Bothalia 23,2: 215–221 (1993)

Studies in the Marchantiales (Hepaticae) from southern Africa. 3. The genus *Targionia* and *T. hypophylla* with notes on *T. lorbeeriana* and *Cyathodium foetidissimum* (Targioniaceae)

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Keywords: *Cyathodium*, Hepaticae, Marchantiales, southern Africa, *Targionia*, Targioniaceae, *T. hypophylla*, *T. lorbeeriana*, Targionioideae

ABSTRACT

A taxonomic account of the genus, *Targionia*, and its only representative in southern Africa, the almost cosmopolitan *T. hypophylla*, is given here. Much more southern African and other material, than was available to the previous authors, Sim (1926) and Arnell (1963) has been examined.

Material collected at Knysna by Duthie was identified by Arnell (1963) as *Cyathodium foetidissimum*, but is shown to have been misidentified and is actually a specimen of *Riccia rubricollis*. The presence of the genus, *Cyathodium* in southern Africa, has not been confirmed.

UITTREKSEL

'n Verslag oor die genus *Targionia* en sy enigste verteenwoordiger in Suider-Afrika, die byna kosmopolitiese *T. hypophylla*, word hier gegee. Baie meer materiaal is ondersoek as wat vir die vorige outeurs, Sim (1926) en Arnell (1963), beskikbaar was.

Materiaal wat Duthie by Knysna versamel het, is deur Arnell (1963) geïdentifiseer as *Cyathodium foetidissimum*. Dit is egter verkeerdelik benaam en die materiaal is 'n voorbeeld van *Riccia rubricollis*. Die teenwoordigheid van die genus *Cyathodium* in Suider-Afrika is nie bevestig nie.

Targionia *(Micheli) L.*, Species plantarum 2: 1136 (1753); Gott. *et al.*: 574 (1846); Schiffn.: 26 (1893); Steph.: 763 (1898); Macvicar: 33 (1926); Sim: 16 (1926); K. Müll.: 325 (1951–1958); Hässel de Menéndez: 68 (1963); Arnell: 46 (1963). Type species: *Targionia hypophylla* L.

Thallus, medium-sized, fleshy, lobes linear, sometimes widening toward apex or cordate, somewhat leathery, light green to darker green, often with a waxy bloom, in crowded patches or extensive sheets; on soil in sheltered rocky clefts or a pioneer on disturbed soil.

Branches often simple, sometimes repeatedly furcate or only apically branched, or with ventral innovations; thickened over midrib, rather abruptly thinning into wings; apex notched, tips of scale appendages curving backwards over it; not grooved. *Dorsal epidermis* hyaline, cell walls thickened, especially at corners; air pores simple, conspicuous, slightly raised, with 3 concentric rings of cells, their walls thin, leading below into shallow air chambers containing chlorophyllose filaments; oil cells present; storage tissue 3–5 times thicker than assimilation tissue above; ventrally purple-black; some rhizoids smooth, others pegged. *Scales* in one row on each side of midrib, dark purple, large, obliquely triangular with broadly 'awl'-shaped appendage.

Autoicous or dioicous. *Antheridia* mostly embedded in swollen disciform apex of small male branch, arising ventrally at side of midrib and emerging laterally. *Archegonia* formed at apex of thallus, and subsequently capsule displaced to just below apex, enclosed in bivalved involucre which opens at central narrow vertical fissure; capsule wall cells with annular thickening bands. *Spores* convex distally, ornamented with a double network, the larger network forming strongly raised, rounded ridges which enclose polygonal areas, all covered by a reticulum of smaller, fine ridges. *Elaters* bispiral, sometimes branched.

Targionia hypophylla *L.*, Species plantarum: 1136 (1753); Steph.: 764 (1898); Macvicar: 33 (1926); Sim: 16 (1926); K. Müll.: 326 (1951–1958); Hässel de Menéndez: 69 (1963); Arnell: 46 (1963); Volk: 241 (1979); Piippo: 274 (1991). Types: 'Italia, Hispania, Constantinopoli' + citation (syn.); (OXF, syn.) Dill.: 532. Lichen no. 9, tab. 78, fig. 9. (1741); (H-SOL, isosyn.) [according to Isoviita (1970) and quoted by Grolle (1976)].

T. michelii Corda: 649 (1829). Type: Italy, leg. *Sieber*.

T. mexicana Lehm. & Lindenb. in Lehm.: 27 (1832). Type: Mexico, leg. *Schiede*.

T. capensis Hübener: 17 (1834).

T. hypophylla var. *capensis* (Hüb.) Krauss: 135 (1846). Type: Cape, 'in promont. bonae Spei', leg. *Zeyher*.

T. bifurca Nees & Mont. in Mont.: 113 (1838); Nees: 315 (1838). Type: Chile, 'prope Quillota', leg. *Brotero*.

T. convoluta Lindenb. & Gott. in Gott. *et al.*: 576 (1846). Type: Mexico, ad Chinantla, leg. *Liebman*.

Thallus medium-sized, somewhat leathery, linear to ligulate, apically often slightly broader, dark green, sometimes with bluish tint, marginally purple and entire to somewhat crenate or scalloped, flat above, not grooved,

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MS. received: 1992-10-23.

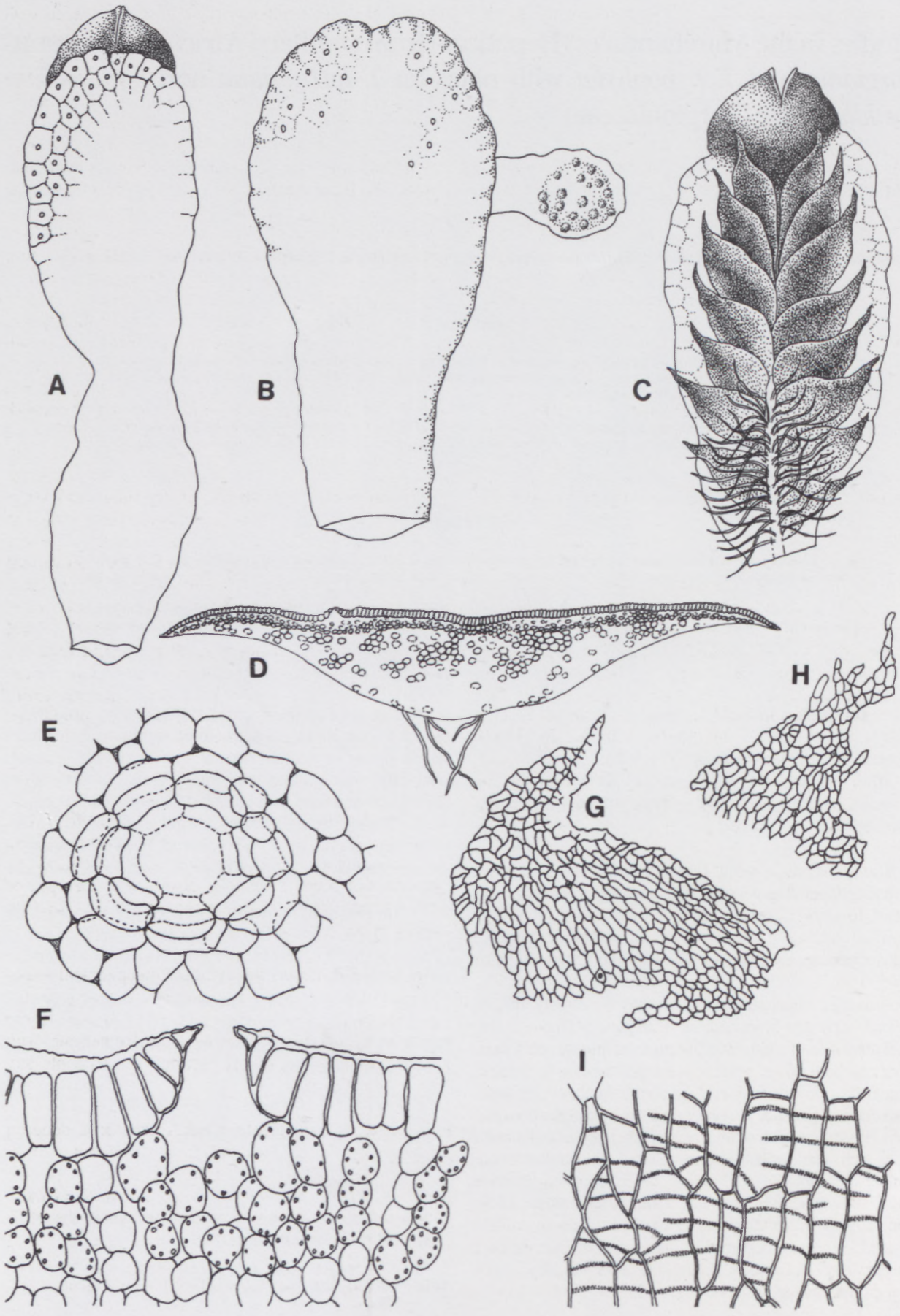

FIGURE 1.—*Targionia hypophylla*, A, dorsal aspect of thallus with tip of involucre protruding at apex; B, thallus with short ventrally innovating branch bearing terminal disc with antheridia; C, ventral aspect of thallus with pouch-like involucre at apex and 2 rows of ventral scales; D, tranverse section of thallus; E, air pore from above; F, transverse section of air pore, dorsal cells and chlorophyllose filaments; G, scale with margins ± intact; H, scale with fimbriate appendage; I, cells of capsule wall with thickening bands. A, C, D, F, I, *Koekemoer 477a*; B, E, G, *Garside 6674*; H, *Schelpe 4947*. A, B, C, × 11; D, × 22; E, × 300; F, × 275; G, H, × 55; I, × 250.

polygonal outlines of subdorsal air chambers clearly visible from above, each with large and well-spaced air pore, wet (Figure 1A); flanks ventrally deep purple and frequently incurved, branches becoming almost tubular, or sides clasped together, mostly covering dorsal epidermis with its conspicuous white-encircled air pores, distal ventral scales exposed, leading branch often becoming erect and elevating ventral sporophyte, dry; in crowded patches, simple to repeatedly furcate or with ventral or apical innovations. *Branches* 5–10 mm long between furcations, total length up to 30 mm, 2.7–3.5 mm wide, 550 µm thick over midrib, laterally thinning out into wings; apex slightly notched with tips of scales reflexed over edge in sterile plants or, when female receptacle present, entire and lacking apical scales; margins acute, thin, ventrally purple; flanks sloping obliquely outward and upward (Figure 1D); ventral face medianly keeled, mostly purple, on either side of midrib with row of imbricate, apically directed, purple to reddish ± triangular scales (Figure 1C). *Dorsal epidermal cells* unistratose, hyaline, from above rounded to oval, 22.5–37.5 × 17.5–25.0 µm, trigones conspicuous, in transverse section cells ± 45 µm high, rectangular, lateral walls thickened; marginal cells mostly purple, from above rectangular, trapezoid or triangular, (25–)30–45(–50) × 20–32 µm, second row purple as well or sometimes hyaline, also variable in shape and size, 22.5–50.0 × 15.0–17.5 µm, an inner third or fourth row of cells frequently also present, all lacking trigones; marginal cells at apex of thallus (17–)22–35 × (12–)25–37 µm; air pores somewhat raised, simple, 52.5–67.5 × 35.0–40.0 µm, oval or rounded (Figure 1E), 250–375 µm distant from each other, bounded by 3 concentric rings of cells: innermost annular row of ± 6 thin-walled, curved, hyaline cells, ± 15 × 25 µm, the remains of a collapsed cell ring, next row of 8–11 sausage-shaped cells, ± 22 × 30 µm, slightly thicker-walled, partly overlying outermost row of 14 also sausage-shaped cells, ± 27 × 35 µm; assimilation tissue with air chambers in one layer, ± 80 µm thick, containing simple or branched, 2- or 3-celled chlorophyllose filaments, cells (20.0–)22.5–34.0 × 25.0 µm, those below air pores larger (Figure 1F), 47.0 × 37.5 µm, with numerous chloroplasts, and except at air pores, in close proximity to dorsal cells; storage tissue ± 425 µm thick, cells closely packed, angular, variable in size, 17.5–50.0 µm wide, occasional cells with oil bodies, ± 27.5 µm wide; rhizoids mainly between scales, some smooth, others pegged, ± 15 µm wide. *Scales* in 2 longitudinal rows, one on either side of costa, reddish to dark purple, obliquely triangular, imbricate, not or hardly reaching thallus margins, 875–1750 µm long and up to 1325 µm wide at base, if receptacle present, those covering it proximally larger, 2250 µm in length, basally up to 2000 µm wide, apically continuing into single, forwardly directed, long-acuminate appendage (Figure 1G), ± 375 µm long; cells in body of scale 4–6-sided, ± 80.0 × 17.5 µm, in appendage 32.5–62.5 × 22.5–27.5 µm, below appendage, polygonal, (20–)37–60 × 25–45 µm, scattered oil cells present, margin entire or not, sometimes with single-celled papillae, 30.0 × 17.5 µm or with fimbria (Figure 1H) ± 75 × 25 µm or longer, especially at appendage of apical scales.

Autoicous or dioicous. *Androecia* borne on short, ventrally innovating branches, protruding at sides of thallus, on terminal disc, 1.3–1.8 mm wide, 750 µm thick and encircled above by low, frilly membrane; *antheridia* several, with conical protruberances, 150 µm high, each with opening leading into antheridial cavity below. *Gynoecia* terminal, enclosed in large, ± 3125 × 3600 µm, shiny black, mussel-like, bivalved involucre, displaced below apex of thallus, wall 4-layered, cells in outer layer thick-walled on outside, 4–7-sided, 62.5–150.0 × 32.5–45.0 µm, in inner layers thin-walled, elongated, ± 100 × 40 µm, interspersed with numerous oil cells; to release spores and elaters, involucre opening along narrow central vertical fissure fringed with several irregular, cellular protuberances; pseudoperianth lacking; calyptra hyaline, delicate, cells irregular in shape and size, 45.0–55.0 × 27.5 µm; capsule subsessile, spherical, wall yellowish brown, cells ± rectangular to mostly spindle-shaped, ± 75 × 35 µm, with thickening bands (Figure 1I) ± 5 µm wide. *Spores* (47–)62–77(–95) µm in diameter, light brown to brown or dark reddish brown, anisopolar, 2 faces different in shape and ornamentation, distal face convex, rounded, with double network (Figure 2A, D–F), the larger network consisting of raised, rounded ridges, enclosing 16 or 17 polygonal areas, 12.5–17.5 µm wide, all covered by superimposed, fine reticulum, the areolae of which mostly smaller on sides and crests of primary ridges and larger within enclosures; proximal face only slightly rounded to flattish or even somewhat hollowed, generally with very irregularly contorted, closely drawn together, reticulated ridges separated by narrow fissures (Figure 2B); at juncture of proximal and distal faces, when seen from inner face, encircling row of reticulated primary ridges on distal face projecting beyond rim of smaller proximal face, appear to form an undulating wing, ± 10 µm wide. *Elaters* yellowish brown, not tapering but sometimes branched, doubly spiral (Figure 2C), up to 290 × 12.5 µm. *Chromosome number*: n = 9 (Bornefeld 1987).

DISCUSSION

In the family Targioniaceae, two subfamilies, Targionioideae and Cyathodioideae Grolle, are recognized, each with only a single genus. They are characterized by gynoecia that become ventrally displaced at the apex of the thallus and capsules which are enclosed in a bivalved, mussel-shaped involucre.

In *Targionia* species the thalli are compact and somewhat leathery, with low air chambers containing chlorophyllose filaments and a thick layer of storage tissue below; in *Cyathodium* species the thalli are delicate, with tall air chambers lacking chlorophyllose filaments and with much reduced storage tissue.

To date, no monographic studies have been done on the genus *Targionia*, although as many as 26 names have been recorded under it (Geissler & Bischler 1990). Piippo (1991), however, recently speculated that most of these names will undoubtedly prove to be synonyms of *T. hypophylla*. There are at least two other *Targionia* species with well-defined specific limits, namely *T. stellaris* (K. Müll.) Hässel de Menéndez (1963) from Argentina and a new species from India reported by Udar & Gupta (1983).

Targionia hypophylla, the only representative of the genus, is a widespread, almost cosmopolitan species [for total range see Piippo (1991)], occurring especially in temperate and seasonally dry areas where it grows as a xero-

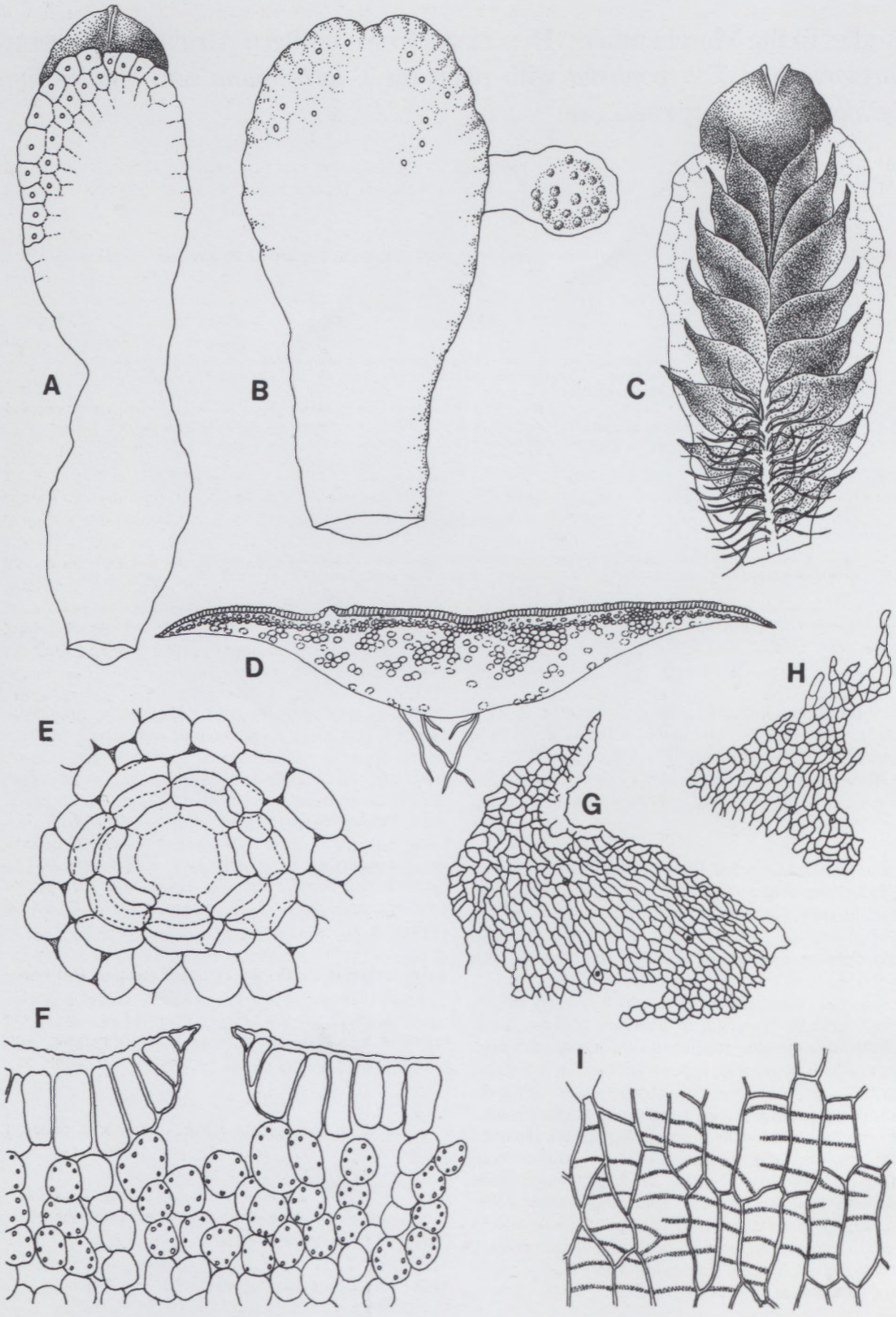

FIGURE 1.—*Targionia hypophylla*, A, dorsal aspect of thallus with tip of involucre protruding at apex; B, thallus with short ventrally innovating branch bearing terminal disc with antheridia; C, ventral aspect of thallus with pouch-like involucre at apex and 2 rows of ventral scales; D, tranverse section of thallus; E, air pore from above; F, transverse section of air pore, dorsal cells and chlorophyllose filaments; G, scale with margins ± intact; H, scale with fimbriate appendage; I, cells of capsule wall with thickening bands. A, C, D, F, I, *Koekemoer 477a*; B, E, G, *Garside 6674*; H, *Schelpe 4947*. A, B, C, × 11; D, × 22; E, × 300; F, × 275; G, H, × 55; I, × 250.

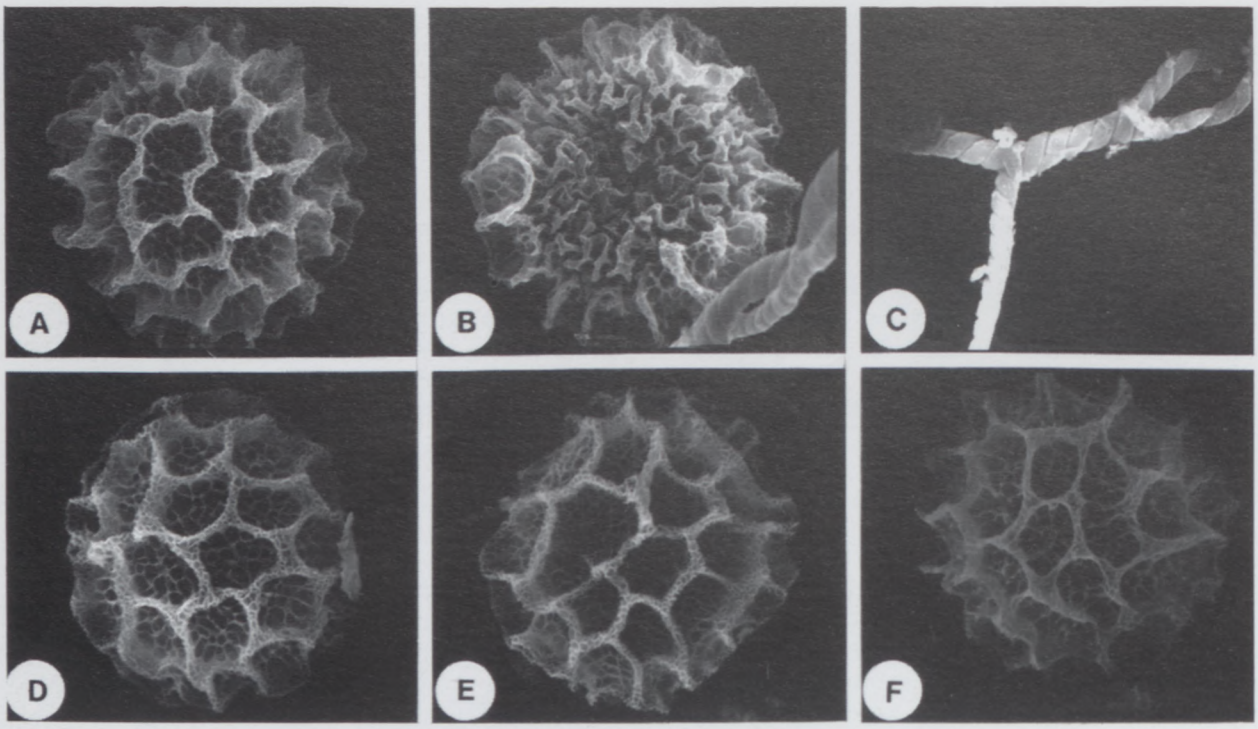

FIGURE 2.—*Targionia hypophylla*. SEM micrographs of spores and an elater. A, D–F, distal face of spore; B, proximal face of spore; C, elater. A–C, *S.M. Perold 2365*; D, *Koekemoer 433*; E, *Garside 6573* (Round House); F, *Schelpe 4947*. A, × 500; B, × 530; C, × 490; D, × 445; E, × 560; F, × 460.

phyte on soil in rock crevices, on soil over rock outcrops or under rock overhangs, or as a pioneer on disturbed earth banks, like road cuttings. Sometimes other liverworts such as *Riccia* spp., *Plagiochasma* spp., or *Mannia* spp. are also present.

Targionia hypophylla is easily recognised, when fertile, by the ventrally displaced capsule contained in a shiny black pouch at the apex, by which further lengthening of the branches is arrested. Sterile plants are distinguished by their dark green, somewhat leathery appearance, the conspicuous white-encircled air pores and reddish to purple-black triangular ventral scales with a single appendage. Kashyap (1914) regards it as a very variable species, and so does Schuster (1992), who thinks that incipient speciation is under way; on the other hand Müller (1951–1958) observes that, in spite of its wide distribution, plants display little variation and the species is probably very old. It is somewhat similar to *Mannia* spp., but these differ from it by their less conspicuous air pores and by capsules borne aloft on a longish stalk. *Plagiochasma* spp. have smaller air pores and more pronounced spicules on the dorsal epidermal cells, with the capsules also raised on a stalk.

T. hypophylla was previously described from southern Africa by Sim (1926) and Arnell (1963). It has been quite rarely collected in Namibia (from whence Volk (1979) recorded 14 collections), central Transvaal, Natal, Orange Free State, Lesotho, Transkei, central, southern and eastern Cape, but frequently in the winter rainfall areas of the northwestern and southwestern Cape (Figure 4).

Further north in Africa it has also been recorded from Ghana by Jones & Harrington (1983), Tanzania (Bizot *et al.* 1978), Kenya and again Tanzania (Bizot *et al.* 1985), Malawi (*S.M. Perold 2665* PRE), Zambia (Vanden Berghen 1972), Zimbabwe (Sim 1926; Best 1990) and the adjacent islands of Madagascar (Arnell 1963) and Réunion (Bischler 1990), although in the latter report, it is listed as *T. hypophylla* and in brackets, 'or *T. lorbeeriana*'. Frey & Kürschner (1988) report *T. hypophylla* from the Arabian Peninsula (together with *T. lorbeeriana*) as well as a possible new morphotype, *T. hypophylla* spp. *linealis* (spp. *nova?*). *T. elongata* is also known from Africa (Ethiopia), and Scott & Pike (1988) have published SEM micrographs of its spores, which are very distinct and clearly different from those of *T. hypophylla*, in that there are only 5 or 6 large, ± smooth areas on the distal face, as opposed to the usual 16 or 17 reticulated ones in *T. hypophylla*. On a recent visit to Malawi, some specimens of *Targionia* were collected, one of which, *S.M. Perold 2653*, had up to 30 reticulated areas (Figure 3F), 7.5–10.0 µm wide, on the distal face; the spore diameters were 65–72 µm. It is not certain, however, whether we are dealing with a different species or not.

Targionia hypophylla L. var. *fimbriata* K. Müller is not treated as a distinct variety in this study of southern African specimens as was done by Arnell (1963), because the presence of fimbria along the ventral scale margins is very variable, even in thalli from the same population. Apical scales are also more frequently fimbriate than older ventral scales on the same branch. Schuster (1992) regards the intrapopulational variation in this feature as so great that no taxonomic segregation of the two extremes seems possible to him.

Statistical and other studies by several authors (Sérgio & Queiroz Lopes 1972; Zamora *et al.* 1990; Jovet-Ast

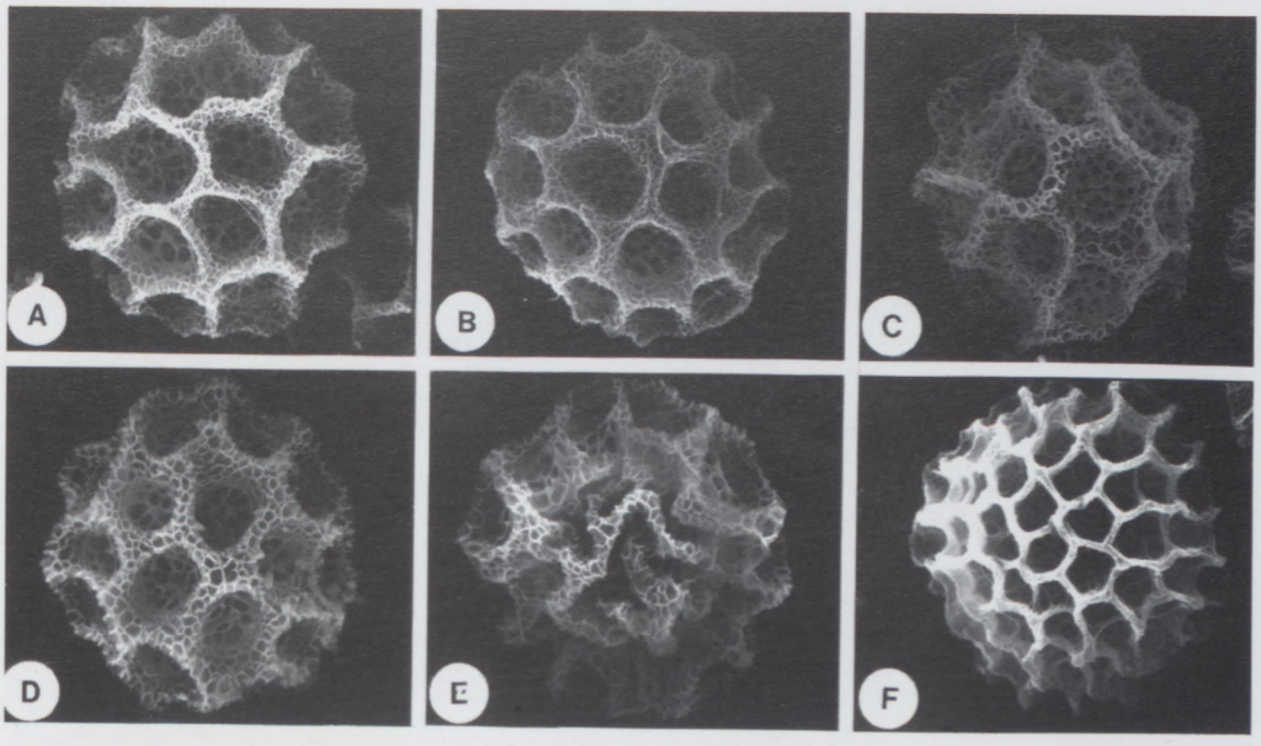

FIGURE 3.—*Targionia* spp. SEM micrographs of spores. A–E, *T. lorbeeriana*: A–D, distal face; E, proximal face. F, distal face of *T.* sp. A, *Sérgio & Sim-Sim Lev. 70*; B, *Cros et al.* 12-VII-1984; C, *Sérgio 148161*; D, E, *S. Arnell s.n.* (Tenerife); F, *S.M. Perold 2653* (Malawi). A, × 550; B, × 490; C, × 635; D, E, × 580; F, × 620.

1956; Jovet-Ast & Zigliara 1967 and Zigliara 1970) have confirmed the existence of an allied species, *T. lorbeeriana* (Müller 1940) of which I have studied the type specimen (leg. *Huber-Tharandl*, (5) collected in Sicily). Arnell (1963) and Magill & Schelpe (1979) record the presence of *T. lorbeeriana* in southern Africa, but this could not be confirmed in the present investigation although (Arnell (1963) even records *T. lorbeeriana* var. *fimbriata* from here). The specimens which Arnell placed under *T. lorbeeriana*, *Garside 6573* [spore diameter 57.5–62.5 µm (Figure 2E)] and *Schelpe 4947* [spore diameter 75–85 µm (Figure 2F)] are undoubtedly *T. hypophylla*, judging by their spore ornamentation and cell measurements of the thalli and scales. The correct naming of old dried herbarium material is, however, difficult, since the colour of the thalli fades, as does the distinctive odour of *T. lorbeeriana*. Spore ornamentation (see later) seems to be a more reliable and certainly more permanent distinguishing character. Grolle (1983) regards reports of the occurrence of *T. lorbeeriana* in the East African Chyulu Mountains (Bizot *et al.* 1978), as well as in the Cape (and India), as needing verification. *Targionia lorbeeriana* is thought to be a 'triploid race' of *T. hypophylla*, as it has 27 chromosomes. It is said to be characterized by a strong smell of acid pear drops when fresh; by the cordate shape and light green colour of the thallus; by larger, oval air pores and by different cell dimensions [for the latter see Zamora *et al.* (1990)]. Schier (1974) reports slight differences in the flavonoids of the two species. Differences in the spore ornamentation of the two species were demonstrated by Jovet-Ast & Zigliara (1967). Scott & Pike (1988) consider the spore sculpturing as the clearest and least ambiguous way of separating the two species: in their Australian material they consistently found that *T. hypophylla* has regular areolae, whereas in *T. lorbeeriana* the areolae are irregular in arrangement.

Spore samples of 20 different specimens of *T. lorbeeriana* (on loan from European herbaria) were presently studied with the SEM and compared with more than 40 spore samples of local *T. hypophylla*. In *T. lorbeeriana* spores there are fewer ridges on the proximal face (Figure 3E) and on the distal face, the fine reticulum, particularly that covering the inside of the polygonal areas of the coarse reticulum, has thicker walls (Figure 3A–D); the proximal spore face in *T. hypophylla* has numerous contorted ridges and the walls on the distal face are thin and the areolae oval or irregular in shape and size, the fine mesh presenting an altogether 'looser' appearance (Figure 2A, D–F). Of the southern African material examined, spore ornamentation of *Magill 6606, Van Rooy 2973, 3142a* seems to be intermediate between *T. hypophylla* and *T. lorbeeriana*. Judging by my findings, the illustrations by Scott &

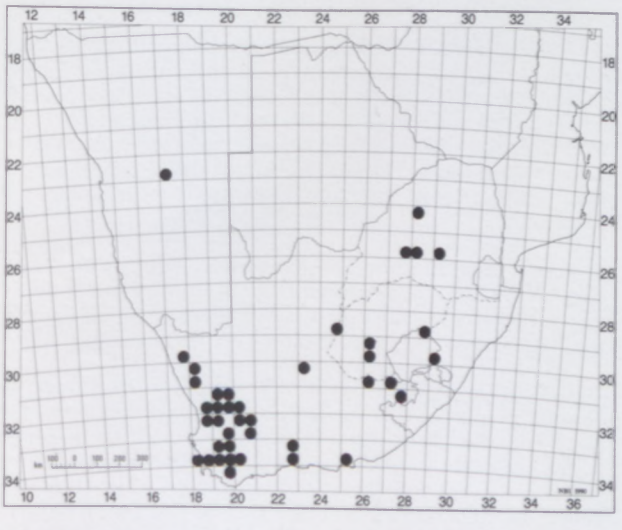

FIGURE 4.—Distribution of *Targionia hypophylla* in southern Africa.

Pike (1988: plate 1.1), appear to be of *T. lorbeeriana* and 1.2 of *T. hypophylla*, in other words, the reverse of what they are stated to be. The *T. hypophylla* spores illustrated by Taylor *et al.* (1974) are closely similar to those in my study.

Cyathodium foetidissimum Schiffner

Arnell (1963) observed that a specimen in the National Herbarium, Pretoria, collected by A.V. Duthie at Belvedere, Knysna, probably belongs to this species, i.e. *Cyathodium foetidissimum*. This specimen has been examined and its spores photographed. It is undoubtedly a species of *Riccia* and the ornamentation of the spores proves it to be *R. rubricollis* Garside & Duthie ex Perold (Perold 1991). On the small specimen packet inside the larger envelope, in Sim's handwriting is the note 'Miss Duthie's (No. 23) new *Riccia*, Belvedere, Aug. 1928' and below it, in Arnell's writing and signed by him is the annotation '*Cyathodium* sp.'. One wonders why Arnell had ignored Sim's identification, as the latter must have received the specimen from Duthie herself. In mitigation, it may be added though, that the material had been pressed and it is only a small sample, perhaps even a little atypical, but the internal sporangia and spores immediately place it correctly.

The other two species of *Cyathodium*, *C. africanum* and *C. aureonitens* which Arnell (1963) thought would possibly be found in southern Africa, have so far not been collected here and it is doubtful if they ever will be, since they are conspicuous and luminous green, and it is unlikely that they could have been overlooked. The presence of the genus, *Cyathodium* in southern Africa has therefore not been confirmed although it is very widely distributed in the rest of Africa (Jones 1952).

SPECIMENS EXAMINED

NAMIBIA.—**2217** (Windhoek): Dassieskuppe, Ostseite, an schattigen Felsen, in Moosgesellschaft, (–CB), *Volk 11357* (M, PRE).

TRANSVAAL.—**2428** (Nylstroom): Waterberg Game Park along Melk River, shady riverbank, (–AB), *Leistner 3558* (PRE). **2527** (Rustenburg): Swartkop Picnic Resort, near Randburg, on steep earth bank above stream, (–DD), *S.M. Perold 249* (PRE). **2528** (Pretoria): Pretoria, along Apies River, (–CA), *Scott 23* (PRE). **2529** (Witbank): Witbank, C.R. Swart Nat. Res., at subsidiary stream entering Olifants River from west, on streambed, clay soil, (–CD), *Glen 1475* (PRE).

NATAL.—**2828** (Bethlehem): Drakensberg, Royal Natal Nat. Park, Broome Hill, in forest, (–DB), *Cholnoky 182* (BOL); Drakensberg, lower western slopes of Sentinel along footpath to chain ladder, alpine heath/grassland with igneous rock outcrops, (–DB), *Magill 6606* (PRE). **2929** (Underberg): Sani Pass Hotel, opposite bank of Mkhomazana River, at waterfall, on soil, (–CB), *S.M. Perold 2509* (PRE); halfway up Sani Pass, vertical rock wall, with earth pockets, on soil, (–CB), *S.M. Perold 2517* (PRE).

O.F.S.—**2926** (Bloemfontein): Bloemfontein, Eagle's Nest, (–AA), *Potts CH 1143* (PRE); Bloemfontein, (–AA), *T.R. Sim CH 1137* (PRE); Farm Lastpoort on the Ruigtespruit, between Reddersburg and Helvetia, grassland with trees and shrubs, on soil, (–DC), *Van Rooy 2345* (PRE).

LESOTHO.—**2828** (Bethlehem): 5 km from New Oxbow Lodge to Mokhotlong, waterfall over basalt cliff in tributary of Fanana River, near Maluti Club Ski Chalet, alpine heath-grassland, S aspect, on soil in sheltered rock crevice, (–DC), *Van Rooy 2961, 2973* (PRE); 6 km from New Oxbow Lodge to Mokhotlong, alpine heath-grassland, on soil over basalt, (–DC), *Van Rooy 3058* (PRE); 4 km from New Oxbow Lodge to Butha Buthe, alpine heath-grassland, on soil bank at flattish basalt outcrops, NW aspect, (–DC), *Van Rooy 3142a* (PRE). **2929** (Underberg): Kotisephola Pass, between Sani Top and Mokhotlong, alpine heath-grassland, basalt outcrops at top of pass, rock overhang, (–CA), *Van Rooy 3399* (PRE); Sani River banks, ± 7 km from Sani Top, along road to Mokhotlong, alpine heath-grassland, on soil in rock crevice, (–CA), *Van Rooy 3461*; Sani Top, mountain slopes, W of Border Post, alpine heath-grassland, on soil, (–CB), *Van Rooy 3554* (PRE).

TRANSKEI.—**3127** (Lady Frere): near top of Cala Pass, moist vertical bank in road cutting, (–BC), *Glen 1718* (PRE).

CAPE.—**2824** (Kimberley): Kimberley, (–DB), *Welman CH 1141* (PRE). **2917** (Springbok): in valley leading from Ookiep to 'Ropeway', damp corners under ledges, (–DB), *Giffen CH 1136* (PRE). **3018** (Kamiesberg): Inkruip, northern Khamiesberg, south slopes, damp ground in lee of large granite boulders, (–AA), *Oliver 7220* (PRE); Sors Sors area, NE of Kamieskroon, (–AA), *Oliver 9206* (PRE); 19 km NE of Kamieskroon, 5 km after turnoff on road to Rooifontein, (–AA), *S.M. Perold 1473* (PRE); 2 km beyond Willem Stone Bridge, Pedroskloof, on road to Rooifontein, on soil under rock, (–AA), *S.M. Perold 1496* (PRE); 3 km along Rooifontein road, after turnoff from Kamieskroon-Leliefontein road, on soil beneath rock overhang, (–AA), *S.M. Perold 2138* (PRE); 5.2 km along Rooifontein road, after turnoff from Kamieskroon-Leliefontein road, (–AA), *S.M. Perold 2169* (PRE); southern Khamiesberg, Klippoort, SE of Hoedberg, granite hill, slope facing south, sandy hollows, (–CB), *Oliver 9557* (PRE). **3023** (Britstown): Britstown, Farm Jakkalskuile, (–AD), *Viljoen CH 4523* (PRE). **3026** (Aliwal North): Albert Dist., ± 12 km SE of Bethulie, Cliftonvale Farm, foot of rocky cliffs, seepage zone, (–CA), *H.H. Burrows 2522* (PRE). **3027** (Lady Grey): Dist. Herschel, Sterkspruit, (–CA), *Hepburn CH 1138, CH 1139* (PRE); Witteberg Mts, Joubert's Pass, 8 km east of Lady Grey, western aspect, alpine heath-grassland, on soil, (–CB), *Van Rooy 2700* (PRE). **3118** (Vanrhynsdorp): Gifberg, SE of Van Rhynsdorp, at top of mountain, underneath rock, drier area away from stream, (–DC), *S.M. Perold 2754* (PRE). **3119** (Calvinia): Van Rhyns Pass, at top of plateau, on soil, (–AC), *S.M. Perold 2186* (PRE); Hantamsberge, top of mountain near FM tower, mountain rhenosterveld, rock and soil pockets, (–BD), *Koekemoer 822* (PRE); south side of Hantams Mountain, near FM tower, on soil between rocks, (–BD), *S.M. Perold 1824* (PRE); Farm Daantjie-se-kraal, 37 km along road between Soetwater and Clanwilliam, 8 km before Botterkloof Pass, (–CB/CD), *S.M. Perold 1871* (PRE); Vondelingsfontein, northern Roggeveld, damp ground in lee of shrubs, (–DD), *Oliver 8911* (PRE); Vondelingsfontein Farm, 10 km from Calvinia on road to Middelpos, along small streamlets at roadside, (–DD), *S.M. Perold 1839* (PRE). **3120** (Williston): northern Roggeveld, Knegtsbank, kloof north of farm, south slopes with dense rhenosterbos scrub, (–CC), *Oliver 8920* (PRE). **3218** (Clanwilliam): middle slopes of Pakhuis Pass, on Clanwilliam side, (–BB), *Koekemoer 433* (PRE); Aggensbachsberge, ground forest, (–BB), *Stirton 9280* (PRE); 20 km N of Citrusdal, past Hexriver Farm, on rocky outcrops at roadside, above Olifantsrivier, (–BD), *S.M. Perold 530* (PRE); 5 km along road to Algeria, after turnoff from Cedarberg road, under damp overhang near road, (–BD), *S.M. Perold 2351* (PRE). **3219** (Wuppertal): 3 km before turnoff to Biedouw/Wupperthal, on R364, between Soetwater and Clanwilliam, at streamlet, on sand over sandstone, (–AA), *S.M. Perold 1883* (PRE); 4 km south of Algeria Forest Station, (–AC), *S.M. Perold 2365* (PRE); Ceres, Kaggakamma Nat. Res., near beacon 3 in streambed, at foot of boulders, (–DA), *Koekemoer 768, 769, 770* (PRE). **3220** (Sutherland): 24 km NW from Sutherland (Roggeveld Mtns), occasional in S aspect rock crevices, (–AB) *Schelpe 4952* (BOL); 2 mls N from Sutherland, occasional on S aspect rock edges under bushes, (–BC), *Schelpe 4947* (BOL); Verlaten Kloof, 18 mls S from Sutherland, locally frequent under asparagus bushes on S aspect, shale slope, (–DA), *Schelpe 4942* (BOL); Sutherland, near top of Komsberg Pass, in rhenosterveld, on sandy-loamy soil, (–DB), *Vlok 2667* (PRE); Smoushoogte, Klein Roggeveld, damp southern slope, with short rhenosterbos scrub, (–DC), *Oliver 8969* (PRE). **3318** (Cape Town): Peninsula, Constantia slopes, (–CD), *S. Arnell 379* (BOL); Kirstenbosch, (–CD), *S. Arnell 565* (BOL); Cave Peak (–CD), *S. Arnell 615* (BOL); Lion's Head, Round House, (–CD), *S. Arnell 1176* (PRE); behind Round House, Camps Bay, on granite soil, (–CD), *Garside 6495* (BOL); Round House, Camps Bay, on soil, (–CD), *Garside 6573* (BOL); Camps Bay, below Round House, (–CD), *Garside 6674* (BOL); Table Mountain, Slongoli, (–CD), *T.R. Sim CH 1149* (PRE); Devil's Peak, (–CD), *T.R. Sim CH 1142* (PRE); Cape Town, (–CD), *H.A. Wager CH 1133* (PRE); Stellenbosch Flats, (–DD), *Duthie CH 1148* (PRE); Stellenbosch, (–DD), *Duthie CH 1147* (PRE); Jonkershoek road, Stellenbosch, earth bank by side of road, (–DD), *Garside H60* (BOL); Jonkershoek, Stellenbosch, (–DD), *Garside 9* (PRE). **3319** (Worcester): Gydo Pass, on soil, (–AB), *Stirton 9160* (PRE); Hex River Pass road, occasional on shaded earthbank in dry stream bank, (–BD), *Schelpe 4918* (BOL); Hex River Pass, near summit, gulley, on damp ground, (–BD), *Stirton 9482* (PRE); Bainskloof,

NE of Wellington, vertical rock wall at roadside, on soil, (–CA), *S.M. Perold 2785* (PRE); Worcester Karroo Garden, amongst karoid shrubs, (–CB), *Koekemoer 364* (PRE); Farm Leipzig, east of Worcester, at foot of Rabiesberg, on soil on rock face, (–DA), *Morley 289* (PRE); Sandhills, north of Worcester, near railway line, on soil on rock outcrop, (–DA), *S.M. Perold 579* (PRE). **3320** (Montagu): Montagu, Bath Kloof, (–CC), *S. Arnell 749, 758* (BOL). **3322** (Oudtshoorn): Prince Albert, at northern base of Swartberg Pass, in arid mountain fynbos, on loamy sandy soil, (–AC), *Vlok 2660* (PRE); Meirings Poort, North of De Rust, near Oudtshoorn, on earth bank above road, (–BC), *S.M. Perold 898* (PRE); near Hoekplaas, on gravel road from De Rust to Uniondale, on rocky slope under karoo bushes, (–DB), *Koekemoer 477a* (PRE). **3325** (Port Elizabeth): Hells Gate, Uitenhage, (–CD), *T.R. Sim CH 1140* (PRE). **3419** (Caledon): Greyton Kloof; on soil on rock wall next to footpath, (–BA), *S.M. Perold 607, 1170* (PRE); Betty's Bay, (–BD), *S. Arnell 695* (BOL).

ACKNOWLEDGEMENTS

My sincere gratitude to Drs C. Sérgio, LISU, and A.J.E. Smith, Bangor, for refereeing this article and for their helpful suggestions. I also wish to thank the following for the loan of specimens; Dr C. Sérgio, LISU, the curators of BOL and S; Prof. Dr O.H. Volk, Würzburg, and Dr R. Lübenau-Nestlé, Kempten, Germany; my thanks to my colleagues at NBI, Dr H.F. Glen, Miss M. Koekemoer and Mr J. van Rooy, for collecting specimens; also to the artist, Ms G. Condy, the typist Mrs J. Mulvenna and the photographer Mrs A. Romanowski, for their valued contributions. Miss S.K. Marner, OXF, is thanked for kindly sending photographs of *Targionia hypophylla* from Dillenius's herbarium.

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