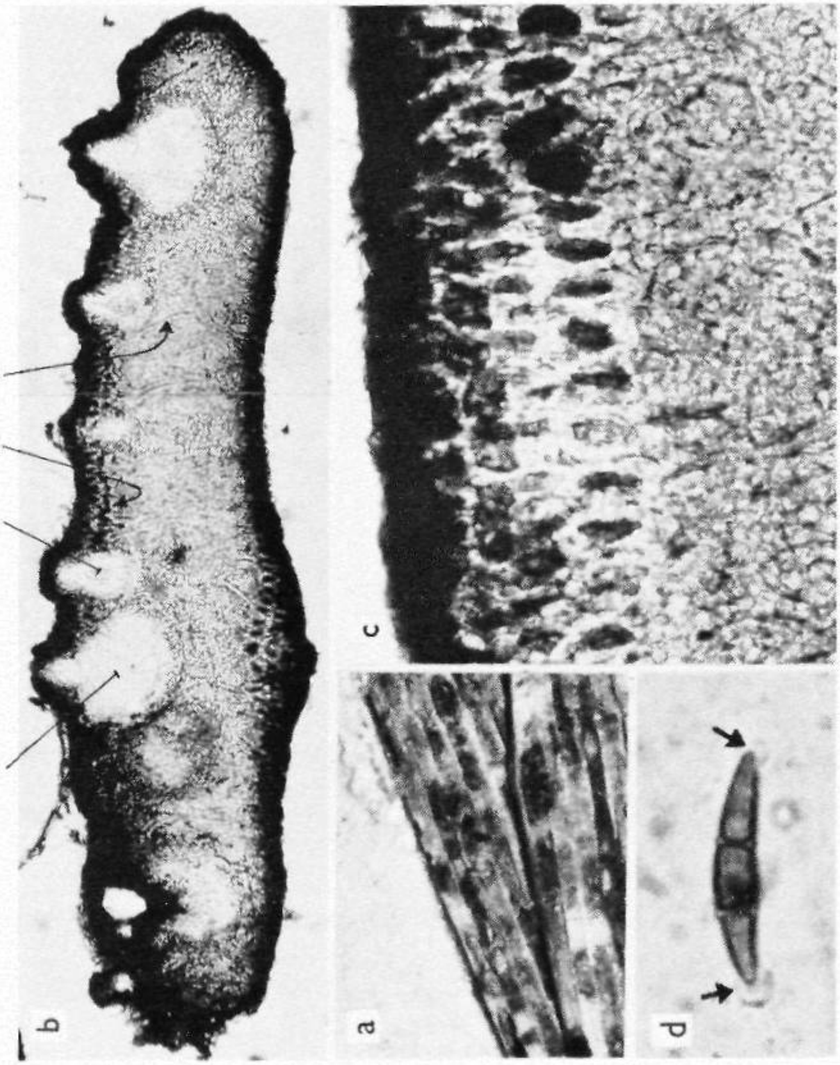

Fig 2. a—d. *Eudarluca caricis*. a. Stromata and rust sori on leaves of *Carex oederi*. b. Pseudothecial loculus (1), pycnidium (2), destroyed uredospores (3) and leaf tissue (4) enclosed in a stroma (longit. sect.). This stroma immature, others on the same leaf with 2-septate ascospores. c. Uredospores in a stroma. d. Ascospore with mucous cushions at the ends. — References to "Collections Examined" (p. 62): a—c (36=*Sphaeria caricis* Fr., coll. orig.), d (37). — Magnifications: a×12 b×110, c×160, d×1550.

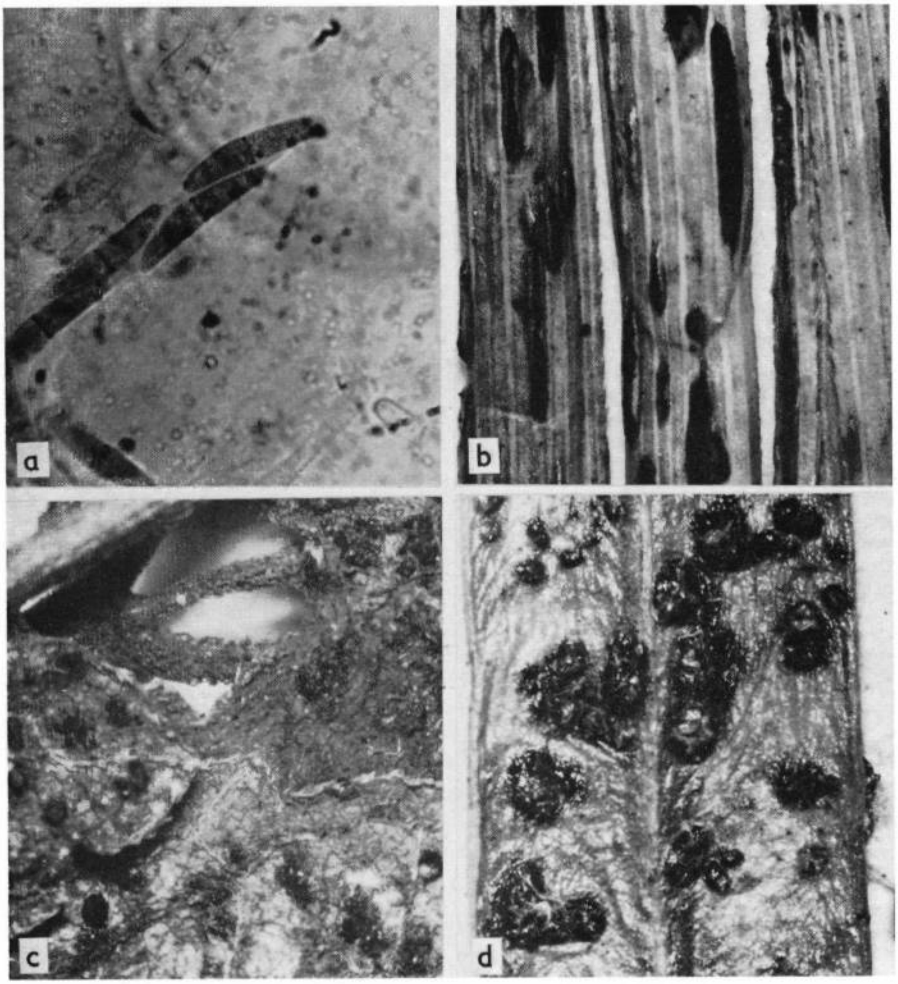

Fig. 3. a—d. *Eudarluca caricis.* a. One-septate ascospores and pseudoparaphyses. b. Ascocarps (yielding 1-septate spores) in leaves of *Carex diandra.* c. Ditto (ditto) in leaves of *Eupatorium sinclairii.* d. Ditto (immature) in "leaves" of *Genista sagittalis.* — References to "Collections Examined" (p. 62): a (38), b (38), c (13), d (32= *Dothidea genistalis* Pers. ex. Fr., coll. orig.). — Magnifications: a×1000, b—d ×11.5.

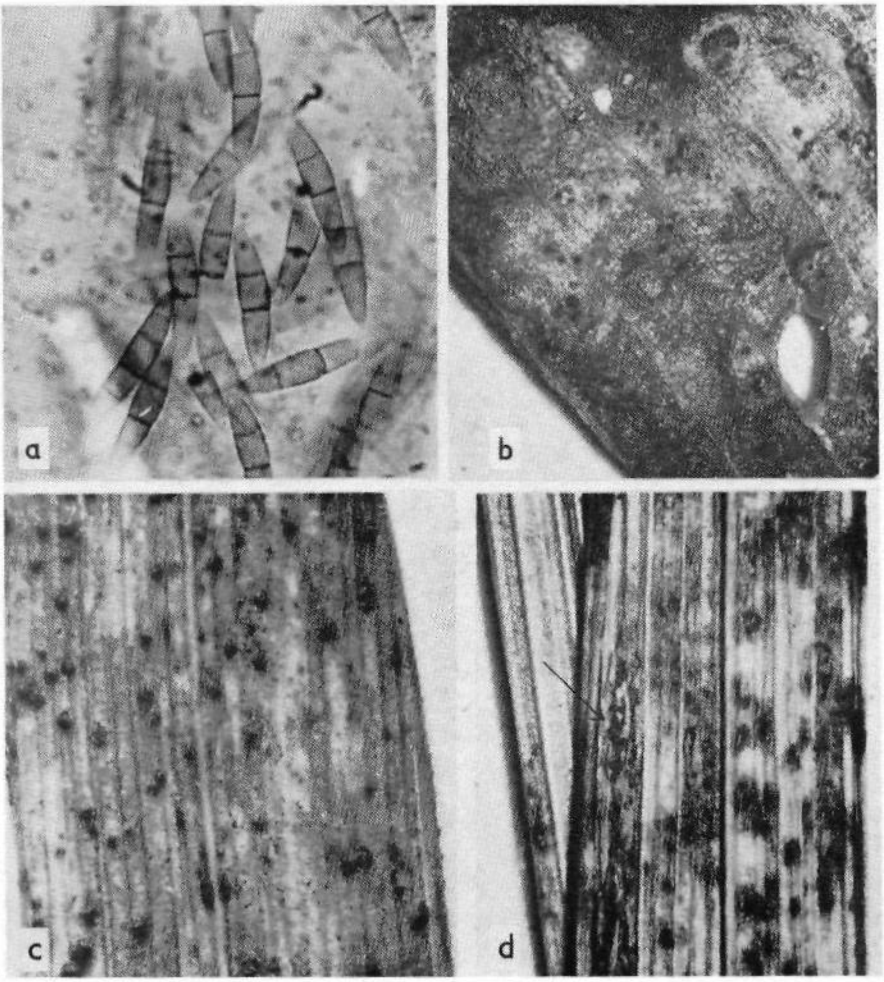

Fig. 4. a—d. *Eudarluca caricis.* a. Two-septate (and one 3-septate) ascospores. b. Ascocarps (yielding 2-septate spores) in leaves of *Canna indica.* c. Ditto (ditto) in leaves of *Elytrigia repens.* d. Ditto (ditto) and pycnidia of *Darluca filum* (arrow) in leaves of *Carex* (cf. *leporina*). — References to "Collections Examined" (p. 62): a (39), b (12=*Eudarluca australis* Speg., Isotypus), c (37), d (40=*Leptosphaeria nigrificans* Bub. & Wróbl., Isotypus). — Magnifications: a×1000, b—d×11.5. — Cf. fig. 2 a—c.

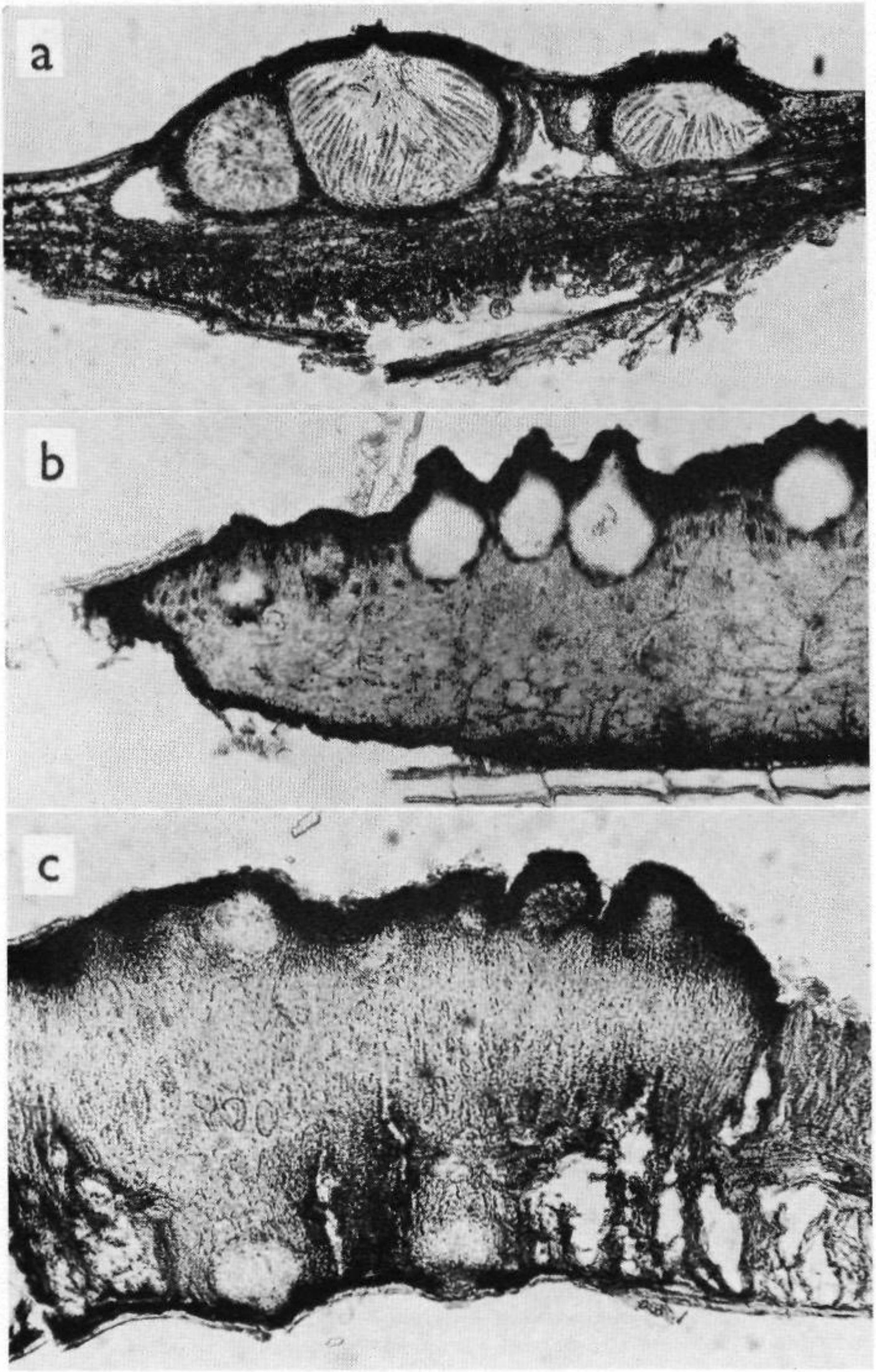

Fig. 5. a—c. *Eudarluca caricis,* Ascocarps with ± well-developed stromatic tissue, a. Ascocarp yielding 2-septate spores (cf. fig. 2 c). b. Immature ascocarp (5. VI.1962, 1-septate spores found 27. VIII. 1964; cf. fig. 3 b). c. Immature ascocarp (cf. fig. 3 d). — References to "Collections Examined" (p. 62): a (37), b (38), c (32=*Dothidea genistalis* Pers. ex Fr., coll.orig.). — Magnification: a—c ×125.

40. *Leptosphaeria nigrificans* Bub. & Wróbl. — TYPUS.
U.S.S.R., Ukraina, Werbiaž Nižny near Kolomea, IX. 1912, A. WRÓBLEWSKI (ISOTYPUS: S).
On *Puccinia* sp. (on *Carex* cf. *leporina* L.).

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Summary

The perfect state of *Darluca filum* (Biv.-Bern. ex Fr.) Cast. is *Eudarluca caricis* (Fr.) O. Eriks. comb. nov. (Basionym: *Sphaeria caricis* Fr.). Synonyms of *E. caricis* are *Dothidea genistalis* Pers. ex Fr., *Dothidella appendiculata* deLacr. ex Br. & Har., *Eudarluca australis* Speg., *Eudarluca indica* Ramakr., *Leptosphaeria nigrificans* Bub. & Wróbl. in Bub., *Myrmaecium cannae* Dearn. & Barth. in Dearn. and *Uleodothis paspali* Stev. Original collections of two varieties of *Darluca filum*, viz. var. *dothideaeformis* Fuck. and var. *stromatica* Fuck., contain immature ascocarps of the perfect state. Possible synonyms of *E. caricis* are *Didymella kariana* Sacc. and *Didymella darluciphila* Speg.

The author has studied about 300 collections of *Darluca-Eudarluca*, 40 of which contained the perfect state of *E. caricis*. Of these collections 11 are from Africa, 10 from America, 5 from Asia, 2 from Australia and 12 from Europe. The perfect state was previously unknown from Europe. The author has found it twice in Sweden in the field, and also discovered it in herbarium material, collected in Austria, Finland, France, Sweden, Switzerland and U.S.S.R.

Nine of the 40 collections are immature. Of the mature collections 24 yielded 1-septate ascospores, while 2- (and sometimes also 1- and 3-) septate spores were found in 7 collections. No taxonomically fundamental differences have been found to exist between 1- and 2- septate spores in this material. Normally the ascospores of *E. caricis* are 1-septate, in the original collection they are 2-septate. The ascospores are provided with a mucous sheath and/or a mucous cupola at each end of the spore.

The ascocarps are commonly plurilocular stromata but unilocular ascocarps have been met with. The loculi often have a lining of one or two rows of cells darker than the remainder of the stroma, which in some collections is very loose or lacking.

E. caricis is generally found on *Puccinia* spp. on members of *Gramineae* and *Cyperaceae*. This is probably due to the fact that these plants grow in and themselves make up a milieu which is favourable for *Eudarluca*.

E. caricis is a parasite, but the possibility that it to some extent may feed upon the vascular plant may not be eliminated.

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Revision of Some Lichen Genera in Southern Africa I

By OVE ALMBORN

Institute of Systematic Botany, Lund

Introduction

In 1953 the present author had an opportunity to undertake a botanical journey in South Africa and some adjacent territories. My main purpose was to study the lichen flora, but I also brought home collections of vascular plants and of bryophytes, fungi and algae. I am preparing a Lichen Flora of Southern Africa, i.e., the Republic of South Africa, S.W. Africa, Bechuanaland, Basutoland, Swaziland, Rhodesia and Portuguese East Africa. This task will obviously take several years. As a preliminary, I am completing revisions of certain genera, out of systematic order, beginning with the foliose and fruticose lichens.

My lichen collections from 1953 amount to some 12 000 numbers. In addition to this material, I have been able to include a considerable number of lichens, mainly undetermined and collected by other botanists, especially from the herbaria at Cape Town, Pretoria and the British Museum in London. Very valuable collections from S. Africa were also placed at my disposal by Professor O. A. HÖEG, Oslo (from 1929—1930), Dr. R. A. MAAS GEESTERANUS, Leiden (from 1949), Dr. S. ARNELL, Uppsala (from 1951) and Dr. LUCIE KOFLER, Grenoble (from 1962—1964). The total number of specimens available for this study is about 30 000.

I have visited most herbaria, where specimens of lichens from S. Africa (especially types) are preserved, and I have had a major part of this material on loan. A survey of the herbaria that contain lichen collections of importance from S. Africa is given below.

Collections of Lichens from South Africa

Berlin. Botanisches Museum (B). Most old lichen collections lost. Some material (e.g., leg. H. WILMS) refound. Recent collections from S. Africa (leg. R. KRÄUSEL: cf. MATTICK 1956 p. 490) and S.W. Africa (leg. E. JENSEN).

Budapest. Museum of Natural History, Dept. of Botany (BP). Some collections by HÖEG (det. GYELNIK, SZATALA and VERSEGHY). Cf. VERSEGHY 1963 p. 579.

Cambridge, Mass. U.S.A. Farlow Herbarium (FH). Collections by C. S. WRIGHT et al. (det. TUCKERMAN).

Cape Town. Bolus Herbarium (BOL). Collections by A. V. DUTHIE, E. ESTERHUYSEN, S. GARSIDE, F. M. LEIGHTON, R. MARLOTH, N. S. PILLANS, E. A. SCHELPE et al.

— Kirstenbosch Botanical Gardens, including the Herbarium of the South African Museum (SAM). Several old collections, e.g., herb. PAPPE.

Genève. Conservatoire Botanique (G). Collections by, e.g., J. F. DRÈGE, H. WILMS, H. SCHINZ (det. J. MÜLLER ARG.), and H. A. JUNOD (det. J. STEINER).

Glasgow. Department of Natural History, Glasgow Art Gallery and Museums (GLAM). Herb. J. STIRTON. (Cf. under London).

Helsinki. Botanical Museum of the University (H). Herb. E. ACHARIUS and W. NYLANDER.

Kew. Botanical Gardens (K). Collections by, i.a., J. F. DRÈGE, C. F. ECKLON, K. ZEYHER, A. EATON, P. MACOWAN, C. S. WRIGHT, F. WILMS, and L. J. BRASS.

Leiden. Rijksherbarium (L). Collections by R. A. MAAS GEESTERANUS.

Lisbon. Institute of Botany, Fac. of Science (LISU). Collections from Angola (F. WELWITSCH et al.) and Portuguese East Africa.

London. Dept. of Botany, British Museum (BM). Collections by ECKLON, ZEYHER, DRÈGE, WELWITSCH (det. VAINIO), EATON (det. NYLANDER, ed. CROMBIE), MACOWAN (det. STIRTON), P. A. V. D. BYL (det. A. L. SMITH), GARSIDE, PILLANS, SCHELPE et al. Herb. STIRTON (in part).

— Linnean Society (LINN). Herb. LINNAEUS and LINNAEUS fil. Some collections by THUNBERG.

Lund. Botaniska museet (LD). Collections by ALMBORN and KOFLER.

München. Botanische Staatssammlung (M). Collections by BREUTEL, H. JELINEK, GUEINZIUS, WAWRA et al. Herb. KREMPELHUBER.

Pietermaritzburg. Dept. of Botany, University of Natal (NU). Collections by COMINS, KILLICK, SCHELPE et al.

Pretoria. Div. of Botany, National Herbarium (PRE). Numerous collections, mostly undetermined.

Salisbury. Southern Rhodesia Government Herbarium (SRGH). Collections by F. EYLES, H. WILD et al.

Stellenbosch. Dept. of Botany including Herb. V.D. BYL (STE-VB).

Stockholm. Dept. of Botany, Riksmuseum (S). Collections by THUNBERG, BREUTEL, DRÈGE, ECKLON, ZEYHER, J. A. WAHLBERG, J. F. VICTORIN et al.

Trondheim. Dept. of Botany, Museum (TRH). Collections by HÖEG.

Turku (Åbo). Dept. of Botany, University (TUR). Collections by WELWITSCH, V. D. BYL et al. (det. VAINIO).

Uppsala. Dept. of Systematic Botany (UPS). Herb. THUNBERG (main collection, det. ACHARIUS). Some later collections by, i.a., WAHLBERG, VICTORIN, G. DE WYLDER, F. LJUNGQVIST and R. E. FRIES.

— Institute of Plant Ecology (Växtbiologiska Institutionen) (UPSV). Collections by J. ÖRTENDAHL and S. ARNELL.

Verona. Museo Civico di Storia Naturale (VER). Collections by BREUTEL, ECKLON, ZEYHER and WAWRA (det. A. MASSALONGO).

Wien. Naturhistorisches Museum (W). Collections by, i.a., WAWRA (det. MASSALONGO), JELINEK, FINCKE, MARLOTH, GUEINZIUS, F. & R. WETTSTEIN, J. B. LESLIE, J. BRUNNTHALER and v. D. BYL (all det. ZAHLBRUCKNER).

— Botanisches Institut der Universität (WU). Collections by MENYHARTH (det. MÜLLER ARG.).

Zürich. Institut für spezielle Botanik der Eidgen. Technischen Hochschule (ZT). Collections by ECKLON, BREUTEL, A. MACLEA, MACOWAN, A. REHMANN, WILMS et al. (all det. STIZENBERGER).

A detailed list of botanists who have collected lichens in southern Africa will be published in a later paper.

Lichen Specialists Consulted

Specialists in certain lichen groups have kindly undertaken revisions of some genera. It is evident, however, that several groups, for which there are currently no specialists, e.g., *Graphidineae*, *Lecideaceae*, and *Lecanoraceae*, will need much more research before any results can be published.

The groups and specialists in question are:

Acarospora (W. A. WEBER, Boulder, Colo., U.S.A.).
Anaptychia (S. KUROKAWA, Tokyo, Japan).
Buellia (H. A. IMSHAUG, East Lansing, Mich., U.S.A.).
Caliciaceae (A. SCHMIDT, Hamburg, Germany).
**Cladonia* (H. DES ABBAYES, Rennes, France).
Collema (G. DEGELIUS, Gothenburg, Sweden).
Foliicolous lichens (R. SANTESSON, Uppsala, Sweden).
Leptogium, sect. *Mallotium* (M. MITCHELL, Galway, Ireland).
**Lichinaceae*, and other "cyanophilous lichens" (AINO HENSSEN, Marburg, Germany).
**Parmelia* (M. E. HALE, Washington, D.C., U.S.A., and S. KUROKAWA, Tokyo).
Peltigera (P. O. LINDAHL, Uppsala, Sweden).
Physcia (D. D. AWASTHI, Lucknow, India).
Ramalina (A. H. MAGNUSSON, [†], Gothenburg, Sweden).
Siphula (R. SANTESSON, Uppsala, Sweden).
Stictaceae (P. W. JAMES, London, England).
Umbilicaria (E. FREY, Bern, Switzerland, and G. A. LLANO, Washington, D.C., U.S.A.).
Usnea (J. MOTYKA, Lublin, Poland).

With the aid of these specialists, it will be possible to complete the lichen flora within a reasonable time.

*Some results published. See Literature cited, p. 111.

Survey of my Collecting in 1953

I arrived in Cape Town on July 11th and left on Dec. 18th. The main features of my itinerary are given in the table below and in the map (Fig. 1.).

Date		Division		Station	Collection Nos.
July	12	Wynberg	Cape	Main road Newlands — Rondebosch, road-side trees (mainly *Quercus*)	fu 1, br 2, li 3—6, br 7—13 [1]
,,	12	,,	,,	Ibid., stonewall near Main Road	br 14—16
,,	16	,,	,,	Location E. of Kirstenbosch Botanical Garden, on *Quercus*	br 17—22, 57, li 23—52, fu 53—56
,,	16	,,	,,	Parking place in Kirstenbosch Bot. Garden, trunks and twigs of oaks	br 58—64, li 65—102, 104—110
,,	16	,,	,,	Ibid., smooth bark (*Brabeium*, etc.)	fu 103, li 111—120
,,	17	,,	,,	Kirstenbosch Bot. Garden, near tea-room, boulders in rock garden	li 121—133
,,	17	,,	,,	Ibid., just above tea-room, near Skeleton Stream, trees (*Quercus, Brabeium*, etc.)	li 133a—140, 143—147, 149—183, 189—249 br 141, 142, 148, 184—188, 250, 251
,,	17	,,	,,	Ibid., boulders near stream	li 252—290
,,	18	,,	,,	Ibid., on *Quercus* and *Brabeium*	li 291—351, 359—382, 403—439, br 352—358
,,	18	,,	,,	Ibid., boulders near stream	li 383—400, br 401, 402
,,	19	Bellville	,,	Melkbosch Strand, dunes	ph 1—39
,,	19	,,	,,	Ibid., shrubs (*Euphorbia, Putterlickia*, etc.) in dunes	li 440—445, 447—455, 457—475, br 446, fu 456
,,	19	,,	,,	Ibid., marine rocks (scanty lichen vegetation)	li 476
,,	19	,,	,,	Blaauwberg Strand, marine rocks (rich lichen vegetation)	li 477—506
,,	20	Wynberg	,,	Kirstenbosch, along Skeleton Stream up to c. 1000', oaks	fu 507, br 508—512, 538, 539 li 513—537, 540—546
,,	20	,,	,,	Ibid., rocks	li 547—560, 569—593, 616—634
,,	20	,,	,,	Ibid., rocks in the stream	li 561—567, br 568, 635—638
,,	20	,,	,,	Ibid., dry ground near tree limit, c. 1000—1500'	ph 39a—51
,,	20	,,	,,	Ibid., trees and shrubs	li 594—615
,,	22	,,	,,	Kirstenbosch, Old Hostel, rocks near Window stream	li 639—804
,,	22	,,	,,	Ibid., old oaks	li 805—812
,,	22	,,	,,	Ibid., twigs of shrubs	li 813—828
,,	23	Cape	,,	Camps Bay Road, near Kloof Nek, c. 600', rocks	li 829—864
,,	23	,,	,,	Above Round House, near Kloof Nek, c. 400', mainly rocks	li 865—914

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[1] al=algae, br=bryophytes, fu=fungi, li=lichens, ph=phanerogams and ferns.

Date		Division		Station	Collection Nos.
July	23	Cape	Cape	Ibid., stone-wall	br 915
,,	23	,,	,,	Hottentots Huise (S. of Camps Bay), rocks near shore	li 916—966, br 967
,,	24	Wynberg	,,	Kirstenbosch, above Old Hostel, near Window Stream, rocks	li 968—999, br 1025—1039, 1045
,,	24	,,	,,	Ibid., oak trunks	li 1000—1022, 1040—1044, 1046, br 1023, 1024
,,	24	,,	,,	Ibid., smooth bark (*Brabeium*, etc.)	li 1048—1103
,,	24	,,	,,	Ibid., shrubs	li 1104—1149
,,	24	,,	,,	Ibid., along Window Stream	ph 52—55
,,	25	,,	,,	Near Witsandsbay, by road-side	ph 56—67
,,	25	,,	,,	Kommetjie, on *Acacia*	li 1150—1167
,,	25	,,	,,	Ibid., marine rocks	li 1168—1183
,,	25	,,	,,	Witsandsbay, on *Acacia* and *Rhus*	li 1184—1193
,,	25	,,	,,	Ibid., stone-posts and rocks by road-side	li 1194—1288, 1290—1332 br 1289
,,	29	,,	,,	Kirstenbosch, near Window Stream,	ph 68—71
,,	29	,,	,,	Ibid., oaks	li 1333—1424, 1427, br 1425, 1426
,,	29	,,	,,	Ibid., rocks	li 1428—1492, br 1493
,,	30	,,	,,	Southern Cross Estate (between Kirstenbosch and Hout Bay), oaks	li 1494—1541, fu 1542
,,	30	,,	,,	Ibid., rocks	li 1543—1549
,,	30	,,	,,	Chapman's Point, steep rocks by road	li 1550—1573
,,	30	,,	,,	Nordhoek, on *Populus* by road	li 1574—1578
,,	31	,,	,,	Kirstenbosch, near Protea Garden	ph 72—76, li 1579
,,	31	,,	,,	Ibid., leaves of *Protea*	fu 1580—1600
,,	31	,,	,,	Ibid., on *Acacia* and *Euphorbia*	li 1601—1625
Aug.	1	Simonstown	,,	Smitswinkelbay, rocks	li 1629—1633
,,	1	,,	,,	Rooihogte, rocks	li 1634—1638
,,	1	,,	,,	Cape of Good Hope, dry ground	ph 77—94
,,	1	,,	,,	Ibid., marine rocks	li 1639—1668
,,	2	Wynberg	,,	Groot Constantia, on *Calodendron*	li 1669, 1670
,,	3	,,	,,	Kirstenbosch, near Window Stream, rocks	li 1671—1721
,,	4	Cape	,,	Table Mt., near Upper Cableway station, rocks and soil	li 1722—1762
,,	4	,,	,,	Ibid., twigs of small shrubs	li 1763—1766
,,	5	,,	,,	Along Blinkwater Ravine	ph 95—116
,,	5	,,	,,	Ibid., mainly rocks	li 1767—1891
,,	9	,,	,,	Table Mt., near Upper Cableway Station, mainly rocks and soil	li 1892—1944, 1946—1957 br 1945
,,	10	Stellenbosch	,,	Jonkershoek, rocks and trees	li 1958—1984
,,	11	Paarl	,,	Between Helshogte and Franschhoek, oaks by road	li 1985—2008, 2011, 2012, fu 2009, 2010
,,	11	,,	,,	Fransch Hoek, wet ground near road	ph 117—131, li 2013—2017

Date		Division		Station	Collection Nos.
Aug.	11	Paarl	Cape	Between Fransch Hoek and Villiersdorp, rocky ground by road, c. 1800'	ph 132—136 li 2018—2024
,,	11	Caledon	,,	10 miles E. of C., roadside just W. of Riviersonderend	ph 137—159
,,	11	,,	,,	Ibid., oak by road	li 2025—2062, br 2063
,,	11	Swellendam	,,	Between Stormsvlei and Sw., rocks by road	li 2064—2082
,,	12	,,	,,	Garden in the N. part of Sw., old oaks	li 2083—2116, br 2117—2119
,,	12	,,	,,	Ibid., shrubs	li 2120—2150
,,	12	,,	,,	Ibid., trees (smooth bark)	li 2151—2173
,,	12	,,	,,	Grootvadersbosch (W. of Zuurbrak), on *Acacia*, etc.	li 2174—2230, 2236—2270, br 2231—2235
,,	12	,,	,,	Ibid., rocks	li 2271, 2272
,,	13	Riversdale	,,	Just W. of Albertinia, roadside	ph 160—182
,,	13	Mossel Bay	,,	Just E. of M. B., sea-shore	ph 183—184, al 185
,,	13	,,	,,	Ibid., marine rocks	li 2273—2295
,,	13	George	,,	Outeniqua Pass, c. 2400', wet rocks on the W. side of road	ph 186 li 2296—2314
,,	13	,,	,,	Ibid., trees (smooth bark)	li 2315—2345, br 2346
,,	14	,,	,,	Main road 7 miles E. of G., ravine near bridge, flat rocks	li 2347—2399
,,	14	,,	,,	Between Wilderness and Knysna, roadside	ph 187—189
,,	14	Knysna	,,	Coney Glen, opposite "The Heads", steep rocks near shore	li 2400—2596
,,	15	,,	,,	Knysna Forest, 6 miles N. of Kn., road to Uniondale, trees (*Quercus, Acacia*, etc.)	li 2597—2839 (except br 2658, 2672, 2687, 2698)
,,	15	,,	,,	Deepwell Forest, 10 miles N. of Kn.	ph 190—198
				Ibid., smooth bark	li 2840—2874
,,	16	,,	,,	Keurboomsrivier, small forest near shore	ph 199—214
,,	16	,,	,,	Ibid., trees (mainly smooth bark)	li 2875—2964, fu 2965—2969
,,	16	,,	,,	Ibid., rocks by shore	li 2970—2983
,,	16	,,	,,	Plantation between Kn. and Plettenberg Bay, on *Pinus radiata*	li 2984—3013
,,	18	,,	,,	Coney Glen (see above), near tea-house, rocks and trees	li 3014—3031, 3033—3082, br 3032
,,	18	,,	,,	Deepwall Forest (see above), smooth bark	li 3083—3153, br 3154—3157
,,	18	,,	,,	Ibid., on *Pinus radiata*	li 3158—3188
,,	19	,,	,,	Gouna Forest	ph 215—248
,,	19	,,	,,	Ibid., trees (mainly smooth bark and leaves)	li 3189—3303, br 3304, 3305, fu 3306—3314
,,	21	,,	,,	Buffelsnek Forest and Deepwalls, mainly smooth bark	li 3315—3542 (except 3377—3379, 3409), fu 3543—3547 br 3377—3379, 3409, 3548—3558

Date		Division		Station	Collection Nos.
Aug.	22	Paarl	Cape	Garden of Eden, trees (smooth bark and leaves)	li 3559—3567, 3570—3614 fu 3568, 3569, br 3615—3617
,,	22	,,	,,	"Nature's Valley", E. of Grootrivier Pass, trees	li 3618—3636, br 3637
,,	23	Humansdorp	,,	Stormsrivier, indigenous forest 1 mile E. of St., trees	li 3638—3676, br 3677—3680
,,	23	,,	,,	Ibid., 3 miles E. of St., trees	li 3681—3722
,,	23	,,	,,	Ibid., 5 miles E. of St., trees	li 3723—3743, fu 3744, 3745
,,	23	,,	,,	Ravine by bridge over Blaauwkrantzrivier, rocks	li 3746—3790
,,	24	,,	,,	Stormsrivier, Tzitzikama Forest, 2—3 miles N. of St., near "The Big Tree" (*Podocarpus falcata*), trees (bark and leaves)	li 3791—3937 (except fu 3863, 3864, br 3865—3876, 3905, 3906)
,,	24	,,	,,	Stormsrivier, coastal shrub forest, indigenous trees (bark and leaves)	li 3938—4005 (except fu 3953, 3954), br 4006
,,	26	Albany	,,	Dassies Krantz (nature reserve near Grahamstown), trees (bark and leaves)	li 4007—4048, 4051—4053, fu 4049, 4050
,,	26	,,	,,	Fern Kloof (near Gr.), wet ground	br 4054—4064
,,	26	,,	,,	Grahamstown, near a Students' Residence	ph 249
,,	27	Uitenhage	,,	Near Coega, Karro vegetation	ph 250—270
,,	27	,,	,,	Ibid., shrubs	li 4065—4125
,,	28	Humansdorp	,,	Stormsrivier, old oaks	li 4126—4154
,,	28	,,	,,	Ibid., on *Acacia melanoxylon* (bark and leaves)	li 4155—4167, fu 4168
,,	28	,,	,,	Near Stormsrivier Pass	ph 271—280
,,	30	Oudtshoorn	,,	Karroo vegetation 4 miles S.S.E. of O., dry ground	ph 281—284, li 4169—4278
,,	30	,,	,,	Ibid., shrubs	li 4279—4290
,,	31	,,	,,	Cango Caves, clay wall near the entrance (very dark situation)	br 4291
,,	31	,,	,,	Karroo vegetation 4 miles N. of Cango Caves, on *Acacia* shrubs and stony ground	li 4292—4326
,,	31	,,	,,	Zwartberg Pass, 4 miles S. of top of pass (4000'), rocks near road	ph 286, 287, li 4327—4360
,,	31	,,	,,	Ibid., rocks near top (5500')	li 4361—4377
,,	31	Prince Albert	,,	N. part of Zwartberg Pass, near "Cathedral Rock", steep rocks (often dominated by *Dermatiscum thunbergii*)	li 4378—4388
,,	31	,,	,,	Karroo vegetation just N. of P.A.	ph 285
Sept.	1	,,	,,	8 miles S.E. of Prince Albert Road, sandy ground near main road	ph 288—297
,,	1	Laingsburg	,,	20 miles N.E. of L., sandy ground by main road	ph 298—303
,,	1	,,	,,	5 miles S.W. of Touws River, sandy ground by main road	ph 304—306

Date		Division		Station	Collection Nos.
Sept.	1	Worcester	Cape	Just S.W. of De Doorns, sandy ground by main road	ph 307—318
,,	5	Cape	,,	Camps Bay, near Blinkwater Stream, *Prionium* swamp by roadside	ph 319—365
,,	5	,,	,,	Roadside near Kloof Nek, rocks	li 4389, 4390
,,	5	,,	,,	Camps Bay, opposite Caltex garage, boulders near shore	li 4391—4477
,,	7	Wynberg	,,	Rondebosch Common, sandy ground	ph 366—417
,,	8	,,	,,	Ibid.	ph 417—421
,,	11	Malmesbury	,,	5 miles N. of M., roadside	ph 422—440
,,	11	Piquetberg	,,	7 miles S.W. of Citrusdal, ravine near road to Eendekuil	ph 441—453
,,	11	,,	,,	Ibid., shrubs and rocks	li 4478—4491, br 4492
,,	11	Clanwilliam	,,	5 miles S.W. of Citrusdal, roadside	ph 454—457
,,	11	,,	,,	3 miles S.W. of Citrusdal, N. side of the pass, roadside	ph 458—462
,,	11	,,	,,	Ibid., rocks	li 4493—4504
,,	12	,,	,,	Orchard in Cl., on *Vitis*	li 4505a
,,	12	,,	,,	Pakhuis Pass, 3 miles N.E. of Cl., Karroo vegetation	ph 463—465, 468—471
,,	12	,,	,,	Ibid., rocks near road	li 4505—4581
,,	12	,,	,,	4 miles S. of Cl., rocks and naked soil between road and Olifants River	ph 466, 467, li 4582—4632
,,	12	Van Rhynsdorp	,,	Van Rhyns Pass (30 miles N.E. of Van Rhynsdorp)	ph 472—490
,,	12	,,	,,	Ibid., rocks	li 4633—4675
,,	12	,,	,,	30 miles N. of V.R., roadside	ph 491—494
,,	14	Namaqualand	,,	4 miles N.W. of Garies, roadside	ph 495—501
,,	14	,,	,,	Hondeklip Bay, N. of harbour, dunes	ph 502—520
,,	14	,,	,,	Ibid., at sea-shore, shrubs	li 4676—4709
,,	14	,,	,,	10 miles N.W. of Garies, on *Acacia* by road	li 4710—4739
,,	15	,,	,,	15 miles S. of Springbok, dry rocky ground dominated by *Aloe dichotoma*	ph 521—526
,,	15	,,	,,	O'okiep, roadside in town	ph 527—534
,,	15	,,	,,	Between O'okiep and Springbok, roadside	ph 535, 536
,,	15	,,	,,	Ibid., rocks and dry ground by road	li 4740—4810
,,	16	,,	,,	1 mile N. of Kamieskroon, rocky ground W. of road	ph 537, 538
,,	16	,,	,,	Ibid., rocks and shrubs	li 4811—4871
,,	16	,,	,,	12 miles S. of Kamieskroon, rocks E. of road	li 4872—4894
,,	16	Van Rhynsdorp	,,	2 miles N. of Nieuwerust, rocks and shrubs W. of road	li 4895—4942
,,	17	Clanwilliam	,,	9 miles S. of Clanwilliam, rocks and sandy ground E. of road	ph 539, 540, li 4943—4967
,,	17	Hopefield	,,	Saldanha Bay, rocks by Saldanha hotel, near shore	li 4968—4985

Date	Division		Station	Collection Nos.
Sept. 17	Hopefield	Cape	Ibid., rocks and shrubs up to 60' alt.	li 4986—5038
,, 17	,,	,,	E. of Saldanha, rocks near shore	li 5039—5042
,, 17	,,	,,	Between Langebaan Road and Hopefield, roadside	ph 541, 542
,, 19	Wellington	,,	Bains Kloof, road to Worcester, sandy ground	ph 543—567
,, 19	,,	,,	Ibid.,near stream E. of Botanical Station, wet rocks	li 5043—5092
,, 20	,,	,,	Bains Kloof, along stream	ph 568—581
,, 20	,,	,,	Ibid., rocks and shrubs	li 5093—5169 (except br 5143, 5144, 5166, 5167)
,, 21	,,	,,	Bains Kloof. 4 miles N. of hotel, wet rocks	li 5170—5229, br 5230—5245
,, 21	,,	,,	Ibid., 5 miles S. of hotel, dry ground and rocks	ph 581a—588, li 5246—5257
,, 23	Stellenbosch	,,	Platklip, dry ground	ph 589—599
,, 23	,,	,,	Ibid., flat rocks	li 5258—5290, br 5291
,, 23	,,	,,	Stellenbosch Flats, sandy soil and sandstone rocks	ph 600—619, li 5292—5346, br 5347, 5348
,, 25	Wynberg	,,	Groot Constantia, oaks	li 5349—5370
,, 25	,,	,,	Kirstenbosch Bot. Garden, stonewall near parking place	li 5371—5387
,, 26	Paarl	,,	Paarl Rock, c. 1300', trees and soil	ph 620—634, fu 5388—5391, li 5392—5401, 5403—5415, br 5402, 5416—5418
,, 26	,,	,,	Ibid., near top, c. 2300', rocks and trees	li 5419—5564 (br 5461)
,, 27	Wynberg	,,	Long Kloof (between Constantia Nek and Hout Bay), oaks by roadside	li 5565—5598
,, 29	Caledon	,,	Between Albertyn and Aldaksrivier (N.W. of Hermanus), roadside	ph 635—647
,, 29	,,	,,	Hermanus, marine rocks in town	li 5599—5640
,, 29	,,	,,	Mossel Rivier, shore, marine rocks	ph 648—651, li 5641—5725
,, 29	,,	,,	3 miles E. of Mossel Rivier, wet ground by a cave	ph 652—658
,, 29	,,	,,	Ibid., rocks and trees	li 5726—5762
Oct. 1	Laingsburg	,,	9 miles S.W. of L., rocks near main road	li 5763—5778
,, 2	Victoria West	,,	Three Sisters, roadside	ph 659—666
,, 2	,,	,,	Ibid., rocks	li 5779—5787
,, 3	Philippolis,	O.F.S.	20 miles N. of Ph., rocks by road	li 5788—5800
,, 3	Trompsburg	,,	Just N. of Tr., rocks by road	li 5801—5828
,, 3	Ventersburg	,,	Just N. of V., rocks by road	li 5829—5847
,, 3	Vredefort	,,	Oudewerpspruit, rocks by road	li 5848—5877
,, 5	Pretoria,	Transv.	Zoological Garden in P., trees	li 5877—5883
,, 6	,,	,,	Near National Herbarium in P., trees	li 5884, 5885, al 5886
,, 7	Waterberg	,,	2 miles N. of Warmbad, trees near road	li 5887—5912
,, 8	Zoutpansberg	,,	Hills E. of "Punchbowl Inn", 9 miles N. of Louis Trichardt, c. 4500', rocks and trees	li 5914—6233, 6243—6285, 6287—6348, br 5913, 6234—6242, 6286, 6349—6355

Date	Division	Station	Collection Nos.
Oct. 8	Zoutpansberg, Transv.	Hills E. of "Punchbowl Inn"	ph 667, 667a
,, 9		Hanglip Forest, 5 miles N.W. of Louis Trichardt, c. 5000', trees	li 6356—6381, 12000—12180, al 12181, br 6382—6400, 12182—12190
,, 10	,, ,,	Overwinning, dry soil	ph 672—674
,, 10	,, ,,	Between O. and Wyllies Poort, trees	li 6401—6409
,, 10	,, ,,	Wyllies Poort, by a stream	ph 668—671
,, 10	,, ,,	Ibid., rocks	li 6410—6429
,, 10	,, ,,	Punchbowl Inn, cultivated trees in garden	li 6430—6477, br 6478, 6479
,, 11	,, ,,	E. of Punchbowl Inn (=Oct. 8), mountain slopes	ph 675—677
,, 11	,, ,,	Ibid., rocks and trees	li 6480—6603, 6608—6629, br 6604—6607
,, 11	,, ,,	Hanglip Forest (=Oct. 9), rocks and trees	li 6630—6675, br 6676—6681
,, 12	Pietersburg ,,	Munnik (36 miles N.E. of P.), trees	li 6682—6692
,, 12	Letaba ,,	8 miles N. of Tzaneen, rocks and trees	li 6693—6700, 6703—6719, br 6701, 6702
,, 12	,, ,,	Houtbosch, 6 miles N. of Tzaneen, rocks	li 6720—6766
,, 12	,, ,,	Houtbosch, trees near road	li 6767—6792, br 6793—6795
,, 12	,, ,,	"Forest Drive" between Houtbosch and Tzaneen, rocks, trees and naked soil	li 6796—6820, 6828—6850, br 6821—6827, 6851
,, 15	Nelspruit ,,	Kruger National Park, near Crocodile Bridge, dry soil	ph 678—685
,, 16	Barberton ,,	Komati River, ± wet rocks	li 6852—6858
,, 16	Sul do Save Moç.	Polana Beach, 8 km. W. of Lourenço Marques, trees near shore	li 6859—6875
,, 17	,, ,,	Lourenço Marques, near Hotel Clubo, trees	li 6876—6883
,, 17	,, ,,	3 km. N. of Vila Luiza, (N. of L.M.), trees in a garden	li 6884—6927
,, 17	,, ,,	18 km. S. of Manhica, trees in orchard near road	li 6928—6955, br 6956—6961
,, 17	,, ,,	20 km. N. of Manhica, trees near road	li 6962—6980
,, 18	,, ,,	8 km. E. of Impamputo (W. of L.M.), trees and rocks near road	li 6981—7105 (fu 7054, 7079—7081)
,, 18	,, ,,	2 km. E. of Namaaqua, on cultivated *Cupressus*	li 7106—7167, al 7168, br 7169—7179
,, 18	,, ,,	Between Boane and Namaaqua, near roadside	ph 686—696
,, 18	,, ,,	Lourenço Marques, Botanical Garden, trees	li 7180—7211, br 7212—7214
,, 20	Nelspruit Transv.	Gladde Spruit (just W. of Nelspruit), rocks in stream near bridge	li 7215—7224

Date		**Division**		**Station**	**Collection Nos.**
Oct.	20	Nelspruit	Transv.	20 miles S.E. of Lydenburg, roadside	ph 697—708
,,	20	,,	,,	Ibid., trees and rocks	li 7225—7291, br 7292—7298
,,	20	Lydenburg	,,	14 miles S.E. of L., trees and rocks	li 7299—7386
,,	20	,,	,,	10 miles S.E. of L., roadside	ph 709—720
,,	20	,,	,,	Ibid., trees and rocks	li 7387—7434
,,	21	,,	,,	Wet indigenous forest 5 miles E. of Mokobulaan Forest Station, c. 6800', steep slopes	ph 721—740
,,	21	,,	,,	Ibid., rocks and trees in the forest	li 7435—7785, fu 7786, 7787, br 7788—7799
,,	22	Pilgrims Rest	,,	The Berg, 5 miles W. of P.R., c. 5400', dry ground near road	ph 741, 742
,,	22	,,	,,	4 miles S.E. of P.R., rocky ground near road	ph 743—761
,,	22	,,	,,	Ibid., rocks	li 7800—7838
,,	22	,,	,,	Mac-Mac Falls N. of Sabie, dry ground	ph 762—776
,,	22	,,	,,	Just S. of Sabie, rocky ground	ph 777
,,	23	Barberton	,,	7 miles E. of Havelock, dry ground near top of pass, alt. 6000'	ph 778—784
,,	23	,,	,,	Ibid., rocks	li 7839—7892
,,	23	Peak	Swaziland	Piggs Peak, on *Jacaranda* near police station	li 7893—7922, 7926, br 7923—7925
,,	23	,,	,,	4 miles S. of Piggs Peak, dry ground	ph 785
,,	23	Mbabane	,,	15 miles S. of Piggs Peak, rocks near road	li 7927—7975
,,	24	Paulpietersburg	Natal	Just N. of PPB., near stream	ph 786—791
,,	25	Vryheid	,,	5 miles N. of Vr., dry ground near road	ph 792—794
,,	25	,,	,,	Ibid., steep rock W. of road	li 7976—8038
,,	25	Nkandhla	,,	Indigenous forest S. of Nk.	ph 795—807
,,	25	,,	,,	Ibid., trees (also leaves)	li 8039—8243 (fu 8050, 8051, 8053), br 8244—8270
,,	25	Eshowe	,,	Dense indigenous forest near E., trees (also leaves)	li 8271—8459 (fu 8432, 8436, 8443, 8452), br 8460—8480
,,	27	,,	,,	E., near post office, on *Jacaranda*	li 8481—8491
,,	27	,,	,,	Square in middle of E., trees	li 8492—8522, br 8523, 8524, al 8525
,,	27	Mtunzini	,,	1 mile N. of Tugela River, roadside	ph 808—816
,,	28	Durban	,,	Botanical Garden in D., trees	li 8526—8540
,,	29	Pietermaritzburg	,,	Bisley (4 miles S. of PMB.), "lowveld" with *Acacia*, *Combretum*, etc.	ph 817—845
,,	29	,,	,,	Ibid., trees	li 8541—8545, br 8546—8552
,,	29	,,	,,	Ibid., sandy ground	ph 846—855
,,	30	,,	,,	Natal Table Mt., slopes and summit, dry ground	ph 856—896

Date		Division		Station	Collection Nos.
Oct.	30	Pietermaritzburg	Natal	Natal Table Mt., trees, rocks and soil	li 8553—8583, 8591—8634, br 8584—8590
,,	31	Lions River	,,	Howick, on *Jacaranda* in town	li 8635—8639
,,	31	,,	,,	Boschfontein Forest near Balgowan	ph 897—899
,,	31	,,	,,	Ibid., trees, rocks and naked soil	li 8640—8647, 8650—8791, fu 8792, br 8648, 8649, 8793—8809
,,	31	,,	,,	Caversham Falls, wet rocks in river	ph 900
Nov.	2	Bergville	,,	Just W. of Cathedral Peak Hotel, alt. c. 4500', dry ground	ph 901—912
				Ibid., rocks	li 8810—8833
,,	2	,,	,,	Indumeni Forest (wet indigenous forest c. 1.5 mile S.E. of C.P. Hotel), alt. c. 5500'	ph 913—916
,,	3	,,	,,	Ibid., trees and rocks	li 8834—8902, 8929—9006, 9010—9024, br 8903, 8904, 8906—8928, 9007—9009, 9025, 9026, al 8905
,,	4	,,	,,	Organ Pipes in the Cathedral Peak Mts. (c. 5 miles S. of C.P. Hotel), alt. 6500—9000', dry ground	ph 917—928
,,	4	,,	,,	Ibid., rocks and naked soil (few cryptogams, no *Umbilicaria* or *Usnea*)	li 9027—9113, br 9114—9119
,,	5	,,	,,	1 mile W. of C.P. Hotel, dry ground	ph 929—932
,,	5	,,	,,	Ibid., rocks and shrubs	li 9120—9182
,,	6	,,	,,	Indumeni Forest, alt. c. 6000', dry ground	ph 933—949
,,	6	,,	,,	Ibid., rocks and trees	li 9183—9289, 9304—9373, br 9290—9302
,,	7	,,	,,	Cathedral Peak area, along "Mountain Road" (c. 2 miles S. of Forester's Office), alt. c. 5000', dry ground	ph 950—955
,,	7	,,	,,	Ibid., rocks and trees	li 9374—9401, br 9402—9404
,,	8	Bergville	,,	Oqualweni Forest (2 miles W. of C.P. Hotel), near stream	ph 956
,,	8	,,	,,	Ibid., rocks and trees	li 9405—9459, br 9460—9475
,,	10	Polela	,,	Polela Forest (near Bulwer), on trees	li 9476—9610, 9616—9627, br 9611—9615
,,	10	Pietermaritzburg	,,	14 miles S.W. of PMB., naked soil by roadside	li 9628
,,	12	,,	,,	Botanical Garden, trees	li 9629—9680, br 9681—9684
,,	14	Inanda	,,	Umhlanga Rocks (N. of Durban), marine rocks (very scanty lichen vegetation)	li 9725

Date		Division		Station	Collection Nos.
Nov.	14	Inanda	Natal	Umhlanga Rocks, N. of Durban, trees	li 9685—9724, 9726, 9727
,,	15	Durban	,,	Isipingo Rocks (S. of D.), dense mangrove vegetation near shore	ph 957—973
,,	15	,,	,,	Ibid., marine rocks (few lichens: no *Roccella*, *Xanthoria* or *Caloplaca*)	li 9728—9762 (br 9752)
,,	15	,,	,,	The Bluff, Fynnland, small grove near road, trees and shrubs	li 9763—9804, br 9805—9811
,,	18	Umzinto	,,	Hibberdene (20 miles N. of Port Shepstone), near road	ph 974—976
,,	18	,,	,,	Ibid., rocks and trees	li 9812—9866
,,	18	,,	,,	1 mile N. of Umzumbi, dry ground near road	ph 977—980
,,	18	Port Shepstone	,,	Ibid., trees and naked soil	li 9867—9903
,,	18	,,	,,	Anerley Beach (4 miles N. of P.S.), marine rocks (few lichens: no *Roccella* or *Xanthoria*)	li 9904—9926
,,	19	Alfred	,,	Impetyne Forest (near Weza), (fairly wet indigenous forest), alt. c. 3500'	ph 981—983
,,	19	,,	,,	Ibid., trees (also leaves), rocks and naked soil	li 9927—10204, br 10205—10242
,,	20	,,	,,	Ingele Forest (c. 15 miles E. of Kokstad), trees (also leaves) and rocks	li 10243—10400, (br 10331—10333)
,,	20	Flagstaff	Cape	Near Emagusheni (c. 20 miles S.S.E. of Kokstad), large boulder near road	li 10401—10422
,,	21	Port St. Johns	,,	2 miles N.W. of P. St. J., indigenous forest near road, mainly trees	li 10423—10481, br 10482—10485
,,	21	,,	,,	Ibid., 5 miles from P. St. J., same forest, trees	li 10486—10543, br 10544
,,	21	,,	,,	Ibid., on *Pinus* in avenue near road	li 10545—10569, br 10570
,,	21	,,	,,	Ibid., 8 miles from P. St., J., indig. forest, trees (also leaves)	li 10571—10602, br 10603—10606
,,	21	,,	,,	P.St.J., 1st Beach, marine rocks	li 10607—10651
,,	24	East London	,,	Queen's Park in E.L., trees	li 10652—10660
,,	24	,,	,,	13 miles N.W. of E.L., *Acacias* by road	li 10661—10679
,,	24	,,	,,	2 miles N.W. of Potsdam, boulders near road	li 10696
,,	24	Peddie	,,	17 miles S.W. of Kingwilliamstown, trees (i.a., *Euphorbia*) near road	li 10697—10713, br 10714
,,	24	,,	,,	Along road 5—10 miles N.E. of Peddie, dry ground	ph 984—987
,,	25	Albany	,,	Fern Kloof, indigenous forest	ph 988—1000
,,	25	,,	,,	Ibid., trees (also leaves)	li 10715—10814, 10832—10857, br 10815—10831
,,	25	,,	,,	Near Milne House in Grahamstown, on *Jacaranda*	li 10858—10863

Date		Division		Station	Collection Nos.
Nov.	28	Knysna	Cape	2 miles W. of Blaauw Krantz Pass, indigenous forest near main road, trees	li 10864—10888, br 10889—10899
,,	29	,,	,,	Near "The Heads", dry ground	ph 1001—1002
,,	29	,,	,,	Deepwalls, 12 miles N. of Kn., near "The Big Tree" (*Podocarpus falcata*), indigenous trees	li 10900—10980, 11006—11092, br 10981—11004, 11094—11105, fu 11005, 11093
,,	29	,,	,,	Ibid., dry ground	ph 1003—1013
,,	30	George	,,	2 miles W. of G., roadside	ph 1014—1016
,,	30	Mossel Bay	,,	2 miles W. of M., roadside	ph 1017—1020
,,	30	Riversdale	,,	5 miles W. of Albertinia	ph 1021—1051
Dec.	2	Caledon	,,	Wild Flower Garden in C., rocks and trees	li 11106—11125, br 11126
,,	6	Wynberg	,,	E. slopes of Table Mt. (along Skeleton Stream up to water reservoir), most collections 2000—2500'	ph 1052—1070
,,	6	,,	,,	Ibid., rocks and trees (also leaves)	li 11127—11378 (br 11297—11307)
,,	8	Stellenbosch	,,	Jonkershoek, near Forest Station, dry ground	ph 1071
,,	8	,,	,,	Ibid., rocks and trees	li 11379—11441 (br 11409—11419)
,,	13	Simonstown	,,	N. of Cape Point, between road and shore, sandy ground	ph 1072—1162
,,	13	,,	,,	Ibid., rocks and shrubs near shore	li 11442—11518

N. B. An additional series (nos. 12000—12190) is inserted on Oct. 9th (see above).

Historical Sketch

LINNAEUS (1771 p. 311) was the first to record a lichen from South Africa, viz. *Lichen chrysophthalmus* [now known as *Teloschistes chrysophthalmus* (L.) Th. Fr.] from the manuscripts of the Danish botanist J. G. KOENIG as growing at the Cape of Good Hope ("Caput bonae Spei"). C. P. THUNBERG ("the father of the South African botany") spent 3 years (1772—1775) at the Cape. In his large botanical collections there are also a number of lichens. LINNAEUS fil. (1781 p. 451) described 4 species of lichens from "Cap. bonae spei", viz. *Lichen flammeus* ["e museo D. MONTIN"; now = *Xanthoria flammea* (L.f.) Hillm.], *Lichen viridis* ["leg. Thunb."; now = *Dermatiscum thunbergii* (Ach.) Nyl.], *Lichen verrucosus* ["leg. Thunb."; now = *Siphula*

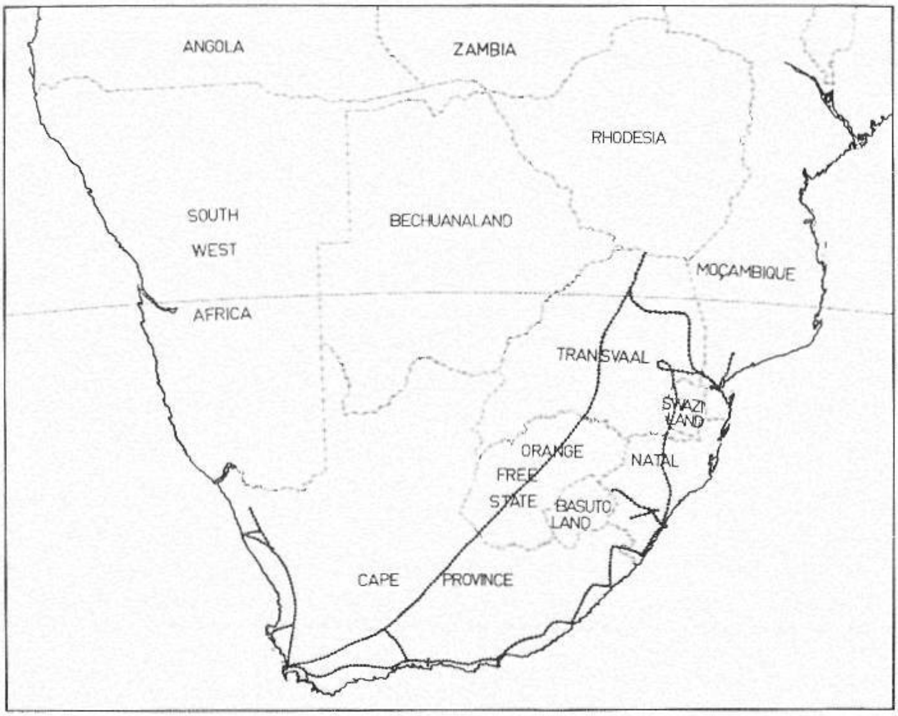

Fig. 1. The author's itinerary in 1953.

verrucigera (J. F. Gmel.) R. Sant.],[2] and *Lichen capensis* ["leg. Thunb."; now=*Teloschistes capensis* (L.f.) Vain. ex Müll. Arg.].

In his fundamental works on the Cape Flora (1800 pp. 175—180, 1823 pp. 741—750) THUNBERG listed a total of 39 lichen species. Most of these were described by E. ACHARIUS (1798, 1803, 1810, 1814). The best material for selecting lectotypes of the THUNBERG lichens is at Uppsala. The THUNBERG herbarium contains 29 species (32

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[2] *Siphula verrucigera* (J. F. Gmel.) R. Sant. ined. — *Lichen verruciger* J. F. Gmelin, C. LINNÉ, Syst. Naturae "Ed. 13". Vol. 2: 2. 1377. 1792 (not 1791, as quoted in ZAHLBR. Cat. Lich. 6. 617. 1930.)

Syn. *Siphula tabularis* (Ach.) Nyl. — *Lichen tabularis* Thunb. ex ACH. Lichenogr. suec. prodrom. 90. 1798 (nom. superfl.)

Lichen verrucosus L. fil., Syst. plant. 451. 1781 is a younger homonym of *L. verrucosus* Huds. Flor. angl. 445. 1762 [=*Pertusaria pertusa* (L.) Tuck. and *P. hymenea* (Ach.) Schaer.], *L. verrucosus* Huds. Flor. angl. ed. 2. 515. 1778 [=*Lobaria scrobiculata* (Scop.) DC.] and *L. verrucosus* Web. Spicil. Flor. Goetting. 273. 1778 [=*Peltigera aphthosa* (L.) Willd.]. The record of a "*Lichen verrucosus* L." (pater) in ZAHLBR. Cat. l.c. is wrong.

specimens) of lichens recorded from S. Africa. (Cf. JUEL 1918 p. 49.) Some THUNBERG material is also in the ACHARIUS herbarium at Helsinki and in a set of Acharian lichens now preserved in the British Museum in London.

For a detailed historic account of the lichenology in S. Africa up to the 1940's, I refer to the important work by DOIDGE (1950 p. 18). Some further information has been added by MATTICK (1956 p. 487).

DOIDGE (l.c. p. 225—376) compiled a fairly complete list of all lichens reported from Southern Africa (up to 15° S), including the present Republic of South Africa, Basutoland, Swaziland, Bechuanaland, S.W. Africa, Rhodesia (formerly S. Rhodesia) and the southern parts of Zambia (formerly N. Rhodesia), Malawi (formerly Nyasaland), Portuguese E. Africa, and Angola. The records were taken from the literature and, to a less extent, from unpublished determinations of material in herbaria in S. Africa (Cape Town, Pretoria, Stellenbosch) and England (British Museum, Kew). All known localities were recorded for each species, and detailed literature references were given. There are, however, no descriptions nor any taxonomic revision of the material. Nevertheless, it is an indispensable account of what was known about the lichen flora of S. Africa up to 1945.

VAN DER BYL (1933 a,b; 1935 a,b) started a series of surveys of some lichen groups in S. Africa, viz. *Roccellaceae, Teloschistaceae, Cladoniaceae, Ramalina,* and *Collemataceae;* in all 73 species. He included keys, short descriptions, records of distribution and ecology, and photographs of the species. His data unfortunately were based on limited material (as a rule determined by STIZENBERGER, MÜLLER ARG., VAINIO, ZAHLBRUCKNER et al.). His descriptions were compiled from various authors, and there is no critical taxonomic revision of the species. VAN DER BYL's papers are still the only attempt at a lichen flora of Southern Africa.

DOIDGE (l.c.) recorded 1159 species, 205 varieties and 92 forms. The number of species is fairly high if we consider that many districts of Southern Africa have no or a scarce tree vegetation and thus lack most of the epiphytic lichens. For comparison may be given some totals from other groups of cryptogams: *Ascomycetes* 835 spp., *Basidiomycetes* 1704 spp. (both sec. DOIDGE l.c.), *Hepaticae* 298 spp. (among them 153 endemes) in the Republic only (sec. ARNELL 1963), *Pteridophyta* c. 300 spp. (communication from Dr. E. A. SCHELPE). Compared to the number of phanerogamic plants, however, about 18000 spp. in the Republic alone, the number of lichens is remarkably low.

It is already evident that at least 200 lichen species hitherto unknown from S. Africa will be added to the flora, but, on the other hand, I believe that taxonomic revisions will reduce the number of species to an even greater extent, so that the total number will probably not exceed 1000.

Some data on the number of localities, in which certain lichen species are known, may be quoted, in order to show how far our knowledge of the South African lichen flora has been extended during the last two decades.

Vague records, as "Cape", "C. B. Sp.", etc., are not included.

	Number of stations sec. DOIDGE 1950	Number of stations known by the present author
Normandina pulchella	2	30
Byssoloma rotuliforme	0	6
Nephroma helveticum	2	22
Dermatiscum thunbergii	5	16
Candelaria concolor	4	69
Parmelia crinita	0	19
— reticulata	1	98
Usnea pulvinata	14	52
Teloschistes capensis	3	35

Phytogeographical Sketch

In spite of our increased knowledge of many species, it is still premature to draw any far-reaching conclusions on the phytogeography of the Southern African lichens. The great majority of lichen species recorded from Southern Africa are imperfectly known as to taxonomy and distribution and cannot be included in any phytogeographical pattern.

It is possible, however, to distinguish some distributional groups. It should be pointed out that they have been selected according to somewhat different principles, and hence they are partly overlapping.

1. Ubiquitous species with a ± worldwide distribution. They are well represented also in South Africa without any distinct phytogeographical tendency, e.g.,

Buellia punctata
Candelaria concolor (fig. 16)
Lobaria pulmonaria
Peltigera canina
Physcia stellaris

A number of lichens common in the N. hemisphere are absent in S. Africa, e.g., *Cladonia rangiferina*, *Parmelia physodes*, *P. sulcata* and

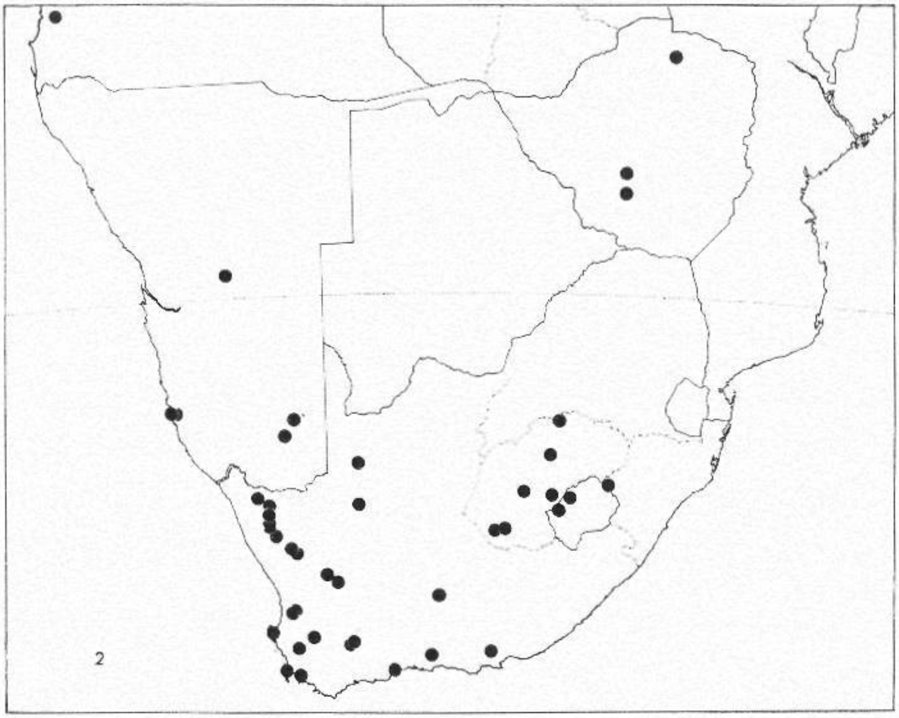


Fig. 2. *Acarospora schleicheri* (Ach.) Mass. World-wide distribution in arid districts, mainly subtropical. Also in S. Europe. Cf. MAGNUSSON 1929 p. 79 and 395 (map).

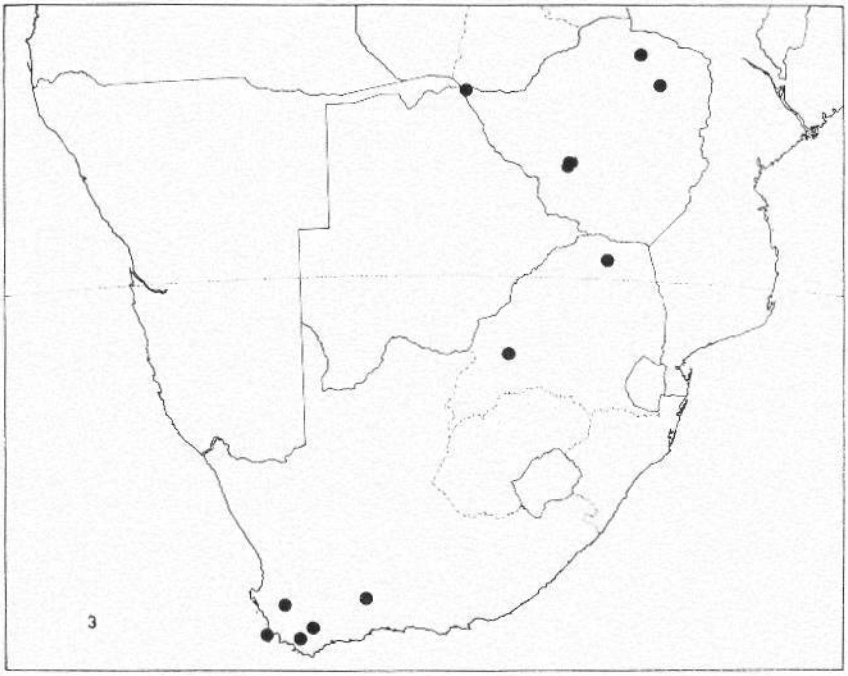
the genera *Cetraria* and *Evernia*. Others are rarely represented, e.g., the genera *Alectoria* and *Stereocaulon*. [LAMB (1953 p. 416) recorded 3 species of *Stereocaulon* from S. Africa.]

2. Steppe and desert species. A considerable number of saxicolous and terricolous species have their distribution concentrated in the arid districts of S.W. Africa, Namaqualand, Kalahari, and Karroo, e.g.,

Acarospora fuscata
— *schleicheri* (fig. 2)
Diploschistes actinostomus
Heppia euploca
Lecidea decipiens
Parmelia hottentotta

Many of them are species characteristic of arid districts in all parts of the world.

3. Montane species, as a rule saxicolous or terricolous, usually met with only at high altitudes, preferably more than 1000 m.s.m., e.g.,



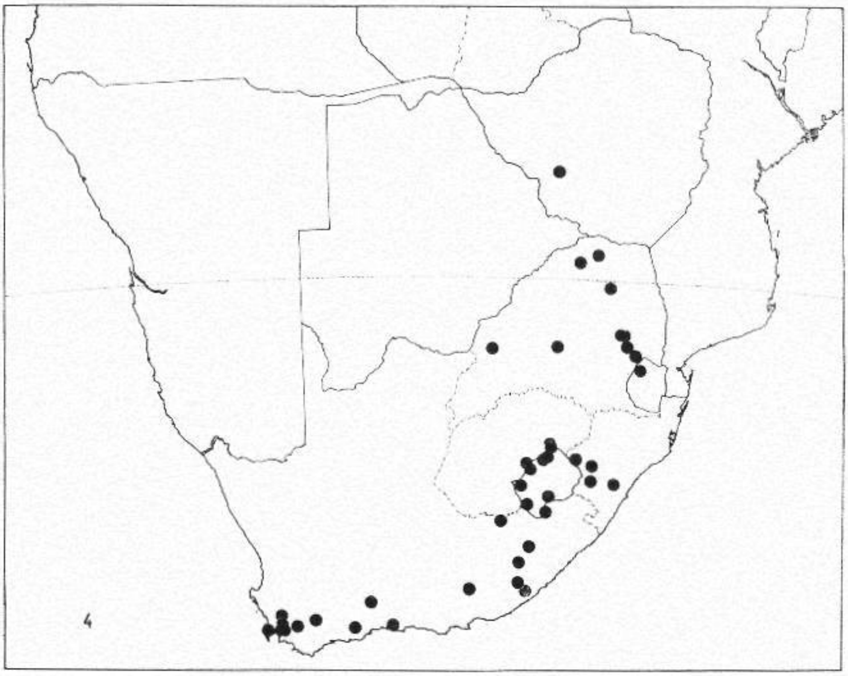


Fig. 3. *Dermatiscum thunbergii* (Ach.) Nyl. Also known from Madagascar.
Fig. 4. *Usnea pulvinata* Fr. Also in Central Africa, Madagascar and Australia.
Cf. MOTYKA 1936—1938 p. 319.

Dermatiscum thunbergii (fig. 3)
Pertusaria leonina
Placopsis gelida (fig. 18)
Rhizocarpon geographicum
Solorina saccata (fig. 17)
Stereocaulon spp. (Cf. LAMB l.c.)
Umbilicaria (s.lat.) spp. (Cf. FREY 1949 p. 425)
Usnea pulvinata (fig. 4)
Xanthoria elegans
— *fallax*

4. Oceanic species, predominant in the ± humid wooded districts in the South and the East, e.g., the slopes of Table Mt., the Knysna district, the Grahamstown district, the S. and E. slopes of the Drakensberg Mts. and the Transvaal Mts. The annual rainfall amounts to c. 800—2000 mm. spread over most part of the year. A considerable number of species belong here, many of them with a ± world-wide distribution in oceanic districts in all parts of the world, e.g.,

Anaptychia leucomelaena
Normandina pulchella (fig. 5)
Pannaria rubiginosa
Parmelia austrosinensis (fig. 7)
— *crinita* (fig. 8)
— *reticulata* (fig. 9)
Pseudocyphellaria aurata
— *crocata*
Sticta fuliginosa
Teloschistes flavicans
Usnea rubiginea (fig. 6)

5. Tropical-oceanic species, mainly restricted to N. Natal (Zululand), E. Transvaal and Moçambique. This district, where sugarcane, pineapple and other important crops are cultivated, has a high mean annual temperature (winters much milder than in the Cape area) and a fairly high annual precipitation. A certain number of lichens belong here, e.g.,

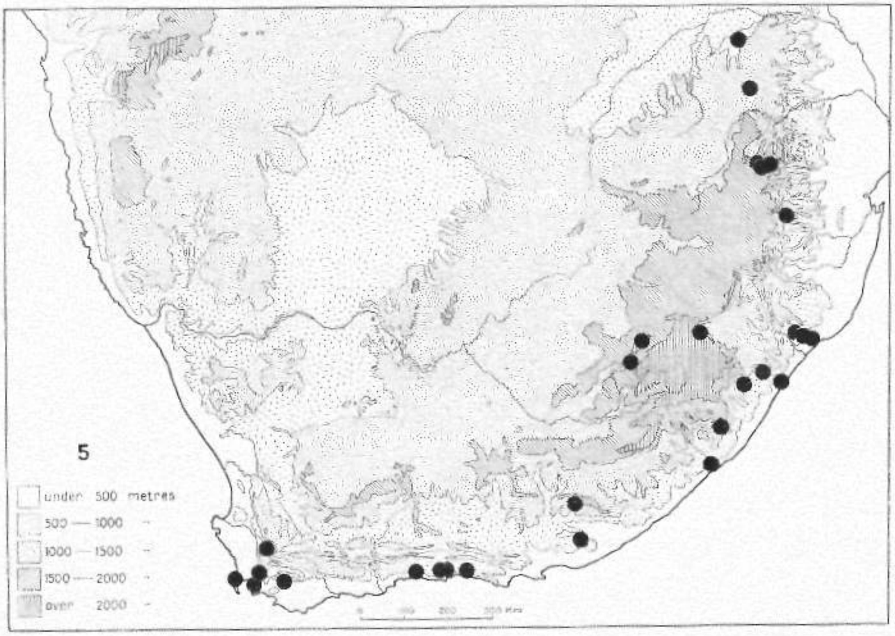
Coccocarpia pellita
Glyphis cicatricosa
Graphina acharii
Gyrostomum scyphuliferum
Parmelia andina (fig. 10)
— *dilatata* (fig. 11)
Strigula elegans (fig. 12)
and other foliicolous lichens.

6. Maritime species, restricted to the marine (or maritime) rocks constitute an ecological group not directly comparable to the previous ones, e.g.,

Caloplaca granulosa
— *sublobulata*
Combea mollusca (fig. 13)
Dirina capensis
Roccella arnoldii
— *hypomecha* (fig. 14)

The endemic species, represented within groups 2—6, afford a number of interesting problems.

Among the 1159 lichen species recorded by DOIDGE, there are 4 genera, viz. *Combea* De Not., *Diploschistella* Vain., *Placothelium* Müll. Arg. and *Placynthiopsis* Zahlbr. (all monotypic), and some 300 species,



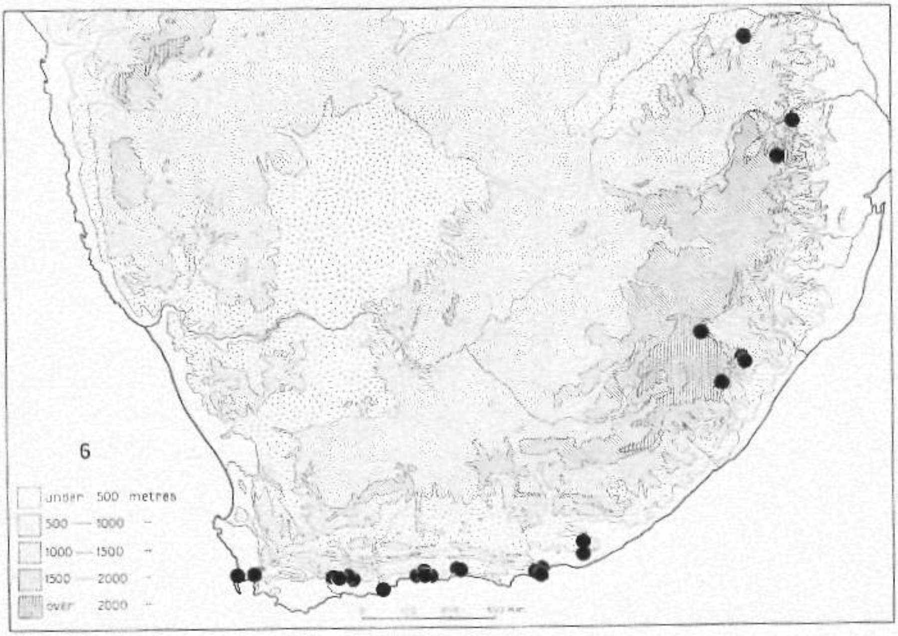
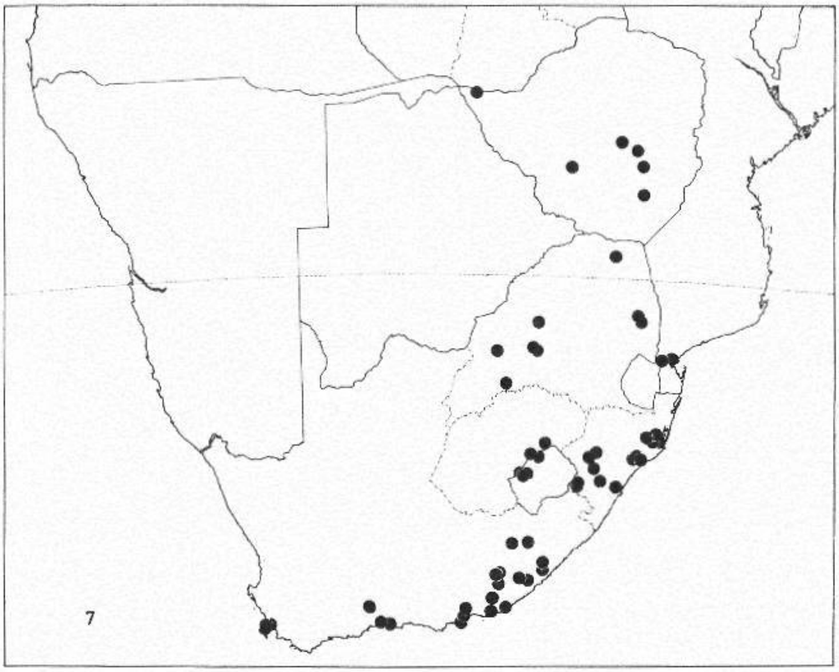


Fig. 5. *Normandina pulchella* (Borr.) Nyl. World-wide distribution, mainly in oceanic—suboceanic districts. Also in W. Scandinavia. Cf. DEGELIUS 1935 p. 101.
Fig. 6. *Usnea rubiginea* (Mich.) Mass. (incl. *U. rubescens* Stirt. and *U. rubicunda* Stirt.) World-wide distribution in oceanic districts. Also in W. Europe. Cf. MOTYKA 1936—1938 p. 342.



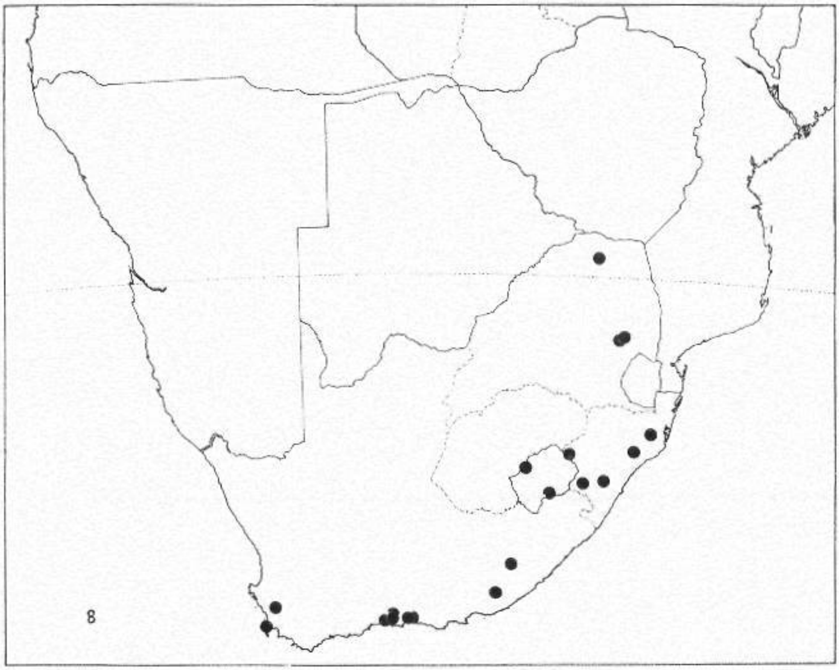
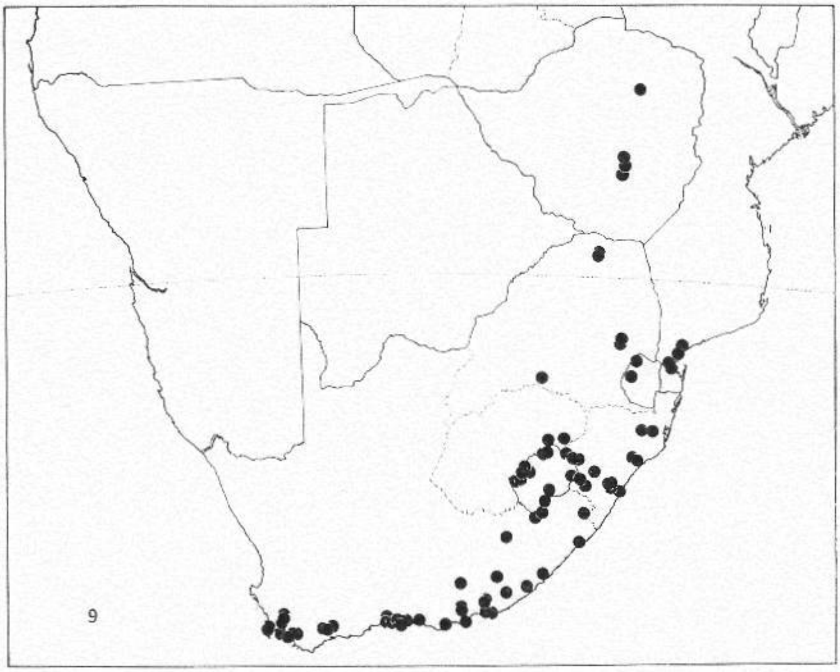


Fig. 7. *Parmelia austrosinensis* Zahlbr. Pantropical—oceanic distribution. Also in Portugal. Cf. HALE 1965 p. 204 (map) and 238.

Fig. 8. *Parmelia crinita* Ach. World-wide distribution in many oceanic districts. Also in W. Europe (incl. W. Norway). Cf. DEGELIUS 1935 p. 126. HALE 1965 pp. 222 (map) and 284.



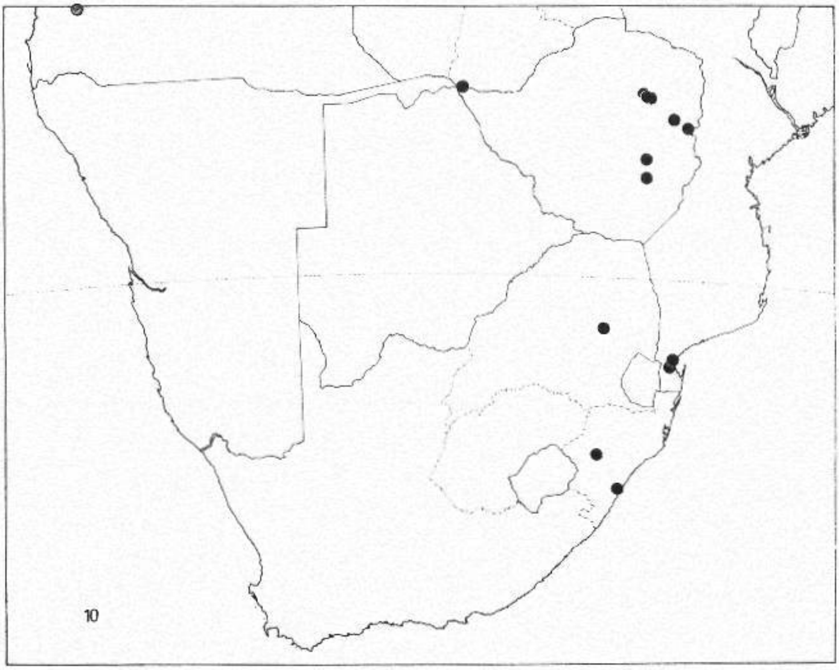
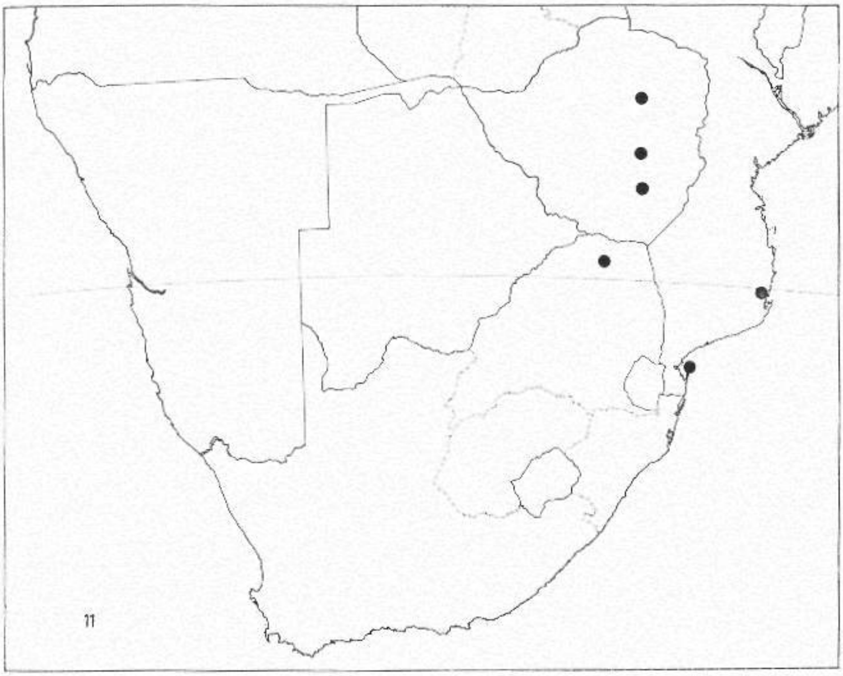


Fig. 9. *Parmelia reticulata* Tayl. World-wide distribution, mainly in oceanic districts. Also in S. and W. Europe.

Fig. 10. *Parmelia andina* Müll. Arg. Wide distribution, mainly in the tropical areas of the southern hemisphere. Cf. HALE 1965 pp. 204 (map) and 236.



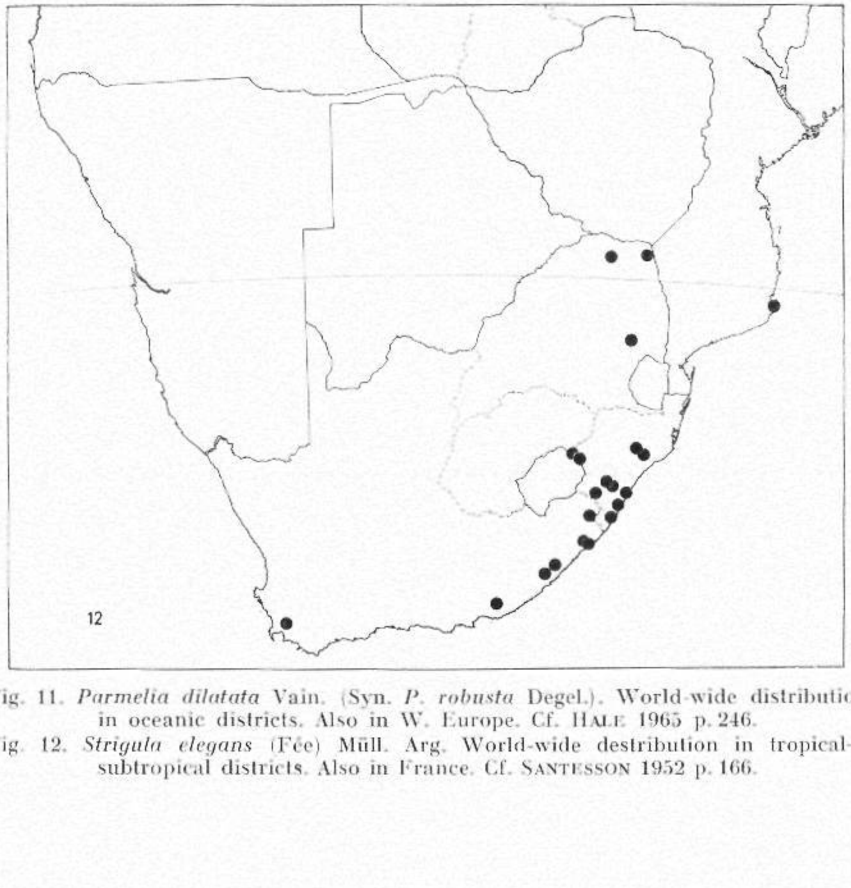


Fig. 11. *Parmelia dilatata* Vain. (Syn. *P. robusta* Degel.). World-wide distribution in oceanic districts. Also in W. Europe. Cf. HALE 1965 p. 246.

Fig. 12. *Strigula elegans* (Fée) Müll. Arg. World-wide destribution in tropical—subtropical districts. Also in France. Cf. SANTESSON 1952 p. 166.

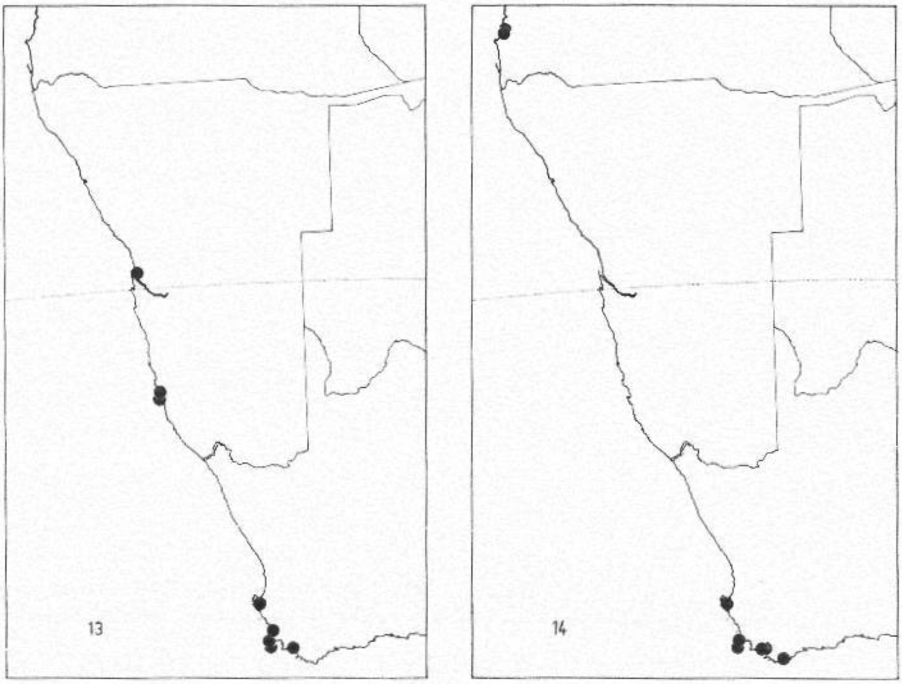


Fig. 13. *Combea mollusca* (Ach.) Nyl. Endemic.
Fig. 14. *Roccella hypomecha* (Ach.) Bory. Endemic.

which were considered as endemic in Southern Africa. Another monotypic endemic genus, *Eremastrella* Vogel, has been described recently from the Drakensberg area (VOGEL 1955 p. 104). Further research has shown that many of these species are identical to species known from other parts of the world, especially Central Africa and South America. The descriptions of several S. African "endemes", at least from the 19th century, are brief and vague, without comparison with related species, and the type collections are often scanty. Access to richer material has made it possible to reduce many of them to synonymy. This has especially been the case in the genera *Lecidea* (106 species listed by DOIDGE), *Acarospora* (36 spp.), *Parmelia* (128 spp.), *Caloplaca* (62 spp.), and *Buellia* (63 spp.).

There are a number of true endemes in the S. African lichen flora, e.g., *Combea mollusca* (Ach.) Nyl., *Parmelia hottentotta* (Ach.) Ach., *Siphula verrucigera* (J. F. Gmel.) R. Sant., *Teloschistes capensis* (L.f.) Vain., and *Toninia bumamma* (Nyl.) Zahlbr., several of them first

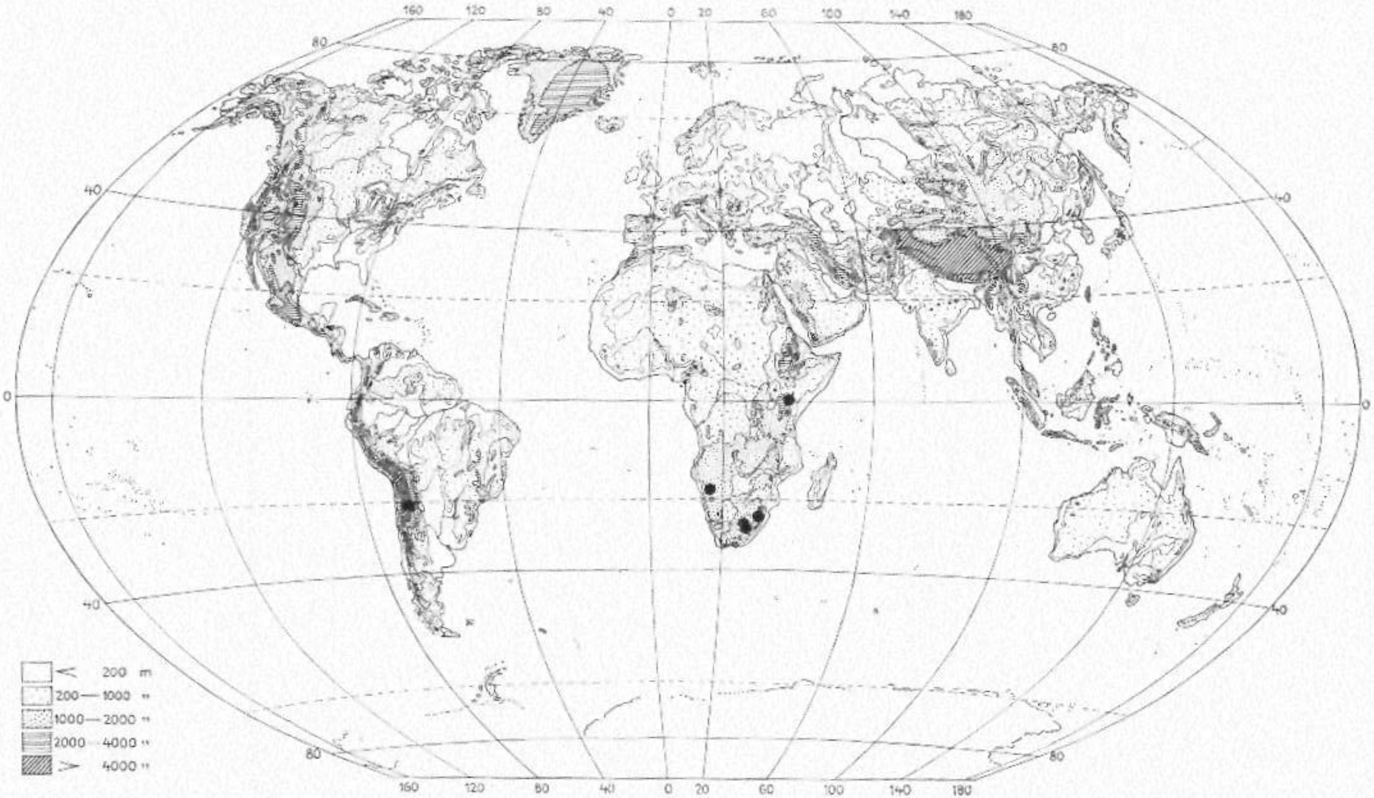


Fig. 15. *Caloplaca subnitida* (Malme) Zahlbr. Total distribution known.

recorded by THUNBERG. On the whole, however, such cases are exceptions to the general rule that the lichen flora has few equivalents to the rich number of endemic families, genera, and species among the phanerogams.

It will become more and more evident that S. Africa has many lichen species in common not only with Central Africa and the Mediterranean districts, which is not surprising, but also with S. America and Asia. It is probable that this south-hemispheric element, e.g., *Caloplaca sublobulata* (Nyl.) Zahlbr., *C. subnitida* (Malme) Zahlbr. (fig. 15), and *Parmelia andina* Müll. Arg. (total distribution mapped by HALE 1965 p. 204), will prove to have several representatives among the lichens.

For reasons mentioned above, it has proved necessary to compare the South African material with many species recorded from other parts of the world. This research has often been extended far beyond the scope of my earlier plans. In order to gain a reasonably sound taxonomic base, several groups are being treated more or less monographically.

My sojourn in Southern Africa was made possible by the generosity of the Royal Physiographical Society, Lund, and the Transatlantic Steamship Company, Gothenburg, which granted me free voyage and transported my car and my collections. The major part of my work was sponsored by grants from the Swedish Natural Science Research Council. To all of these, to the Directors of the herbaria mentioned above and to my lichenological colleagues, who have aided me in many ways, I express my sincere thanks. I want to mention especially Dr. M. E. HALE, Dr. R. SANTESSON and Dr. E. A. SCHELPE, who have critically read my manuscript.

Candelaria Mass.

MASS. Flora 35 : 567. 1852. ZAHLBR. Cat. lich. univ. 6 : 3. 1929, 8 : 551. 1932, 10 : 500. 1940. HILLM. Rabenh. Kryptog. Fl. Deutschl. ed. 2. IX. 5/3 : 19. 1936. LAMB. Index nom. lich. 139. 1963.

Type species: *C. vulgaris* Mass. (syn. of *C. concolor*). Cf. below.

Thallus minutely foliose or squamulose, suborbicular or spreading (c. 0.5—2 cm. diam.), closely appressed to ascending, corticate on both surfaces; yellow above (K—, calycin present), pale beneath, with ± developed whitish rhizines. Algae bright green (*Trebouxia*).

Apothecia sessile, lecanorine. Asci broadly clavate, with 20—50 spores. Spores hyaline, ellipsoidal, 1-celled (or sometimes pseudoseptate). Paraphyses discrete, septate and clavate. Pycnidia not unfrequent, laminal, immersed in yellow or orange-coloured warts, spherical or pyriform, c. 0.1 mm. diam. Microconidia hyaline, ellipsoidal, c. 2×0.5 μ.

1. C. concolor (Dicks.) Stein

Stein in Cohn, Kryptog. Fl. Schles. II. 2 : 84. July 1879. Arn. Flora 62 : 364. Aug. 1879. Doidge, Bothalia 5 : 309. 1950.

Lichen concolor Dicks. Fasc. Plant. Cryptog. Brit. 3 : 18. 1793. — Type collection: "Scotland 1786 J. Dickson" (BM, lectotype).

Parmelia parietina var. *laciniosa* Duf. ex E. Fries, Lich. eur. ref. 73. 1831. — Type collection (as "*Parmelia fibrosa* nob.", scr. E. Fr.): France. St. Seves (?). Dufour no. 240 (UPS, lectotype).

Lecanora laciniosa (Duf. ex E. Fr.) Nyl. Flora 64: 454. 1881. Stizenb. Ber. St. Gall. naturv. Ges. 1888—89, no. 637. 1890.

Candelaria vulgaris Mass. Flora 35: 568. 1852. — Type collection: Flörke, Deutsche Lich. no. 171 B (UPS, lectotype).

Candelaria substellata ("Ach.") Räs. An. soc. cient. Arg. 128 : 137. 1939, sec. specimina austroameric. in herb. Räs. (H).

[*Lecanora candelaria* var. *substellata* Ach. Syn. meth. lich. 192. 1814 is illegitimate, being a superfluous name for *Lecanora candelaria* var. *substellaris* Ach. Lich. univ. 417. 1810. The type of the latter ("in cortice arborum Silesiae. Mosig") in herb. Ach. (H) (as "var. γ *substellata*") is *Xanthoria fallax* (Hepp) Arn. Cf. Vainio, Etude lich. Brésil 1: 71. 1890.]

Candelaria quintanilhae C. Tav. Revista de biol. 4 : 138. 1964. — Type collection: Cape Verde Islands. S. Antao, on bark of *Jatropha*, 1958 K. Byström (LISU 159, holotype).

Thallus irregularly spreading or growing in small rosettes, ± deeply incised; upper surface smooth, dull, chrome-yellow (or greenish yellow to greyish). Lobes c. 1 mm. long, c. 0.1—0.5 (—1) mm. broad, ± laciniate, discrete or ± imbricate; margin entire or often granulose; soredia developing from marginal granules (rarely also laminal), ± abundant, sometimes densely crowded in the central parts, concolorous with the upper surface.

Apothecia not infrequent in South Africa, rounded, c. 0.5—1.5 mm. diam.; disc concave to flat, yellow (or brownish yellow); exciple concolourous, entire or granulose-sorediose, sometimes bearing white fibrils. Spores 6—15×4—6 μ.

Variability. There are very few differences in the range of variation between the South African and European populations. It is difficult to distinguish any subspecific units founded on genotypic characters. The small variation is obviously due to environmental factors.

Forms with extremely broad lobes (up to 1 mm.) have been noticed exceptionally, e.g., in Qachas Nek, Basutoland. This collection evidently grew in a wet habitat (on bryophytes). It seems to be identical to *C. quintanilhae* C. Tav., recently described from 3 stations in the Cape Verde Islands, according to a specimen kindly placed at my disposal by Dr. TAVARES. There is no distinguishing character quoted other than the broad lobes.

Forms with narrow, discrete, radiant lobes are much more frequent and form every intergrade with the main type. These forms correspond well with the South American plants recorded by RÄSÄNEN as *C. substellata* ("Ach.") Räs.

Forms growing on substrates subject to high impregnation with dust have their marginal lobes reduced to scattered squamules, and the centre forms a ± continuous granulose — sorediose crust ["var. *effusa* (Tuck.) Merr. et Burnh.", more or less identical with "f. *citrina* (Krempelh.) Arn." and "f. *granulosa* (Harm.) Boist."]. They seem to be less frequent in South Africa than in many parts of Europe and N. America. The colour of the upper surface is rarely greyish or greyish yellow (often only part of an individual). Such shade forms ("f. *chlorina* Harm.") are rare in our material.

An aberrant colour of the apothecia seems to be more than a modification: f. *phaeocarpa* n.f. Discus apotheciorum rufofuscus vel obscure fuscus. — Disc reddish brown to dark brown.

Angola. Prov. Biè, Chinguar, avenue in the village, on *Jacaranda*, common. 1960 G. DEGELIUS (Herb. DEGEL., holotype; LD, isotype). The rich material contains apothecia in all stages of development, all with brown discs without any tinge of yellow. — The same form is also observed from **Brazil.** Prov. Matto Grosso, Santa Anna da Chapada, on bark, 1894 MALME 2397 (S). Cf. MALME 1937 p. 34 (without any comments on the colour).

Excluded Species. DOIDGE recorded two other species, viz. *C. fibrosa* and *C. stellata*. The latter has proved to be synonymous with the former. The true *C. fibrosa* is a good species, but the S. African records belong to *C. concolor*.

C. fibrosa (Fr.) Müll. Arg.

MÜLL. ARG. Flora 72: 319. 1887.

Parmelia fibrosa Fr. Syst. orb. veg. 284. 1825. — Type collection: "America septentrionalis" (UPS, lectotype).

Physcia fibrosa (Fr.) Nyl. Syn. lich. 1 : 413. 1860.

Lecanora laciniosa ssp. *fibrosa* (Fr.) Stizenb. Ber. St. Gall. naturv. Ges. 1888—89, no. 638. 1890.

Parmelia fibrosa var. *stellata* Tuck. in DARLINGTON, Flora cestrica, ed. 3: 440. 1853. — Type collection: U.S.A. New Hampshire, "in *Pyro Malo*; vulgaris in Pomario Crawfordiano. Sept. 1848. E. T(UCKERMAN)" (FH, lectotype, as "*P(hyscia) candelaria* var. *stellata* Tuck.")

Physcia candelaria var. *stellata* (Tuck.) Nyl. Enum. gén. lich. 106 (1857) 1858. TUCK. Proceed. Am. Acad. 4: 388. 1860. (Citations in ZAHLBR. Cat. lich. 6: 9. 1930 are misleading.)

Candelaria stellata (Tuck.) Müll. Arg. Flora 72: 319. 1887. LYNGE, Nyt Mag. Naturv. 62: 95. 1924.

Lobes appressed, ± imbricate, as a rule broader than in *C. concolor* and not so deeply incised, sometimes narrow and stellate, convex, somewhat incurved or slightly crenulate, lacking soredia. Apothecia numerous, constricted at the base, bearing ± numerous white fibrils below, disc ± brownish yellow, often pruinose, exciple entire or ± crenulate, sometimes fibrillose. Otherwise as in *C. concolor*.

MÜLLER ARG. and HUE distinguished between two non-sorediate species, *C. fibrosa* (lobes c. 2—3 mm. broad) and *C. stellata* (lobes narrow, elongate, c. 0.2—0.5 mm.). The brief report by MÜLLER and the very detailed descriptions by HUE give no other distinguishing characters. I have been able to examine TUCKERMAN's material preserved at the Farlow Herbarium in Cambridge, Mass. It consists of 14 samples in the same envelope. According to the Rules of Nomenclature. Art. 9, the whole set can be considered as the lectotype. This rich material shows all transitions between the "normal" broad-lobed *fibrosa* type and the narrow-lobed *stellata* type. Two copies of TUCKERMAN's exsiccat Lich. Amer. sept. no. 88 (as *Parmelia fibrosa* Fr.) in BM and UPS exhibit the same variation. As in *C. concolor,* therefore, lobe width seems to be of no taxonomic importance.

C. fibrosa (s. lat.) is distributed in various parts of N. and S. America and in E. Asia (China and Japan). It often grows together with *C. concolor* and was considered a synonym of it by TUCKERMAN in his later years (1882 p. 51). *C. fibrosa* is well separated in having more appressed lobes and principally in the lack of soredia. The white fibrils under the apothecia, often quoted as a diagnostic character, are sometimes found also in *C. concolor*. In U.S.A. the two species often grow intermixed, one sometimes growing over the other, but without any transitional stages. *C. fibrosa* and *C. concolor* constitute an analogy to other pairs of species, one non-sorediate and fertile, the other sorediate (or isidiate) and as a rule sterile; e.g., *Xanthoria elegans* and *X. sorediata, Physcia pulverulenta* and *Ph. grisea*. Cf. further my paper on *Xanthoria africana* (ALMBORN 1963 p. 166) and literature quoted there.

Some fertile, fibrillose specimens from southern Africa have been quoted as *C. fibrosa* (cf. list of localites below). Since they are sorediate,

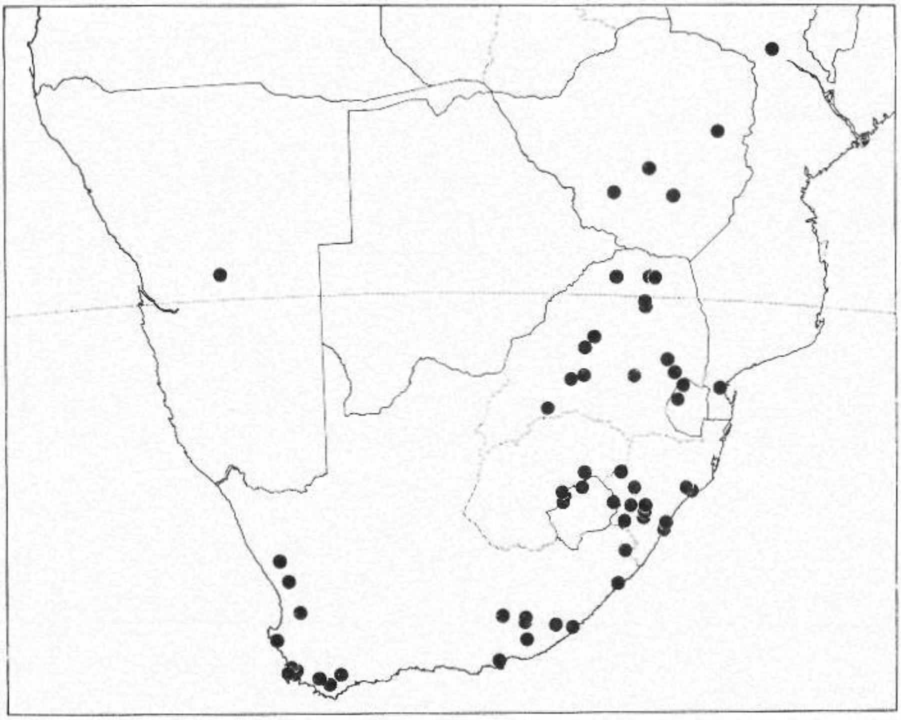


Fig. 16. *Candelaria concolor* (Dicks.) Stein. World-wide distribution, mainly in temperate districts.

they should be identified as *C. concolor*. Some specimens in the S. African material (especially from Polela Forest in Natal and the Zoutpansberg and Pietersburg divisions in Transvaal) have scattered granules but lack really developed soredia. I have been in doubt as to their identity, but Dr. R. SANTESSON has shown me similar specimens from S. America, e.g., Chile, Prov. Santiago, San José, on shrubs in mountain slope, 1940 SANTESSON 2433 (S) and Argentina, Prov. Santa Cruz, Rio Gallegos, Estancia Güer-Aike, on basaltic rocks, 1940 SANTESSON 7087 (S). This material contains all transitions to typical sorediate *C. concolor*.

Ecology. On trunks of trees, mainly in parks, gardens and along roadsides, rarely on rocks. A coniophilous species, favoured by the influence of dust containing nitrogen and phosphorus compounds.

Distribution. Fairly frequent, at least in the wooded districts, though often in small quantities, rare in the almost treeless arid areas.

Cape Province

Namaqualand. 10 miles N.W. of Garies, on twigs of *Acacia*, ALMBORN 4716 (LD) (±pulvinate). — Sine loco exacto, on twigs of a shrub, MARLOTH 6405 (PRE, W as "*Xanthoria fibrosa*"). ZAHLBRUCKNER 1926 p. 547, DOIDGE 1950 p. 356 (all as *Xanthoria candelaria* f. *fibrillosa*). — Van Rhynsdorp. 2 miles N. of Nieuwe Rust, rocks near road, ALMBORN 4896 a (LD). — Clanwilliam. C., on *Vitis* in an orchard, ALMBORN 4504 a (LD). — Hopefield. Saldanha, near Danger Bay, on twigs, F. M. LEIGHTON (BOL with *Teloschistes capensis* no. 1724). — Bellville. Durbanville, on *Schinus molle*, v. D. BYL. 422 (STE, TUR), det. VAIN., v. D. BYL 1931 p. 13. DOIDGE 1950 p. 309. — Cape. Cape Town, between Kloofnek and the Round House, on *Quercus*, ALMBORN 914 (LD) (greyish, fibrillose). — Kirstenbosch Botanical Gardens, on *Acacia*, ALMBORN 1605 (LD) (± pulvinate, fibrillose). — Ibid., Window Gorge, on branches of a shrub, ALMBORN 1116 (LD). — Ibid., Skeleton Gorge, on *Brabeium* near stream, ALMBORN (LD with *Physcia erosula* no. 228). — Southern Cross Estate, on *Quercus* by the road, ALMBORN 1521, 1522 (LD) (fibrillose). — Stellenbosch. S., sine loco exacto, DUTHIE 9 (STE). DOIDGE l.c. — S., on *Salix*, GARSIDE 93 (BM). v. D. BYL l.c. — Eerste River, on *Quercus*, GARSIDE L. 68 (BM) (both fibrillose). — Caledon. 10 miles E. of C., on *Quercus* by main road, ALMBORN 2036 (LD) (± pulvinate). — Bredasdorp. Napier, on bark, H. SWART (BOL with *Teloschistes chrysophthalmus*). — Swellendam. On shrubs in a garden in the N. part of Sw., ALMBORN 2125—27, 2172 (LD) (fibrillose). — Port Elizabeth. Near Coega, on twigs of shrubs. ALMBORN 4082—84, 4093 (LD). — Ibid., on trunks of *Euphorbia*, ALMBORN 4111 (LD) (both ± pulvinate). — Somerset East. Boschberg, on bark, MACOWAN 502 [BM as *Physcia fibrosa*, SAM as "*Physcia candelaria* (*fibrosa*)"]. STIRTON 1877 p. 215 (as *Ph. fibrosa*). STIZENBERGER 1890 no. 637 (as *Lecanora laciniosa*). DOIDGE l.c. — Albany. Grahamstown. Rhodes College, near Milne House, on *Jacaranda*, ALMBORN 10858 (LD) (±pulvinate, fibrillose). — Fort Beaufort. F.B., on twigs, SCHAEFER (PRE with *Physcia* sp. no. 2075). — Stockenstroom. On hill W. of Tidbury's Toll, on twigs of *Lycium* and *Rhus*, F. A. S. TURNER (PRE 1862). — Kingwilliamstown. K., on bark, H. A. WAGER (BM). — East London. E. L., on trees in Queen's Park, ALMBORN 10652 (LD). — 13 miles E. of E. L., near road to Potsdam, on *Acacia*, ALMBORN 10674 (LD) (±pulvinate). — Port St. Johns. 5 miles N.W. of P.St.J., on *Pinus* near road, ALMBORN 10557—59 (LD) (± pulvinate, fibrillose).

Natal

Alfred. Ingele Forest, on rocks, ALMBORN (LD with *Teloschistes exilis* no. 10334). — Polela. Polela Forest, on bark, ALMBORN 9422, 9564 (LD) (narrow-lobed, fibrillose, scarcely sorediate). — Durban. D., on *Hyphaene crinita*, HÖEG (TRH with *Anaptychia* sp.). — Botanical Garden, on bark, ALMBORN 8540 (LD) (± pulvinate). — Isipingo Rocks, on bark, ALMBORN 9730—31 (LD) (± pulvinate). — Berea, on bark, v. D. BYL 18 (BM). — Lions River. Boschfontein Forest, on bark, ALMBORN 8669 (LD). — Pietermaritzburg. Chatterton Road near P.M.B., on *Quercus*, HÖEG (TRH with *Physcia* sp.). — Natal Table Mt., lower slopes, on bark, ALMBORN 8558 (LD). — Camperdown. C., on *Syringa*, HÖEG (TRH with *Parmelia* and *Anaptychia* spp.). — New Hanover. Appelsbosch, on bark, FR. LJUNGQVIST (UPS). — Weenen. W., Town Land, on twigs, H. P. THOMASSET. Comm.

Höeg (TRH with *Physcia* sp.). — Eshowe. E., near post-office, on *Jacaranda*, Almborn 8483 (LD). — Along Inyezane River between Mtumzemi road and Inyezane Siding, on isolated *Erythrina* trees, Höeg (TRH with *Physcia* sp.). — Klip River. Brakval Station, on *Pinus*, Höeg (TRH with *Physcia* sp.).

Orange Free State

Ladybrand. L., on sandstone rock, Maas Geesteranus 11970 (L with *Parmelia* sp.). — Betlehem. Clarens, on bark of *Prunus persica*, v. d. Blank (PRE 1914) (p.p. narrow-lobed, fibrillose). — Ibid., on rocks, v. d. Blank (PRE 1911).

Basutoland

Maseru. Near Masite Mt., alt. 1700—2000 m., on bark, J. Hewitt (TRH). — Maphotong Valley, on sandstone, Kofler (LD). — Near Caledon River, on bark, Kofler (LD). — St. Michael, on mossy rock, Kofler (LD). — Qachas Nek. Black Mts. between Mokhotlong and Sani Pass, alt. c. 3200 m., among mosses on basalt rock, Kofler (LD) (broad-lobed). — Leribe. Buthabuthe, on *Eucalyptus*, Kofler (LD).

Transvaal

Potchefstrom. P., on *Thuya*, Kofler (LD). — Krugersdorp. Magaliesberg, N. slopes near Klein Wonderboom, on *Croton*, Mogg (PRE with *Physcia* sp. no. 1981). — Pretoria. P., on *Jacaranda*, Kofler (LD with *Physcia* sp.). — Zoological Garden, on bark, Almborn 5883 (LD). — Hartebeest Dam, near the hotel, on bark, Höeg (TRH). — Fountains Valley, on *Acacia karroo*, Doidge (PRE with *Physcia* sp. no. 1760). — Meintjes Kop, on *Acacia caffra*, Mogg (PRE with *Physcia* sp. no. 1837). — Waterberg. Two miles N. of Warmbad, on bark, Almborn 5902—07 (LD). — Krantzkop, near Nylstrom, on trees in bush, Kofler (LD). — Middelburg. Olifants Rivier, on bark, E. Scott (PRE with *Pyxine* sp. no. 1825). — Lydenburg. Spitzkop near L., on bark, Wilms (ZT). Stizenberger 1890 no. 637. Doidge p. 309 (all as *Physcia* or *Candelaria fibrosa*). — Nelspruit. N., on bark, Schaefer (PRE 1927). — Pietersburg. Woodbush, Kaaimansgat Forest, on twigs, Mogg (PRE with *Physcia* sp. no. 1981). — Blaauwberg, rocky S. slopes, alt. 1800 m., on twigs, Esterhuysen 21549 a (LD with *Teloschistes exilis*) (granular, few soredia; ap. brownish yellow). — Letaba. Between Munnik and Tzaneen, on bark, E. Scott (PRE with *Pyxine* sp.). — Zoutpansberg. Piesanghoek, on *Citrus limonum*, P. Watson (PRE 774). Doidge l.c. (as *C. fibrosa*) (fibrillose, granular, few soredia). — Louis Trichardt, S. slope, on twigs, Kofler (LD). — Near Punch Bowl Inn, N. of Louis Trichardt, on rocks and on bark and twigs of cultivated trees, Almborn 6207, 6297, 6455, 6456, 6614 (LD) (p.p. fibrillose, granular, few soredia). — Between Overwinning and Wyllies Poort, on bark, Almborn 6404 (LD). — Hanglip Forest near Louis Trichardt, on rocks, alt. 1500 m., Almborn 6637 (LD).

Swaziland

Mbabane. M., Swazi Inn, on bark, Kofler (LD). — Peak. Piggs Peak, near police station, on *Jacaranda*, Almborn 7900 (LD).

Moçambique

Sul do Save. Lourenço Marques. Botanical Garden, on bark, Almborn 7183—87 (LD). — Ibid., near Hotel Clubo, on base of cultivated trees, Almborn 6876 (LD). — Tete. Boroma, on bark, Menyharth 262, 264 (WU). Müller Arg. 1893 p. 296. Stizenberger 1895 p. 22 (under no. 638 *Lecanora laciniosa *L. fibrosa*). Doidge l.c. (as *C. fibrosa* and *C. stellata*).

Rhodesia

Bulawayo. Near B., on trees in the bushfield near Mr. Mennell's farm, Höeg (TRH with *Physcia* sp.). — Victoria. Zimbabwe, on the stem of a big *Acacia*, Höeg (TRH, fragment with *Physcia* sp.). — Ibid., on trees in the ruins, Höeg (TRH with *Parmelia* sp.). — Gwelo. G., on *Acacia* along road, Höeg (TRH with *Physcia* sp.). — Makoni, Sine loco exacto, on bark, alt. 1600 m., Eyles 824 (BM, K, PRE no. 211).

S.W. Africa

Windhoek. Wasserberg (near Windhoek), on bark, Fincke (W 341).

Angola

Huila. Humpata Plateau, above Sá-da-Bandeira, *Brachystegia* forest, alt. c. 1900 m., Degelius (Deg., LD). — Bié. Chingüar. Degelius (f. *phaeocarpa;* see above). — Bengüela. C. 50 km. S. of town, dense bush (*Acacia* etc.) near road, on shrub, Degelius (Deg.) (p.p. granular). — Cuanza Sul. Faz. Chipepe (near Cassongue), on *Cupressus*, alt. c. 1800 m., Degelius (Deg.). — Quanza Norte. Golungo Alto, "ad truncis in sylvis prope Sange, Welwitsch 153. — Pungo Andongo," ad *Vellosias* in rupibus prope Praesidium, Welwitsch 111. Both sec. Vainio 1901 p. 402.

N. B. The Angola stations are located N. of the area covered by the map (fig. 16).

Solorina Ach.

Ach. K. Vet. Akad. Nya Handl. 1808: 288. Id. Lich. univ. 27 et 149. 1810. Hue Monogr. gen. *Solorinae* (in Mém. Soc. Sci. Nat. Cherbourg 38: 1). 1911. Zahlbr. Nat. Pfl. Fam. 8. Lichenes 188. 1926. Id. Cat. lich. univ. 3: 408. 1925, 8: 313. 1932, 10: 279. 1939. Lamb, Index nom. lich. 662. 1963. — Type species: *S. crocea* (L.) Ach. Fink, Lich. Minnes. (in Contrib. U.S. Nat. Herb. 14(1) 158. 1910.

Solorinina Nyl. Le Naturaliste 6: 387 (repr. 2). 1884. Id. Flora 67: 219. 1884. Type species: *S. simensis* (Flot.) Nyl.

Thallus foliose or squamose, orbicular, irregularly lobed, rather loosely attached to the substratum, heteromerous; upper surface grey or brown, smooth, corticate; under surface pale brown or whitish (in *S. crocea* deep orange or brick red), ecorticate, naked or bearing long scattered whitish rhizines. Algae forming a thin layer immediately under the upper cortex, green (*Palmellaceae*) or blue-green (*Nostoc*), often both types together, the latter ("internal cephalodia") sometimes predominating over the former. Cf. further MOREAU 1921 p. 81, OZENDA 1963 p. 118.

Apothecia laminal, adnate or often immersed; disc roundish, concave, reddish brown or dark brown. Asci cylindrical, containing 1—8 spores. Spores oblong or ellipsoid, 2-celled, pale to dark brown, often constricted at the septum, episporium often granular. Paraphyses unbranched, septate. Pycnidia unknown.

1. S. saccata (L.) Ach.

ACH. ll. cc. HUE l.c. 21 (descr. ampl.).

Lichen saccatus L. Fl. Suec. ed. 2.419. 1755. Id. Sp. Pl. ed. 2.1616. 1763. — Type collection: Norway, "in alpibus[3] norvegicis". T. HOLM (LINN, specimen no. 1273: 197, lectotype).

Peltigera saccata var. *pruinosa* Del Amo. Fl. Crypt. Penins. Ibér. 368. 1870. — Type collection: Spain (not located).

Solorina saccata var. *pruinosa* (Del Amo) Gyelnik, Lilloa 3: 60. 1938.

Solorina simensis Hochst. ex Flot. Linnaea 17: 17. 1843. NYL. Synopsis Lich. 1: 330. 1860. HUE l.c. 12. — Type collection: Ethiopia, Simien Prov., "ad rupes umbrosas montis Bachit prope Demerki". 1838 W. SCHIMPER. SCHIMPER, Iter Abyss. (exs.) no. 445 (K, lectotype; isotype in UPS).

Solorinina simensis (Flot.) Nyl. l.c.

Thallus c. 2—4 (—6) cm. diam.; lobes c. 0.5—1 mm. broad, rounded, slightly crenate or incised; upper surface brownish grey to ash-grey (green when moist), sometimes minutely areolate-scabrid and whitish pruinose; under surface ± indistinctly veined, reddish brown to whitish, with long scattered rhizines.

Apothecia scattered, rounded, c. 1—2 (—5) mm. diam., concave and ± deeply sunk, rarely plane or somewhat convex, dark brown to reddish brown, epruinose; exciple concolourous with the thallus, soon disappearing. Spores 4 in the ascus, in the S. African material c. 28—43 × 14—19 μ; otherwise up to 60 × 24 μ.

Variability. The South African material shows a certain variation as to the colour and pruinosity of the thallus surface and the shape of the apothecia. The colour varies from greyish to brownish, often slightly pruinose. The rich material from Mohales Hoek distributed in my exsiccat no. 55 has a thick pruinose cover that imparts a whitish tinge to the thalli. It is evident that in *S. saccata*, as in many other lichen

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[3] Not "rupibus", as quoted by SAVAGE, Cat. Linn. Herb. 198. 1945.

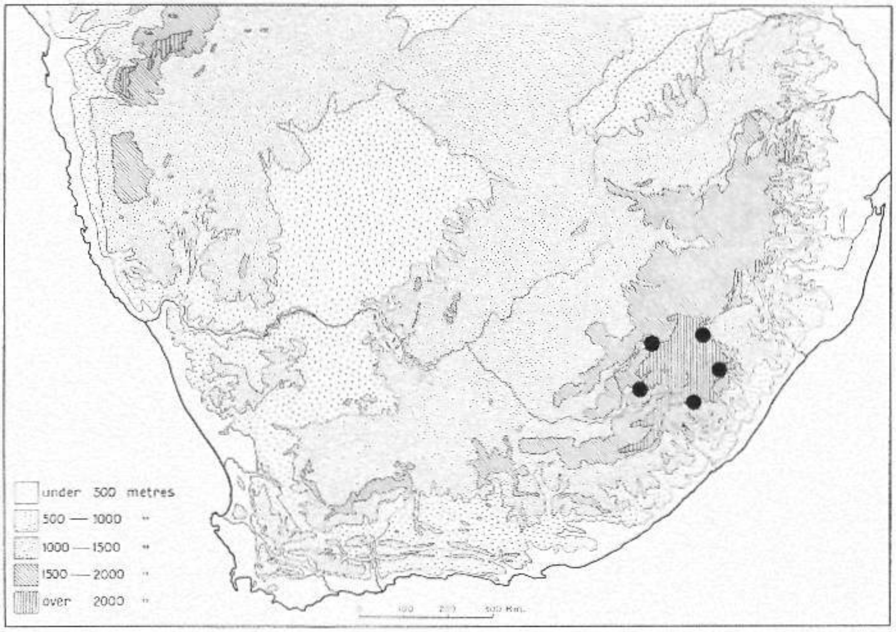

Fig. 17. *Solorina saccata* (L.) Ach. Worldwide distribution, mainly in high mountains and in calcareous districts.

species, pruinosity is a response to environmental factors and should not be used as a taxonomic criterion. I agree with WEBER (1962 p. 318) in his thorough discussion of this problem. Cf. also ALMBORN 1963 p. 167.

Most of the specimens have plane (to slightly convex) apothecia. In this respect they agree well with the lichen known as *S. simensis* Flot. The material from from Mohales Hoek mentioned above, however, has wide variation in the shape of the apothecia, from deeply saccate (=the main type of the species) to plane. An examination of much material of *S. saccata* from various parts of the world shows that the apothecia can occasionally be more or less plane. NYLANDER (1860) stated *S. simensis* to be "arcte affinis *S. saccatae*" but differing in having a somewhat more distinctly veined under surface and plane or slightly impressed apothecia. Later (1884) he reported it as having bluish "gonimia". For this reason he created a new genus, *Solorinina* Nyl., including *S. simensis, S. crocoides* NYL. (now included in *S. crocea*) and, with doubt, *S. sorediifera* (Nyl.) Nyl. (cf. below). The subdivisions of *Solorina* proposed by HUE (l.c.) characterized by different algal components, have no validity according to the present principles of lichen taxonomy. It is evident that *S. simensis* falls within the range of variation of *S. saccata*.

Ecology. In crevices of rocks or on bare soil, in moist shaded places, at high elevation.

Distribution. Rare or overlooked, known from 5 stations in Basutoland and the Drakensberg area.

Cape Province

Matatiele. S. of Qachas Nek, near boundary to Basutoland, among shrubs of *Leucosidea*, near road, alt. c. 1700 m., KOFLER (LD) (brownish grey, slightly pruinose, ap. plane).

Natal

Bergville. Drakensberg, Mt. Weni area, on mossy faces or on rather bare soil, alt. 2700—3000 m., ESTERHUYSEN 21604 (BOL, LD) (brownish grey, not pruinose, ap. plane to convex).

Basutoland

Mohales Hoek. Near Mphrane (10 miles N.E. of M.H.), on vertical rocky bank of a stream, on soil, alt. c. 2500 m., KOFLER 31131. ALMBORN, Lich. afr. 55 (LD etc.) (whitish grey, pruinose, ap. plane to concave). — Maseru. Maluti Range, near Blue Mountain Pass, alt. c. 3000 m., KOFLER 36218 (LD) (brownish, slightly pruinose, ap. plane to concave). — Qachas Nek. Q.N., Sani Pass, alt. 2700 m., KOFLER 31115 (LD) (brownish grey, slightly pruinose, ap. plane).

Excluded Species.

Solorina sorediifera Nyl.

NYL. Synopsis lich. I: 331. 1860. HUE, Monogr. gen. *Solorinae* (in Mém. Soc. Sci. Nat. 38: 15). 1911. DOIDGE 263. 1950. — Type collection: "Cap. B. Spei. Herb. Sonder" (H: herb. Nyl. no. 32915, lectotype; isotype in PC, sec. HUE l.c., cf. below).

"Thallus lurido-pallescens vel subcervinus rotundato-lobatus, ambitu undulatus, fere mediocris (latit. circa 1-pollicaris) sorediis caesio-viridibus discoideis adspersus, subtus pallidus, nervis indeterminatis crassiusculis fuscis et ambitum versus rufescentibus vel pallidis vellereis.

Ad Promontorium Bonae Spei.

Apothecia non visa, sed omnino hujus generis videtur. Affinis sit *Simensi*, at nervis paginae inferae thalli aliis, nec rhizinae nullae elongatae visae." (NYLANDER l.c.).

The type material (without an exact locality) is the only collection of this lichen. GYELNIK (1932 p. 43) studied the type in the Paris herbarium and stated that it is identical with *Peltigera leptoderma* Nyl. In my opinion, "*P. leptoderma*" falls within the range of variation of *P. spuria* (Ach.) DC. The sorediate stages of this species, which intergrade completely with "typical" *P. spuria,* have sometimes been called *P. erumpens* (Tayl.) Vain.

I have studied the type material in Helsinki (herb. NYL.). It is sterile and sorediate and has no resemblance to any *Solorina* species. It belongs without doubt to *P. spuria,* a species now known from several localities in S. Africa.

Placopsis (Nyl.) Lindsay

LINDSAY, Transact. Linn. Soc. Lond. 25: 536. 1866. LAMB, Lilloa 13: 151. 1947. Id. Index nom. lich. 577. 1963.

Lecanora subgen. *Placopsis* Nyl. Journ. Linn. Soc. Bot. 9: 251 (footnote). 1866.

Placodium sect. *Placopsis* Müll. Arg. Bot. Jahrb. 5: 135. 1884.

Lecanora sect. *Placopsis* (Müll. Arg.) Zahlbr. Nat. Pfl. Fam. 1: 1. Lichenes. 202. 1907 et ibid. ed. 2. 8. Lichenes 225. 1926. Id. Cat. lich. univ. 5: 664. 1928, 8: 547. 1932, 10: 492. 1940.

Dr. R. SANTESSON has drawn my attention to the fact that the usual citation "*Placopsis* Nyl. Ann. Sci. Nat. Bot. sér. 4(15): 376. 1861" is incorrect. NYLANDER never accepted *Placopsis* as a genus. L.c., he incidentally wrote "*Placopsis gelida*", but the species was listed as *Squamaria gelida* (L.) Hook. Under *Squamaria rhodocarpa* Nyl. he introduced "subgenus idem, cui nomen *Placopsis* proposui" (with a short description), but he did not clearly indicate the position of the subgenus (under *Lecanora*?). As he also (l.c.) treated the same two species as "forsan melius sicut sectionem peculiarem generis *Lecanorae* . . .", these subdivisions cannot be considered as accepted by NYLANDER in 1861.

Type species: *P. gelida* (L.) Lindsay sec. LAMB 1947 p. 180.

Thallus ± distinctly lobate to effigurate at the circumference, crustaceous in the centre, usually greyish, in some species isidiate (not in the S. African species) or sorediate. Algae green ("*Pleurococcus*"); upper surface bearing cephalodia containing blue-green algae.

Apothecia usually present in most species, immersed (aspiciloid) to sessile (lecanorine). Asci cylindrical, containing 8 spores. Spores uniseriate, simple, hyaline.

1. Placopsis gelida (L.) Lindsay

LINDSAY l.c. 1866. LAMB, Lilloa 13: 190. 1947 (descr. ampl.).

Lichen gelidus L. Mantissa plant. 133. 1767. — Type collection: Iceland. J. G. KÖNIG (holotype lost). LINNAEUS (l.c.) quoted DILLENIUS, Hist. musc. tab. 18, fig. 18 a, c. 1741, which, however, refers to *Caloplaca murorum* (Hoffm.) Th. Fr. (or a related species), sec. CROMBIE, Journ. Linn. Soc. Bot. 17: 565. 1880 (as

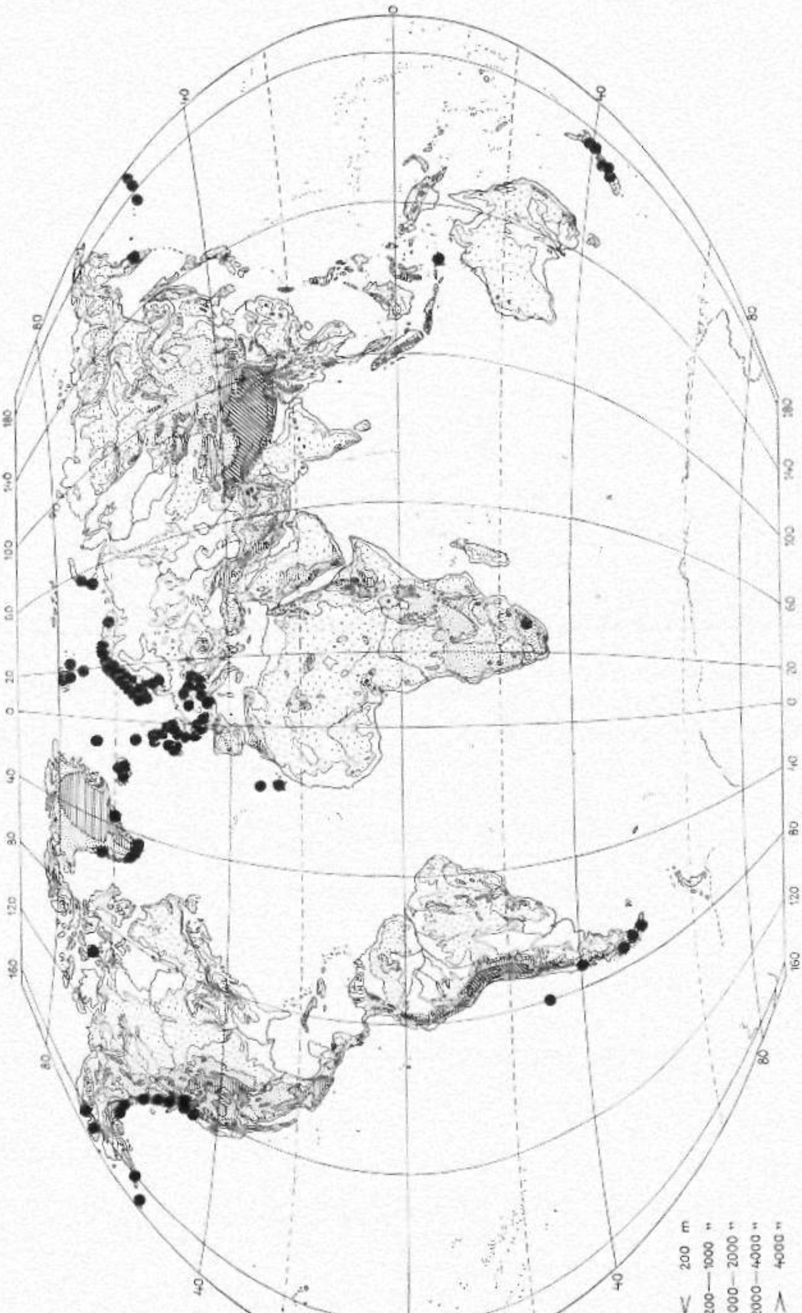

Fig. 18. *Placopsis gelida* (L.) Lindsay. Total distribution known. Data from LAMB 1947 p. 190 with the addition of the S. African station.

"*Placodium murorum*"). Neotype (LAMB l.c. p. 202): Iceland, Arnes, Reykir 1937, leg. LYNGE (O).

Lecanora gelida (L.) Ach. Lich. univ. 428. 1810. ZAHLBR. Cat. lich. univ. II. cc.

Thallus orbicular, c. 2 cm. diam., ± confluent, closely adpressed to the substratum; marginal lobes contiguous, subdichotomously branched, c. 2 (—5) mm. long, c. 1 mm. broad; central part rimose to areolate; upper surface smooth, dull, (dirty brownish) grey, not pruinose; soredia scattered over the centre, rounded to irregular, c. 0.5—1 mm. diam., not elevated, dark greenish; cephalodia scattered over the centre, orbicular, c. 1—2 mm. diam., plicate, cracked or granular, brownish to flesh-coloured.

Reactions. Cortex K + yellowish, C + rose-red, Pd —. Medulla K —, C + rose-red, Pd —.

Apothecia absent in the S. African material.

This brief description is based only on the S. African specimens. For further details as to morphology and synonymy, I refer to the detailed monographic treatise by LAMB (l.c.).

Variability. The scarce material present from our area seems to by fairly uniform. The specimens are sterile and somewhat depauperate, but otherwise they agree well with the "main type" of the species, as represented in the Scandinavian high mountains.

Ecology. On wet rocks, at high altitude. Cf. below.

Distribution. Known from one station:

Basutoland

Leribe: Oxbow, valley E. of the camp, on basaltic rock near a stream, alt. c. 3000 m., KOFLER 311 291 (LD). Confirm. LAMB.

LAMB (l.c.) accepted 31 species of *Placopsis*, most of them with fairly restricted areas. 11 species are known from the southern parts of S. America only, 9 species from the Australia — New Zealand area only, and 4 species from both of these main centres. The distribution of the genus has a marked preponderance in the southern hemisphere. No species has hitherto been recorded in literature from the African continent. Collections from the Canary Islands and Madeira are somewhat doubtful (sec. LAMB). There may be a distinct variety or species in Macaronesia. Sec. LAMB (in litt.) there is an unpublished record of *P. parellina* (Nyl.) Lamb from Kenya, Mt. Kenya, on soil in *Podocarpus*-forest, alt. c. 3300 m.

P. gelida is the only species in this genus with a wide distribution also in the northern hemisphere (fig. 18). In this area it has a clear oceanic tendency, but it is decidedly more arctic — circumpolar than the lichens treated by DEGELIUS (1935). It has reached optimal ecological conditions in colder temperate and arctic regions, as well in the Scandinavian and British high mountains as near sea level. It is evident that the essential factor in its ecology is constant and high humidity.

The scattered stations known from the southern hemisphere (Java, New Zealand, S. Chile, and (with doubt) Juan Fernandez Islands demonstrate a bipolar type of distribution, which has several analogies among phanerogams and bryophytes. Concerning the many theories dealing with this phytogeographical element and its presumed history (hypothetical migrations, trans-antarctic land connections, etc.), I refer to the detailed discussion in DU RIETZ (1940 p. 215).

The addition of an African station to the area of *P. gelida* has considerable phytogeographical interest.

Summary

The present paper is an introduction to a series of revisions of lichen genera occurring in Southern Africa. The scope of this work is to complete a Lichen Flora of Southern Africa (up to the 15th parallel). This proposed flora will be founded on the author's own collections from 1953 (c. 12000 nos.) and a large amount of material from African and European herbaria (altogether c. 30000 nos.).

A survey is given of the author's itinerary in 1953 and of the present state of the lichenological exploration of S. Africa.

The outlines of a phytogeography of the S. African lichens are discussed briefly. We can roughly distinguish 6 groups: 1. ubiquitous species, 2. steppe and desert species, 3. high mountain species, 4. oceanic species, 5. tropical-oceanic species, 6. maritime species. The endemic lichens are few. The lichen flora has hardly any correspondence to the rich endemic "Cape Flora" known in the phanerogams. On the other hand, the S. African lichens show interesting connections with other floras, especially S. America.

Candelaria concolor has a wide distribution in most wooded districts of S. Africa, whereas *C. fibrosa* and *C. stellata*, which are synonyms, should be excluded from the S. African lichen flora. *C. concolor* f. *phaeocarpa* Almb. is described as new.

Solorina saccata (incl. *S. simensis*), now known from 5 stations at high altitudes in the Drakensberg area, is an interesting addition to the S. African lichen flora. The only *Solorina* species previously recorded from S. Africa, viz. the "endemic" *S. sorediifera*, should be excluded. The type material belongs to *Peltigera spuria*.

Placopsis gelida is reported, as new to the African continent, from one sta-

tion in the Drakensberg area. The total range of this bipolar species (otherwise known mainly from New Zealand, Java and Chile in the southern hemisphere) is discussed.

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Från Lunds Botaniska Förenings förhandlingar 1965

5 februari. Professor J. A. Nannfeldt höll föredrag om »Svamparna som fanerogamsystematiker». Föredragshållaren gav ett flertal intressanta exempel på hur svampangrepp kan ge upplysningar om värdväxtens fysiologiska, biokemiska och taxonomiska särart. Sammanfattande framhöll föredragshållaren, att svamparna i sitt umgänge med värdväxter i regel visat sig ha samma uppfattning om släktskap som vetenskapsmännen i systematisk botanik.

8 mars. Professor Henning Weimarck gav en översikt av florainventeringens framskridande i Skåne.

Docent Hans Runemark talade om *Agropyron pungens*.

Fil. lic. Folke Andersson höll föredrag om »Flora och vegetation i Linnebjer». Domänreservatet Linnebjer presenterades, och vissa av de ekologiska undersökningar, som utförts inom området, berördes.

Fil. mag. Göran Svensson höll föredrag om »Store Mosse och Kävsjön». Vegetationen på Store Mosse behandlades översiktligt, varefter föredragshållaren redogjorde för sina studier av Kävsjöns och dess närmaste omgivningars vegetationsutveckling under de senaste åren.

26 mars. Dr Per Wendelbo höll föredrag om »Inntryck fra en botanisk innsamlingsreise i Afghanistan i 1962».

Inledningsvis berördes Afghanistans botaniska upptäcktshistoria, och föredragshållaren skildrade därefter landets flora och vegetation, som belystes med detaljer från de företagna expeditionsturerna.

26 april. Revisionsberättelse avseende 1964 års räkenskaper framlades. Den av revisorerna i anslutning härtill föreslagna ansvarsfriheten beviljades.

Fil. lic. Sven Asker höll föredrag över »Cytogenetiska studier inom *Potentilla*». Föredraget handlade huvudsakligen om de arter och artgrupper inom släktet, där apomixis förekommer. Föredragshållarens egna studier avsåg att belysa genetiska skillnader mellan de sexuella och apomiktiska typer, som kan uppträda »inom arten».

27 maj. Exkursion till sydöstra Skåne ägde rum under ledning av laborator Nils Malmer och professor Henning Weimarck. Exkursionen, som företogs med privata bilar, samlades vid Röddinge. Route: Röddinge—Fylan—Lyckås—Benestad—Övraby—Tosterup—Glemminge—Kåseberga—Hammenhög (där exkursionen upplöstes).

Första anhalt gjordes på den lilla vägen c. 1 km sydöst om Röddinge kyrka, varifrån deltagarna förflyttade sig till fots till skogsområdet c. 500 m söder om Röddingeberg. Här höll professor WEIMARCK en kort presentation av Fyledalen, och laborator MALMER beskrev de olika skogstyperna, som finns på platsen. I den delvis starkt sluttande terrängen kan en tydlig differentiering i fältskiktets flora iakttas, vilken kan korreleras med markens skiftande fuktighetsförhållanden. På fuktiga ställen kring bäckar dominerar *Petasites albus;* i anslutning härtill följer en *Allium ursinum* - zon, som avlöses av *Mercurialis perennis.* Den torrare delen av sluttningen karakteriseras av ett *Galium odoratum* - samhälle, som på krönet av en kulle uppträder i en artfattig variant.

Nästa gång stannade man vid Benestads kyrka och vandrade sedan till det fredade området c. 500 m västnordväst om kyrkan (»Benestads backar»). Studiet av flora och vegetation på denna lokal försiggick i ett stundom kraftigt strilande regn. Trots detta kunde i *Schoenus* - kärret antecknas *Dactylorchis majalis, Primula farinosa* och *Valeriana diocia.* I de (vanligtvis) torra sluttningarnas gräsmark kunde på vissa ställen ses *Senecio integrifolius* (ännu ej blommande); och särskilt längs upptrampade stigar fanns många och stora exemplar av *Hutchinsia petraea.*

Vid Kåseberga besöktes den välkända skeppssättningen »Ales stenar», varefter exkursionsdeltagarna klättrade nedför branten mot Östersjön. I denna sluttning noterades bl. a. *Arenaria serpyllifolia, Artemisia campestris, Capsella bursa-pastoris, Cerastium semidecandrum, Holosteum umbellatum, Hutchinsia petraea, Geranium molle, Myosotis hispida* och *stricta, Saxifraga tridactylites, Senecio vernalis, Stellaria media, Veronica triphyllos* och *Vicia lathyroides.*

I den nedre delen av branten hittades på några ställen *Asparagus officinalis, Lithospermum arvense* v. *caerulescens* och *Alyssum alyssoides.* Bland klappern på stranden växte *Honkenya peploides.* Slutligen kan från mera ruderatbetonade ställen nära Kåseberga hamn nämnas *Lamium album, Onopordum acanthium* och *Stellaria apetala.*

19 september. Exkursion företogs med buss till nordvästra Skåne. Route: Lund—Ängelholm—Skäldervikens strand (vid Ängelholm)—Ängelholms havsbad—Munka-Ljungby—Herrevadskloster—St. Nybo (Riseberga sn)—Bandsjön (Riseberga sn)—Spången—Lund. Första exkursionsmålet var Skäldervikens strand i Ängelholm nära gränsen till Strövelstorps socken. En frisk kuling blåste in från Kattegat, vilket gav en uppfattning om vindens och vågornas roll för strandens och vegetationens utformning. På den s.k. förstranden växte *Honkenya peploides, Salsola kali, Atriplex latifolia* och *A. sabulosa.* Den sistnämnda, som naturligt nog mest tilldrog sig intresset, hade påträffats under sommarens inventeringsarbete av MATS GUSTAFSSON. *Atriplex sabulosa* fanns just i den nedersta kanten av dynvegetationen, där *Ammophila arenaria* började uppträda.

Anhalt nr två var Ängelholms havsbad, där en lokal ett par hundra meter öster om havsbadet i närheten av Rönne å skulle studeras. Här hade på ett område med *Molinia*-äng grästorv upptagits. Strängar av ängen fanns kvar, och på ytorna mellan dessa härskade ett igenväxningsstadium med ännu ej sluten vegetation: En gles *Phragmites*-vass, där i det lägre fältskiktet en rik förekomst av *Centunculus minimus* var särskilt värd att lägga märke till. På grund av den hårda pålandsvinden hade emellertid knutarvslokalen mer eller mindre övergått till havsbad, och *Centunculus* befann sig på 40 cms vattendjup, varför den intressanta lokalen dessvärre inte inbjöd till besök ens med svenska normalstövlar.

I Munka-Ljungby, som inventerats av BENGT BENTZER, studerades floran utmed Rössjöholmsån vid Munka-Ljungby kvarn. Från en stenbro hade man god utblick över de stora *Osmunda*-ruggarna nere vid ån. Hundra m ovanför bron fanns *Leersia oryzoides* dock svåråtkomlig vid då rådande höga vattenstånd i ån.

I Riseberga socken gjordes först halt c. 600 m VNV Herrevadskloster för besök på de delvis kärrartade betesmarkerna utmed Rönne å. Här finns en av denna sockens få rikkärrslokaler, bl.a. förekommer *Epipactis palustris*. På av kreaturen upptrampad fuktig mark kunde man finna *Isolepis setacea* och *Glyceria declinata*.

Tvåhundra m NÖ St. Nybo underkastades vägkanterna utmed en mindre grusväg en intensiv granskning. Här förekom bl.a. *Centunculus minimus, Radiola linoides* och *Juncus bufonius*.

I det så småningom allt bättre vädret avslutades dagens floristiska studier vid Bandsjön (c. 800 m N Riseberga kyrka). Å den omedelbart V sjön belägna mossen fanns ett bestånd av *Scheuchzeria palustris* i en igenväxt torvgrav. Kallgräset befann sig i vackert fruktstadium. I kanten av en annan igenväxt torvgrav hittade ARNE H. HOLMQVIST en liten buske av *Ledum palustre*. Efter detta fynd visade det sig, att flera *Ledum*-buskar fanns i den tallbevuxna randzonen av mossen (jfr WEIMARCK 1947: Natur i Skåne sid. 255).

4 november. Till styrelse för år 1966 valdes professor H. WEIMARCK, ordf., docent O. ALMBORN, v. ordf., undertecknad, sekr., fil. stud. G. MATTIASSON, v. sekr., samt lic. F. ANDERSSON, lic. S. O. FALK, laborator B. LÖVKVIST, docent H. RUNEMARK och lic. S. O. STRANDHEDE.

Till revisorer valdes lic. S. SNOGERUP och lic. S. PETTERSSON samt såsom suppleanter lic. L. O. BJÖRN och docent R. DAHLGREN.

Laborator NILS MALMER höll föredrag om Sydsveriges regionala växtgeografi. Föredragshållaren diskuterade olika växtgeografiskt grundade gränslinjer inom Sydsverige, gav exempel på där förekommande floristiska element och skildrade områdets kända vegetationstyper. Som sammanfattning belystes den växtgeografiska differentieringen i Sydsverige från ekologisk ståndpunkt.

9 december. Professor KAI LARSEN, Aarhus, höll föredrag om »Indtrykk fra botaniske undersøgelser i Thailand». Under föredraget skildrades några danska botaniska expeditioner företagna i Thailand i samarbete med landets myndigheter. I anslutning till expeditionsberättelsen gav föredragshållaren en beskrivning av bl.a. den tropiska regnskogen i landets södra del och av monsunskogarna i den norra delen. Vidare gavs en mycket instruktiv skildring av risodlingens praktik.

JAN ERICSON

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Litteratur

HELMUT J. BRAUN: Die Organisation des Stammes von Bäumen und Sträuchern. — Stuttgart (Wissenschaftliche Verlagsgesellschaft M.B.H.) 1963. XII+162 pp. 137 figs. Price DM. 40: —.

In the first two chapters (92 pages) the cell types. tissues and tissue systems in stems are dealt with. The third chapter (28 pages) is devoted to the functions of tissues and tissue systems, and the fourth (20 pages) to the organization of the wood. The characteristics of the species investigated (157) are brought together in a table. Most space is devoted to the mature stem, and the primary structure is treated rather briefly. Node anatomy is not mentioned. The species more fully discussed are mainly European, but this material is supplemented with a great number of species from other parts of the world.

Wood is composed of few cell types only, but they vary in many respects and may be combined in an astonishing number of ways. Almost every genus can be recognized from the characteristics of its wood. Within the plentiful material the author has distinguished fourteen organization types. They have been arranged into series, each with several organization levels. On the lowest level is the gymnosperm type (with tracheids and ray parenchyma only). From this the series radiate. On higher levels are the many types found among angiosperms (and also *Ephedra* and *Gnetum*). They show stronger differentiation (have vessels and fibers also and more specialized cells) and more elaborate organization (water conduction is more or less restricted to the vessels). When the material is systematized in this way, it suggests the use of an evolutionary point of view. The author does so, with appropriate caution.

The book treats thoroughly a subject, which is usually touched upon in a cursory way in textbooks of anatomy. The distribution in space of the cell types is described in great detail, and the relations between structure and function are continually stressed. The many excellent figures (drawings and photomicrographs) are well chosen and instructive. There are a few criticisms of the layout, e.g., there is no species index and the table mentioned above is not clear enough in arrangement and typography.

Thanks to the thorough treatment of elementary things hardly any previous knowledge is required from the reader. The book is thus an excellent introduction to the study of the mature woody stem. To taxonomists it affords many things of interest.

K. H. MATTISSON

The Plant Cover of Sweden. Acta Phytogeographica Suecica 50. — Almqvist & Wiksell, Uppsala 1965. X+314 pages, 118 photos, 35 maps, 13 diagrams and 12 tables. Price: Sw. Kr. 72: —, clothbound Sw. Kr. 87: —.

Acta Phytogeographica Suecica, issued by The Swedish Phytogeographical Society, has presented its fiftieth volume. For the second time since the foundation of the Society in 1923 a symposium has been published. The first one in 1940 was a phytogeographical study dedicated to the late Professor CARL SKOTTSBERG and the present one has been dedicated to a conspicuous leader of geobotany in Sweden, Professor G. EINAR DU RIETZ in celebration of his seventieth birthday on the 25th of April 1965. With this survey of the general features of Swedish vegetation pupils and friends wish to honour this prominent scientist and teacher.

In the preface the Editorial Committee has given some points of view, which ought to be considered in a review. "The scope of the book is naturally wide but problems of method, technique or classification and other specialized aspects of research have generally been left aside. We have thought it proper that the survey, although far from being a manual, should be written in an international language, so that its contents may be available to naturalists and friends of Scandinavia throughout the world. We also wish to relieve ourselves of the blame for our previous reluctance to share with the outside world the results of geobotanical investigations in our homeland, a country where, fortunately, the landscape and its plant covering is not yet so grossly worn down or destroyed as in more heavily populated or ruthlessly exploited countries."

The contents of the book are divided into four sections: Regional Survey (6 papers), Aspects of the South (12 papers), Aspects of the North (11 papers) and finally Past and Present (4 papers). In all 34 authors have contributed to this work.

The introductory chapter, written by the foremost authority of this survey Professor H. SJÖRS, treats the physiographic and climatic conditions of Sweden. It is a well illustrated contribution, which gives plenty of information and necessary background to those who are not familiar with the country.

Regional aspects of the marine, benthic vegetation have been given by M. WÆRN. Contributions concerning the west coast, by J. SÖDERSTRÖM and P. E. LINDGREN, deal with special problems such as vertical zonations and distribution of algae due to gradients of salinity and pollution. S. PEKKARI for his part has studied the extreme conditions in the northernmost part of Bothnian Bay.

The coastal vegetation has been treated in two ways, partly provincially and partly thematically. Provincial descriptions from the county of Bohuslän and the Bothnian coast have been written by H. P. HALLBERG and E. SKYE respectively. There is a survey of the salt marshes of South Sweden by V. GILLNER, and the paper "Maritime sands" by B. PETTERSSON contains notes on coastal sand vegetation, including vegetation with *Corynephorus* and *Koeleria*.

In the paper "The vegetation of Swedish lakes" G. LOHAMMAR gives regional aspects of limnic vegetation. Provincial contributions regarding living and lost lakes and rivers in northern Sweden have been written by L. GRANMARK, S. PEKKARI, N. QUENNERSTEDT and G. WASSÉN.

Terrestrial vegetation in Sweden is dominated by forests in most parts and these form a basis for a regional dividing of the country. H. SJÖRS has in the chapter "Forest regions" discussed the biotic or vegetation regions. Here some notes are also given on distribution, ecology and floristic features of the forests. These regions are named according to a terminology adapted by SJÖRS in 1963, viz., nemoral, boreo-nemoral and boreal regions or zones. Terms of this kind indicate the affinity to larger regions in an obvious way.

Another paper which elucidates the regional division of the country ought to be mentioned. It is a contribution by S. FRANSSON, which treats the borderland between the boreo-nemoral and the boreal regions. In addition the mountain regions are presented in two papers by S. KILANDER and O. RUNE respectively.

A very characteristic feature of the research of Swedish plant cover has for a long time been the study of mires, and this tradition has given rise to a rather good knowledge of these elements of the landscape. The results of these investigations are surveyed by N. MALMER, H. SJÖRS and Å. PERSSON, who in the following order treat southern, northern and mountain mires. The vegetation of northern mires is also dealt with in descriptions from the county of Jämtland by F. BJÖRKEBÄCK and Y. NORDQVIST. The micro-vegetation of a mire is described by T. FLENSBURG.

In order to complete the presentation of "Aspects of the South" the following titles should be mentioned: "The south-western dwarf shrub heaths" by N. MALMER, "Gotland and Öland. Two limestone islands compared" by B. PETTERSSON, "Vegetation on coastal Bohuslän" by H. P. HALLBERG and R. IVARSSON, "Stipa pennata and its companions in the flora of Västergötland" by L. FRIDÉN and finally "The growth on rock" by E. VON KRUSENSTJERNA.

Among the sequence of papers in "Aspects of the North", only those treating mountain vegetation have not yet been mentioned. O. GJÆREVOLL and K.-G. BRINGER describe the alpine vegetation. A paper by H. HOLMEN may be mentioned in this connection. It deals with pre- and subalpine tall herb vegetation in an area with oceanic influence and it gives some notes on the nutrient economy of this environments.

In the last section of the book, "Past and Present", M. FRIES gives a survey of the late-quaternary vegetation. The influence of Man, too, is treated. Special information on this subject is given by B. PETTERSSON in a paper "Recent changes in flora and vegetation". The previous sections, however, also contain many aspects concerning Man as an ecologic factor, and so the influence of cultural exploitation on Swedish vegetation is well documented.

From what has been reported here it will be seen that the symposium touches upon most fields of ecology in Sweden. Although it has been said that the volume should not be equated with a manual, its purpose in reality comes very close to that and in practice it will probably be used as such. This is only to be expected, since a proper survey of Swedish vegetation in an international language has for a long time been urgently needed.

If one is to use this volume as a manual, however, there are some practical details lacking, especially a brief survey or index of described plant communities. Perhaps such a brief survey could also indicate more properly to what extent Swedish vegetation is actually investigated. Another point of difficulty for the reader may be the absence of an index to plant species. Facilities of this kind would make it possible to pick out special details with only short descriptions, such as *Koeleria*-vegetation.

These criticisms should not lessen the indisputable value of "Plant Cover of Sweden". It is of greatest importance that for the first time a presentation has been achieved in an international language of the results of Swedish plant ecologic research. The many references in the text give in summarized form an almost complete bibliography of Swedish geobotanical literature written in Swedish or in other languages. The publishing of this symposium will certainly increase the knowledge of geobotanic research in Sweden.

Last but not least it should be mentioned that this important Acta Phytogeographica Suecica is, like all the other numbers in the series, a most well presented volume.

Folke Andersson

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