

Recircumscription and distribution of elements of the ‘*Ceterach cordatum*’ complex (*Asplenium*: Aspleniaceae) in southern Africa

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Keywords: Aspleniaceae, *Asplenium*, *Ceterach*, ferns, pteridophytes, southern Africa, xerophytes

ABSTRACT

Ceterachoid aspleniums in southern Africa have long been treated as a single widespread and variable taxon, *Asplenium cordatum* (Thunb.) Sw. (= *Ceterach cordatum* Thunb.). In addition to *A. cordatum*, a further two ceterachoid taxa are now recognized as occurring in the *Flora of southern Africa* (FSA) region, namely *A. capense* (Kunze) Bir, Fraser-Jenk. & Lovis and *A. phillipsianum* (Kümmerle) Bir, Fraser-Jenk. & Lovis. We provide full descriptions and distributions of these three taxa.

INTRODUCTION

Pteridophyte treatments for the *Flora of southern Africa* (FSA) (Roux 1986; Schelpe & Anthony 1986; Burrows 1990) and *Flora zambesiaca* (FZ) (Schelpe 1970) regions, have considered a single xerophytic rock fern, *Ceterach cordatum* Thunb., to occur widely throughout the region and to show great morphological variability. *Ceterach* is currently treated as a subgenus of *Asplenium* L. (Crabbe *et al.* 1975; Bir *et al.* 1985; Roux 2001). Subgenus *Ceterach* is distinguished from subgenus *Asplenium* in our region by its lack of indusia and the presence of densely-set scales (paleae) on the abaxial lamina surface, versus indusiate sori and sparsely-set scales in subgenus *Asplenium* (Roux 2001). Moore (1857) early recognized that the strictly African ceterachoid species were anatomically and morphologically distinct from the Eurasian-Macronesian elements, and therefore excluded them from *Asplenium* subgen. *Ceterach*. More recent molecular analyses have demonstrated the polyphyly of subgenus *Ceterach*, implicating homoplasy in the dense scale cover and in pinnatisect laminae of these asplenioid ferns (Pinter *et al.* 2002; Van den Heede *et al.* 2003). The taxonomic implications are that southern African taxa referred earlier to subgenus *Ceterach* should either be accommodated in a new subgenus, or that distinction at a subgeneric level (*sensu* Roux 2001) should be abandoned altogether (Van den Heede *et al.* 2003).

The multiple origins in *Asplenium* of redundant indusia and dense abaxial scales have been attributed to independent adaptation to rocky xeroseres across its range (Van den Heede *et al.* 2003). We further postulate that the pinnatisect fronds common to both groups is a poikilohydric modification that allows for frond integrity to be maintained in the inrolled, desiccated state (Figure 1), and for even restoration following rehydration. Ceterachoid taxa in southern Africa are extremely

desiccation-tolerant; a member of this group has been shown by Gaff (1977) to tolerate relative humidities in the 0–5% range for at least six months, with an initial water potential (ψ) of 18%, expressed in terms of the relative humidity at 28°C.

We concur with Roux (2009a) in his reinstatement of *Asplenium capense* (Kunze) Bir, Fraser-Jenk. & Lovis as distinct from *A. cordatum* (Thunb.) Sw., but we also identify *A. phillipsianum* (Kümmerle) Bir, Fraser-Jenk. & Lovis as occurring in the FSA region (Table 1). This taxon extends from the island of Socotra off Somalia through East and Central Africa to the northern provinces of South Africa, as far south as the northern regions of Mpumalanga, Gauteng, and North West Province. Pappe & Rawson (1858) recognized the widespread European and North African taxon *Asplenium ceterach* L. (= *Ceterach officinarum* Lam. & DC) as South African, based on a Krebs collection made on the Baviaans River. This species is not currently considered to occur south of the Sahara, and has been taken as a misidentification (Roux 1986, 2009a).

We provide the recircumscription and distribution of the three ceterachoid elements of *Asplenium* currently known from southern Africa.

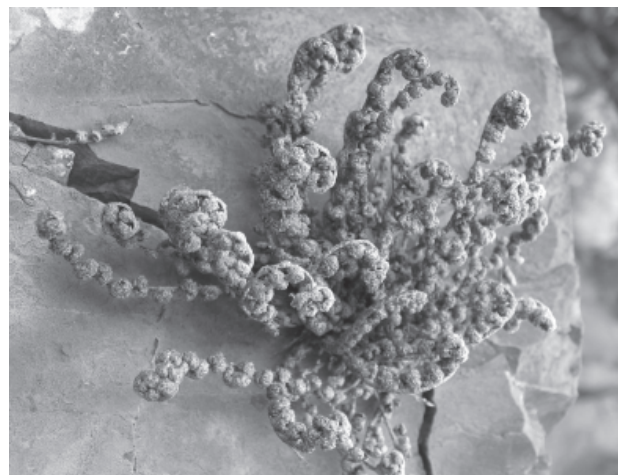


FIGURE 1.—Inrolled pinnatisect leaves of a desiccated plant of *Asplenium cordatum*, Nieu Bethesda, Eastern Cape Province. Photo: N. Crouch.

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TABLE 1.—Characters distinguishing ceterachoid members of *Asplenium* occurring in the FSA region.

Character/taxon	<i>A. cordatum</i>	<i>A. capense</i>	<i>A. phillipsianum</i>
Fronde division	shallowly to very deeply 2-pinnatifid, sometimes 2-pinnate	pinnatisect to pinnate, sometimes shallowly 2-pinnatifid	pinnatisect to very shallowly 2-pinnatifid
Fronde apex division	to near apex	to some way below apex	to some way below apex
Pinnae width	narrower at base	broader at base	broader at base
Pinnae shape	narrowly oblong to oblong-lanceolate, apex bluntly acute; petiolulate throughout; base flared to somewhat auriculate-cordate	ovate-oblong, apex obtuse; apical pinnae adnate with base decurrent; basal 1–2 pinnae pairs becoming petiolulate with base somewhat flared to auriculate-cordate	narrowly ovate-oblong, apex obtuse; base adnate and decurrent throughout
Scale density on abaxial surface	very dense	very sparse	sparse
Scale shape	deltate, attenuate	deltate to lanceolate, attenuate	lanceolate
Scale margins	serrate	finely serrate	finely serrate
Scale composition	cells short roundish to oval	cells narrowly oblong	cells oblong
Scale colour on stipe	not darker towards apex	darker towards apex	darker towards apex
Rhachis robustness	strong, rigid	strong, fairly rigid	weaker, flexible
Sori size	small, up to 2 mm, not confluent	very large, 3–6 mm, later confluent	large, 2–3 mm, later confluent
Gemmae	absent	absent	sometimes present near apex
Stipe length	17–40 mm	15–35 mm	5–20 mm

MATERIALS AND METHODS

All ceterachoid *Asplenium* material held in the following herbaria (totalling almost 600 specimens) were studied: Geo-Potts Herbarium (BLFU), University of the Free State, Bloemfontein; Buffelskloof Nature Reserve Herbarium (BNRH), Lydenburg; Bolus Herbarium (BOL), University of Cape Town, Cape Town; Selmar Schönland Herbarium (GRA), Albany Museum, Grahamstown; the Herbarium at the Royal Botanic Gardens, Kew (K), London, United Kingdom; Mpumalanga Parks Board Herbarium (LYD), Lydenburg; Compton Herbarium (NBG), SANBI, Cape Town; KwaZulu-Natal Herbarium (NH), SANBI, Durban; National Museum Herbarium (NMB), Bloemfontein; Bews Herbarium (NU), University of KwaZulu-Natal, Pietermaritzburg; National Herbarium (PRE), SANBI, Pretoria; H.G.W.J. Schweickerdt Herbarium (PRU), University of Pretoria, Pretoria; A.P. Goossens Herbarium (PUC), North West University, Potchefstroom; and the South African Museum Herbarium (SAM), SANBI, Cape Town.

The JSTOR Plant Science website (<http://plants.jstor.org>) was consulted for type material held in other herbaria. Images of type specimens were directly obtained from The Museum of Evolution Herbarium (UPS), Uppsala University, Uppsala, Sweden. Types seen electronically are cited as e!

Herbarium acronyms follow Holmgren *et al.* (1990). Author citations used follow the standardized author abbreviations provided by the International Plant Names Index (<http://www.ipni.org>).

TAXONOMY

Three taxa are recognized in southern Africa, all chasmodontophytic saxicoles (Jacobsen 1983):

Key to the species

- 1a. Fronds always pinnate, with stronger, rigid rachis; pinnae free from rachis (petiolulate), with flared to somewhat auriculate/cordate base, abaxially very densely covered with overlapping, broadly deltate scales; sori small, discrete 1. *A. cordatum*
- 1b. Fronds pinnatisect to pinnate, with weaker, flexible rachis; pinnae adnate to rachis, with broader decurrent base (at least in distal half of frond), abaxially sparsely covered with ovate lanceolate scales; sori large and confluent:
 - 2a. Pinnae adnate to rachis and decurrent apically, becoming free from rachis (petiolulate) with ± flared to auriculate/cordate base basiscopically; rachis winged apically 2. *A. capense*
 - 2b. Pinnae adnate to rachis and decurrent throughout; rachis almost winged throughout 3. *A. phillipsianum*

1. ***Asplenium cordatum* (Thunb.) Sw.** in Journal für die Botanik 1800,2: 54 (1801). *Acrostichum cordatum* Thunb.: 171 (1800). *Grammitis cordata* (Thunb.) Sw.: 23, 217 (1806). *Cincinalis cordata* (Thunb.) Desv. (1811). *Notholaena cordata* (Thunb.) Desv.: 92 (1813). *Gymnogramma cordata* (Thunb.) Schldl.: 16 (1825). *Ceterach cordatum* (Thunb.) Desv.: 223 (1827). Type: South Africa, 'e Cap bonae Spei', *Thunberg s.n.* (UPS-Thunb 24439, holo. e!).

Ceterach crenata Kaulf.: 85, 86 (1824), nom. illegit. superfl. Type: as for *Acrostichum cordatum* Thunb. [McNeill *et al.* (2006) Art. 7.5].

Gymnogramma namaquensis Pappe & Rawson: 42 (1858). *Gymnogramma cordata* var. *namaquensis* (Pappe & Rawson) Sim: 212 (1892). *Ceterach cordatum* var. *namaquensis* (Pappe & Rawson) Sim: 176 (1915). Type: South Africa, Namaqualand, between rocks near Modderfontein, 1856, *Whitehead s.n.* (K, holo.!).

Grammitis cordata [var. and] subvar. *nudiuscula* Hook.: t.7 (1860), nom. illegit. superfl. Type: as for *Gymnogramma namaquensis* Pappe & Rawson [see Roux (2009a)].

Grammitis cordata var. *pinnato-pinnatifida* Hook.: t.7 (1860), nom. inval. [McNeill *et al.* (2006) Art. 26.2].

Gymnogramma cordata var. *subbipinnata* Hook.: t.7 (1860). *Ceterach cordatum* var. *subbipinnata* (Hook.) Kümmerle: 289 (1909). Type: South Africa, 'elevated mountain of Macaliesberg', *Ecklon & Burke s.n.* [missing, see Schelpe & Anthony (1986: 206) and Roux (2009: 83)].

Gymnogramma cordata var. *bipinnata* Sim: 212 (1892). Type: South Africa, Namaqualand, without precise locality, *Holland s.n.* [NBG, lecto.!, designated by Schelpe & Anthony (1986: 206)].

Notholaena inaequalis Kunze γ *eckloniana* (Kunze) Kuntze var. *rawsonii* (Pappe) Kuntze forma *minor* Kuntze: 379 (1898). Type: South Africa, [Eastern Cape], 'Capland', Cradock, 940 m, 12 Feb. 1894, *Kuntze s.n.* [NY, lecto., designated by Roux (2009b: 228)].

Rhizome to 3–6 mm diam., erect or procumbent; scales sessile, clathrate, very narrowly lanceolate, 2–3 \times 0.5–0.6 mm, acuminate, frequently with a hair point, irregularly serrate, bicolorous, chestnut-brown distally, brown proximally, with paler margin throughout, with narrowly oblong to ovate cells. *Fronde* tufted, suberect to erect; *stipe* (10–)17–40(–60) mm long, dark chestnut-brown, densely scaled when young, becoming subglabrous with age, scales sessile, lanceolate, 3.0–3.5 \times 0.7–0.9 mm, acuminate, irregularly serrate, glossy, sometimes bicolorous, chestnut-brown, sometimes with narrow paler margin, with oblong to ovate cells; *lamina* subcoriaceous, involute and inrolled when dry, elliptic or narrowly elliptic to oblanceolate in outline, shallowly to very deeply 2-pinnatifid, sometimes 2-pinnate, (20–)50–120(–150) \times (10–)15–40(–50) mm, basal pinnae gradually decrescent; *rachis* not winged between pinnae, scales as for stipe but lanceolate, 3.0 \times 0.9 mm; *pinnae* (4–)6–19(–30) \times (2–)3–7(–13) mm, free from rachis (petiolulate), with flared to \pm auriculate-cordate base, narrowly oblong to oblong-lanceolate, bluntly acute, margin irregularly scalloped to incised, glabrous above at maturity, abaxially very densely scaled, scales sessile, deltate, \pm 2.0 \times 1.5 mm, attenuate, serrate, glossy, light reddish brown, with short roundish to oval cells; *sori* linear along (obscure) veins, up to 2 mm long, exindusiate, almost totally obscured by scales. Figure 2A–D.

Etymology: *cordatum* = heart-shaped, referring to the basally lobed pinnae.

Distribution and ecology: *Asplenium cordatum* is widespread in South Africa, Lesotho, Swaziland, Namibia, Botswana, and Zimbabwe (Figure 3); also in Angola, Tanzania, Kenya, Uganda, and Ethiopia.

It occurs in rocky crevasses in exposed, hot, and dry habitats, often at the base of boulders, well away from water. A dense scale cover on the abaxial surface of the fronds serves to protect the sori of this xerophytic species.

Asplenium cordatum is very variable in size, with the largest specimens originating from the dry areas of the north-western parts of the Western and Northern Cape

provinces. This immense variability is reflected in the long list of synonyms for this taxon. Burrows (1990) noted that northwards of the Limpopo River it becomes progressively rarer, reaching the extreme of its range in Ethiopia.

Although purported to occur in Madagascar (Roux 2009a), where a ceterachoid element has been reported from a single locality on Mount Morahahiva (Tardieu-Blot 1957), this collection best matches *Asplenium philipsianum* (Tardieu-Blot 1958: Fig. XVII).

Vouchers: *H.H. Burrows* 3294 (GRA); *E. Esterhuysen* 25624 (BOL); *D. Galpin* 4782a (BLFU); *H.H.W. Pearson* 8557 (BOL, K, NBG); *L.E. Taylor* 2913 (NBG).

2. *Asplenium capense* (Kunze) Bir, Fraser-Jenk. & Lovis in Fern Gazette 13,1: 61 (1985). *Ceterach capense* Kunze: 496 (1836). *Grammitis capensis* (Kunze) T.Moore: lxiii (1857). Type: South Africa, 'Port Natal et Afrique meridionalea', *Drège s.n.* [G, lecto.!, isolecto., designated by Roux (1986: 352)]; 'Ceded territory, bergwaldungen an den Quellen des Kattriver, Oberhalb Philipstown', *Ecklon & Zeyher s.n.* (UPS, syn. e!).

Gymnogramma capensis Spreng. ex Kaulf.: 183 (1831), nom. nud. *Ceterach cordatum* var. *capense* (Spreng. ex Kaulf.) Hieron. ex Kümmerle: 287 (1909). Type: South Africa, 'Cap. Bon spei: in einer Felsenritze am Löwenberg', *Zeyher s.n.* Fl. Cap. No. 273 (HAL, holo. e!; BOL, iso.!).

Grammitis cordata var. *pinnata* Hook.: t.7 (1860), Type: as for *Ceterach capense* Kunze [see Roux (2009a)].

Rhizome to 4 mm diam., erect or procumbent; scales sessile, clathrate, lanceolate, 3–5 \times 1.0–1.5 mm, acuminate, frequently with a hair point, irregularly serrate, bicolorous, with dark brown central region and paler margins, with narrowly oblong cells. *Fronde* tufted, erect to suberect; *stipe* 15–35(–60) mm long, chestnut-brown to dark chestnut-brown, densely scaled, scales sessile, narrowly triangular, 3–5 \times 0.5–1.0 mm, acuminate, irregularly finely serrate, glossy, sometimes bicolorous, with narrow rust coloured central region and broad straw coloured margin, with oblong to ovate cells; *lamina* herbaceous, involute and inrolled when dry, elliptic to narrowly obovate in outline, pinnatisect to pinnate, sometimes shallowly 2-pinnatifid, (80–)90–120(–190) \times (20–)30–45(–52) mm, basal pinnae gradually decrescent; *rachis* somewhat winged apically, not winged between widely spaced pinnae basally, scales as for stipe but 2–4 \times 0.7–1.0 mm; *pinnae* (10–)15–25(–28) \times (4–)5–10(–11) mm, adnate to rachis with decurrent base apically, becoming free from rachis (petiolulate) with somewhat flared to auriculate-cordate base basiscopically, ovate-oblong, obtuse, margin sinuate to scalloped, glabrous above at maturity, abaxially very sparsely scaled, scales sessile, deltate to lanceolate, 1.5–2.5 \times 0.4–0.7 mm, attenuate, finely serrate, glossy, bicolorous, with narrow rust coloured central region and broad straw coloured margin, with narrowly oblong cells; *sori* linear along (obscure) veins, 3–6 mm long, becoming confluent at maturity, exindusiate, not obscured by scales. Figure 2E–H.

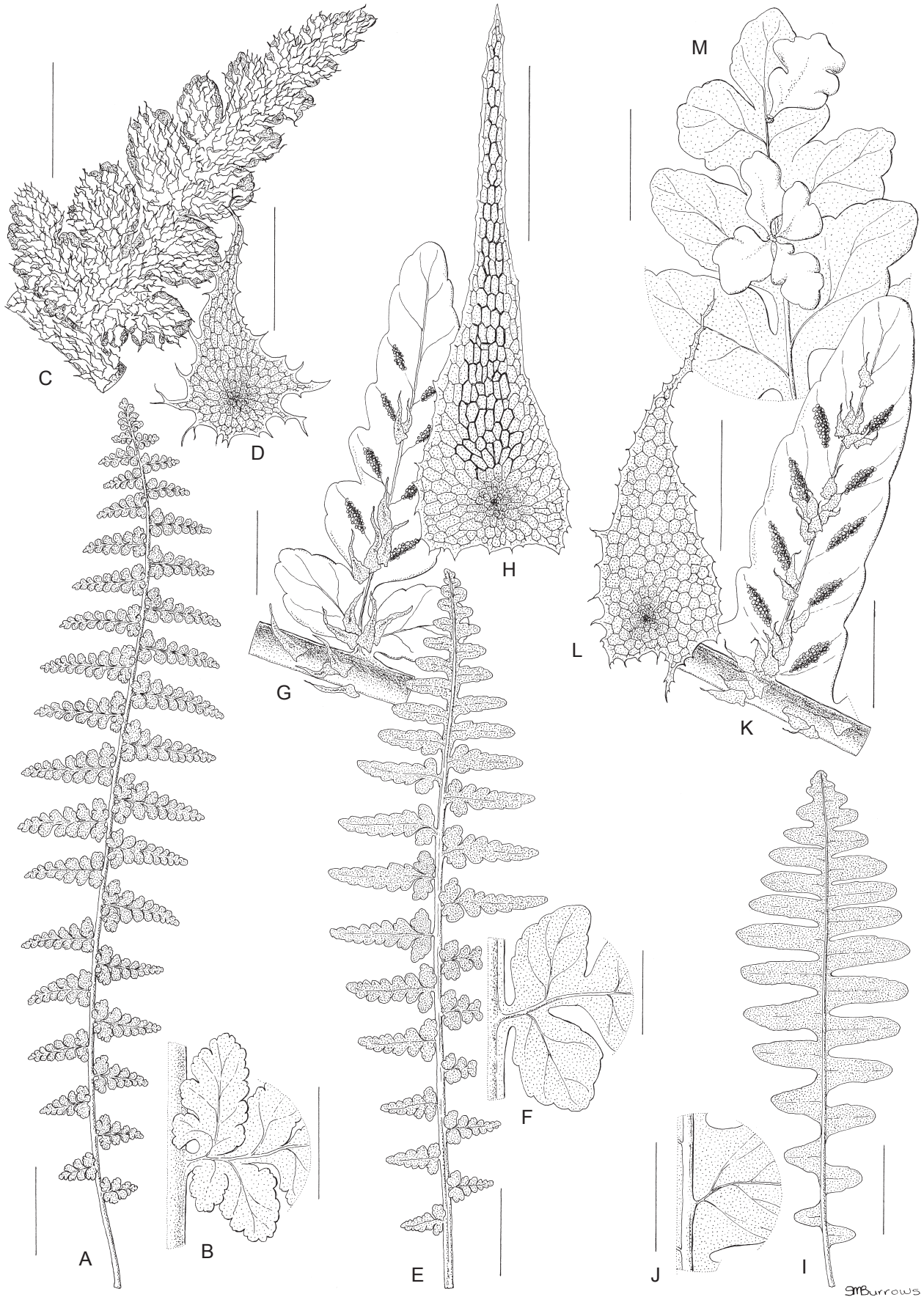
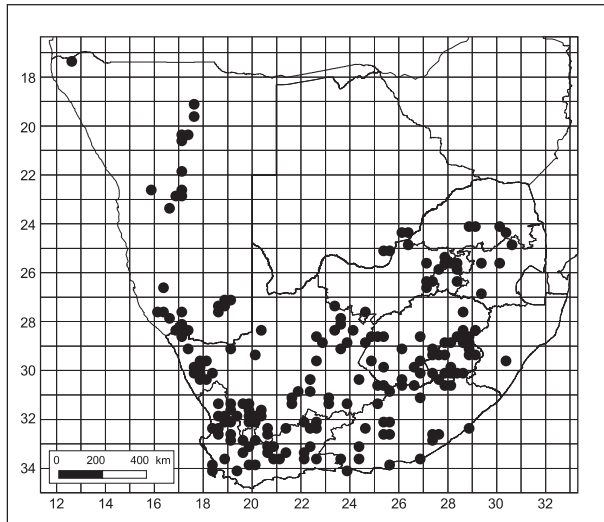


FIGURE 2.—A–D, *Asplenium cordatum*, J.E. Burrows 1110 (BNRH): A, complete frond; B, cordate pinna base; C, abaxial surface of pinna with dense scales; D, lamina scale. E–H, *Asplenium capense*, H.H. Burrows 2891 (BNRH): E, complete frond; F, pinna base; G, abaxial surface of pinna with sparse scales; H, lamina scale. I–M, *Asplenium phillipsianum*, J.E. Burrows & S.M. Burrows s.n. (BNRH): I, complete frond; J, adnate pinna base; K, abaxial surface of pinna with sparse scales; L, lamina scale; M, gemmae at frond apex. Scale bar: A, E, I, 20 mm; B, C, F, G, J, K, M, 5 mm; D, H, L, 1 mm. Artist: Sandra Burrows.

FIGURE 3.—Distribution of *Asplenium cordatum* in the FSA region.

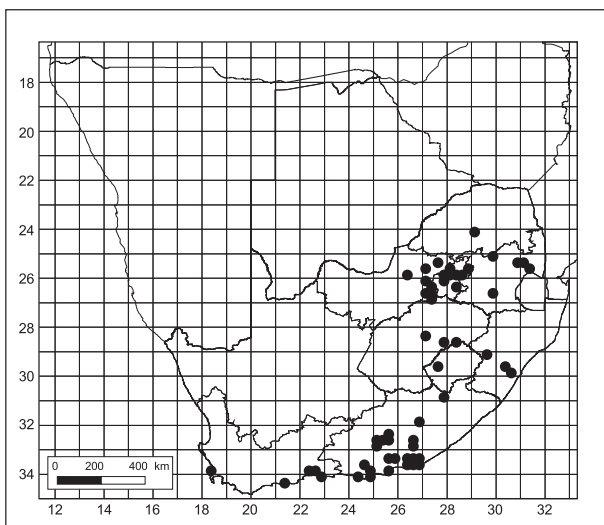
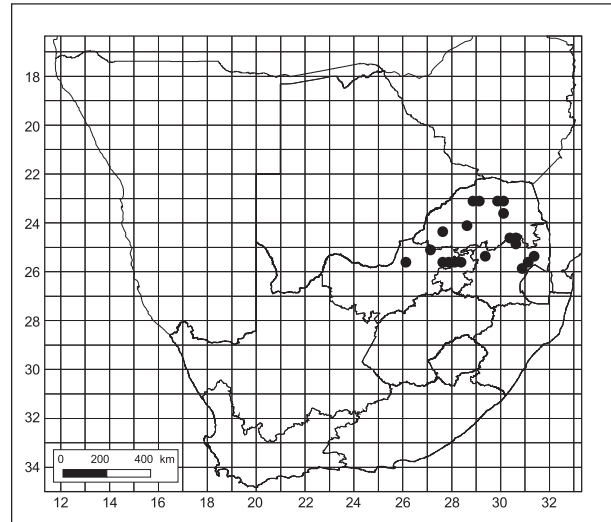
Etymology: *capense* = pertaining to the Cape.

Distribution and ecology: *Asplenium capense* occurs from the Cape Peninsula through the Western and Eastern Cape, KwaZulu-Natal, the Free State and northern provinces of South Africa (Figure 4), extending sporadically to central and tropical East Africa.

This species typically grows in sandy soil on forest floors, as well as under coastal dune scrub, often fairly close to streams and under trees on steep damp earth banks. It is usually associated with riparian or open forest, most often in lightly rather than deeply shaded conditions.

Vouchers: *Th.C.E. Fries*, *T. Norlich* & *H. Weimark* 30-8 (BOL, K); *D.B. Müller* 890 (NMB; PRE); *R. Schlechter* 2703 (GRA, K); *E.M. van Zinderen Bakker* 1135 (BLFU, PRE); *C.J. Ward* 12400 (NH, NU, PRE).

3. *Asplenium phillipsianum* (Kümmerle) Bir, *Fraser-Jenk. & Lovis* in *Fern Gazette* 13,1: 62 (1985).

FIGURE 4.—Distribution of *Asplenium capense* in the FSA region.FIGURE 5.—Distribution of *Asplenium phillipsianum* in the FSA region.

Ceterach phillipsianum Kümmerle: 287 (1909). Type: Somalia, 'Ferns from deep shade Wagga Mountain, anno 1897', *Phillips s.n.* (BM, holo.; K, iso.!).

Rhizome to 4 mm diam., erect or procumbent; scales sessile, clathrate, lanceolate, 3–4 × 0.6–1.0 mm, acuminate, frequently with a hair point, irregularly serrate, sometimes bicolorous, with dark chestnut-brown central region, sometimes with darker apex, with paler margins throughout, with narrowly oblong to ovate cells. *Fronde* tufted, suberect to spreading; *stipe* 5–20(–30) mm long, dark chestnut-brown, densely scaled, scales sessile, lanceolate, 3–4 × 0.7–1.0 mm, acuminate, irregularly serrate, glossy, bicolorous, distally dark brown and proximally chestnut-brown with paler margins throughout, with narrowly oblong to ovate cells; *lamina* herbaceous, involute and inrolled when dry, elliptic to obovate in outline, pinnatisect to very shallowly 2-pinnatifid, (5–)70–100(–130) × (16–)24–33(–50) mm, lower pinnae gradually decrescent, occasionally produces 1–3 gemmae situated adaxially in the sinus of the distal pinnules; *rachis* almost winged throughout, scales as for stipe but 2.5–3.0 × 0.6–1.0 mm, concolorous reddish brown, sometimes chestnut-brown towards apex; *pinnae* (6–)10–20(–25) × (3–)4–6(–9) mm, adnate to rachis with decurrent base throughout, narrowly ovate-oblong, obtuse, margin entire to weakly sinuate, glabrous above at maturity, abaxially sparsely scaled, scales sessile, lanceolate, 1.7–2.4 × 0.6–0.8 mm, attenuate, finely serrate, glossy, brown, with oblong cells; *sori* linear along (obscure) veins, 2–3 mm long, becoming confluent at maturity, exindusiate, not totally obscured by scales. Figure 2I–M.

Etymology: *phillipsianum* = commemorates the English explorer Ethelbert Lort-Phillips (1857–1944) who in 1897 collected the type specimen in Somalia.

Distribution and ecology: *Asplenium phillipsianum* occurs from the northern provinces of South Africa (Limpopo, North West, Gauteng, and Mpumalanga) (Figure 5), through central and tropical Africa as far north as Socotra; also known from Réunion and Madagascar.

This species is typically found close to streams, shaded under trees on steep damp earth banks.

Of the three regional ceterachoid species, *A. phillipsianum* is the only member noted to be gemmiferous (J. Nel, pers. comm.) (Figure 2M).

Vouchers: *J.E. Burrows & S.M. Burrows s.n.* (BNRH); *M.F. Glen PRE62127* (PRE); *E. Retief & S.E. Strauss 2154* (PRE); *J.P. Roux 3195* (NBG); *A. Winterboer s.n.* (PRU).

Excluded name

Ceterach cordatum var. *pinnatifida* Sim: 177 (1915). The syntypes cited by Sim (1915) include representatives of both *A. capense* and *A. phillipsianum*.

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Dr Hugh Glen, KwaZulu-Natal Herbarium, SANBI, Durban, is thanked for translating Latin texts and for providing nomenclatural advice; Prof. John McNeill, Royal Botanic Gardens, Edinburgh, for providing nomenclatural advice; Ms Hester Steyn, National Herbarium, SANBI, Pretoria, for producing updated distribution maps. The Curators of BLFU, BNRH, BOL, GRA, K, LYD, NBG, NH, NMB, NU, PRE, PRU, PUC and SAM kindly facilitated access to their collections.

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