



Exochaenium natalense (Gentianaceae), a reinstated taxon endemic to KwaZulu-Natal, South Africa

JONATHAN KISSLING^{1*}, KATE W. GRIEVE^{2,3}, GRAHAM GRIEVE^{2,4} & BENNY BYTEBIER⁵

¹ *Institute of Biology, University of Neuchâtel, Rue Emile-Argand 11, 2000 Neuchâtel, Switzerland*

✉ jonathan.kissling@unine.ch; <https://orcid.org/0000-0002-1078-4000>

² *Custodians of Rare and Endangered Wildflowers (CREW) Programme, South African National Biodiversity Institute, South Africa*

³ ✉ kw.grieve@gmail.com; <https://orcid.org/0000-0003-1606-4132>

⁴ ✉ grahamgrieve46@gmail.com; <https://orcid.org/0009-0001-3274-3226>

⁵ *Bews Herbarium, Centre for Functional Biodiversity, School of Life Sciences, University of KwaZulu-Natal, Pietermaritzburg, South Africa*

✉ bytebier@ukzn.ac.za; <https://orcid.org/0000-0002-4661-5727>

*Author for correspondence

Abstract

Based on morphological and ecological considerations, *Belmontia natalensis* (syn. *Exochaenium grande* var. *homostylum*) is reinstated as *Exochaenium natalense* (Gentianaceae). It only occurs in a section of the coastal region of the Eastern Cape (Pondoland) and southern KwaZulu-Natal provinces, South Africa. *Exochaenium natalense* differs from *E. grande*, the only other South African *Exochaenium* taxon, by having smaller flowers (corolla diameter < 2 cm vs > 3 cm) with a different colour (white vs cream-salmon or yellow). Because the type material of *E. natalense* consists of two sheets, a lectotype is designated.

Key words: KwaZulu-Natal, Pondoland, South Africa, summer rainfall region, taxonomy

Introduction

The African genus *Exochaenium* Grisebach (1845: 55; Gentianaceae; see Kissling 2012 for a detailed taxonomic history) currently includes 23 taxa (Kissling 2015). *Exochaenium* species are only found in sub-Saharan Africa (Kissling *et al.* 2009) and most of them are distylous (Kissling & Barrett 2013 and references therein). Among them, *Exochaenium grande* (Meyer 1837: 183) Grisebach (1845: 55) is not only the type species of the genus, but also the species with the widest distribution. Indeed, it occurs in grasslands from Senegal (West Africa) to Ethiopia in the East and southwards to South Africa.

In 1894 Hans Schinz described *Belmontia natalensis* Schinz (1894: 220) based on a plant collected in Natal (South Africa) by F.R.R. Schlechter (*Schlechter 3060*), of which two sheets are preserved at the Zürich herbarium (Z + ZT), Switzerland. Hill (1908), in preparation of the Gentianeae treatment for *Flora Capensis* (Hill & Prain 1909), transferred this taxon to *Exochaenium* and changed its rank to become *E. grande* var. *homostylum* Hill (1908: 338). Hill's variety was based on the size of the flower and the position of the stigma relative to the anthers (*i.e.* at the same height, hence the epithet '*homostylum*'). Marais & Verdoorn (1963) did not recognize this variety and synonymized it with *E. grande*.

North of the Limpopo River, in the *Flora Zambesiaca* region, *E. grande* is a morphologically homogenous species with only some variation in plant and flower size, as well as in number of flowers per inflorescence. Nevertheless, like in many other distylous species [e.g., *Primula* Linneaus (1753: 142) (Primulaceae), *Pulmonaria* Linneaus (1753: 135) (Boraginaceae), *Turnera* Linneaus (1753: 271) (Passifloraceae), etc.] occasional homostylous populations can be encountered in *E. grande* (as observed by J.K. in Zambia). Therefore, it is likely that previous authors (including the first author, see Kissling 2012) agreed that the homostyly in *E. grande* var. *homostylum* was in fact only a normal occurrence within *E. grande*.

In 2015, two morphologically different *Exochaenium* taxa (see Fig. 1) were found growing at the same locality. The first one undoubtedly corresponded to *E. grande*, whereas the second one could not immediately be identified. The flowers of the second taxon were pure white as in many other *Exochaenium* species, but different from *E. grande*, which has cream or yellow flowers. Although the height of the plants was similar, the size of the flowers in the unknown taxon was considerably smaller, and the stigma was at the same level as the anthers (or slightly above). Over a period of six years, we regularly visited seven Eastern Cape and KwaZulu-Natal coastal grasslands where both taxa occurred, but did not discover any intermediate flowers. Furthermore, the size of the flowers of both taxa were remarkably stable. It also became clear that there were phenological differences between the two taxa. *Exochaenium grande* generally flowers in October–November (but may flower earlier when the plants’ appearance is stimulated by grassland burning), while the small-flowered taxon usually flowers in December and only grows in damp sites. Both species continue flowering until May–June given adequate rainfall. In addition to phenology, there are notable differences in ecological preferences between the two taxa (*i.e.* the unknown taxon always grows in wet to moist grassland and sometimes in water, whereas *E. grande* are always in dry grassland). While monitoring these two taxa, it was noted that the unidentified species corresponded well to the descriptions provided by Schinz (1894), and later added to by Hill (1908), for *Belmontia natalensis* described from a specimen collected near eThekweni [Durban] in KwaZulu-Natal, South Africa. Based on observations and research, it is recommended that the two taxa should be recognised as distinct and that *Belmontia natalensis* should be reinstated as *Exochaenium natalense* (Schinz) Kissling & K.W.Grieve.

Materials and methods

Exochaenium natalense was studied from live plants observed in the field, as well as herbarium material and photographs (see below: representative specimens examined). All relevant material was examined in BM, BOL, BR, C, DSM, G, GRA, K, MO, MRSC, MPR, NBG, NEU, NH, NU (incorporating PCE), PRE, S, WAG, and Z herbaria (abbreviations following Thiers 2022—continuously updated). Plant measurements were conducted on fresh individuals of *E. natalense* ($N=15$) that covered the whole range of morphological variation within that species, as well as on fresh individuals of *E. grande* ($N=15$) found in sympatry with *E. natalense*. The following measurements were taken: (i) flower diameter, (ii) floral tube length, (iii) petal width, and (iv) ovary length. Means were compared using Student’s *t*-test. Because of the distylous nature of *E. grande*, further characters such as anther position, stigma length, or anther length cannot be used for comparison between both species (see Wolfe *et al.* 2009).

Results

Both species differ significantly in perianth size (width and length; Table 1). *Exochaenium natalense* is easily recognisable, because of its white and much smaller flowers (corolla diameter < 2 cm) vs cream or yellow flowers larger than 3 cm in diameter for *E. grande*.

TABLE 1. Floral traits of *Exochaenium natalense* and *E. grande*.

	<i>E. natalense</i>	<i>E. grande</i>	<i>t</i> -test
Petal width	4.23±0.51	15.97±2.33	<0.0001
Flower diameter	12.85±1.63	37.46±3.81	<0.0001
Flower tube length	12.62±1.80	22.22±2.53	<0.0001
Ovary length	4.78±1.18	5.34±1.31	0.1259

Dimensions are in mm. Values are means ± s.e. $N=15$ flowers for *E. natalense* and $N=15$ flowers for *E. grande*.

Interestingly, Schinz (1894), while describing *E. natalense* (as *Belmontia natalensis*), emphasized that the flower colour of *E. natalense* is “pure white (according to information from the collector)” and that differs from *E. grande*. This observation is confirmed by the authors’ own field experience (*E. grande* having cream to yellowish flowers).

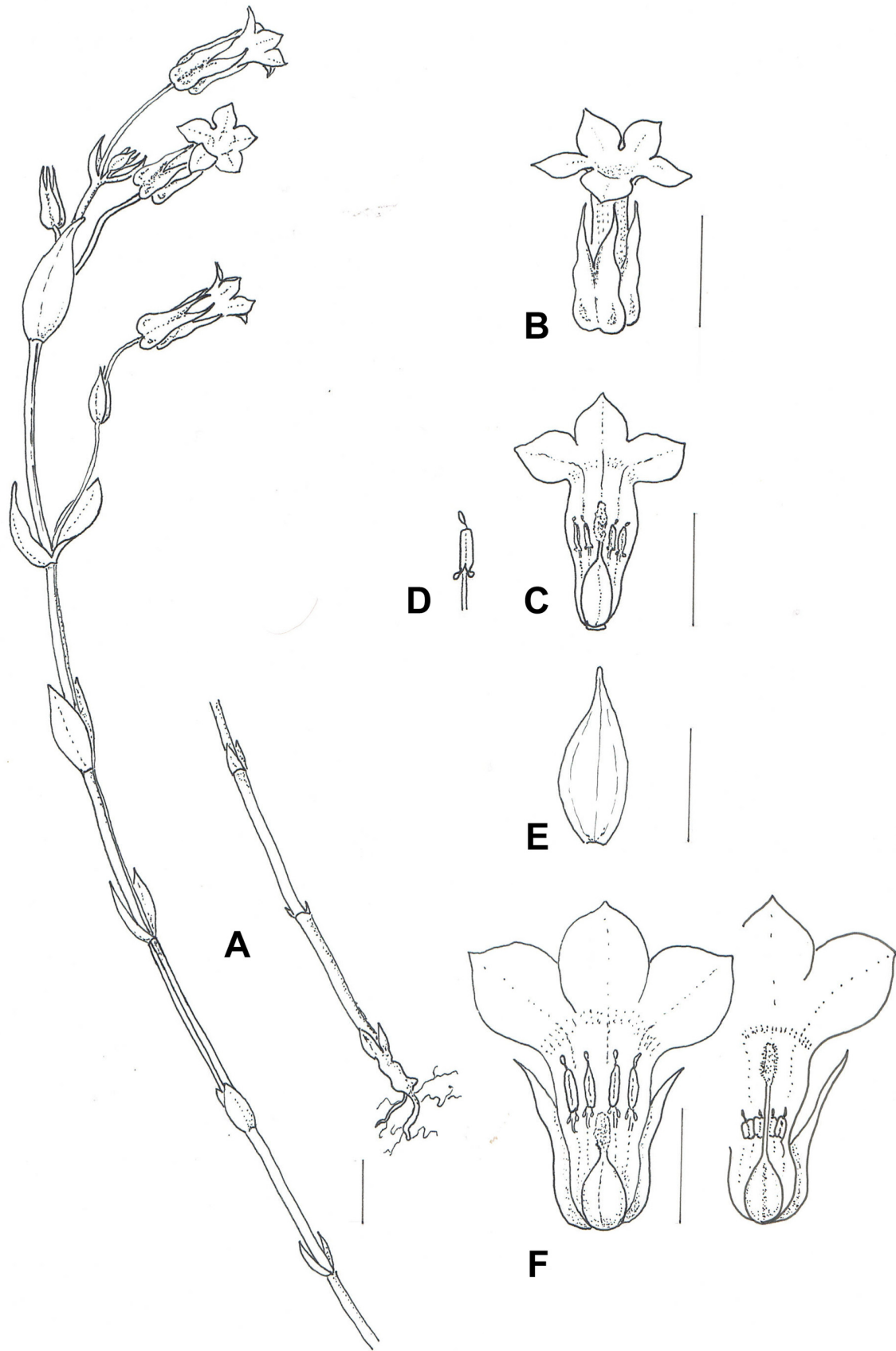


FIGURE 1. Comparison of *Exochaenium grande* and *E. natalense*. (A–E) *E. natalense* from K.W.Grieve 3078 (NH): **A.** Aerial parts; **B.** Flower showing calyx with conspicuously undulated wings; **C.** Open flower, showing the relative position of the anthers and pistil; **D.** Anther with apical and basal glands; **E.** Leaf; **F.** *E. grande* open flower showing the relative position of the anthers and pistil in distylous flowers (short and long style). Scale bar = 10 mm. Artist: Kate Grieve.

Taxonomic treatment

Exochaenium natalense (Schinz) Kissling & K.W.Grieve, *combinatio nova*.

Basionym:—*Belmontia natalensis* Schinz (1894: 220).

Homotypic synonyms:—*Exochaenium grande* var. *homostylum* Hill (1908: 338).

Sebaeanatalensis (Schinz) Schinz (1906: 782), *nom. illeg.* [non *Sebaea natalensis* Schinz (1896: 442)]. Type:—SOUTH AFRICA. KwaZulu-Natal, Clairmont, 5 Aug. 1893, *Schlechter 3060* (Lectotype Z [Z000070706]!, *hic designatus*; isolectotype Z [Z000070705]!).

Nomenclatural notes:—There are two sheets of *Schlechter 3060* at Herb. Z. One [Z000070706] contains five stems each with a single flower, whereas the other [Z000070705] contains a single stem from which the flower is removed and stored in a pocket. These two specimens should be considered as duplicates and thus a lectotype needed to be chosen, in accordance with the *International Code of Nomenclature for algae, fungi and plants* Arts 8.2 and 8.3 (Turland *et al.* 2018). The first author (JK) has studied the type material in detail and confirmed that both sheets represent the same taxon. The sheet with five stems contains more and better material and is consequently chosen here as lectotype.

When Schinz transferred *Belmontia natalensis* to the genus *Sebaea* in 1906, he clearly forgot that he had already described a different and currently still accepted species, as *Sebaea natalensis* in 1896. Thus, should *Exochaenium natalense* ever be transferred to the genus *Sebaea*, it will need a new name.

Diagnosis:—This species is morphologically closely allied to *Exochaenium grande* (E.Mey.) Griseb., but is markedly different in terms of its much smaller flower size of *c.* 0.8–1.5 cm diameter (*vs c.* 3.0–4.5 cm for *E. grande*) and the arrangement of the reproductive organs, with anthers positioned at the same level as the stigma (*vs* distyly in *E. grande*), possibly indicating differences in pollination strategies. The species can also be differentiated on the basis of their ecological preferences.

Description:—Annual, erect herbs, 15–20 cm tall. *Stems* simple, rarely branched from base, sometimes branched above, 4-ridged. *Leaves* sessile, opposite, 7–20 mm long, 3–6 mm broad, lanceolate, acute at apex, base narrowed, margin entire, basal leaves sometimes reduced. *Inflorescence* corymbose, lax, single to several flowered. *Calyx* of 4 or 5 free sepals, each 7–16 mm long, 3–5 mm broad, ovate-lanceolate, acuminate, with conspicuous keel-wing, 2–3 mm broad at semi-cordate base, hyaline, presence of colleters on inside base. *Corolla* pure white; tube 9.0–14.5 mm long, infundibuliform; corolla lobes suborbicular, 5.0–8.5 mm long, 4–5 mm broad, margins entire, apex acuminate. *Stamens* inserted \pm half way up tube, at same level as stigma. *Filaments* 6.0–9.5 mm long; *anthers*, *c.* 1–2 mm long, each with apical and 2 tiny stipitate basal glands. *Ovary* ovoid, *c.* 2–6 \times 2–4 mm, bilocular, placentation axile, ovules numerous. *Style* and *stigma* 4–18 mm long, filiform. *Stigma* slightly clavate, papillose. *Fruit* and *seed* not seen.

Iconography:—Hill (1908: 317, plate G). See also drawing accompanying plate K000195293 (*J.M. Wood 541*) from Royal Botanic Gardens Kew.

Distribution:—This species occurs along a section of the eastern coastal region of South Africa. It is found mainly in the Port Edward district, on the border between the Eastern Cape and southern KwaZulu-Natal, South Africa. The range extends northwards to Port Shepstone (Oribi Flats) and uMzinto districts in KwaZulu-Natal. There are historical records from the greater eThekweni [Durban] area and Zululand, localities that have been transformed by urban development and agriculture. The species has been observed by the second and third authors along the eastern seaboard of the Eastern Cape, known as the Pondoland coast, between Port St Johns and the Umtamvuna River, although no specimens have been collected from this region as yet.

Ecology and habitat:—The species inhabits the Indian Ocean Coastal Belt biome, in particular Pondoland-Ugu Coastal Sourveld (CB4) and KwaZulu-Natal Coastal Belt Sandstone Sourveld (CB3) (Mucina & Rutherford 2006). These vegetation types are characterised by undulating coastal plains, species-rich grasslands, rocky outcrops and forested gullies, at elevations up to 600 m. The area receives mostly summer rainfall with some rain in winter.

Exochaenium natalense and *E. grande* occur sympatrically although the latter has a much wider distribution. The two species also have different ecological preferences—whereas *E. grande* is usually found in well drained grassland, *E. natalense* is always found in seasonally wet to moist grassland (sometimes even in water).

Etymology:—This taxon was named by Schinz (1894), after its geographical origin, previously named Natal and now KwaZulu-Natal, in South Africa.

Conservation status:—This species has a restricted distribution and is endemic to the southwestern region of KwaZulu-Natal. A small part of the region is statutorily conserved and the rest is transformed by agriculture and subsistence farming, infrastructure development and urban sprawl and for these reasons, the area is regarded as being

of conservation concern (Mucina & Rutherford 2006). *Exochaenium natalense* is a habitat specialist and is fairly uncommon within this region of c. 1230 km². Because the extent of occurrence of the species is estimated to be less than 5000 km², based on historical collections and the authors' observations, and because populations seem to be fragmented, and population decline is projected due to habitat loss and degradation, it is suggested that this species should be regarded as Endangered: B1ab(i–iv).

Representative specimens examined:—SOUTH AFRICA. KwaZulu-Natal: Eisdumbeni, 1800 ft., *J.M. Wood 133* (K [K000195293], NH [NH0004093-0]); [Durban] “Bei Port Natal”, 28 Mar. 1832, *J.F. Drège s.n.* (P [P00560847]); [Durban] Fields Hill, 358 m, n.d., *H. Evans 190* (NH); Inanda, [Durban district], [252 m], *J.M. Wood 541* (K [K000195293], NH [NH0002056-0]); Izingolweni district: Kwazamane, 394 m, 21 Mar. 2019, *K.W. Grieve 2841* (PRE); Margate, [114 m], 4 Feb. 1987, *H.B. Nicholson 2561* (PCE[PCE0005454]); Mvoti kloof, Canema estate, 7 Oaks, [2930BA], 20 Jan. 1990, *A. Abbott 4999* (PCE[PCE0005472], NH); Oriibi, [432 m], Apr. 1937, *A. McClean 442* (NH); Paddock district, Oriibi Flats, Whistling Pine Farm, 482 m, 25 Jan. 2017, *K.W. Grieve 2295* (PCE[PCE0014180]); Port Edward, Red Desert Nature Reserve coastal section, 10 m, 8 Dec. 2015, *K.W. Grieve 1886* (NU[NU0088250]); Port Edward, Red Desert Nature Reserve coastal section, 17 m, 23 Feb. 2017, *K.W. Grieve 2322* (PCE[PCE0014181]); Port Edward, Red Desert Nature Reserve coastal section, 24 m, 6 Jan. 2022, *K.W. Grieve 3078* (NH); Port Edward, Izingolweni roadside, [3130AA], 2 Jan. 1965, *O.M. Hilliard 3038* (NU[NU0092021]); Port Edward, Umtamvuna Nature Reserve, [350 m], 14 Apr. 1982, *H.B. Nicholson 2248* (PCE[PCE0005455]); Port Edward, Umtamvuna Nature Reserve, Clearwater, [350 m], 3 Mar. 1983, *A. Abbott 880* (PCE[PCE0005451]); Port Edward, Umtamvuna Nature Reserve, [350 m], 13 Mar. 1984, *A. Abbott 1827* (NH, PCE[PCE0005450]); Port Edward, Umtamvuna Nature Reserve, Office [Beacon Hill], [350 m], 12 Feb. 1986, *A. Abbott 2982a* (NH, PCE[PCE0005449]); Port Edward, Umtamvuna Nature Reserve, [350 m], 31 Mar. 1995, *A. Abbott 6740* (NH); Port Edward, Umtamvuna Nature Reserve, Beacon Hill, [350 m], 2 Mar. 1997, *C.J. Potgieter s.n.* (NU [NU0092023]); Port Edward, Umtamvuna Nature Reserve, western heights, 365 m, 9 Feb. 2017, *K.W. Grieve 2306* (PCE[PCE0014179]); uMzinto district, Vernon Crookes Nature Reserve, 449 m, 7 Feb. 2019, *K.W. Grieve 2801* (PCE[PCE0013839]); Uvongo sandflats, [19 m], 19 Dec. 1965, *R. Strey 6181* (NH); Zululand, Hlabisa district, Lake St Lucia, east shore [2832AB], 5–10 m, 30 Apr. 1974, *R.H. Taylor 175* (NU [NU0092020]); Zululand, Lake Nhlabane, 5 Jan. 1992, *C.J. Ward & A. Rajh 11674* (UDW[UDW13406]); Zululand, “N’goya” [oNgoye, 2831DD], 1000–2000 ft., 18 Mar. 1904, *J.M. Wood 9322* (K [K000195292]).

Key to South African *Exochaenium*

- Flowers white, corolla diameter < 2 cm; anthers and stigma ± at the same level (sometimes stigma slightly above the anthers).....
.....*E. natalense*
- Flowers cream or yellow (rarely white), corolla diameter > 3 cm; distylous.....*E. grande*

Acknowledgments

We thank the BM, BOL, BR, C, DSM, G, GRA, K, MO, MRSC, MPR, NBG, NEU, NH, NU, PRE, S, WAG, Z, and ZT herbaria for allowing access or loans, Ezemvelo KwaZulu-Natal Wildlife (permit OP3779) for allowing collection of plants in KwaZulu-Natal, and Dr Alessia Guggisberg, curator of the ZT Herbarium for rapidly providing high-resolution scans of collections when herbarium visits were restricted due to the COVID-19 pandemic.

References

- Grisebach, A.H.R. (1845) Gentianaceae. In: Candolle, A. de (Ed.) *Prodromus systematis naturalis regni vegetabilis, vol. 9*. Fortin, Masson et Sociorum, Paris, pp. 39–141. [<https://www.biodiversitylibrary.org/item/247794#page/43/mode/1up>]
- Hill, A.W. (1908) Notes on *Sebaea* and *Exochaenium*. *Bulletin of Miscellaneous Information (Royal Gardens, Kew)* 1908: 317–341. [<https://doi.org/10.2307/4111714>]
- Hill, A.W. & Prain, D. (1909) Gentianaceae. In: Thiselton-Dyer, W.T. (Ed.) *Flora Capensis. Vol. IV, Section 1*. Lovell Reeve & Co. LTD, London, pp. 1056–1121. [<https://www.biodiversitylibrary.org/item/15242#page/1070/mode/1up>]
- Kissling, J. (2012) Taxonomy of *Exochaenium* and *Lagenias*: two resurrected genera of tribe Exaceae (Gentianaceae). *Systematic Botany* 37 (1): 238–253. [<https://doi.org/10.1600/036364412X616800>]

- Kissling, J. (2015) *Exochaenium clavatum* subsp. *stella-pallustre* (Gentianaceae—Exaceae), a new subspecies from Zambia. *Phytotaxa* 203 (3): 297–300.
<https://doi.org/10.11646/phytotaxa.203.3.10>
- Kissling, J. & Barrett, S.C.H. (2013) Variation and evolution of herkogamy in *Exochaenium* (Gentianaceae): implication for the evolution of distyly. *Annals of Botany* 112 (1): 95–102.
<https://doi.org/10.1093/aob/mct097>
- Kissling, J., Yuan, Y.-M., Küpfer, P. & Mansion, G. (2009) The polyphyletic genus *Sebaea* (Gentianaceae): A step forward in understanding the morphological and karyological evolution of the Exaceae. *Molecular Phylogenetics and Evolution* 53 (3): 734–748.
<https://doi.org/10.1016/j.ympev.2009.07.025>
- Linnaeus, C. (1753) *Species Plantarum. Vol. 1.* Holmiae, Impensis Laurentii Salvii, pp. 135, 142, 271.
<https://doi.org/10.5962/bhl.title.669>
- Marais, W. & Verdoorn, I.C. (1963) Gentianaceae. In: Dyer, R.A., Codd, L.E. & Rycroft, H.B. (Eds.) *Flora of Southern Africa. Vol. 26.* Government Printer, Pretoria, pp. 172–211.
- Meyer, E.H.F. (1837) *Commentariorum de plantis Africae Australioris. Vol. 1, fascic. 2.* Leopold Voss, Leipzig, 326 pp.
<https://doi.org/10.5962/bhl.title.50>
- Mucina, L. & Rutherford, M.L. (2006) *The vegetation of South Africa, Lesotho and Swaziland. Strelitzia 19.* South African National Biodiversity Institute, Pretoria, pp. 1–816.
- Schinz, H. (1894) Beitrage zur Kenntnis der Afrikanischen Flora. *Bulletin de l'Herbier Boissier* 2: 180–228. [<https://www.biodiversitylibrary.org/item/105264#page/200/mode/1up>]
- Schinz, H. (1896) Gentianaceae. *Bulletin de l'Herbier Boissier* 4: 442–444. [<https://www.biodiversitylibrary.org/item/104951#page/476/mode/1up>]
- Schinz, H. (1906) Gentianaceae. *Bulletin de l'Herbier Boissier, Sér. 2, 6:* 714–746. [<https://www.biodiversitylibrary.org/item/105785#page/794/mode/1up>]
- Theirs, B. (2022 [continuously updated]) *Index Herbariorum: A global Directory of Public Herbaria and Associated Staff.* New York Botanical Garden's Virtual Herbarium. Available from: <http://sweetgum.nybg.org/science/ih/> (Accessed 15 August 2022).
- Turland, N.J., Wiersma, J.H., Barrie, F.R., Greuter, W., Hawksworth, D.L., Herendeen, P.S., Knapp, S., Kusber, W.-H., Li, D.-Z., Marhold, K., May, T.W., McNeill, J., Monro, A.M., Prado, J., Price, M.J. & Smith, G.F. (Eds.) (2018) *International Code of Nomenclature for algae, fungi, and plants (Shenzhen Code) adopted by the Nineteenth International Botanical Congress Shenzhen, China, July 2017. Regnum Vegetabile 159.* Koeltz Botanical Books, Glashütten.
<https://doi.org/10.12705/Code.2018>
- Wolfe, L.M., Massinga, P.H. & Johnson, S.D. (2009) A quantitative evaluation of the distylous syndrome in *Sebaea grandis* (Gentianaceae). *South African Journal of Botany* 75 (4): 785–790.
<https://doi.org/10.1016/j.sajb.2009.07.014>