

Notes on the genus *Frithia* (Mesembryanthemaceae) and the description of a new species, *F. humilis*, in South Africa

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Keywords: *Frithia* N.E.Br., Mesembryanthemaceae, new species, South Africa, summer rainfall mesembs, taxonomy, window plants

ABSTRACT

Frithia N.E.Br. (Mesembryanthemaceae), formerly thought to be a monotypic genus, has been found to comprise two species. Populations from the eastern parts of the distribution range of *Frithia pulchra* N.E.Br. are recognised as a distinct species, *Frithia humilis* P.M.Burgoyne. The genus has a limited distribution, although present in three provinces of South Africa, namely Gauteng, North-West and Mpumalanga. The two window-leaved species are allopatric and morphological differences between the roots, leaves, flowers, pollen, capsules and seeds are discussed. A formal description of the new species, an identification key and a distribution map of the two species are provided.

INTRODUCTION AND HISTORICAL OUTLINE

The genus *Frithia* (N.E.Br.) was first mentioned in a key by Brown (1925). At that time no species were assigned to the genus and only later was a full description of *Frithia pulchra* given (Brown 1926). The genus was named after Frank Frith (1872–1954), a railway services gardener stationed at Park Station, Johannesburg. He was responsible for decorating railway platforms from 1900 until his retirement in 1932 (Kroon 1997). In 1906, Olive Nation sent a specimen of a plant she discovered near Rustenburg to Brown at Kew for identification. The live specimen did not survive the journey, but the remains were seen by Brown who regarded it as a distinct entity. After Miss Nation died, a search for more material proved unsuccessful. Some time later, a Mrs Dobie of Rustenburg sent plants to Frank Frith, who took the specimens to Brown at Kew while on a visit to London, to create the African garden at the Wembley Exhibition. Dobie's specimen allowed Brown to finally describe the genus.

De Boer (1968) published the name *Frithia pulchra* var. *minor* in the Dutch journal *Succulenta*, but as no type material was cited the name was invalid. Plants of this variety are generally smaller than those included in var. *pulchra* and are restricted to the eastern parts of the distribution range of the genus. These differences were again alluded to by Hardy & Fabian (1992). Zimmermann (1996) confirmed the different characters of var. *minor*, but gave no formal description or type validating the varietal epithet. Although a number of short articles have been written on *Frithia* (Brink 1985; Germishuizen 1975; Steffens 1988; Venter 1979, 1983), no in-depth study has been done on the genus.

This paper reports on the taxonomic status of the genus, and specimens from the eastern parts of its distribution range are formally described as a new species, *Frithia humilis*.

TAXONOMY

To prevent possible confusion with the illegitimate name *Frithia pulchra* N.E.Br. var. *minor* de Boer, the varietal epithet *minor* is not used at the specific rank. The name of the new species is derived from the Latin *humilis*, which means 'smaller than others of its kind'.

Key to species

- Window of leaf tips convex with no markings along margins; leaves 15–25 mm long, blue-green or grey-green; flowers bright magenta with gold, yellow or white centre, 25–35 mm diam.; growing west of Pretoria in the Rustenburg area 1. *F. pulchra*
- Window of leaf tips concave with crenulate markings along margins; leaves shorter than 15 mm, brown-green or dull green; flowers white with yellow centre, pale pink, rarely entirely pink, petals sometimes tipped with pale pink, 15–20 mm diam., when pollinated turn pale yellow or salmon-orange; growing east of Pretoria in the vicinity of Bronkhorstspuit and Witbank 2. *F. humilis*

Frithia humilis P.M.Burgoyne, sp. nov.

Frithia pulchra N.E.Br. var. *minor* de Boer: 147, 148 (1968), nom. illeg.

Plantae perennes nanae succulentae, radicibus succulentis lateraliter ramosis, tempore mensium hibernium in humum arenosum retractae per foliis contractilibus longitudinaliter vietas fiunt praesentia eorundum cavis relictis indicata. *Caulis* simplex, brevis, ad 10 mm longus. *Folia* spiraliter disposita, obscure virides ad brunneo-virides, mensis aridis hibernis purpureo-suffusa, maxime succulenta, ad 15 mm longa, cylindrica, idioblastis ceraceis distincte serialibus, apicibus foliorum fenestratis cum centro concavo, maculisque conspicuis crenulatis perimetro. *Flores* solitaires, 15–20 mm diametro, albi vel perdilute rosei, centro flavo, ante ad post meridiem aperiens. *Sepala* 5, inaequalia, folia simulantia, tubum brevem connata. *Petala* 20–30, in verticillis plures disposita, apices plerumque acuminati, interdum rotundati. *Staminodia* petaloidea ad filiformia, verticillos aliquot staminum cingentia. *Hypanthium* basibus connatis petalorum staminodium staminumque formatum. *Necta-*

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ria 5, libra, atroviridia, crenulata. *Ovarium* supra leviter conicum, stigmata 5 vel 6, perbrevia. *Fructus* capsula 5-vel 6-locularis, doliiformis, perfragilis, maturitate rumpens, semina spargens; valvae ad positionem erectam aperientes, alae valvarum absentes, margines valvarum recurvati ubi omnis aperti, cristae turgescens pallide luteo-brunneae, apicibus divergentibus marginibusque scissis, membranae tegentes ad regulam reductae. *Semina* rubro-brunnea, parva, tuberculis parvis tecta. Florescentia a Decembri ad Februarium.

TYPE.—Gauteng, 2528 (Pretoria): Bronkhorstspuit Dist., 29 km northeast of Bronkhorstspuit on tarred road to Verena, then 3 km along road to Susterstroom, on Farm Susterstroom, in sandy flat areas associated with rough rocky outcrops, (–BD), *Burgoyne* 6693 (PRE, holo.).

Perennial, dwarf succulent with fleshy roots branching laterally; plants retracting into sandy soil by means of contractile leaves shrinking lengthways during dry winter months, leaving holes marking their presence. *Stems* single, short, up to 10 mm long. *Leaves* arranged spirally, dull green to brown-green with a purple tinge in dry winter months, highly succulent, up to 15 mm long, cylindrical, covered by waxy idioblasts arranged in distinct rows, tips windowed, with concave centre and conspicuous crenulate markings along perimeter. *Flowers* single, 15–20 mm diam., white or very pale pink, with yellow centre, opening during mid-morning to mid-afternoon. Pollinated flowers turn yellow or salmon-orange. *Sepals* 5, unequal, resembling leaves, united to form a short tube. *Petals* 20–30 per flower, arranged in several whorls, tips mostly acuminate, sometimes rounded. *Staminodes* petaloid to filiform, surrounding several whorls of stamens. *Hypanthium* formed by fused bases of petals, staminodes and stamens. *Nectaries* 5, free, dark green, crenulate. *Ovary* slightly conical above; stigmas 5 or 6, very short. *Fruit* a capsule, 5- or 6-locular, barrel-shaped, very fragile, breaking up when ripe and then dispersing seeds; valves opening to an upright position, valve wings absent, valve margins recurved when fully open; expanding keels light yellow-brown, parallel, with diverging tips and torn margins; covering membranes reduced to a ledge; closing bodies absent. *Seeds* red-brown, small, covered by small tubercles. *Flowering time*: December–February (summer in the southern hemisphere).

As the formerly monotypic genus *Frithia* now has two species, the type species of the genus is *Frithia pulchra* N.E.Br.

SPECIMENS EXAMINED

All specimens held at PRE.

Burgoyne 6692, 6693, 6694, 6694b, 6696, 6698, 6699 (2), 6699b, 6699c (1).

Crundall PRE54981 (2).

Dyer 4774 (1). *Dyer & Verdoorn* 3922 (1).

Gilfillan 7272 (2).

Jacobsen 758 (1).

Rose Innes 167 (1).

Vari PRE54978 (1). *Venter* 2997 (2).

Young 38395 (1).

DISTRIBUTION AND HABITAT

Frithia is one of the few genera in the Mesembryanthemaceae exclusive to the summer rainfall region of South Africa. Other mesemb genera with a distinctly summer rainfall distribution include *Neohenricia*, *Mossia* and *Khadia*, while *Delosperma*, *Hereroa*, *Lithops*, *Chasmatophyllum*, *Nananthus* and *Stomatium* may occur in summer rainfall areas but also have wider distributions.

Previously thought to be a monotypic genus and a Magaliesberg endemic, an enlarged *Frithia* still has a restricted distribution. Populations of these miniature window plants have been found in two disjunct regions, in the North-West between Rustenburg and the Hartbeespoort Dam in the west, and in an area between Bronkhorstspuit (Gauteng) and Witbank (Mpumalanga) in the east (Figure 1). The two areas are roughly 150 km apart, and so far, no specimens of either species have been collected in the intervening area.

Both species of *Frithia* grow in very shallow soils derived from coarse sediments: quartzites of the Magaliesberg Formation of the Pretoria Group of the Transvaal Supergroup in the case of *Frithia pulchra* and sandstones of the Irrigasie Formation of the Ecce Group of the Karoo Supergroup for *F. humilis*. Rocks in both areas are very rough, porous and weather to form a very coarse gravel.

Frithia pulchra mostly grows exposed on rock plates, the roots anchored in cracks between the coarse quartzites. This substrate reaches very high temperatures in summer. Plants are also found in coarse gravel and are not restricted to rocky outcrops. *F. humilis* grows predominantly in shallow sand along the rims of large, flat, rock plates. Temperatures of the substrate are probably lower as more organic matter is present, insulating the plant bodies against heat and desiccation.

Both species grow at altitudes ranging from 1 368 m to 1 616 m, and rainfall varies between 700 and 800 mm per annum. Winters are cold and dry and severe frost occurs in the areas where the plants grow.

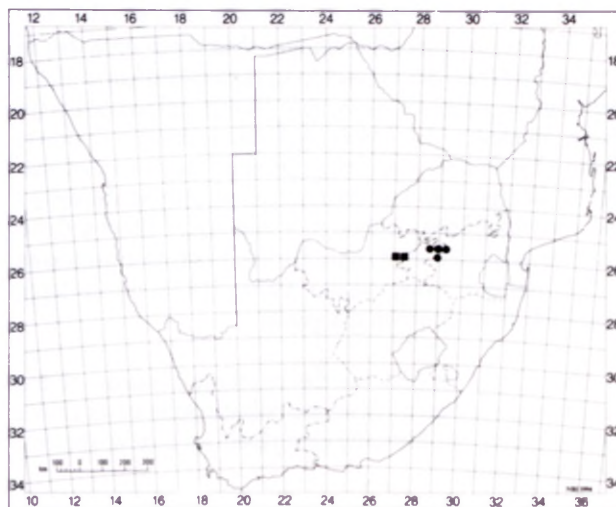


FIGURE 1.—Known distribution of *Frithia pulchra* ■, and *F. humilis*, ●.

Other species often associated with both species of *Frithia* are the fern ally *Selaginella dregei* and the legume *Indigofera melanadenia*. Species sometimes found associated with either species of *Frithia* are the succulents *Anacampseros subnuda* subsp. *subnuda*, *Crassula lanceolata* subsp. *transvaalensis*, *C. setulosa* var. *setulosa* and *Mossia intervallaris*. Monocots like *Microchloa kunthii*, *Anthericum calyptocarpum* together with an extremely minute and monophyllous species of *Drimia*, are also found in these habitats. The habitat of *Frithia pulchra* tends to be drier than that of *F. humilis*, the soils where the latter grow, having a higher organic content, sometimes resembling peat, and thus retaining moisture better.

FRITHIA IN HORTICULTURE

Frithia pulchra and *F. humilis* differ widely in their horticultural history. *F. humilis* was introduced to the Dutch seed trade by de Boer thirty years ago and a few of the plants dating from that introduction are still alive. This species is obviously quite tolerant and it responds to water more eagerly than does *F. pulchra*. The latter has been in continuous cultivation since the late 1920's but the plants are usually not long-lived, easily succumbing to rot. Both species can mature in a few months from seed under favourable conditions, and in this respect they are typical of a *Delosperma* alliance. The two species readily hybridize (S. Hammer pers. comm.) producing fertile offspring, with a variety of flower colours including orange and bright pink. Many attempts made by Hammer to hybridize *Frithia* with other genera (*Delosperma*, *Drosanthemum*, *Dorotheanthus*, *Lithops* and *Fenestraria*) have always failed, not even producing the 'dummy' (empty) fruits which often result from such disjunct liaisons.

MORPHOLOGICAL CHARACTERS

Habit

Both species are dwarf perennials with thickened roots. The stems are much reduced and during periods of drought the plants retract into the sandy soil. This has been ascribed to contractile roots, but no such roots are present in either species. However, in *Frithia* the cells of the leaves are arranged in columnar, axial rows and when moisture is lost and the cells shrink, the tangential walls contract. Artificially induced dessication using silica gel, indicated that a leaf may contract to up to one third of its length (Figure 2B). This causes the plants to retract into the soil, a mechanism which renders protection to the plants during times of drought (Figure 3C). Retraction into the ground is thus achieved by means of 'contractile leaves', not contractile roots.

Roots

Roots of *Frithia pulchra* differ from those of *F. humilis* in being more fibrous, possibly because of the drier conditions prevailing in its habitat and the strategy to insulate the plants against the heat of surrounding rocks in summer.

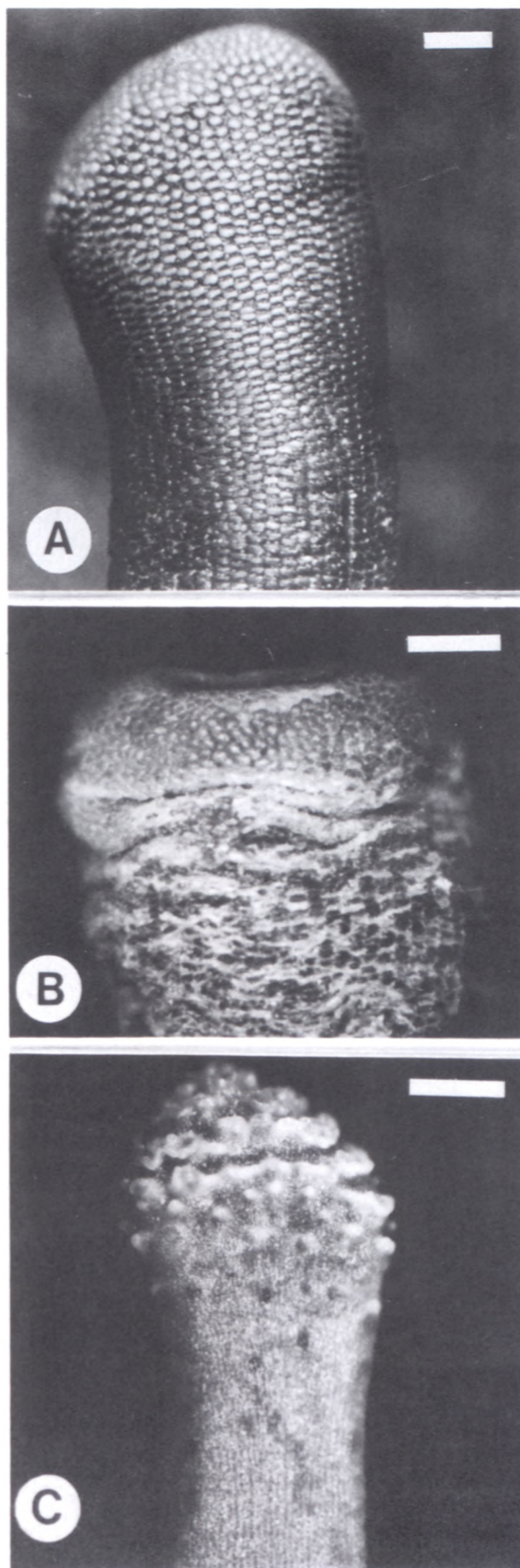


FIGURE 2.—*Frithia pulchra*: A, turgid leaf when conditions are favourable; B, shrunk leaf under drought conditions C, *Neohenricia sibbettii*, leaf. A, Burgoyne 6699c; B, Burgoyne 6694b; C, Burgoyne 6786b. Scale bars: 1 mm.

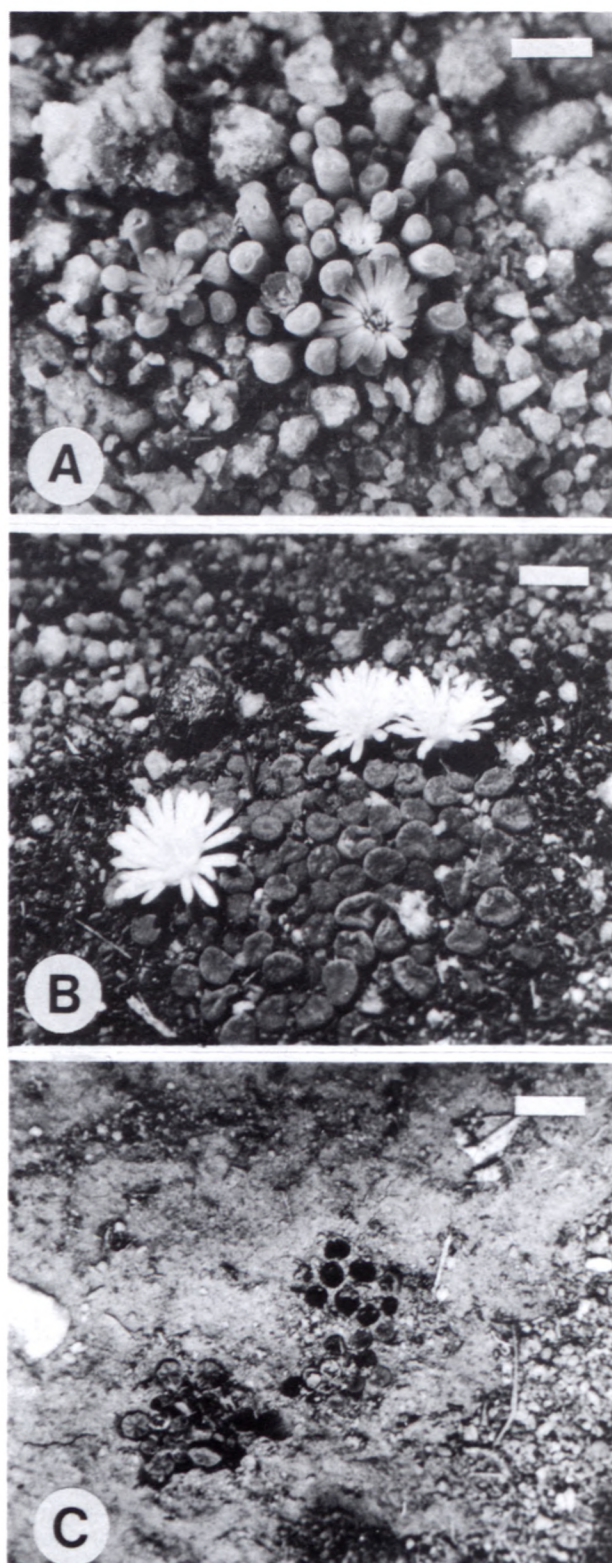


FIGURE 3.—Habit of *Frithia*: A, *F. pulchra*; B, *F. humilis*; C, plants of *Frithia humilis* retract underground during periods of drought. Scale bars: A, 10 mm; B, 30 mm; C, 10 mm.

Leaves

Borne spirally, the leaves of both species are cylindrical with windowed tips and are covered by an epidermal layer of waxy idioblasts arranged in distinct rows (Figure 2A). Leaves in adult plants of *F. pulchra* are longer (15–25 mm) than in *F. humilis* (shorter than 15 mm). Leaf colour also varies slightly between the two species, those of *F. pulchra* having a bluish tinge, whereas those

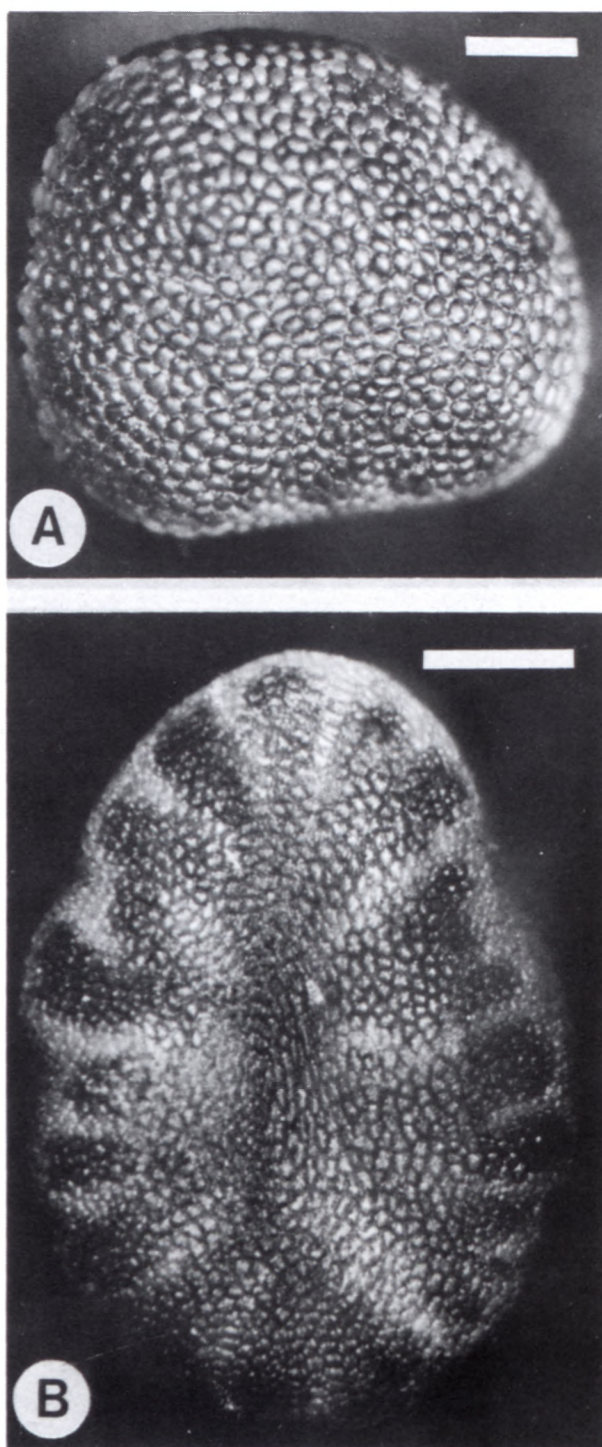


FIGURE 4.—Surface of leaf tips of *Frithia*: A, *F. pulchra* showing convex tips and no markings; B, *F. humilis* with concave centre and crenulate markings on margins. A, Burgoyne 6699c; B, Burgoyne 6694b. Scale bars: 1 mm.

of *F. humilis* are tinged brown or purple. The windowed tips of the leaves, however, differ conspicuously between the two species. Windows of *F. pulchra* are convex when turgid, slightly concave when flaccid (Figure 4A) and those of *F. humilis* are concave even when turgid, with crenulate markings (Figure 4B) along the margins. These leaf differences were also noted by Zimmermann (1996).

Flowers

Flowers in both species are borne singly and on very short stalks or are stalkless. They are subtended by five

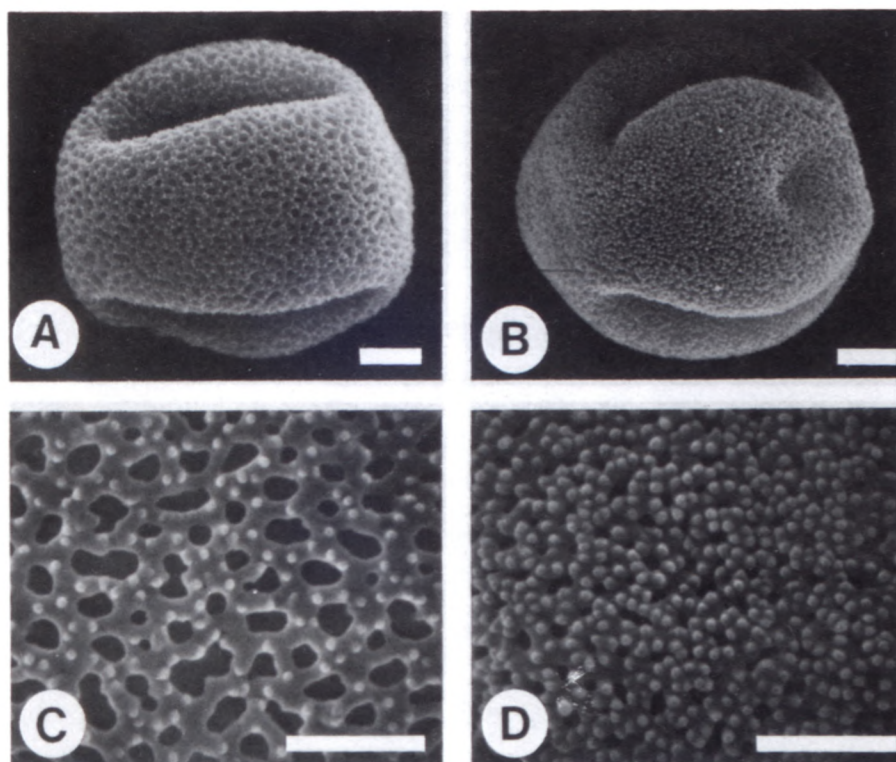


FIGURE 5.—Pollen of *Frithia*. SEM micrographs of unacetolyzed pollen grains: A, *F. pulchra*; B, *F. humilis*. Detail of pollen surface: C, *F. pulchra*; D, *F. humilis*. A, C, Burgoyne 6699c; B, D, Burgoyne 6694b. Scale bars: A, B, 1 μ m; C, D, 0.5 μ m.

unequal sepals closely resembling the cylindrical leaves. Flowers of *F. pulchra* are bright magenta with a white or light yellow centre and are 25–35 mm in diam. Those of *F. humilis* are white with a yellow centre, sometimes tipped with pale pink, and are generally smaller (15–20 mm diam.). The petals number between 30 and 45 in *F. pulchra* and tend to have blunt, rounded tips, whereas those of *F. humilis* number between 20 and 30 and usually have acuminate tips (Figure 3A, B).

Pollen

Pollen in both species of *Frithia* is yellow. The grains are tricolpate and simplicolumellate in *F. pulchra* (Punt *et al.* 1994) with a perforate surface and lumens of different sizes. Pollen in *F. humilis* has a perforate surface, and is pluricolumellate, with lumens of more or less equal size (Figure 5).

Fruit

Fruits are hygrochastic capsules, the shape resembling a barrel. Thick tissue surrounds the capsules of *F. pulchra*, whereas that of *F. humilis* is more fragile (Figure 6C). However, this character is not constant for the two species and seems to vary with environmental conditions. Capsules of both species tend to break up shortly after ripening. In both species, there are five or six locules, no valve wings and no closing bodies. Expanding keels are parallel with divergent tips (Figure 6), and are dark brown in *F. pulchra* and lighter brown in *F. humilis*. Covering membranes are reduced to a ledge in both cases.

Seeds

From Figure 7 it can be seen that the seed of *F. pulchra* is quite different from that of *F. humilis*. In *F. pulchra* (Figure 7A) the end where the seed has been

attached to the funicle (hilar end) has a sharp point, whereas in *F. humilis* it is more rounded. The length of the micropylar regions appears to be similar in the two species. The surface sculpturing is irregular in both species of *Frithia* (Figure 7B, E) and although there are no microbaculae present, the surface of the epidermal cells differs markedly between the two species (Figure 7C, F), that of *F. pulchra* being rough-textured whereas the cell surface of *F. humilis* is smoother.

NEAREST RELATIVES

The position of *Frithia* within the *Stomatium* Group proposed by Hartmann (1998) has always been tentative because of the outlier geographical distribution range and unique leaf characters displayed by the genus. Perhaps the most unusual feature is the spirally arranged leaves, a unique character within the subfamily Ruschioideae Schwantes in Ihlenf., Schwantes & Straka (1962) emend. Bittrich & H.E.K. Hartmann. Superficially, plants of *Frithia* resemble the genus *Fenestraria* N.E.Br., also with windowed leaf tips. However, *Fenestraria* occurs in northern Namaqualand and Namibia and no other characters are shared by the two genera.

As stated by Hammer (1998), *Frithia* has characters in common with *Delosperma*, but major differences still separate the two genera. One of the similarities is the leaf epidermis which is covered by opaque idioblasts. Idioblasts of *Delosperma deilanthoides* S.A. Hammer (1998) most closely resemble those of *Frithia* and are also arranged in rows. Capsules in both genera lack covering membranes and closing bodies. Distributions of these two genera overlap. The distribution of *Delosperma deilanthoides* is centred in the Steenkampsberg, Mpumalanga. It has similar habitat requirements (sandy, well-drained soil with a high organic content and porous,

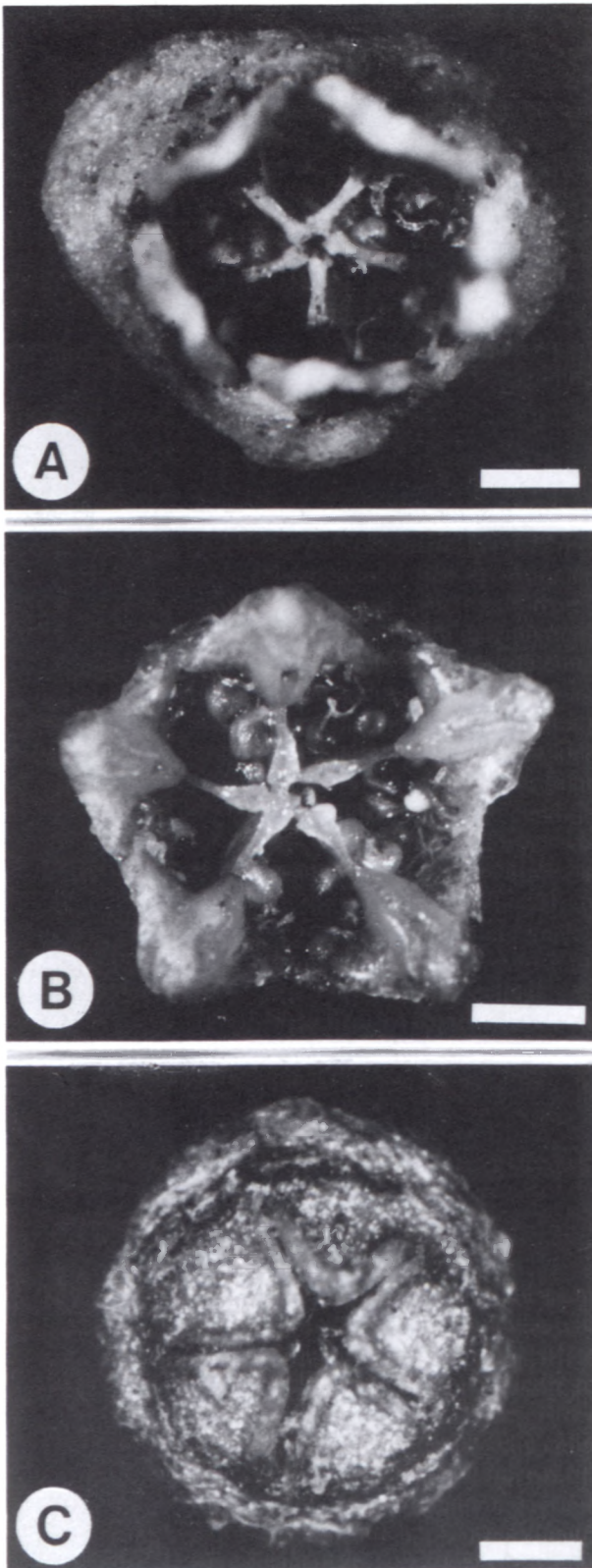


FIGURE 6.—Fruit capsules of *Frithia*: A, *F. pulchra*; B, *F. humilis*; C, closed capsule of *F. humilis*; A, Burgoyne 6699c; B, C, Burgoyne 6694b. Scale bars: 1 mm.

coarse lithology) to those of *Frithia*, but the Steenkampsberg receives a higher rainfall ($\pm 1\ 200$ mm per annum). Flowers of both genera belong to the white/pink colour range and open from mid-morning to mid-afternoon (Smith *et al.* 1998). However both flower colour and the presence or absence of epidermal idioblasts are considered to be pleiomorphic and are not suitable to indicate relationships.

The spiral leaf arrangement, not opposite as in other mesembs, gives rise to the interpretation that *Frithia* may have retained this primitive character (spirally arranged leaves are regarded as primitive) while developing advanced states in other characters. A more likely explanation may be that the spiral leaf arrangement found in *Frithia* is a derived feature, since it is not present in any genus holding a more basal position within the Mesembryanthemaceae. Based on this data it could be assumed that *Frithia* may be considered a highly specialised 'Delosperma'.

The leaves of *Neohenricia sibbetti* (L.Bolus) L.Bolus most closely resemble those of *Frithia* (Figure 2C) in shape, but the leaf surfaces of these two genera differ markedly. Leaves of *Neohenricia* are covered by wart-like crustose epidermal outgrowths, with opaque idioblasts scattered among them. Leaves of *Neohenricia* are opposite, whereas those of *Frithia* are arranged spirally. Capsules of the two genera are similar except that those of *Neohenricia* have four to six locules (four locules being the norm) and are shallow; those of *Frithia* are five- or six-locular and barrel-shaped. Moreover, the capsules of *Neohenricia* are borne on a remarkably thin pedicel and stand above the mass of leaves, whereas those of *Frithia* are buried within the leaves on a short pedicel and tend to be expelled via leaf pressure when ripe. However, flower colour and morphology differ considerably. Flowers of *Neohenricia* are pale yellow, borne on long pedicels and have thin spiky petals, opening in the mid-afternoon to evening. Nectaries are in the form of a glandular ring in *Neohenricia*, whereas those of *Frithia* are free. Flowers of both genera have very short stigmas with the staminodes and stamens that are fused, almost forming a hypanthium. The distribution ranges of these two genera do not overlap.

Further investigation is being done to examine the relationship (if any) between *Conophytum limpidum* S.A.Hammer and *Frithia* (Burgoyne in prep.) as they have some characters in common: a hypanthium is present; the petals, petaloid staminodes and anthers are comparable; windowed leaf tips present; fruit capsules can be compared as closing bodies; covering membranes are absent. Both are summer rainfall mesembs.

CONSERVATION STATUS

Use of the IUCN red list of categories (IUCN Species Survival Commission 1994), indicate that both species of *Frithia* should be regarded as Vulnerable, as the total area that they occupy is less than 100 km². Although the areas where these species grow are not in any immediate danger of being destroyed because they are too rocky, the limited distribution poses the risk that human activity could wipe out a large part of the populations should their habitat be used and transformed in the future. One locality of *F. humilis* is situated at the edge of an informal housing development, but the habitat is so unsuitable for any utilisation by man that it has remained largely undisturbed except for littering. The conservation status of *F. pulchra* is more secure, as a large part of the population is situated in the Rustenburg Nature Reserve. All other areas where populations of both species of *Frithia*

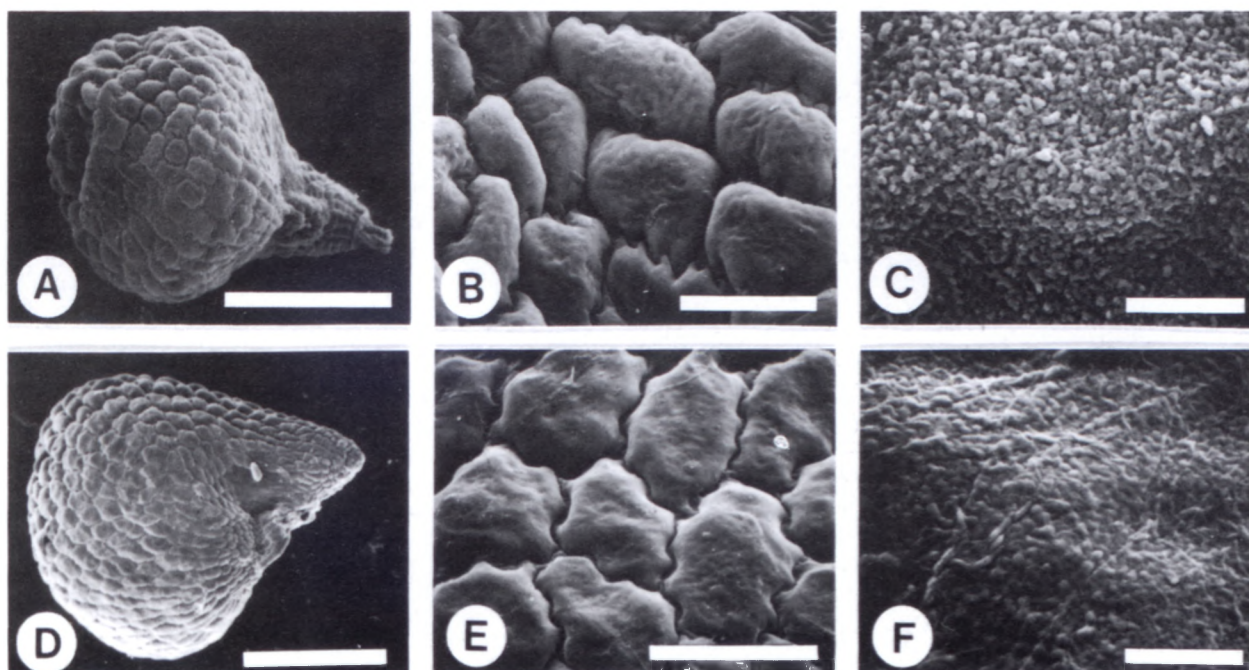


FIGURE 7.—Seed of *Frithia*: SEM micrographs: A–C, *F. pulchra*, Burgoyne 6699c; D–F, *F. humilis*, Burgoyne 6694b. Scale bars: A, D, 100 µm; B, E, 10 µm; C, F, 1 µm.

grow are in the hands of private land owners, many not even aware of the presence of these tiny plants. Unscrupulous succulent collectors may pose the greatest threat to populations of *Frithia*. Further population studies of both species of *Frithia* will be undertaken and their new conservation status will be determined (Burgoyne, Krynauw & Smith in prep.).

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