

The genus *Erodium* in southern Africa

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Accepted 28 August 1989

A taxonomic treatment of *Erodium* L'Hérit. (Geraniaceae) in southern Africa is presented. Eight species, of which two are possibly no longer present in southern Africa, are recognized. All of these species are exotics from Europe and the Mediterranean Region. Only *Erodium cicutarium* (L.) L'Hérit. is widely distributed over southern Africa, the rest are largely concentrated in the south-western Cape where they inhabit moist situations. *Erodium incarnatum* (L.) L'Hérit., only indigenous *Erodium* species in southern Africa is to be transferred to *Pelargonium*.

'n Taksonomiese verwerking van *Erodium* L'Hérit. (Geraniaceae) in suider Afrika word aangebied. Agt spesies, waarvan twee waarskynlik nie meer in suidelike Afrika voorkom nie, word onderskei. Al hierdie spesies is uitheems en afkomstig uit Europa en die Middellandse Seegebied. Slegs *Erodium cicutarium* (L.) L'Hérit. is wyd oor suider Afrika versprei, die ander is hoofsaaklik in die suidwestelike Kaap gekonsentreer waar hulle in vogtige omgewings groei. *Erodium incarnatum* (L.) L'Hérit., die enigste inheemse *Erodium*-spesie in suider Afrika sal na *Pelargonium* oorgeplaas word.

Keywords: *Erodium*, Geraniaceae, southern Africa, taxonomy

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Introduction

Erodium L'Hérit. belongs to the Geraniaceae, a family comprising five (Bortenschlager 1967) or six (Hutchinson 1969) genera. Of these *Monsonia* L., *Sarcocaulon* (DC.) Sweet, *Geranium* L., *Erodium* and *Pelargonium* L'Hérit. occur in southern Africa. Monographs on *Monsonia* (Venter 1979) and *Sarcocaulon* (Moffett 1979), and revisions of *Geranium* (Hilliard & Burtt 1985) and four sections of *Pelargonium* (Olivier & van der Walt 1984; van der Walt 1985; van der Walt & Boucher 1986; van der Walt & van Zyl 1988) have been published, so far, in the recent revision of the Geraniaceae in southern Africa.

The common diagnostic characteristic of the family is the schizocarpic fruit. *Monsonia*, *Sarcocaulon* and *Geranium* have regular flowers, *Erodium* has regular or zygomorphic flowers, and *Pelargonium* has zygomorphic flowers. *Monsonia* and *Sarcocaulon* have 15 fertile stamens per flower, *Geranium* has 10, all fertile, *Erodium* has 5 fertile and 5 infertile, while *Pelargonium* has 10 stamens of which 2–7 are fertile (Dyer 1975). These distinctions, however, do not always hold true, since a small number of *Pelargonium* species have regular flowers and/or 5 fertile stamens as in *Erodium*.

The present article constitutes a taxonomic treatment of *Erodium* in southern Africa. The genus is essentially from the Mediterranean Region and it is therefore not surprising to find *Erodium* concentrated in the south-western Cape with its mediterranean climate.

Eight species have been recorded in southern Africa of which two are possibly no longer present. All of these species are exotics from Europe, especially from the Mediterranean Region, and are old immigrants to southern Africa. Thunberg (1794, 1823) listed *E. maritimum*

(L.) L'Hérit. and *E. moschatum* (L.) L'Hérit. as occurring at the Cape. Drège (1843) listed *E. moschatum* (L.) L'Hérit. for the Cape. *E. ruthenicum* Bieb. was collected by Cooper in 1862 in the Orange Free State, *E. chium* (L.) Willd. by Pappé at the Cape before 1867, and *E. cicutarium* (L.) L'Hérit. by Shaw at Colesberg in 1873.

The following species are recognized in southern Africa:

(1) *Erodium botrys* (Cav.) Bertol., (2) *E. brachycarpum* (Codr.) Thell., (3) *E. chium*, (4) *E. cicutarium*, (5) *E. malacoides* (L.) L'Hérit., and (6) *E. moschatum*. *E. maritimum* and *E. ruthenicum* were collected in southern Africa only once in the previous century, are most probably no longer present and are thus omitted from this account.

While the floral morphology is uniform and therefore of little diagnostic value, the leaf and fruit characteristics have proved valuable in this regard.

Different indumentum types are present. These were identified and named after Lawrence (1951). *Erodium* is also conspicuously glanduliferous. Several kinds of glands were observed, namely sessile globular 'droplet' glands which are common on the leaf blade, and glandular hairs which may be of the acicular or columnar type. These gland-tipped hairs are most common on the peduncles, pedicels and sepals. The indumentum of *Erodium* is of little value in identification.

Collections from the following herbaria were studied: BLFU, BM, BOL, BR, G, GRA, J, K, KMG, LINN, MA, MPU, NBG, NH, NU, P, PEU, PRE, PRU, PUC, S, SAM, SBT, STE, STEU. Apart from herbarium material, fresh material, where available, was also studied. Chromosome numbers were obtained from

Webb & Chater (1968) and Guittonneau (1985). Specimen lists were compiled which present collecting localities and grid references, collectors' names and collecting numbers and the symbols of the herbaria where these specimens are housed. From these lists geographical distribution maps were compiled.

Erodium incarnatum (L.) L'Hérit. was always regarded as the only indigenous species of the genus in southern Africa. However, it deviates so much in floral morphology (fused staminal filaments and abnormal nectary) from *Erodium* that it is excluded from this treatment and will be dealt with separately as a species of *Pelargonium*.

Geographical distribution and ecology

Apart from *Erodium cicutarium* which is widespread in southern Africa the majority of the *Erodium* species occur in the south-western Cape (Figures 7 & 8). The species are all weeds on cultivated or disturbed ground when favourable moisture conditions prevail. *E. cicutarium*, however, is found in a wide variety of habitats that range from very dry and hot semidesert to moist and cool, high-altitude mountain slopes.

Citation of specimens

Unless otherwise indicated, all specimens cited in this revision were seen by the senior author.

Nomenclature

Only the correct names and their basionyms are provided. Detailed nomenclature is available in Knuth (1912). The identity of *E. brachycarpum* was verified by Prof. G.G. Guittonneau, University of Orleans, France.

Taxonomic treatment

Erodium L'Hérit. Geraniologia: Tab. 1-6 (1787-88), 414-416 (1789); Willd.: 625 (1800); Knuth: 221 (1912); Webb & Chater: 199 (1968); Dyer: 278 (1975); Guittonneau & Roux: 97 (1977)

Geranium L.: 676 (1753). Type: *Erodium macradenum* L'Hérit.

Rosulate or caulescent herbs or subshrubs. *Stems* pilose, hirsute or hispid and glandular. *Leaves* alternate, subopposite or opposite, those of a pair unequal, the smaller with a lateral branch and/or inflorescence in the axil; petiolate; stipules usually paired, broadly ovate to narrowly ovate, apex acute to acuminate, scarious; blade pinnately or palmately veined, simple or compound, elliptic, very broadly ovate to ovate, oblong-ovate or deltate-ovate; pinnae ovate or obliquely ovate, dentate to serrate; apex obtuse, acute or acuminate; base truncate or cordate; indumentum as on stem. *Inflorescence* a cymose pseudo-umbel with indumentum as on stem; bracts ovate to subulate, mostly scarious, margin ciliate, whitish to straw coloured. *Flowers* bisexual, actinomorphic, 5-merous, hypogynous. *Sepals* free, persistent and enlarged around fruit, elliptic to ovate and navicular, indumentum as on stem, with 3-5 parallel veins, apex obtusely mucronate. *Petals* free,

obovate, white, pink or violet, apex obtuse. *Stamens* free, hypogynous, 10; 5 fertile stamens antiseptalous and alternating with 5 staminodes; anthers 2-thecous, oblong-elliptic, introrse with longitudinal slits; pollen tricolporate, prolate spheroidal to suboblate, reticulate to striate. *Nectaria* 5, oblong, between fertile stamens and sepals. *Pistil* superior, sessile; ovary with terminal rostrum, hispid, deeply 5-lobed, 5-locular, with 2 axile ovules/locule, lower ovule abortive; style absent or very short, stigmas 5, filiform. *Fruit* a rostrate schizocarp with 5 tailed mericarps borne on a double-jointed stalk; mericarps 1-seeded; head obliquely ovoid, tapering towards spinose base, hispid with hairs ascending, brown, apex pitted and mostly furrowed or obliquely domed; tail crested and helically twisted. *Seed* brown. $2n = 20$ or 40 .

Diagnostic features

Rosulate to caulescent herbs or subshrubs. Leaves with laminae orbicular to ovate or narrowly ovate and pinnatifid, pinnate, bipinnate or palmate. Flowers *actinomorphic*. Stamens *free*, 5 *fertile* and antiseptalous, *staminodes* 5 and alternating with fertile stamens. Nectaria 5, antiseptalous. Mericarps with spinose bases, pitted apices and crested tails.

Classification of *Erodium* in southern Africa (after Guittonneau & Roux 1977):

Subgenus *Barbata*

a. Section *Malacoidea*

Subsection *Chamaedryoidea*

- E. brachycarpum*
- E. botrys*
- E. chium*
- E. malacoides*

b. Section *Cicutaria*

Subsection *Cicutaria*

- Erodium cicutarium*
- E. moschatum*

Vernacular names: Turk(se)naels, muskuskruid, oorlosies; stork's bill, heron's bill, musk heron's bill.

Key to *Erodium* in southern Africa

1a Leaves *all simple*.

2a Leaves broadly to very broadly ovate or broadly deltate-ovate, mostly with *shallow* incisions only, margin *obtusely* dentate to serrate.

3a Leaf blade pinnately veined; petals 5-8 mm long; mericarp *without* a furrow below apical pit and tail 30-40 mm long. **3. *E. chium***

3b Leaf blade sub-pinnately to sub-palmately veined; petals 4-5 mm long; mericarp with *one* distinct furrow below apical pit and tail 20-25 mm long **5. *E. malacoides***

2b Leaves narrowly ovate, incisions *deeper than halfway* to midrib, at least upper leaves *deeply* incised and *sharply* dentate (thistle-like).

4a Mericarp without or with *one* furrow below apical pit ... **2. *E. brachycarpum***

- 4b Mericarp with 2–3 furrows below apical pit 1. *E. botrys*
 1b Leaves compound, or lower (rosulate) leaves simple and upper (cauline) leaves compound.
 5a Leaves carrot-like; pinnae always divided for more than halfway to midrib, often pinnate 4. *E. cicutarium*
 5b Leaves celery-like, pinnae somewhat pinnately incised, but incisions usually less than halfway to midrib 7. *E. moschatum*

1. *Erodium botrys* (Cav.) Bertol., *Amoenitates italicae* 35 (1819).

Geranium botrys Cav.: 218 (1787). Type: Herbarium Cavanilles, MA, photo!

Annual prostrate rosulate to caulescent herb. *Stems* up to 0.4 m long, reddish-brown, hispid and with glandular hairs. *Leaves* alternate, subopposite to opposite, sparsely to densely hispid and glandular; petiole 5–90 mm long; stipules 4–6, ovate; blade 25–60(–100) × (5–)10–35(–45) mm, pinnately veined, oblong to ovate, at least the upper deeply pinnatifid and sharply dentate, apex acute to subulate, base obtuse. *Inflorescence* of 1–4 flowers; hispid to hirsute and glandular; peduncles (20–)40–70(–125) mm; pedicels (11–

20–30(–37) mm long; bracts 4–6, ovate, subglabrous, free, straw coloured, scarious. *Sepals* 5–6 × 3 mm, hirsute and glandular, apical mucro terete and 1 mm long, margin often reddish. *Petals* 7–14 × 3–4 mm, pink to pale violet and often with dark red veins. *Stamens* free; fertile stamens with narrowly ovate filaments of 5 mm long; pollen striate interwoven to reticulate, polar diameter 77 µm; staminodes subulate, 2 mm long. *Nectaria* equal, 0.7 × 0.7 mm. *Ovary* 1–1.5 mm long with terminal beak 2–3 mm long; style 0; stigmas 1 mm long. *Mericarps*: head 6–14 mm long, apical pit eglandular and with 2(–3) furrows below pit, tail 50–110(–200) mm long. *Seed* 5 mm long. (Figure 1). $2n = 40$.

Flowering occurs from July to December with the peak in September.

Diagnostic characteristics: Annual prostrate hispid herb. Leaves oblong to ovate, upper deeply pinnatifid and sharply dentate. Petals pink to pale violet. Mericarps with eglandular apical pits and 2 furrows below the pit, tail 50–110(–200) mm long.

Distribution and habitat: *Erodium botrys* is a naturalized weed in the south-western Cape, especially in the areas of Malmesbury and Stellenbosch and may be common to abundant (Figure 7). Its favourite habitat



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Figure 1 *Erodium botrys*. A. habit; B. mericarp [A & B after Montgomery 482 (STE)].

seems to be sandy peaty ditches along roadsides where moisture accumulates.

Specimens examined

- **3218** (Clanwilliam): Nardouw Kloof (-BB), *Stokoe 67091* (SAM).
 — **3318** (Cape Town): Malmesbury-Vredenburg Road at turn off to Hopefield (-AB), *Botha & Coetzee 1679* (PRU, BLFU); Snydersfontein (-AC) *Thompson 3497* (PRE), Hoopenberg, Muldersvlei (-AD), *Hugo 2441* (PRE); 10.3 km NW of Malmesbury (-BC), *Acocks 20720* (PRE); South of Malmesbury along road (-BC), *Esterhuysen 20413* (BOL, NBG, PRE); 53 km from Cape Town on road to Malmesbury (-DA), *Gillett 4157* (K); Paarl (-DB), *Compton 11782* (NBG), *Verhoeven 163* (BLFU); Bellville, Boston (-DC), *Botma 8* (STE); Cape Town to Malmesbury (-DC), *Montgomery 482* (STE); Malmesbury District, Kalabas Kraal (-DC), *Salter 7010* (BOL, K); Road between Pinelands and Ndobeni (-DC), *Salter 8684* (BOL, NBG); Blackheath (-DC), *van der Walt 436* (STE); Stellenbosch, Voëltjiesdorp (-DD), *Boucher 3920* (STE); Stellenbosch Primary School (-DD), *van der Walt 735* (STEU); Stellenbosch (-DD), *Verhoeven 130* (BLFU), *131* (BLFU), *Marsh 704* (PRE).
 — **3319** (Worcester): Gouda (-AC), *Barker 9214* (NBG).
 — **3418** (Simonstown): Wynberg Hill (-AB), *Salter 9136* (BOL, SAM); Faure, Farm Vergenoegd (-BA), *Thompson 2120* (STE); Kogelbaai Bridge (-BA), *Boucher 531* (STE).
 South-west Cape, *Leipoldt BH32209* (BOL).

2. *Erodium brachycarpum* (Godr.) Thell. in Report of the Botanical Society and Exchange Club of the British Isles 5: 17(1917); Guittonneau *et al.*: 417-425 (1987).

Erodium botrys var. *brachycarpum* Godr. 1: 424 (1853), 2: 72 (1854). Type: Port Juvènal, (MPU, lectotype, photo!)

Annual rosulate to caulescent herb. *Stems* up to 0.2 m long, prostrate, hispid and with glandular hairs. *Leaves* alternate, subopposite or opposite, sparsely to densely hispid and glandular; petiole *c.* 15 mm long; stipules 4-6, ovate; blade *c.* 30 × 15 mm, pinnately veined, oblong to ovate, at least the upper deeply pinnatifid and sharply dentate, hispid with glandular hairs, apex acute, base obtuse. *Inflorescence* of 2 flowers; peduncles 25-30 mm long, hispid and glandular; pedicels 6-7 mm long, pubescent and glandular; bracts *c.* 6, ovate, subglabrous, straw coloured, scarious. *Sepals* 5-6 × 3 mm, densely glandular and pubescent, apical mucro terete and 1 mm long. *Petals* 7-8 × 3-4 mm, violet. *Stamens* free; fertile stamens with narrowly ovate filaments of 4 mm long; staminodes subulate, 2 mm long. *Ovary* 1-2 mm long with terminal beak 2-3 mm long; style 0-1 mm long; stigmas 1 mm long. *Mericarps*: head *c.* 8 mm long, apical pit eglandular and with 1 furrow below pit, tail *c.* 65 mm long. *Seed* 3-4 mm long. (Figure 2). *2n* = 40.

Flowering occurs from August to September.

Diagnostic characteristics: Annual, rosulate or branched, hispid herb. Leaves oblong to ovate, at least upper deeply pinnatifid and sharply dentate. Petals violet. Mericarps with apical pits eglandular and with 1

furrow, tail *c.* 65 mm long. [The description is based on *Acocks 19469* (K) and Webb & Chater (1968)].

Distribution and habitat: *Erodium brachycarpum* seems to be very localized in its distribution in the north-west Cape (Figure 7). According to *Acocks 19469* the species was 'locally frequent in a seepage area' which indicates its preference for a moist habitat.

Specimen examined

- **3017** (Hondekliipbaai): Grootvlei west of Khamieskroon (-BB), *Acocks 19469* (K).

3. *Erodium chium* (L.) Willd. *Phytographia*: 10 (1794).

Geranium chium L.: 1143 (1759). Type: Mediterranean Region, (LINN no. 858.45!, holo.)

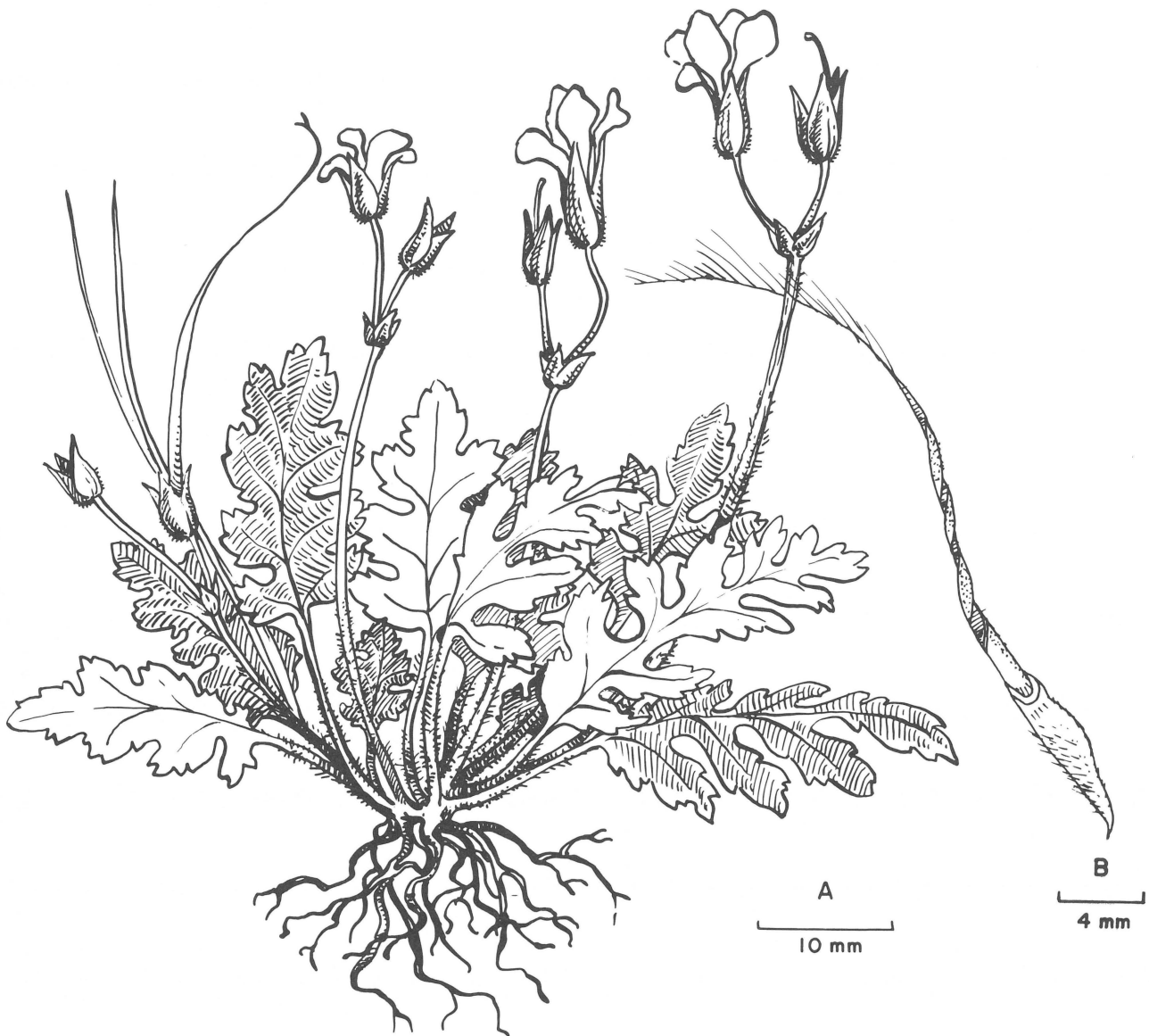
Annual, caulescent herb. *Stems* up to 0.5 m long, decumbent to prostrate, hispid to hirsute and with numerous glandular hairs. *Leaves* alternate, subopposite or opposite; petiole 25-90(-115) mm long, indumentum as on stem, stipules 2, ovate; blade simple, (20-)40-70(-110) × (20-)30-45(-100) mm, pinnately veined, broadly ovate to broadly deltate-ovate, sparsely hispid to hirsute with glandular hairs and sessile glands, margin very variably dissected but usually only shallowly lobed and obtusely dentate to serrate, apex obtuse to acute, base cordate. *Inflorescence* of 2-8 flowers, indumentum as on stem; peduncle (15-) 30-100(-130) mm long; pedicels 5-25 mm long; bracts 3 or more, ovate, straw coloured, scarious. *Sepals* 5-7 × 2 mm, apical mucro terete and 2 mm long, indumentum as on stem. *Petals* 5-8 × 2-3 mm, pinkish to purplish. *Stamens* free; fertile stamens with filaments narrowly ovate and apex terete, 4-5 mm long; pollen striate interwoven to reticulate, polar diameter 73 μm; staminodes subulate, 3 mm long. *Ovary* 1-2 mm long with terminal beak 2-3 mm long; style 0-1 mm long; stigmas 1 mm long. *Mericarps*: head 3-5 mm long, apical pit shallow and glandular, without any furrow below pit; tail 30-40 mm long. *Seed* 2-3 mm long. (Figure 3). *2n* = 20.

Flowering takes place from August to December with the peak in September and October, while fruiting stretches from September to December.

Diagnostic characteristics: Annual caulescent, hispid to hirsute and glandular herb. Leaves broadly ovate to broadly deltate-ovate, margin usually shallowly lobed and obtusely dentate to serrate. Petals pinkish to purplish. Mericarps with glandular apical pits and without any furrow below pit, tail 30-40 mm long.

Distribution and habitat: This species seems to be restricted to the winter rainfall area of the Cape, its distributional range being from Saldanha Bay to Port Elizabeth (Figure 7).

Erodium chium prefers sandy soil and is commonly found on the dunes along the seashore, however, it also occurs further inland in shady mountain habitats. The recorded altitudinal range varies from 0-800 m above sea level.



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Figure 2 *Erodium brachycarpum*. A. habit; B. mericarp [A & B after Acocks 19469 (K)].

Specimens examined:

— 3317 (Saldanha): Saldanha Bay (-BB), Hutchinson 227 (BOL, K).

— 3318 (Cape Town): Shore west of Slangkop (-AD), Wolley Dodd 3267 (BOL, K); Robben Island (-CD), Zeyher s.n. (BOL).

— 3320 (Montagu): Montagu (-CC), Page 15632 (BOL).

— 3418 (Simonstown): Simonstown (-AB), Wolley Dodd 2090 (BOL, PRE); Vishoek (-AB), Page PRE-41207 (PRE); Hout Bay (-AB), Salter 7027 (BOL); Kogel Bay bridge (-BD), Boucher 532 (STE); Cape of Good Hope (-?), Pappé s.n. (K).

— 3419 (Caledon): Rawston (-AC), Schlechter 1577 (PRE), 9475 (BOL, K, PRE); Kogel Bay (-BD), Parker BOL-24337 (BOL, NBG); Kleinbos, Bobbejaansfontein (-CB), Hugo 1904 (STE); Between kelders and Franskraal (-CB), Taylor

1557 (SAM); Kleinbos, ou Bobbejaansfontein (-CB), Hugo 1904 (PRE)

— 3420 (Bredasdorp): Bredasdorp, Nachtwacht (-CA), Smith 3071 (PRE).

— 3425 (Skoenmakerskop): Sea View (-AB), Acocks 21426 (K).

4. *Erodium cicutarium* (L.) L'Hérit. in Aiton, Hortus Kewensis 2: 414 (1789)

Geranium cicutarium L.: 680 (1753). Type: No locality given (LINN no. 858.43!, holo.).

Annual prostrate, rosulate to caulescent herb. Stems up to 0.5 m long, hirsute to hispid with glandular hairs. Leaves alternate, subopposite to opposite, sparsely to densely hirsute or hispid and with glandular hairs;

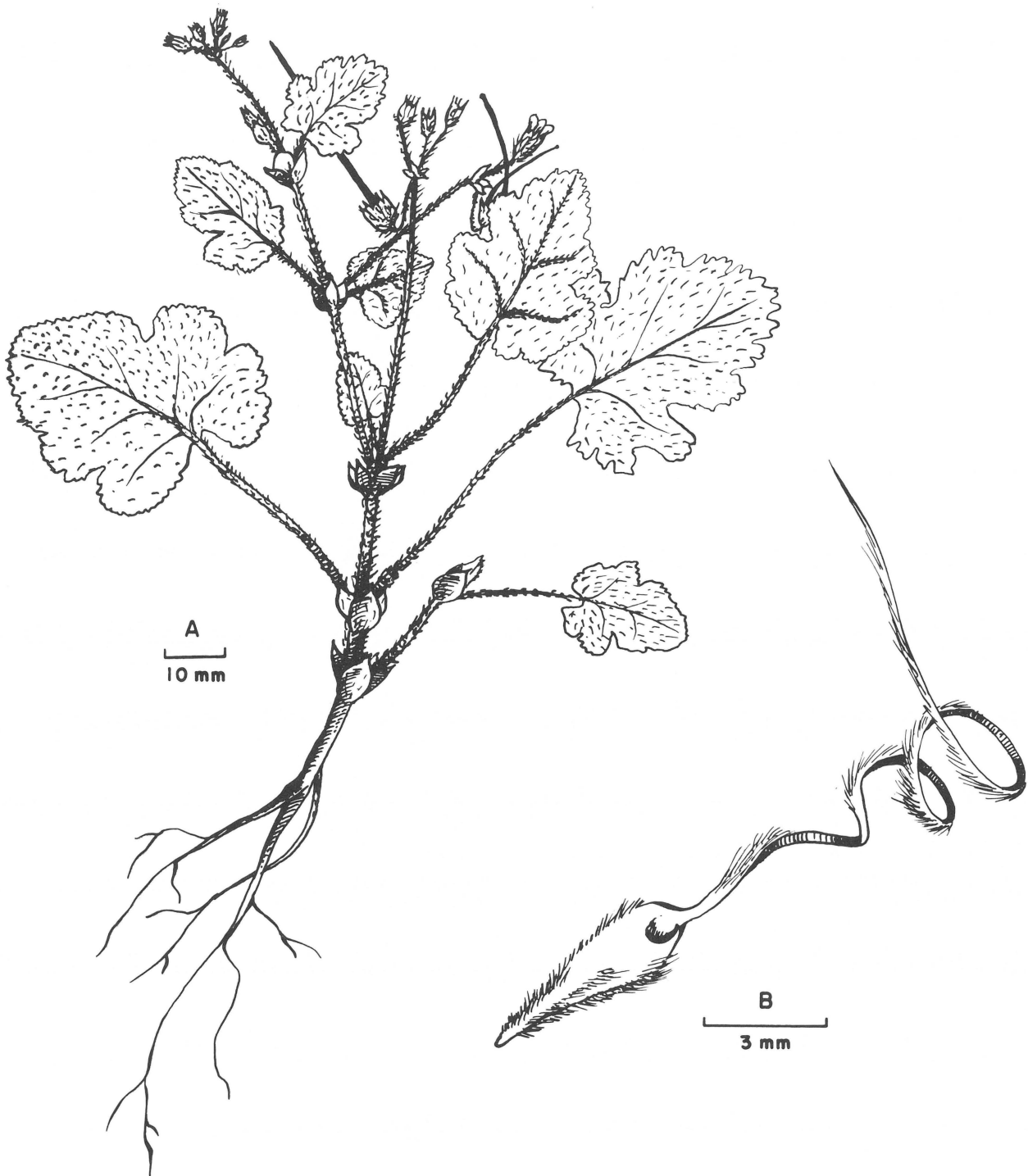
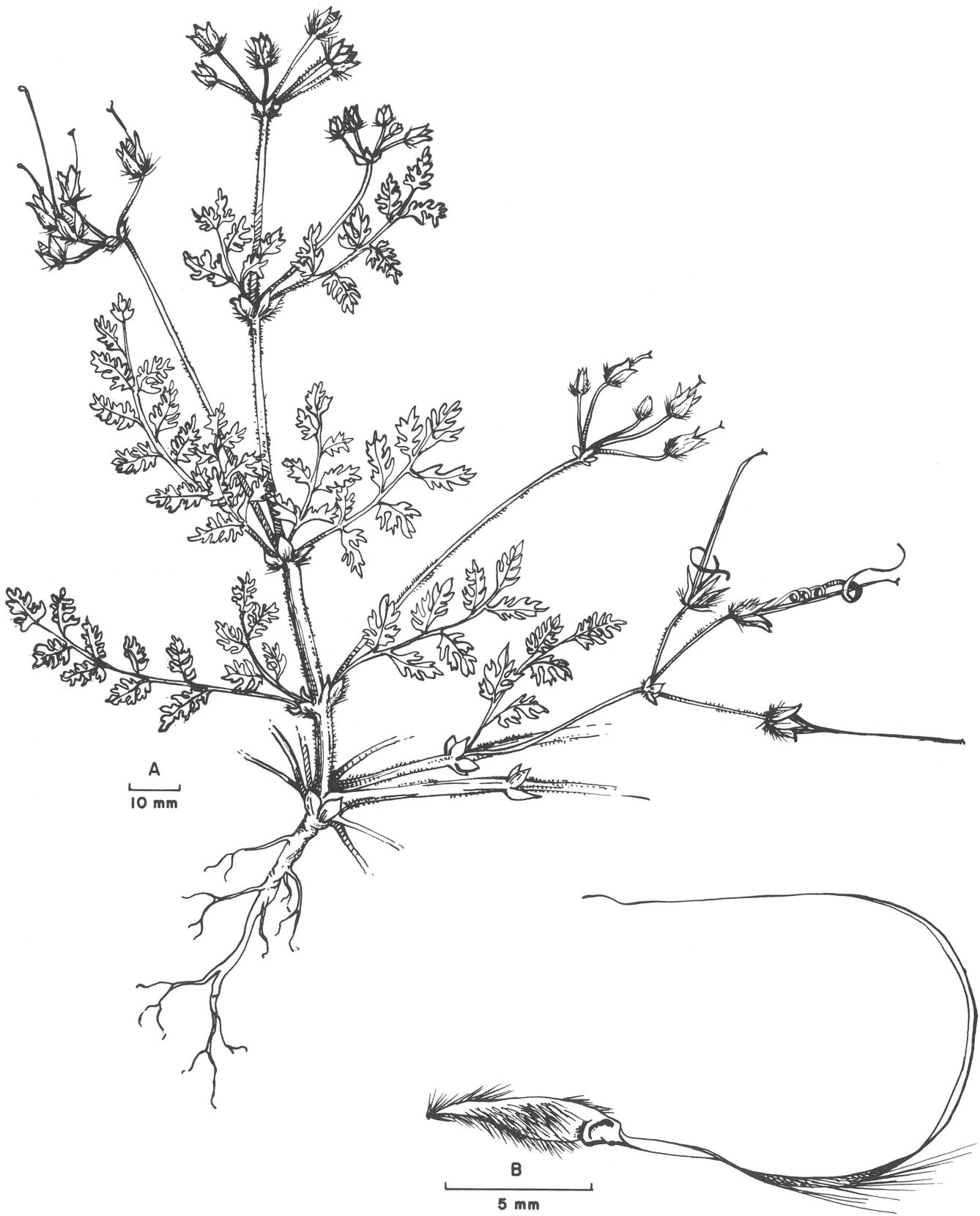


Figure 3 *Erodium chium*. A. habit; B. mericarp. [A after Wolley 3267 (K) and B after Schlechter 1577 (PRE)].

petiole up to 150 mm long; stipules 2, ovate with apex acuminate, margin ciliate, pinkish to straw coloured; blade carrot-like 45–115 × 15–35 mm, pinnate, ovate to elliptic; pinnae pinnatifid to pinnate, but always divided for more than half-way to midrib, margin serrate to dentate. *Inflorescence* of up to 10 flowers, sparsely to densely hirsute or hispid and glandular; peduncles 17–20 mm long, reddish-purple; pedicels 5–7 mm long, reddish-purple; bracts 4–6, ovate, straw coloured to pinkish, scarious, fused or free. *Sepals* 4–7 × 1–3 mm, indumentum as on stem, apical mucro terete, 1–2 mm long. *Petals* 4–10 × 2–3 mm, purplish-pink to whitish.

Stamens free; fertile stamens with filaments narrowly ovate and apex terete, 3–5 mm long; pollen striate interwoven to reticulate, polar diameter 61 μm; staminodes subulate, 2–3 mm long. *Ovary* 1–2 mm long with terminal beak 1–2 mm long; style 0–1 mm long; stigmas 1–2 mm long, pinkish-purple. *Mericarps*: head 4–7 mm long, apical pit eglandular, furrow below pit absent, faint or distinct, tail 10–70 mm long. *Seed* 3–4 mm long. (Figure 4). $2n = 40$.

Flowering occurs throughout the year, but peaks in September/October in both the winter and summer rainfall areas.



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Figure 4 *Erodium cicutarium*. A. habit; B. mericarp. [A & B after Verhoeven 127 (BLFU)].

Vernacular names: Muskuskruid, oorlosies, Turkse-naels, heron's bill, leloele (Sotho).

Diagnostic characteristics: Annual prostrate hispid to hirsute and glanduliferous herb. Leaves ovate to elliptic, pinnate; pinnae pinnatifid to pinnate, but always divided for more than half-way to midrib. Petals purplish-pink to whitish. Mericarps with eglandular apical pits, furrow below pit absent, faint or distinct, tail 10–70 mm long.

Distribution and habitat: *Erodium cicutarium* occurs scattered as a weed in the Cape Province, Orange Free State, southern Natal, south-western Transvaal, Lesotho and Transkei (Figure 7). One specimen comes from the southern Namib. The largest concentration of localities is in the south-western and western Cape.

E. cicutarium is found in virtually any kind of habitat, ranging from strandveld at the coast to the high cold mountainous regions or the hot arid desert. Wherever it occurs it seems to be associated with situations where moisture collects, e.g. roadside ditches. In the wetter areas it is found in natural veld, in gardens, or in cultivated fields.

Webb & Chater (1968) recognize three subspecies in *E. cicutarium*, viz. subspecies *cutarium*, *bipinnatum* Tourlet and *jacquinianum* (Fisher, C.A. Meyer & Avé-Lall.) Brig. Although much variation occurs in *E. cicutarium* in southern Africa all the specimens examined belong to *E. cicutarium* subsp. *cutarium* (G.G. Guittonneau, University of Orleans, Orleans, France, pers. comm., 1987).

Specimens examined

- 2527 (Rustenburg): Brits (–DB), *Marais PRE-41204* (K, PRE).
- 2528 (Pretoria): Pretoria (–CA), *Stent 5041* (J, PRE).
- 2616 (Aus): Kuibis (–DB), *Range 1863* (SAM).
- 2627 (Potchefstroom): Witpoortjie (–BB), *Gilliland 26615* (PRE).
- 2828 (Bethlehem): Leribe (–CC), *Dieterlen 642* (K, SAM), 645 (NBG, PRE).
- 2829 (Harrismith): Harrismith (–AC), *van der Zeyde NBG 98966* (NBG).
- 2917 (Springbok): Spektakelpas (–CA), *Zietsman 931* (PRE), 976 (PRE); Koufonteinberg (–CD), *Moffett 921* (STEU); Nababeep golf course (–DB), *Rösch & le Roux 38* (PRU); Hester Malan Wild Flower Reserve (–DB), *Rösch & le Roux 397* (PRU), 506 (PRU).
- 2923 (Douglas): 34 km NE of Strydenburg (–DD), *Herman 639* (PRE).
- 2926 (Bloemfontein): Bloemfontein, University of the Orange Free State, (–AA), *Verhoeven 127* (BLFU).
- 2927 (Maseru): Roma University Campus (–BC), *Schmitz 50* (PRE); Wepener (–CA), *Strauss PRE 41203* (PRE).
- 2929 (Underberg): Torwood (–DB), *Young NH-20979* (NH).
- 3017 (Hondeklipbaai): Hondeklipbaai (–AD), *Thompson 220* (PRE).
- 3018 (Kamiesberg): Leliesfontein (–AB), *Rodin 1485b* (K).
- 3024 (De Aar): Phillipstown (–AD), *Vahrmeijer 1593* (K, PRE).
- 3025 (Colesberg): Colesberg (–CA), *Shaw s.n.* (K); Taaiboslaagte, Colesberg (–CC), *Grobbelaar 2899* (PRE).
- 3026 (Aliwal North): Rouxville (–BD), *Maree 14* (PRE).
- 3027 (Lady Grey): Zastron (–AC), *Maree 74* (PRE); Barkley East District (–DC), *Gerstner 74* (PRE).
- 3028 (Matatiele): Lake Letsie (–AC), *Killick 4397* (PRE), *Acocks 12334* (PRE); Rhodes, Naudesnek (–CA) *Hilliard 3954* (BOL, NU), *Venter 9179* (BLFU).
- 3029 (Kokstad): Kokstad (–CB), *Sidney 554* (PRE); Harding (–DB), *Lennox 4* (NU).
- 3118 (Van Rhynsdorp): Vredendal (–CD), *Bayliss 6213* (K); Van Rhynsdorp (–DA), *Acocks 14845* (PRE); Klaver (–DC), *Steyn 406* (BOL, NBG); Nardouwberg (–DD), *Burrows s.n.* (NBG).
- 3119 (Calvinia): Nieuwoudtville Reserve (–AC), *Perry & Snijman 2163* (NBG); 20 km from Calvinia on road to Loeriesfontein (–BC), *Coetzer 815* (PRE); Calvinia (–BD), *Story 4429* (PRE), *MacPherson 3144* (BOL), *van der Schijff 7223* (PRE, PRU); Ekerdam (–BD), *Taylor 2723* (NBG); Lokenburg (–CA), *Story 4429* (PRE).
- 3120 (Williston): Frasersburg/Williston Rd (–BC), *Bayliss BRI.B.554* (PRE).
- 3121 (Fraserburg): Frasersburg, Vondeling (–CD), *van Ee BLFU-10133* (BLFU); Spitskop, south of Frasersburg (–CD), *Thompson 3022* (STE).
- 3123 (Victoria West): Victoria West (–AC), *Whitlock 578* (PRE).
- 3124 (Hanover): Middelburg, Lootsberg Pass (–DC), *van der Walt 2145* (STEU).
- 3125 (Steynsburg): Grootfontein (–AC), *Theron 169* (PRE), 377 (PRE); Middelburg (–AC), *Bolus 14099* (BOL).
- 3126 (Queenstown): Molteno (–AD), *Smuts STE-31230* (STE); Boesmanshoek Pass (–AD), *Balsinhas 3310* (K).
- 3127 (Lady Frere): Dordrecht (–AC), *Taylor 5644* (NBG); Sterkspruit (–BB), *Stewart 1871* (NU).
- 3128 (Clanwilliam): Brandvlei (–BB), *Galpin 12922* (PRE); Piekienierskloof (–DB), *van der Walt 738* (STEU).
- 3219 (Wuppertal): Skoongesig (–CC), *Hanekom 935* (K).
- 3220 (Sutherland): Sutherland (–AA), *Moffett 1222* (STEU); Rivierplaats (–BC), *Levyns 1662* (BOL).
- 3321 (Merweville): Aarfontein between Sutherland & Frasersburg (–AD), *Moffett 3706* (PRE); Layton, Frasersburg (–BB), *Shearing 1095* (PRE).
- 3222 (Beaufort West): Beaufort West, Klaversvlei (–BC), *Niewoudt 17* (NU); Karoo National Park (–BC), *Bensig 371* (PRE); Mountain View Farm (–BD), *Gibbs Russell, Robinson & Herman 479* (PRE).
- 3227 (Stutterheim): Cathcart (–AC), *Johnson 1204* (PRE).
- 3228 (Butterworth): Cala (–AB), *Pegler 1747* (PRE).
- 3318 (Cape Town): Kirstenbosch (–CD), *Steyn 681* (NBG); Camps Bay (–CD), *Salter 7778* (BOL); Paarl (–DB), *Verhoeven 161* (BLFU); Bottelary (–DD), *Verhoeven 332* (BLFU).
- 3319 (Worcester): Kleinwintershoek Mountains, Tulbach (–AA), *Stirton 8312* (PRE); Ceres (–AD), *Middlemost 2274* (NBG); Worcester (–CB), *Olivier 272* (PRE, STE).
- 3321 (Ladismith): Ladismith (–AD), *Mauve, Reid & Wikner 66* (PRE).
- 3322 (Oudtshoorn): De Rust (–CB), *Dahlsrand 2413* (PRE).

- **3323** (Willowmore): 5 km outside Uniondale on road to Willowmore (–CA), *Germishuizen 4301* (PRE).
 — **3419** (Caledon): Napier (–BD), *Jordaan 35* (STE).
 — **3421** (Riversdale): Riversdale (–AB), *Muir 1615* (BOL, PRE).

5. *Erodium malacoides* (L.) L'Hérit. in Aiton, Hortus Kewensis 2: 415 (1789).

Geranium malacoides L.: 680 (1753). Type: No locality given (LINN no. 858.46!, holo.)

Annual or biennial erect to decumbent or prostrate herb. *Stems* up to 0.5 m long, pilose with deflexed hairs, with glandular hairs and sessile glands. *Leaves* alternate, sub-opposite to opposite; petiole 25–165 mm long, indumentum as on stem; stipules 2 or 4, ovate with apex acuminate, whitish; blade 35–45 × 30–40 mm, simple, broadly ovate to broadly deltate-ovate, sub-pinnately to sub-palmately veined, margin serrate and nearly entire to shallowly lobed to rarely pinnatifid, usually soft-textured, base cordate to truncate, apex obtuse to acute, sparsely pilose with numerous sessile glands adaxially and abaxially. *Inflorescence* of 3–7 flowers, indumentum as on stem; peduncles 30–60 mm long; pedicels 10–16 (–22) mm long; bracts 4–6, ovate, glabrous to glandular, ciliate, whitish to straw coloured. *Sepals* 3 × 2 mm, indumentum as on stem and dense, apical mucro terete and 0.6 mm long. *Petals* 4–5 × 2–2.5 mm, violet or white. *Stamens* free; fertile stamens violet, 3–4 mm long, narrowly ovate becoming terete in upper half; pollen striate interwoven to reticulate, polar diameter 66 µm; staminodes narrowly ovate, 2 mm long. *Ovary* 0.5 mm long with rostrum 1.5 mm long; style 0–1 mm long; stigmas 0.6 mm long. *Mericarps*: head 3–5 mm long, apical pit glandular with one distinct furrow below pit, tail 20–25 mm long. *Seed* c. 3 mm long. (Figure 5). $2n = 40$.

Flowering occurs from August to December.

Diagnostic characteristics: Erect to prostrate pilose and glandular herb. Leaves with petiole 25–165 mm long; lamina simple, broadly ovate to broadly deltate-ovate with base cordate to truncate, sparsely pilose with numerous sessile glands, normally soft-textured, margin serrate and usually only shallowly lobed. Petals violet or white. Mericarps with glandular pits and one furrow below pit, tail short, 20–30 mm long.

Distribution and habitat: Only a limited number of collections were made in southern Africa. These were found in two areas, in the Port Elizabeth/Uitenhage/Addo region and in the Bellville/Tygerberg area (Figure 8).

E. malacoides seems to prefer a sandy habitat, from coastal dunes to village sidewalks, where it may become locally abundant. Webb & Chater (1968) state that this species is found in dry places in southern Europe.

Specimens examined

- **3318** (Cape Town): Bellville, Welgemoed (–DC), *Verhoeven 129* (BLFU), *132* (BLFU); Tygerberg Nature Reserve (–DC), *Loubser 3358* (NBG).

- **3325** (Port Elizabeth): Addo Elephant Park, near Ceasars Dam (–DA), *van der Walt 884* (STEU); Swartkop River Mouth (–DC), *van der Walt STEU-1705* (STEU); Amsterdamhoek (–DC), *Ward STEU-1221* (STEU); Near Veeplaas (??), *S, R, & O 126* (UPE).

- **3425** (Skoenmakerskop): Port Elizabeth, near Sea View (–AB), *Acocks 21426* (K, PRE).

6. *Erodium moschatum* (L.) L'Hérit. in Aiton, Hortus Kewensis 2: 414 (1789).

Geranium moschatum L.: 680 (1753). Type: No locality given (LINN no. 858.44!, holo.)

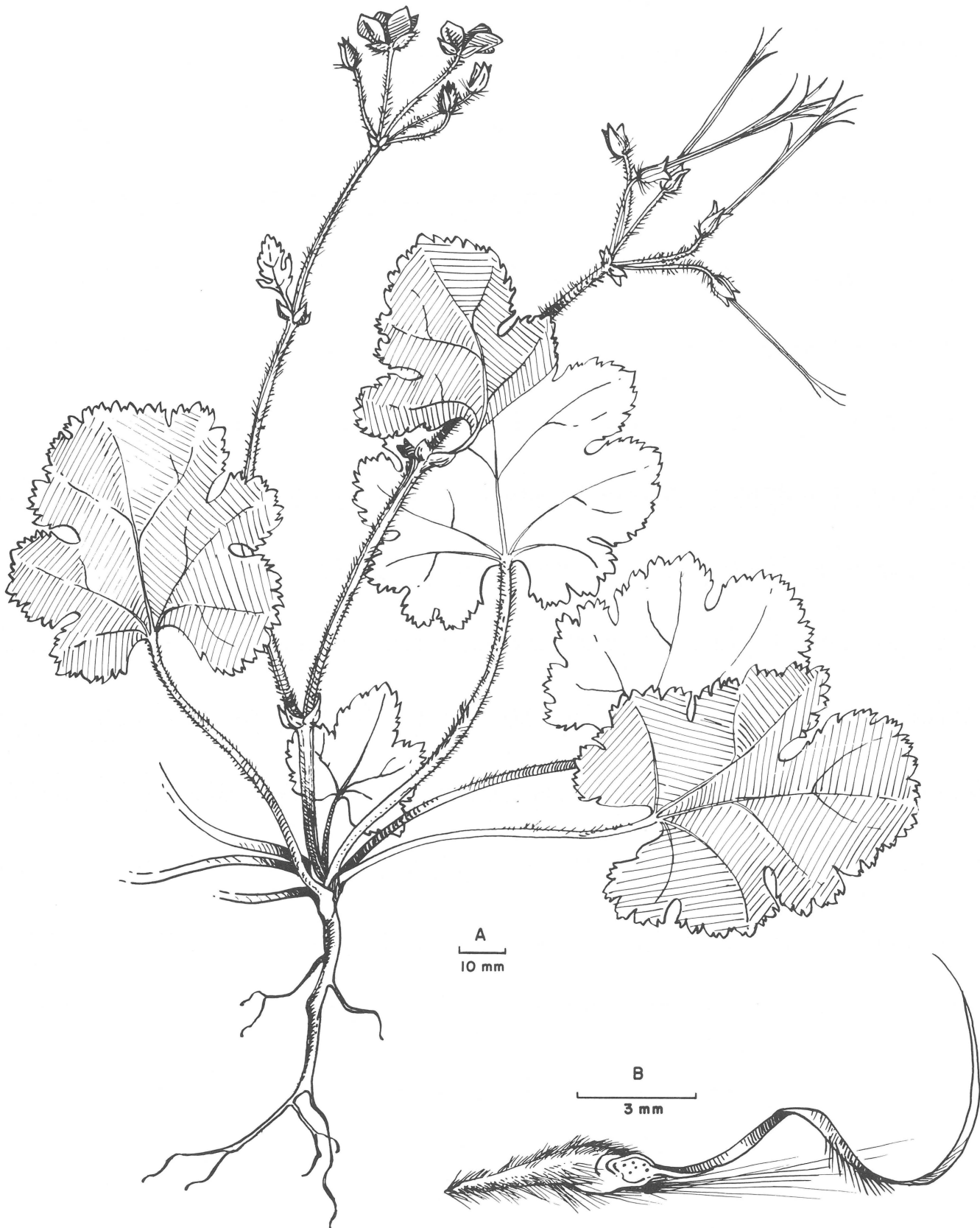
Annual or biennial rosulate to caulescent aromatic herb. *Stems* up to 0.5 m long, pilose to hispid with hairs usually deflexed, with glandular hairs and sessile glands. *Leaves* alternate, subopposite to opposite, indumentum as on stem; petiole 25–115 mm long; stipules 2, c. 3 mm long, broadly ovate; blade celery-like, (12–)30–80(–130) × (14–)25–65 mm, oblong-ovate compound; pinnae 15–40 × 5–25 mm, ovate, dentate to serrate or somewhat pinnately incised but incisions usually less than half-way to midrib, apex acute to obtuse, base obliquely obtuse. *Inflorescence* of 5–13 flowers, indumentum as on stem; peduncles (20–)70–200(–240) mm long; pedicels 4–16 mm long; bracts c. 6–12, ovate, glabrous, scarious, whitish to straw coloured. *Sepals* 5 × 2–3 mm, indumentum as on stem but dense, apical mucro narrowly triangular and 1 mm long. *Petals* 6–8 × 2–3 mm, violet to pink. *Stamens*: fertile stamens 5 mm long, base subulate and upper 3/4 terete; pollen striate interwoven to reticulate, polar diameter 60 µm; staminodes narrowly ovate, 3 mm long. *Ovary* 1–1.5 mm long with rostrum 1.5–3.5 mm long; style 0–1 mm long; stigmas c. 1 mm long. *Mericarps*: head (4–)7–9(–11) mm long, apical pit wide and deep, with glandular hairs, with distinct deep, glandular furrow below pit, tail (9–)25–40 mm long. *Seed* c. 3 mm long. (Figure 6). $2n = 20$.

Flowering occurs from June to December peaking during July, August and September.

Diagnostic characteristics: Rosulate to caulescent pilose to hispid and glandular herb. Leaves oblong-ovate, pinnate; pinnae ovate, dentate to serrate or somewhat pinnatifid but incisions usually less than half-way to midrib. Inflorescence of 5–13 flowers. Sepals with narrowly triangular mucro. Petals violet to pink. Mericarps with apical pits wide and deep, glandular, one distinct glandular furrow below pit, tail 25–40 mm long.

Distribution and habitat: *Erodium moschatum* has become a well-established and well-collected weed in the Cape Province from Steinkopf in the north-west, along the west, south-west and south coast as far east as Cala district in the Transkei (Figure 8). One specimen was collected in the arid area of De Aar at Potfontein.

This species is commonly found along roadsides, in cultivated fields, in gardens, waste grounds and in open veld on soils ranging from sandy to clayey.



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Figure 5 *Erodium malacoides*. A. habit; B. mericarp [A & B after van der Walt 1705 (STEU)].



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Figure 6 *Erodium moschatum*. A habit; B. mericarp. [A. & B. after Venter 8833 (BLFU)].

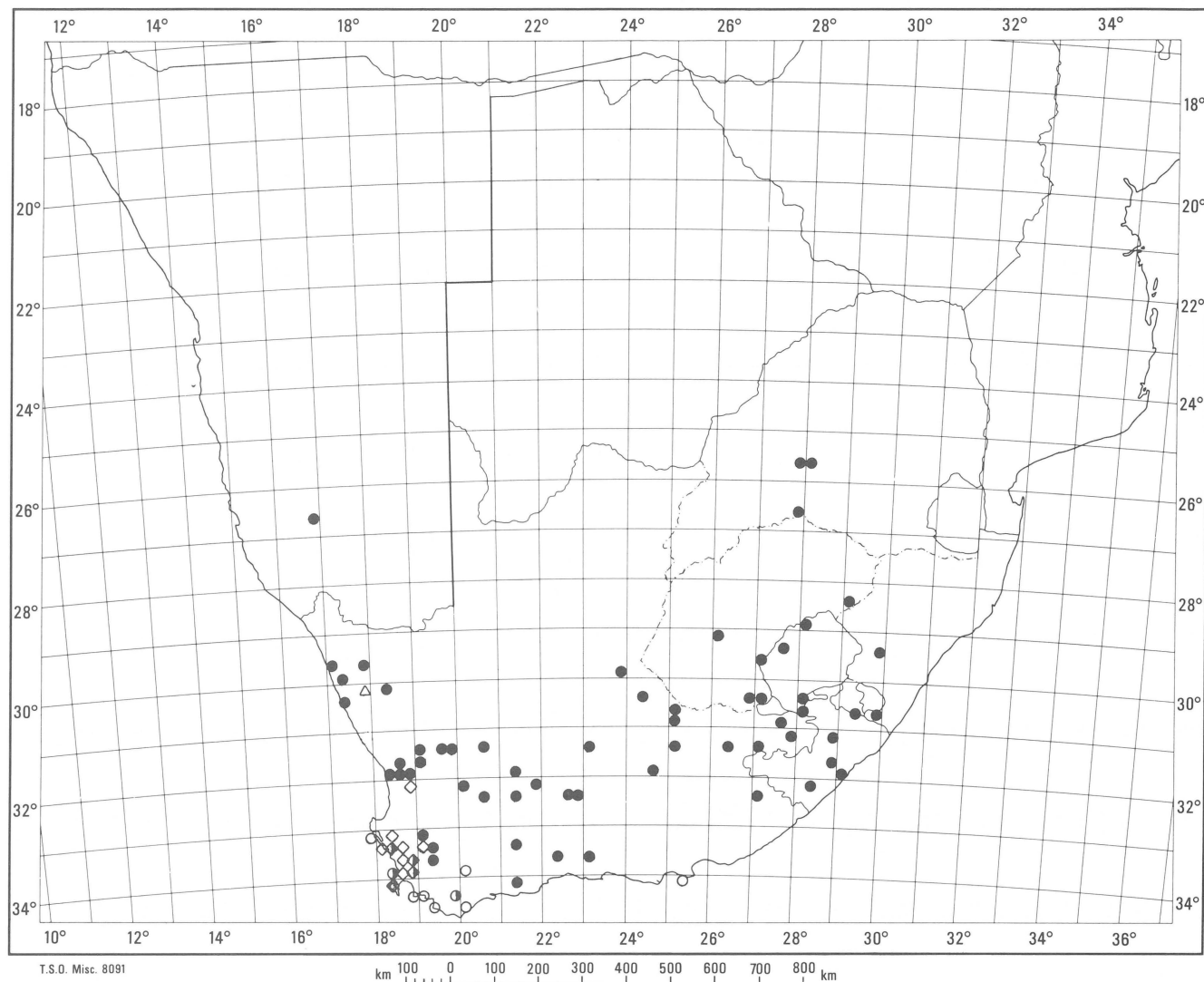


Figure 7 Known geographical distribution of *Erodium botrys* (◇), *E. brachycarpum* (△), *E. chium* (○) and *E. cicutarium* (●). Species sharing the same 1/16 th degree square: *E. botrys*/*E. chium* (◇), *E. chium*/*E. cicutarium* (●) and *E. botrys*/*E. cicutarium* (◆).

Specimens examined

— **2917** (Springbok): 2 km east of Anenous Pass (–BA), *Venter* 8832 (BLFU); 8833 (BLFU); Springbok Caravan Park (–CA), *Zietsman* 979 (PRE); Springbok, Hester Malan Nature Reserve (–DB), *Rösch & le Roux* 514 (PRU).

— **3017** (Hondeklipbaai): Kamieskroon (–BD), *Crosby* 56 (PRE).

— **3018** (Kamiesberg): Leliefontein (–AB), *Rodin* 1485a (BOL, K, PRE); Kamiesberg, Kohms ravine (–AC), *Pearson* 6586 (K).

— **3119** (Calvinia): Nieuwoudt Reserve (–AC), *Perry & Snijman* 2231 (NBG); Glen Lyon, Nieuwoudtville (–AC), *Mauve s.n.* (STE); Calvinia, Tierhoek Reserve (–BD), *Henrici* 3496 (PRE); Calvinia, Eker Dam (–BD), *Taylor* 2717 (BOL, NBG).

— **3024** (De Aar): Potfontein (–AA), *Moss* 3014 (K).

— **3127** (Lady Frere): Between Cala and Nqamakwe (–AA), *Pegler* 1747 (BOL).

— **3218** (Clanwilliam): Clanwilliam (–BB), *Leipoldt* 109 (BOL); Piekienerskloof (–DB), *de Vos s.n.* (STE); *Weintraub* J19799 (J), *van der Walt* 739 (STEU).

— **3219** (Wuppertal): Sederberg, Middleberg Hut (–AC), *Weintraub* J19388 (J), J19303 (BOL).

— **3318** (Cape Town): Dassen Island (–AC), *Lang* 6702 (PRE); Moorreesburg (–BA), *Bolus* anno 0/10/1902 (BOL); Moorreesburg, Die Panne (–BA), *Boucher* 3883 (STE); Cape Town to Malmesbury Road (–BC), *Montgomery* 452 (STE), Malmesbury (–BC), *van der Walt* 1039 (STEU); Mamre (–CB), *Baur* (*Marloth* 6608) (PRE); Cape Town (–CD), *Page* anno 0/8/1916 (PRE), *Worsdell* anno 0/0/1909 (K), *Tyson* SAM 14532 (SAM); Kirstenbosch (–CD), *Anon* anno 0/3/1916 (BOL); Sea Point (–CD), *Smith* 2901 (PRE); Robben Island (–CD), *Walgate* 487 (NBG); Van Rhynsdorp (–DA), *Steyn* 469 (NBG); Wellington (–DB), *Knobel* PRE 23757 (PRE), *Thomson* PRE 41209 (PRE); Paarl (–DB), *Verhoeven* 162 (BLFU); Blackheath (–DC), *van der Walt* 437 (STEU); Jonkershoek (–DD), *Garside* 1700 (K); Southern Paarl (–DD), *Roberts & Adendorff* PRE 17661 (PRE); Stellenbosch (–DD), *van der Walt* 736 (STEU).

— **3319** (Worcester): La Palisante (–AC), *Zantovska* 67 (PRE); Worcester (–CB), *Zantovska* 52 (PRE).

— **3322** (Oudtshoorn): Boomplaas, Kango Valley (–AC), *Moffett* 161 (STEU); Prins Albert, Swartberg Pass (–AC), *Bolus* 11734 (BOL); Oudtshoorn, Die Krans (–CB), *Dahlstrand* 2413 (J); Doornkraal, 5 km east of de Rust (–DA), *Dahlstrand* 1451 (J, PRE), 1514 (J).

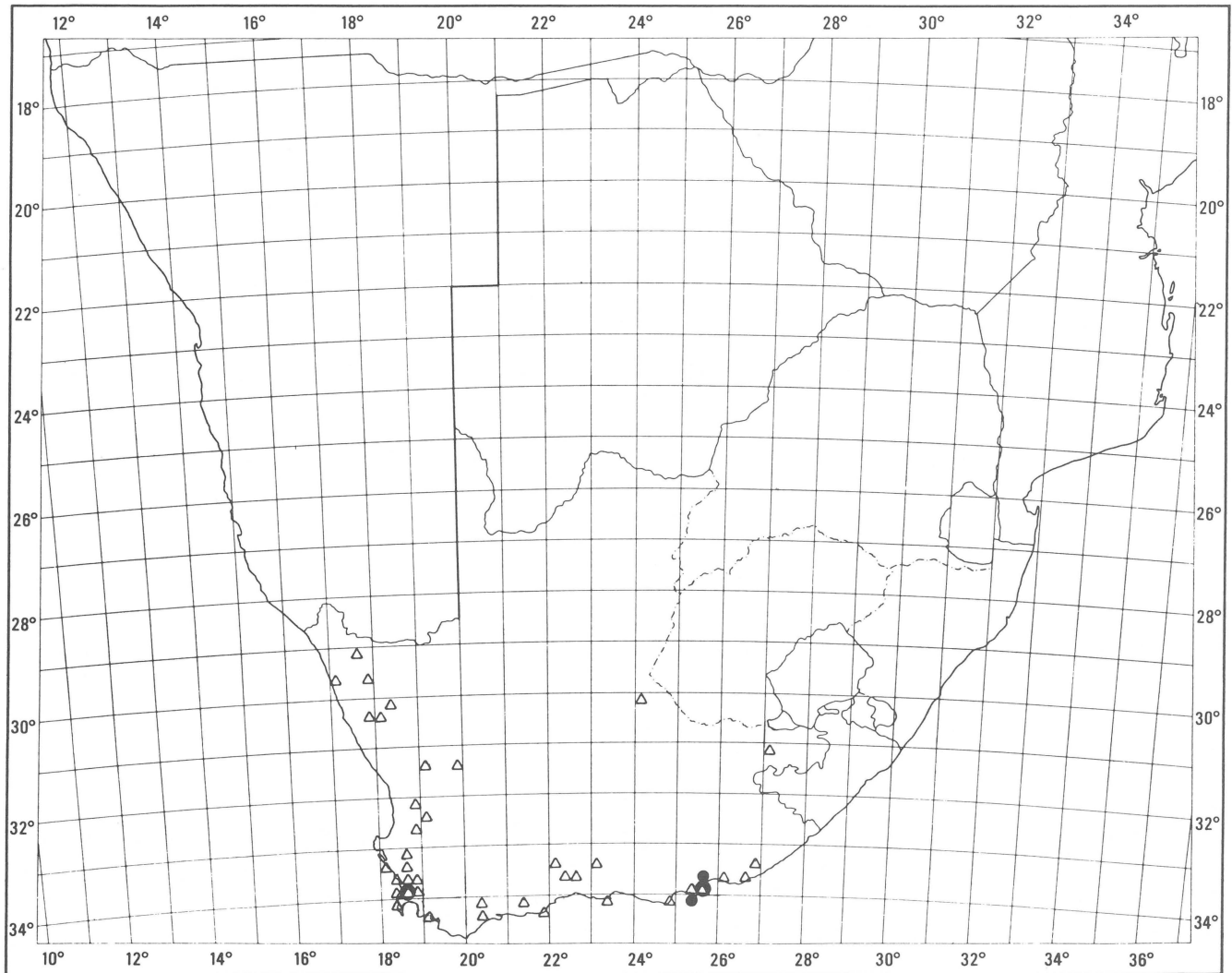


Figure 8 Known geographical distribution of *Erodium malacoides* (●) and *E. moschatum* (△). Species sharing the same 1/16th degree square: *E. moschatum*/*E. malacoides* (⊗).

- 3323 (Willowmore): Uniondale, Hot Springs (–AC), *Fourcade 6089* (STE); 5.6 km from Uniondale (–AC), *Fourcade 4661* (BOL).
- 3324 (Steytlerville): Banks of Gamtoos River (–DD), *Macaskill A1494* (PRE).
- 3325 (Port Elizabeth): Uitenhage, Bethelsdorp (–CD), *Long 100* (K); Port Elizabeth (–DC), *Burnie 85* (UPE).
- 3326 (Grahamstown): Kowie (–BD), *Britten 835* (PRE); Dassieklip, 46 km SE of Grahamstown (–CA), *Story 2782* (K, PRE); Alexandria District, Ghio Bridge (–DA), *Archibald 5294* (K, PRE).
- 3418 (Simonstown): Simons Bay (–AB), *Wright s.n.* (K); Bergvliet, Constantia (–AB), *Purcell SAM 89523* (SAM), *SAM 89524* (SAM).
- 3419 (Caledon): Kleinmond (–AC), *de Vos 66* (STE).
- 3420 (Bredasdorp): Swellendam (–AB), *Taylor 3738* (STE); De Hoop, Potberg Nature Reserve (–AD), *Scott 435* (PRE).
- 3421 (Riversdale): Riversdale; (–AB), *Muir 1615* (BOL, PRE); Vleesbaai (–BD), *Koegelenberg 2784* (STEU).
- 3423 (Knysna): Keurboomstrand (–AB), *Theron 1779* (K); Witte Drift (–AB), *Fourcade 4813* (BOL).

- 3424 (Humansdorp): Jeffreys Bay (–BB), *Fourcade 3281* (BOL, K, STE).

Discussion

The classic division of *Erodium* and *Pelargonium* does not hold true. According to this division *Erodium* has actinomorphic flowers with 5 fertile stamens and 5 staminodes which alternate with the fertile ones, while *Pelargonium* has zygomorphic flowers with 10 stamens of which 2–7 are fertile (Knuth 1912; Dyer 1975). However, there are *Pelargonium* species with the *Erodium* complement of 5 fertile stamens alternating with 5 staminodes, e.g. *P. minimum* (Cav.) Willd. Furthermore, these flowers may be actinomorphic.

The decisive distinguishing characteristic is to be found in the nectariferous glands. *Erodium* has 5 such glands situated at the outside base of the fertile stamens. *Pelargonium* has only one nectary at the bottom of the nectar tube in the hypanthium or modified receptacle.

Erodium maritimum (L.) L.'Hérit. and *E. ruthenicum* Bieb. were both collected once only in southern Africa. Of *E. maritimum* a specimen, *Thunberg 87* (SBT), was collected at an unstated locality at the Cape. Cooper in

1862 collected a specimen of *E. ruthenicum*, probably in the Orange Free State, and which is housed at K.

Acknowledgements

Thanks are due to the University of the Orange Free State and the Council for Scientific and Industrial Research for financial support. We also thank all the herbaria listed for kindly lending us their specimens of *Erodium*. We are indebted to Prof. G.G. Guittonneau, Department of Botany, University of Orleans, France, for his valued assistance.

References

- BERTOLONI, A. 1819. *Amoenitates italicae*. Typis Annesii de Nobilibus, Bologna.
- BIEBERSTEIN, L.B.F., von. 1810. *Centuria Plantarum Rariorum* 1: tab 48.
- BORTENSCHLAGER, S. 1967. Vorläufige Mitteilungen zur Pollenmorphologie in der familien Geraniaceae und ihre systematischen Bedeutung. *Grana Palynol.* 7: 400–468.
- CAVANILLES, A.J. 1787. *Monodelphiae classis dissertationes decem*. Quarta dissertatio botanica, de Geranio. F.A. Didot, Paris.
- DRÈGE, J.F. 1843. *Zwei Pflanzengeographische Documente*. *Flora* 2: 38–230.
- DYER, R.A. 1975. The genera of southern African flowering plants. Vol. 1, Dept. Agric. Services, Pretoria.
- GODRON, D.A. 1853. *Flora juvenalis*. *Mém. Acad. Montp.* sect. *Med.* 1: 424.
- GODRON, D.A. 1854. *Flora juvenalis*. *Mém. Acad. Stanislas*, 2nd edn, p. 72.
- GUITTONNEAU, G.G. 1985. Observations critiques sur la caryologie, la morphologie et la chorologie du genre *Erodium* L'Hérit. dans le Bassin méditerranéen. *Bull. Soc. bot. Fr.* 132, *Lettres bot.* (4/5): 319–325.
- GUITTONNEAU, G.G., MONSERRAT, P. & VILLAR, L. 1987. *L'Erodium brachycarpum* (Godr.) Thell., espèce méditerranéenne méconnue de la série évolutive de l'*E. botrys* (Cav.) Bertol. (Geraniaceae). *Candollea* 42: 417–425.
- GUITTONNEAU, G.G. & ROUX, M. 1977. Sur la taxonomie du genre *Erodium*. *Les Cahiers de l'Analyse des Données* 2: 97–113.
- HILLIARD, O.M. & BURTT, B.L. 1985. A revision of *Geranium* in Africa south of the Limpopo. *Notes R. bot. Gdn Edinb.* 42: 171–225.
- HUTCHINSON, J. 1969. *Evolution and phylogeny of flowering plants*. Academic Press, London.
- KNUTH, R.L. 1912. Geraniaceae. In: *Das Pflanzenreich Regni vegetabilis conspectus*, ed. Engler, H.G.A., Vol. 4.129, Wilhelm Engelmann, Berlin.
- LAWRENCE, G.H.M. 1951. *Taxonomy of vascular plants*. The Macmillan Company, New York.
- L'HÉRITIER DE BRUTELLE, C.L. 1787–88. *Geraniologia, seu Erodii, Geranii, Monsoniae et Grieli Historia iconibus illustrate*. Petri-Francisci Didot, Paris.
- L'HÉRITIER DE BRUTELLE, C.L. 1789. Geraniaceae. In: Aiton, W. *Hortus Kewensis*, George Nicol, London.
- LINNAEUS, C. 1753. *Species Plantarum*. 1st edn, Impensis Laurentii Salvii, Stockholm.
- LINNAEUS, C. 1759. *Systema Naturae*. 10th edn, Impensis Laurentiae Salvii, Stockholm.
- LINNAEUS, C. 1764. *Species Plantarum*, 3rd edn, Joannis Thomae de Trottner, Vienna.
- MOFFETT, R.O. 1979. The genus *Sarcocaulon*. *Bothalia* 12: 581–613.
- OLIVIER, MARIA, C. & VAN DER WALT, J.J.A. 1984. The taxonomy of the *Pelargonium peltatum* (L.) L'Hérit. complex. *Jl S. Afr. Bot.* 50: 1–14.
- THELLUNG, A. 1917. *Erodium brachycarpum*. *Bot. Soc. Cl. British Isl. Rep.* 5: 17.
- THUNBERG, C.P. 1794. *Prodromus plantarum capensium...*, Part 1. J. Edman, Uppsala.
- THUNBERG, C.P. 1823. *Flora Capensis*. 2nd edn, J.F. Euman, Copenhagen.
- VAN DER WALT, J.J.A. 1985. A taxonomic revision of the type section of *Pelargonium* L'Hérit. (Geraniaceae). *Bothalia* 15: 345–385.
- VAN DER WALT, J.J.A. & BOUCHER, D.A. 1986. A taxonomic revision of the section *Myrrhidium* of *Pelargonium* (Geraniaceae) in southern Africa. *S. Afr. J. Bot.* 52: 438–462.
- VAN DER WALT, J.J.A. & VAN ZYL, L. 1988. A taxonomic revision of *Pelargonium* section *Campylia* (Geraniaceae). *S. Afr. J. Bot.* 54: 145–171.
- VENTER, H.J.T. 1979. Monograph of *Monsonia* (Geraniaceae). *Meded. Landbouwhoogeschool Wageningen*, Netherlands. 79-9: 1–128.
- WEBB, D.A. & CHATER, A.D. 1968. *Erodium*. In: *Flora Europaea*, eds Tutin, T.G., Heywood, V.H., Burgess, N.H., Moore, D.M., Valentine, D.E., Walters, S.M. & Webb, D.A., Vol. 2: 199–204, Cambridge University Press, Cambridge.
- WILLDENOW, C.L. 1794. *Phytographia*. Erlangen.
- WILLDENOW, C.L. 1800. *Caroli a Linnè Species Plantarum*, 4th edn, Vol. 3, Nauk, Berlin.