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## *Zingela* (Asparagaceae, Scilloideae), a distinct new urgineoid genus from KwaZulu-Natal, South Africa

NEIL R. CROUCH<sup>1,2\*</sup>, MARIO MARTÍNEZ-AZORÍN<sup>3\*</sup>, MANUEL B. CRESPO<sup>3</sup>, MICHAEL PINTER<sup>4</sup> & MARÍA Á. ALONSO-VARGAS<sup>3</sup>

<sup>1</sup>Biodiversity Research, Assessment & Monitoring, South African National Biodiversity Institute, P.O. Box 52099, Berea Road 4007, South Africa; e-mail: [n.crouch@sanbi.org.za](mailto:n.crouch@sanbi.org.za)

<sup>2</sup>School of Chemistry and Physics, University of KwaZulu-Natal, Durban 4041, South Africa

<sup>3</sup>dCARN (Depto. Ciencias Ambientales y Recursos Naturales) and CIBIO (Instituto Universitario de la Biodiversidad), Universidad de Alicante, P.O. Box 99, E-03080 Alicante, Spain; e-mail: [mmartinez@ua.es](mailto:mmartinez@ua.es)

<sup>4</sup>Institute of Biology, Division Plant Sciences, NAWI Graz, Karl-Franzens-University Graz, Holteigasse 6, A-8010, Graz, Austria

\*authors for correspondence

### Abstract

In the course of resolving the identity of plants usually named ‘*Drimia indica*’ from KwaZulu-Natal Province, South Africa, molecular and morphological data revealed the identity of more than one taxon carrying this name. Our studies support the establishment of a new urgineoid genus, *Zingela* gen. nov., to accommodate a species (*Z. pooleyorum*) collected and illustrated some 50 years ago, but never validly published. We here provide data on its morphology, ecology, and distribution.

**Keywords:** *Drimia*, Hyacinthaceae, taxonomy, Urgineoideae, *Zingela*

### Introduction

Hyacinthaceae *sensu* APG (2003) includes ca. 700–1000 species of bulbous plants mostly occurring in Africa, Europe, and Asia, with a single genus, *Oziroë* Rafinesque (1837: 53), in South America (Speta 1998a, b, APG 2003, Martínez-Azorín *et al.* 2011). Four subfamilies are accepted in Hyacinthaceae (Hyacinthoideae, Ornithogaloideae, Oziroëoideae and Urgineoideae), corresponding to monophyletic clades (Speta 1998b, Pfosser & Speta 1999, Manning *et al.* 2004, Martínez-Azorín *et al.* 2011). Alternatively, Hyacinthaceae is treated as Asparagaceae subfamily Scilloideae, and consequently the former subfamilies are reduced respectively to the tribes Hyacintheae, Ornithogaleae, Oziroëeae, and Urgineae (APG 2016, Chase *et al.* 2009).

Generic circumscriptions within Urgineoideae have been especially controversial in recent decades. This subfamily occurs in Africa, Europe, and western Asia, reaching Indochina in the east. Although some studies accept only ca. 100 species in Urgineoideae (Manning *et al.* 2004), we consider the true number to be considerably greater, given the imperfect knowledge of urgineoids across their wide distribution range, and the lack of detailed comprehensive taxonomic revisions. The paucity of good revisions has precluded improved generic circumscriptions and so widely differing taxonomies have been proposed. On the one hand, Manning *et al.* (2004) presented, based on disputable phylogenetic data, a very broad-concept treatment, where only two genera were recognised for the whole subfamily: *Bowiea* Harvey ex Hooker (1867: t. 5619) with two species (Reid *et al.* 1990), and *Drimia* Jacquin (1797: 38) with about 100 species involved. This study expanded the concept of *Drimia* to accommodate enormous variation in floral and vegetative morphologies, and resulted in the synonymisation of several traditionally accepted genera which are easily identified by distinct morphological syndromes. The synonymised genera include *Litanthus* Harvey (1844: 314), *Rhadamanthus* Salisbury (1866: 37), *Rhodocodon* Baker (1880: 280), *Schizobasis* Baker (1873: 105), *Tenicroa* Rafinesque (1837: 52), *Thuranthos* Wright (1916: 233), and *Urginea* Steinheil (1834: 321). On the other hand, Speta (1998a, 1998b, 2001) and Pfosser & Speta (2001) favoured a more analytical approach, in which about 20 different genera (excluding *Igidia* Speta (1998b: 70) of subfamily Ornithogaloideae, see Wetschnig *et al.* 2007), were accepted. However, some of these genera were found to be para- or polyphyletic (Pfosser & Speta 2001, 2004, Manning *et al.* 2004, Pfosser *et al.* 2012).

Generic delimitations in Urgineoideae supported by morphological synapomorphies and molecular data are becoming increasingly well-defined. Our phylogenetic studies in the subfamily (M. Martínez-Azorín and collaborators, in preparation) include three plastidial regions (*trnL-trnF*, *matK* and *ycf*) and a nuclear one (*Agt1*) and more than 250 samples covering almost the entire subfamily distribution range. Our findings strongly support a multi-generic treatment in Urgineoideae, with taxa arranged in several well-supported clades that correspond to distinct traditionally accepted genera, and/or clades which show unique syndromes of morphological characters and biogeography. This molecular work has motivated the circumscription of some recently described genera such as *Mucinaea* M.Pinter, Mart.-Azorín, U.Müll.-Doblies, D.Müll.-Doblies, Pfosser & Wetschnig in Pinter *et al.* (2013: 296), *Sagittanthera* Mart.-Azorín, M.B.Crespo, A.P.Dold & van Jaarsv. in Martínez-Azorín *et al.* (2013b: 46), *Aulostemon* Martínez-Azorín *et al.* (2017: 288) and *Austronea* Mart.-Azorín, M.B.Crespo, M.Pinter & Wetschnig in Martínez-Azorín *et al.* (2018: 105) besides *Iosanthus* Martínez-Azorín *et al.* (2018: in press). This taxonomic treatment for Urgineoideae parallels that presented for the sister subfamily Ornithogaloideae (Martínez-Azorín *et al.* 2011), in which consistent morphological elements recognised at generic rank are fully congruent with clades based on plastidial and nuclear DNA regions.

The taxonomic subject of this paper was first observed and collected approximately 50 years ago by Elsa Pooley in the Ndumo Game Reserve (GR) in Maputaland, northern KwaZulu-Natal (*Pooley 661*, NU). Elsa Pooley also illustrated this taxon at the time of collection (Fig. 1). We were able to collect this same species in Ndumo GR as well as to the south along the mid-reaches of the Thukela River (Fig. 1). Our studies revealed that these plants show a unique syndrome of morphological characters within the Urgineoideae.

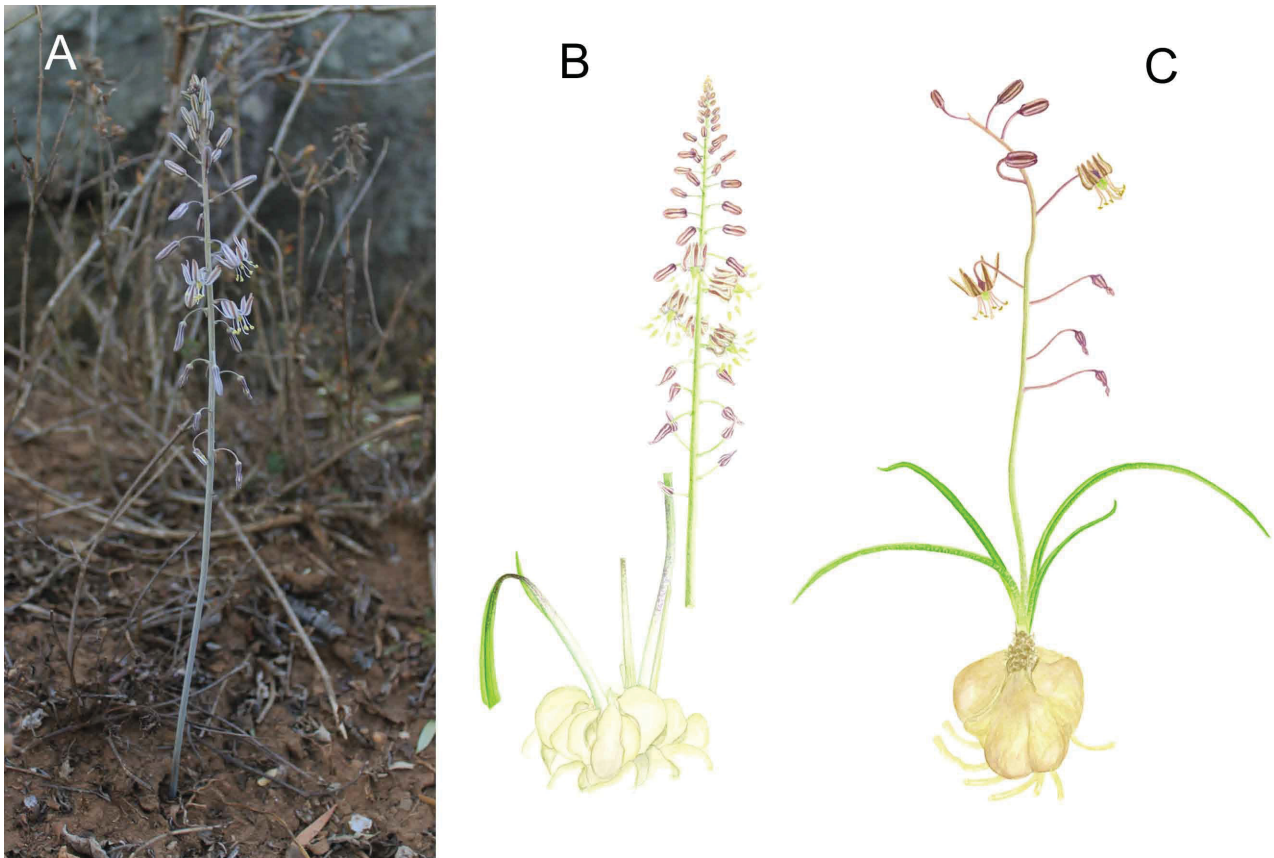
To obtain a name Pooley sent her voucher (*Pooley 661*, NU) to O. Hilliard at NU for identification, through which repository it was forwarded to A.A. Mauve (Obermeyer) at the National Herbarium of South Africa (PRE). Simultaneously, a specimen of a further urGINEOID was gathered in Ndumo GR (*Pooley 127*, NU), which the collector recognised as different in several respects, most notably in leaf and bulb form, in the number, size and orientation of flowers, in floral scent and opening times, and in habitat preference (Pooley 1978). This taxon was also illustrated by E. Pooley (Fig. 1). Recent observations of this species in Ndumo GR and in cultivation have revealed several significant features that distinguish it from *Pooley 661* (NU). The bulb is compact; leaves synanthous, narrowly canaliculated, with dark green maculations below that merge to form distinct transverse bands along the entire length, especially at the base; lax raceme with up to 13 flowers, pedicels 20–30 mm long; bracts minute and inconspicuous at anthesis; bracteoles absent; flowers brown, nodding, nocturnal, strongly scented; stamens curved; filaments free, incurved along the lower half, almost connivent to style in middle section and spreading distally, thickened, terete in cross-section, proximally attenuated to only 0.3 mm wide; anthers not circinnate; ovary ovate with narrowly clavate, deflexed style and subcapitate stigma; and capsule ovate with conspicuous chestnut markings.

Our study revealed that the collections *Pooley 127* and *Pooley 661* held at NU not only belong to two different species, but to two different genera within the Urgineoideae, based on clear morphological differences and conspicuous genetic divergence. Preliminary molecular analyses reveal that plants with hysteranthous, keeled leaves, multiflowered racemes, diurnal flowers and spreading stamens with circinnate anthers (corresponding to *Pooley 661*, NU) are placed in an isolated position within our Urgineoideae phylogeny. These represent a distinct genus, here named *Zingela*. Four samples of *Zingela* from the KwaZulu-Natal Province form a well-supported clade in our phylogeny which is sister to *Thuranthos s.str.*, represented in South Africa by *T. macranthum* Wright (1916: 223), *T. nocturnale* Dyer (1964: t. 1439), and *T. basuticum* (Phillips 1917: 306) Obermeyer (1980: 139) which also forms a strongly supported clade. However, the clade comprising both *Zingela* and *Thuranthos* show weak bootstrap support, hindering inclusion of *Zingela* in *Thuranthos*. Further, *Thuranthos* differs morphologically from *Zingela* in having the filaments of the stamens distinctly broad in the lower half and constricted at their middle to form a cage-like structure connivent to the style; nocturnal flowers with a distinct musty scent; flower bracts early caducous, and leaves that are immaculate. On the other hand, *Pooley 127* (NU) resolved in a well-supported clade together with *Vera-duthiea* Speta (2016: 154) sampled from central Africa, a finding supported by floral morphology comparison. This latter collection will be published soon as *V. zebrina* Mart.-Azorín *et al.* (in prep.) (Fig. 1C).

Nonetheless, the affinities of these two taxa originally collected by Pooley in Ndumo GR were related by Obermeyer in 1970 to *Urginea indica* (Roxburgh 1832: 147) Kunth (1843: 333). However, as reflected in her correspondence and also sheet annotations, Obermeyer initially considered both taxa to be new, with *Pooley 661* (NU) only a floriferous variety of *Pooley 127* (NU). She accordingly proposed the names *in schedae* “*Urginea zebrina* Oberm. n. sp. ms.” for *Pooley 127* (NU) and “*Urginea zebrina* Oberm. n. sp. var. *multiflora* Oberm. var. nov. ms.” for *Pooley 661* (NU). Shortly thereafter, and seemingly based on the opinion of the South African Botanical Liaison Officer (SABLO) at Kew (then D. Killick), Obermeyer accepted both taxa to be conspecific with the ‘variable’ *U. indica*, a view reflected thereafter in Hyacinthaceae treatments for the FSA region (e.g., Jessop 1977 who treated *Drimia indica* (Roxburgh

1832: 147) Jessop 1977: 272). Based on new evidence, and given that neither of the *in schedula* names have been validly published, we here recognise *Pooley 661* (NU) at a different rank and describe *Zingela pooleyorum*, which also represents and typifies a new urgineoid genus.

Notably, our phylogenetic studies include several samples of *Drimia indica* from India and Thailand and these form a well-supported monophyletic clade which corresponds to *Indurgia* Speta (2001: 169), a genus putatively endemic to southwestern Asia. Further, the *Indurgia* clade is far placed from the *Zingela*, *Thuranthos* and *Vera-duthiea* clades. Although some species of *Indurgia* are superficially similar, in vegetative or sexual form, to species of *Zingela* and *Vera-duthiea*—probably due to convergence events and at times nocturnal flowering patterns—the Asian taxa are morphologically distinct from both of the South African taxa collected by Pooley. We, therefore, exclude *Drimia indica* from the South African plant species catalogue.



**FIGURE 1.** **A.** *Zingela pooleyorum* N.R.Crouch, Mart.-Azorín, M.B.Crespo, M.Pinter & M.A.Alonso plant in flower at Zingela, E of Colenso, KwaZulu Natal Province, South Africa, on 11 October 2015; **B** *Zingela pooleyorum*; **C.** *Vera-duthiea*, both from Ndumo Game Reserve, KwaZulu-Natal Province, South Africa, corresponding to *Pooley 661* (NU) and *Pooley 127* (NU) respectively.

## Materials and methods

Detailed morphological studies of *Zingela pooleyorum* and related taxa from South Africa were undertaken on natural populations as elaborated upon in Martínez-Azorín *et al.* (2007, 2009). Herbarium specimens from the following herbaria were studied: ABH, BOL, GRA, NBG, NH, NU, and PRE (acronyms according to Thiers 2018). Nomenclatural issues accord with the Shenzhen Code (Turland *et al.* 2018).

## Description of the new genus

*Zingela* N.R.Crouch, Mart.-Azorín, M.B.Crespo, M.Pinter & M.A.Alonso *gen. nov.* (Fig. 2)

The new genus differs from *Thuranthos* in its staminal filaments which spread rather than constrict at the middle to form a cage-like structure connivent to the style, and are essentially filiform rather than distinctly broad in the lower half. Although both genera are hysteroanthous the flowers of *Zingela* are diurnal rather than nocturnal as with *Thuranthos*, and lack the distinct musty scent characteristic of the latter. The flower bracts of *Zingela* persist at flowering whereas those of *Thuranthos* are early caducous. The leaf bases of *Zingela* additionally exhibit obvious purple maculations, a feature not documented for *Thuranthos*.

**Type:**—*Zingela pooleyorum* N.R.Crouch, Mart.-Azorín, M.B.Crespo, M.Pinter & M.A.Alonso (holotype).

**Etymology:**—*Zingela*: after the location in central KwaZulu-Natal where the authors first encountered plants of this genus in flower.

*Zingela pooleyorum* N.R.Crouch, Mart.-Azorín, M.B.Crespo, M.Pinter & M.A.Alonso *sp. nov.* (Figs. 1A–B, 2, 3).

= *Urginea indica* (Roxb.) Kunth var. *multiflora* Oberm. *nom. nud.* (Art. 38 Ex. 1)

= *Urginea zebrina* Oberm. var. *multiflora* Oberm. *nom. nud. in sched.*

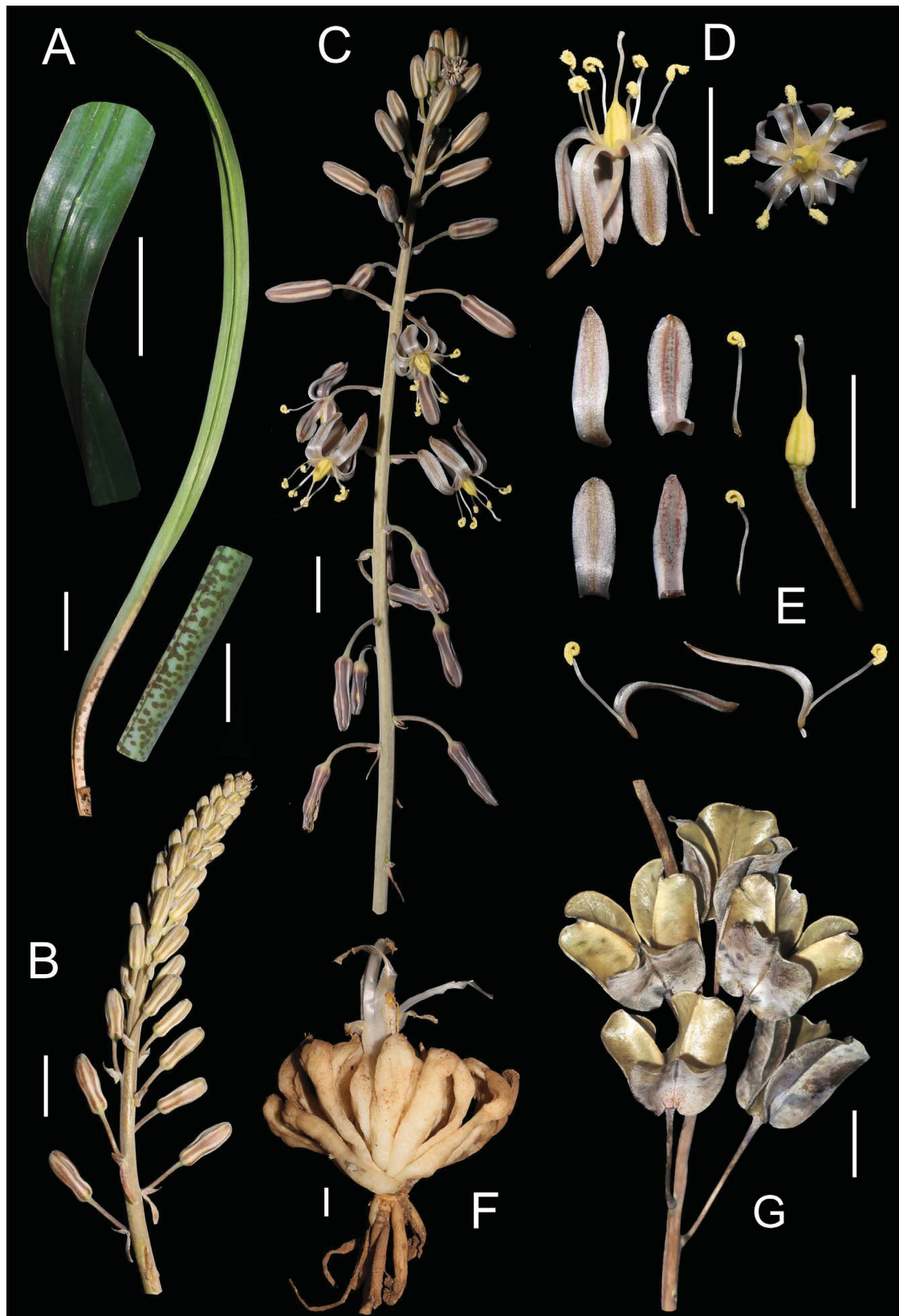
The new species shows a unique syndrome of characters, comprising loose-scaled bulbs; glaucous, hysteroanthous, keeled leaves, bearing purple maculations at the base; long multiflowered racemose inflorescence with persistent bracts and distinct bracteoles; subpatent to nodding, faintly scented diurnal flowers, with almost free, white, reflexed tepals; spreading stamens with filiform filaments and circinnate anthers post pollen release; ovary ovoid to subconical, style filiform, erect to slightly sinuous; and wide, shortly oblong capsules, differing from any other known Urgineoideae.

**Type:**—SOUTH AFRICA. KwaZulu-Natal, Bela Vista (2632CD): On Pongola floodplain edge, Ndumo [Ndumo] Hill, Ndumo [Ndumo] Game Reserve, 15 October 1969, *E.S. Pooley 661* (holotype, NU!).

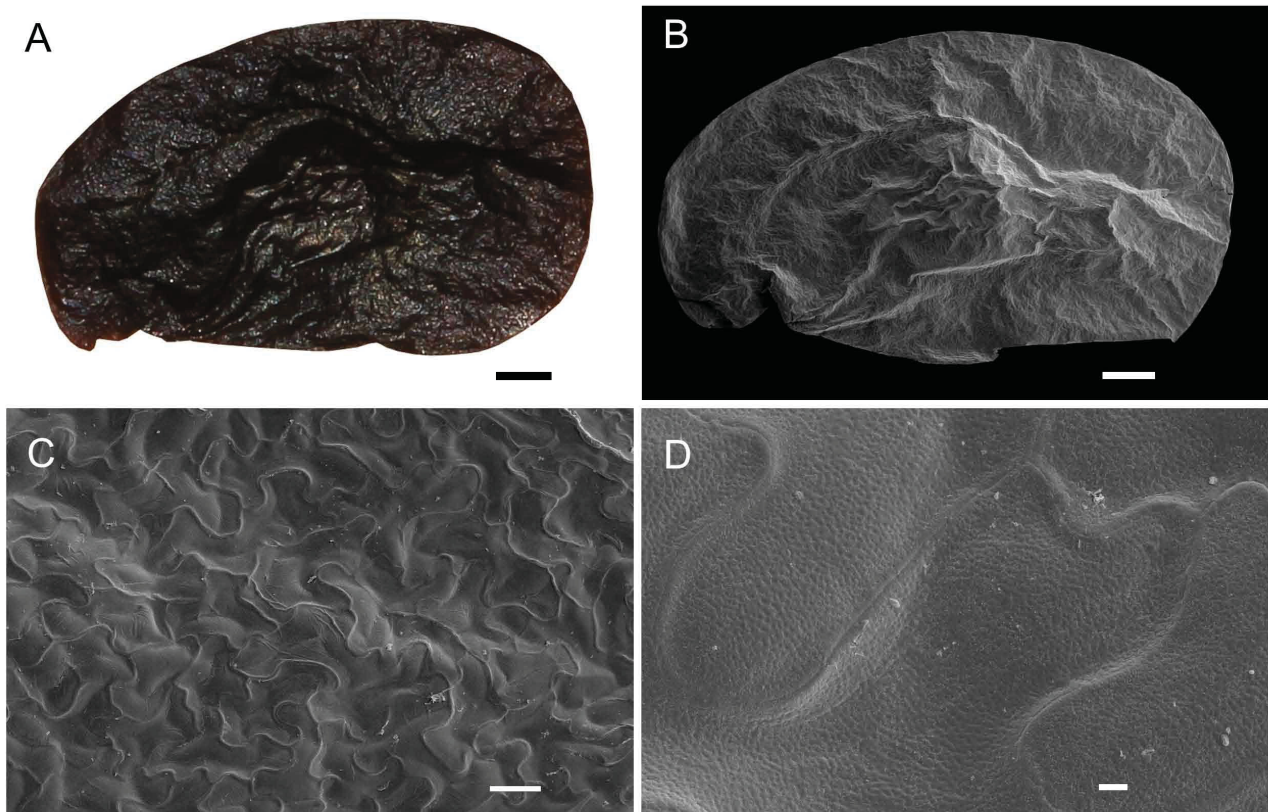
Herbaceous, perennial, bulbous plant. Bulb hypogean, 5–8 × 6–9 cm, composed of 10–25 thickened, fleshy, white, elongated loose scales, with copious threads when torn, ca. 6 × 1 cm; roots pale brown, thickened, contractile, 2–5 mm in diameter. Leaves 1–2, mostly hysteroanthous, glaucous green, long narrowly oblong with pointed apex, 10–35 × 0.5–1 cm, with 2 grooves adaxially, strongly keeled abaxially in a V shape, with the keel more prominent along the central part, commonly twisting from the base, sometimes distally, convolute at base with distinct purple maculations abaxially. Inflorescence long racemose, the peduncle 30–60 cm long, greenish-brown, mottled covered a white bloom, the raceme long and lax, 15–30 cm long, with 25–55 flowers, subpatent to nodding; pedicels of flowers 10–12 mm long, patent and arching down, purple-brown, with whitish bloom, elongating up to 2 cm long and arching up in fruit. Bracts lanceolate, acute, 2–4 mm long, cream with a brown central band, the lowermost with a long basal spur up to 6–8 mm long which is flattened and appressed to the stem, those from the middle and upper parts of the inflorescence showing very short or inconspicuous spurs, persistent at anthesis; bracteoles present and distinct, white. Flowers pentacyclic, trimerous, stellate, subpatent to nodding, opening in the afternoon and closing about sunset. Tepals 6, biseriate, almost free from the base, reflexed, outer tepals lanceolate, 10–11 × 2.5–2.8 mm, with obtuse apex, inner tepals oblong-lanceolate, 9–10 × 2.8–3 mm, with acute apex; tepals white with a broad purplish-brown median stripe, being more evident abaxially. Stamens 6, spreading; filaments free, filiform, ca. 6 × 0.3 mm, only slightly flattened and triangular at the very base in connection to the ovary; anthers narrowly oblong, pale yellow, ca. 4 × 0.8 mm before dehiscence, ca. 3 mm long and distinctly circinnate after pollen release, dehiscing longitudinally along the whole length, not connivent to the style. Ovary ovoid to subconical, yellowish, shallowly 3-angled, 3.8–4 mm long, 2.1 mm wide at the base and tapering to the style. Style filiform, white, erect to slightly sinuous, 5–5.7 × 0.4–0.5 mm, curved outwards in the distal part. Stigma small and indistinctly trigonous. Capsule pale brown, trilobulate, loculicide, shortly oblong, ca. 16 × 13 mm, valves splitting to the base. Seeds flattened, subelliptic, with prominent central embryo and broad wings, 10–11 × 5–7 mm, black, with puzzle-like cells delimited by narrow raised ridges (Figs. 1A–B, 2, 3).

**Variation:**—Plants from the Maputaland subpopulation present substantially broader median tepal stripes both above and below. In Ndumo GR, plants of *Z. pooleyorum* are generally larger, more erect, with longer leaves and inflorescences, and with anthers less strongly circinnate.





**FIGURE 2.** *Zingela pooleyorum* N.R.Crouch, Mart.-Azorín, M.B.Crespo, M.Pinter & M.A.Alonso from Zingela, east of Colenso, KwaZulu-Natal Province, South Africa, on 11 October 2015, corresponding to *MMA1382* (ABH74185). **A.** Leaves; **B.** Inflorescence in bud; **C.** Inflorescence at anthesis; **D.** Flowers, lateral and frontal views; **E.** Dissected flower; **F.** Bulb; **G.** Infructescence. Scale bars: 1 cm.



**FIGURE 3. A–D.** Seed morphology of *Zingela pooleyorum* N.R.Crouch, Mart.-Azorín, M.B.Crespo, M.Pinter & M.A.Alonso from Crouch 1291 (ABH78366). Scale bars: A–B: 1 mm; C: 100 µm; D: 10 µm.

**Biology:**—Flowering occurs in late spring and early summer, October through November in southern Africa, with the inflorescences fully developed even prior to the first seasonal rains. Both individuals in flower lacking leaves and in vegetative stage were simultaneously observed in the northernmost populations. The developing scapes are capable of penetrating remarkably compact dry soil, emerging from bulbs positioned up to 20 cm below the surface. The flowers open from 13h30 until 18h00, and are only faintly scented. Pollinators are not yet confirmed although *Apis mellifera* has been observed as a flower visitor.

**Habitat:**—At Ndumo Game Reserve plants grow in the partial shade of thicket at an elevation of approximately 50 m, on both clay and sandy soils in both Western Maputaland Sandy Bushveld (SV1 19) and Western Maputaland Clay Bushveld (SV1 20) within the Savanna Biome (Rutherford *et al.* 2006). The *Zingela* subpopulation on the central Thukela River to the south occupies more stony terrain at elevations of 700–840 m, also within the Savanna Biome (Rutherford *et al.* 2006), but in Thukela Valley Bushveld (SVs 1). Pooley (1978) records that both leaves and flowering heads are eaten by duiker (antelope belonging to several genera of the family Bovidae, subfamily Cephalopinae).

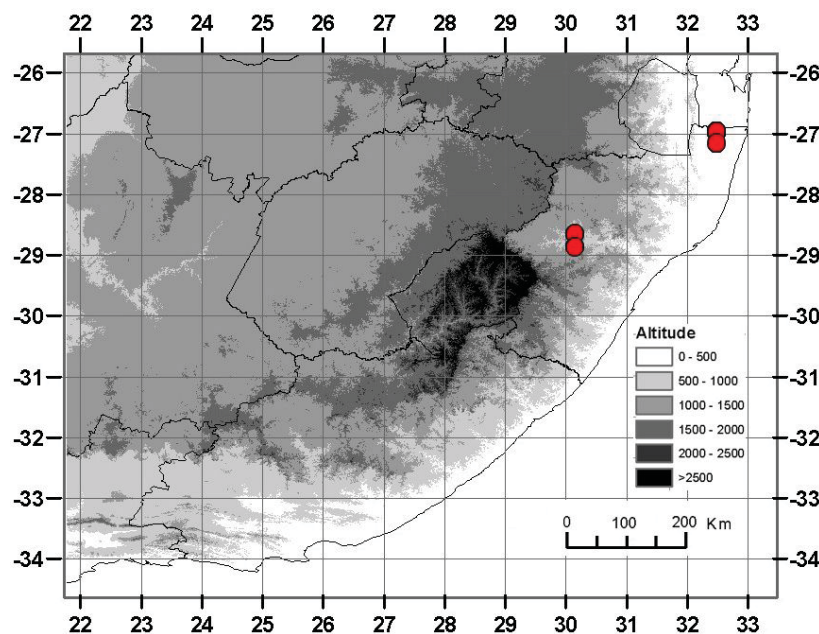
**Distribution:**—Known so far only from two macrolocalities, some 300 km distant, both within the KwaZulu-Natal Province, South Africa (Fig. 4). The likelihood of *Z. pooleyorum* occurring in southern Mozambique is very high given that the northern boundary of Ndumo GR forms part of the international border between these two countries. In correspondence (Ref 12/1/1/1, PRE) between A. Mauve and E. Pooley dated 3 April 1981, Mauve indicated that bulbs of *Zingela* had been found along the Sabie River near Skukuza in Kruger National Park, Mpumalanga. This locality requires confirmation.

**Taxonomic relationships:**—The alliance of *Zingela* is undoubtedly with *Thuranthos* which also has bulbs composed of loose, cucullate, pedicellate scales, and leaves which are prominently keeled. It is possible that *Thuranthos macranthus* Wright (1916: 223) is sympatric in the south of its range, although this has not been documented yet. The relationship to taxa in the *Drimia indica* complex (as *Urginea indica*) has been noted by A.A. Obermeyer in correspondence, when she considered attributing plants from Ndumo represented by Pooley 661 (NU) to the taxon “*Urginea zebrina* Oberm. var. *multiflora* Oberm.”, through a name she annotated on that particular specimen. Her concept for ‘*U. zebrina*’ was never validly published, although the varietal epithet (as *Urginea indica* (Roxb.) Kunth var. *multiflora* Oberm.) was used in the checklist for the Ndumo Game Reserve (Pooley 1978), this being a nomen

nudum (Art. 38 Ex. 1). Plants corresponding to the type of *Drimia indica* are not with certainty known from the African continent. Rather, our preliminary molecular findings reveal that the southern African material attributed to *D. indica* must be placed in *Vera-duthiea*.

**Eponymy:**—The name “pooleyorum” commemorates the award-winning conservationists Elsa Pooley (1947–) and Tony Pooley (1938–2004), whose manifold interest in the biota of Ndumo Game Reserve is reflected in Elsa’s discovery of this species.

**Additional material studied (paratypes):**—SOUTH AFRICA. KwaZulu-Natal: Dundee (2830): ca. 24 km east of Colenso, on way to Zingela, ca. 2 km from main house (-CA), elev. 749 m, 11 October 2015 (in flower), *M. Martínez-Azorín, M. Pinter, M.B. Crespo, N. Crouch & M.A. Alonso MMA1382* (ABH74185!, GRA); Dundee (2830): ca. 24 km east of Colenso, on way to Zingela, ca. 4 km from main house (-CA), elev. 771 m, 12 October 2015 (in flower), *M. Martínez-Azorín, M. Pinter, M.B. Crespo, N. Crouch & M.A. Alonso MMA1387* (ABH74190!, GRA); Immediately S of Ndumo Game Reserve, 0.8 Km west of main gate to reserve (-CD), elev. 58 m, 16 November 2016, *N. Crouch 1291* (ABH78366!).



**FIGURE 4.** Known distribution of *Zingela pooleyorum* N.R.Crouch, Mart.-Azorín, M.B.Crespo, M.Pinter & M.A.Alonso in eastern South Africa.

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