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Short communication

# Back from the brink: *Gladiolus halophila* (Iridaceae: Crocoideae), a remarkable new species from southern Namibia escapes imminent extinction

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**Abstract**

The new species *Gladiolus halophila* Goldblatt & J.C.Manning from near Keetmanshoop in southern Namibia is described and illustrated. It is closely allied to *G. longicollis* and *G. tristis* from southwestern and eastern South Africa but is distinguished by its lilac flowers with shorter perianth tube, 35–40 mm long. The flowers last just one day and are self-compatible. The species, which is restricted to saline seepages, is known from just two populations, one of which is due to be inundated by a planned dam, and it is therefore classified as Endangered. The action of the Namibian Government in commissioning a search for additional localities serves as a valuable example in similar instances.


*Keywords:* *Gladiolus*; Conservation; Iridaceae; Namibia; New species; Taxonomy

## 1. Introduction

With over 260 accepted species, *Gladiolus* L. is the second largest genus of Iridaceae after *Iris* L. itself (Goldblatt and Manning, 2008). Largely sub-Saharan in its distribution, the genus is centred in southern Africa, where some 170 species are recorded. Species of *Gladiolus* are strikingly diverse in floral and vegetative morphology but are all characterized by leathery, somewhat inflated capsules containing globose, circumferentially winged seeds (the wings rarely secondarily reduced), and by the apically expanded style branches (Goldblatt and Manning, 1998, 2008). The sub-Saharan African species have been the subject of recent monographic studies (Goldblatt, 1989, 1996; Goldblatt and Manning, 1998) and are now taxonomically well understood. New species continue to be described, however, mostly from southern Africa, where an additional five species have been named within the last decade (Manning et al., 1999; Manning and Goldblatt, 2009). The current classification of the southern African species recognizes seven sections, defined largely by vegetative features, and numerous series, distinguished by various combinations of vegetative and floral characters (Goldblatt and Manning, 1998).

*Gladiolus* has two centres of diversity in southern Africa: the central winter rainfall region, and the high Drakensberg Escarpment in the eastern summer rainfall part of the subcontinent. Species diversity drops off markedly towards the centre of the subcontinent, with just two species recorded from the drier central plateau. Six species have been recorded from Namibia but only two are known from the southern portion of the country, both of them widely distributed taxa. The more common of these two species, *Gladiolus saccatus* (Klatt) Goldblatt & M.P.de Vos, is widely dispersed along the western escarpment as far north as Grootfontein in northern Namibia, whereas *G. orchidiflorus* Andrews, although widespread through the winter rainfall region and western central South Africa, just extends into extreme

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southern Namibia. Both species are members of sect. *Hebea* (Persoon) Benth. & Hook., which is most diverse in the winter rainfall region but also includes several summer rainfall species.

The recent discovery of an unnamed species of the largely winter rainfall sect. *Homoglossum* (Salisb.) Goldblatt & J.C. Manning near Keetmanshoop in southern Namibia is thus unprecedented and totally unexpected. The plant was originally found in flower by Warren McClelland during a scoping study for the proposed new Neckartal Dam and irrigation scheme. This new species, described here as *G. halophila*, is not only of considerable biogeographic significance but exhibits several unique ecological adaptations in the genus. The species, which occupies a highly localized habitat, is currently known from just two populations, one of which lies within the catchment of a dam that is planned for the middle reaches of the Fish River in south-central Namibia. The second population is situated just above the full supply level of the dam, providing some hope that the species will escape imminent extinction.

The action of the Nambian Government on learning of the discovery of this species provides a useful protocol to be adopted in similar situations in the future and is presented here as an example.

## 2. Taxonomy

### 2.1. *Gladiolus halophila* Goldblatt & J.C.Manning, sp. nov.

Haec species quoad laminam foliarem in transectione cruciatam et capsulas oblongo-ellipsoideas *Gladiolos longicolli* Baker et *G. tristi* L. similis, sed ab eis floribus die uno durantibus, perianthio pallide malvino-opalescenti, bractea externa 22–25 mm longa, tubo perianthii 35–40 mm longo et filamentis ±14 mm longis distinguitur.

Type: Southern Namibia, 2617 (Bystick): Keetmanshoop, tributary valley of Fish River S of Snyfontein, in salty seepage at base of cliffs in dry river course, (–DB), 10 August 2010, *C. Mannheimer 4383* (WIND, holo.; EBH, K, MO, MSB, NBG, PRE, iso.).

Deciduous geophyte, (150–)300–600(–1000) mm high. *Corm* 15–20 mm diam., tunics of firm papery layers, splitting into coarse vertical fibres from base. *Cataphylls* reaching shortly above ground, pale and membranous below but green above ground. *Leaves* three, lower two basal and imbricate, lowermost longest and sheathing stem at base with free blade usually reaching at least to base of spike, blade centric, 1.0–2.5(–3) mm diam., cruciform in section with midrib raised at right angles to blade, lamina surface usually ±0.5 mm wide and exposed, second leaf largely or entirely sheathing and with short blade, entirely sheathing lower± two thirds of stem, sheath with hyaline longitudinal suture running entire length, uppermost leaf distant from second leaf, short and bract-like, entirely sheathing with margins free to base and imbricate or connate below. *Stem* stiffly erect or flexed slightly outwards above second leaf, usually unbranched but very rarely with small branch in axil of uppermost leaf, 0.5–1.0 mm diam. below spike. *Spike* suberect, ±straight, 1–5(–7)-flowered; bracts pale green or flushed greyish, outer 22–25 mm long, inner slightly shorter to slightly longer than outer, minutely notched apically. *Flowers* pale mauve or opalescent with darker mauve feathering along midline, especially on upper lateral tepals and mauve speckled on reverse, lower tepals white in basal half and in throat with yellowish green midline and spotted with purple, tube pale creamy yellow, sutures between tepals transparent for 10 mm, most conspicuously so between upper laterals and dorsal, weakly scented during day but strongly scented of carnations and cloves from early evening; *perianth tube* 35–40 mm long, narrowly and obliquely funnel-shaped, narrowly cylindrical portion 25–30 mm long, minutely puberulous in lower throat; *tepals* broadly lanceolate–attenuate, unequal, dorsal largest, weakly hooded and ±horizontal over stamens, 25–30 × 10–12 mm, upper laterals suberect below and arching or spreading in distal two thirds, 25–30 × 8–10 mm, lower laterals united with upper laterals for 2–4 mm and to one another for additional 2 mm, straight and directed forwards below but recurved or deflexed in distal two thirds, 23–25 × 6–8 mm. *Filaments* ±14 mm long, included in upper part of tube or barely exserted for up to 1 mm; *anthers* ±13 mm long, apiculate, just exserted, lilac with dark purple thecae and pale yellow pollen. *Ovary* cylindrical, ±8 mm long; style arching over stamens, minutely puberulous below, dividing just below to just beyond anther apices, branches 3–4 mm long, apices reaching beyond anthers. *Capsules* oblong–ellipsoid, 35–40 × 6–7 mm, much longer than outer bracts. *Seeds* elliptic to oblong, 5.5–7.5 × 3.5–4.5 mm, broadly and unequally winged, wings transparent orange-brown, broader at chalazal and micropylar ends, seed body darker brown. *Flowering time*: August (Fig. 1).

#### 2.1.1. Ecology

*G. halophila* is currently known only from the Karas Region, west of Keetmanshoop in southern Namibia, where it appears to be restricted to tributary valleys on the eastern side of the Fish River Canyon south of Snyfontein (Fig. 2). Just two populations have been located despite intensive searches of the area in 2010. The regional vegetation is Dwarf Shrub Savanna (Giess, 1998). Temperatures vary between 6 °C minimum and 36 °C maximum, with average annual temperature around 20–22 °C. Rainfall is unpredictable, both spatially and temporally, with an annual average of 150–200 mm (Mendelsohn et al., 2002).

The species occupies a highly specialized habitat, restricted to more or less perennial seepages and drainage lines in defiles or near the head of gorges leading into the Fish River. These seepages emerge from the fractures in the red sandstones and shales of the Fish River. *G. halophila* grows in dense colonies among tussocks of *Scirpoides dioecus* (Kunth) J.Browning and *Cyperus marginatus* Thunb. (Cyperaceae). The ground water is rich in dissolved salts, which form crusts on the surface as it evaporates, the plants often growing through the salt crusts, between the sedge tussocks or along the edges, in fine-grained clays. Very few other vascular plants are associated with this unusual habitat, although lush colonies of algae thrive in the moisture. Associated flowering plants include the halophyte *Limonium dregeanum* (C.Presl) Kuntze (Plumbaginaceae), *Sebaea pentandra* E.Mey. (Gentianaceae) and the succulent daisy, *Mesogramma apiifolium* DC. (Asteraceae).

Apart from this unique habitat for the genus, the phenology of *G. halophila* is similarly unique for *Gladiolus*. Anthesis occurs shortly after sunset, 18:00–18:30 local time, with the pollen shed almost

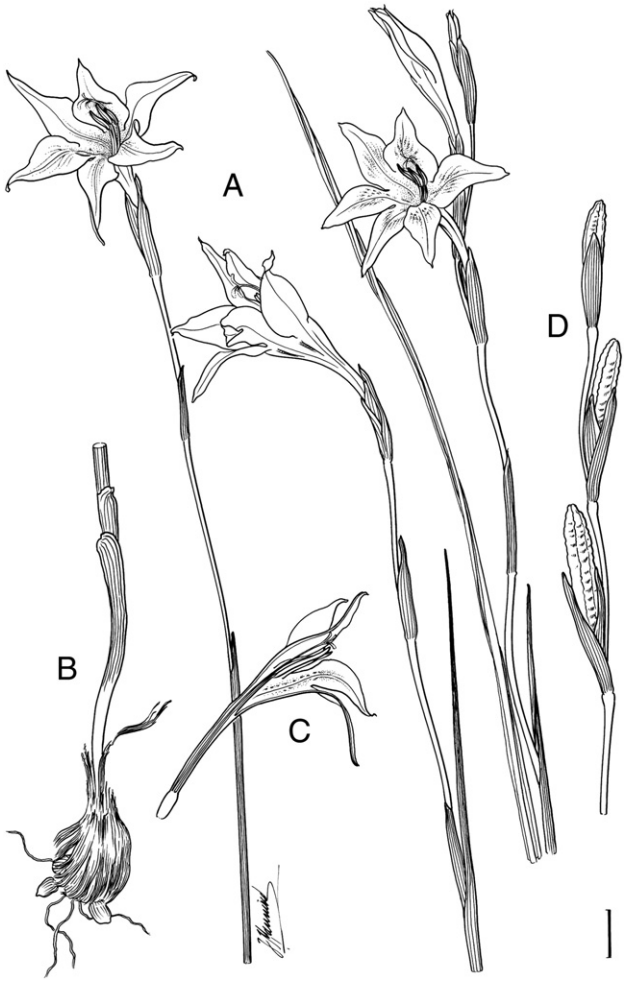


Fig. 1. *Gladiolus halophila,* Mannheimer CM4383 (NBG). A, flowering stems; B, corm; C, half-flower; D, infructescence. Scale bar: 10 mm.

immediately, and the stigmas becoming receptive shortly thereafter. The flowers at this time are strongly scented of clove and carnation. By the middle of the next day the flowers are only weakly scented and the perianth is somewhat flaccid in appearance although still expanded but is completely withered at the end of the day, at which time the next flower opens. Each flower thus lasts for just a single day, and each spike consequently has only a single flower fully open at a time. The flowers of all others species of *Gladiolus* last several (generally three or four) days. Also unusual in the genus, the species is facultatively self-compatible. As each flower withers, the stigmas contact the anthers and pollination occurs, with every stem producing a full complement of fruits with viable seeds. Other species in the genus are, with two known exceptions, self-incompatible and obligate outcrossers, only developing fruits after cross-pollination (Goldblatt et al., 1998). The other two self-compatible species that are known, *G. gueinzii* Kuntze, a littoral species restricted to coastal foredunes, and *G. tristis* L. (Ohri and Khoshoo, 1981), a wetland species from the Cape Floristic Region, both have specialized habitat requirements. The selective pressures leading to the development of self-incompatilibilty in these three species remain to be investigated but probably involve specialized habitat and reduced pollination success.

Fig. 2. Known distribution of *Gladiolus halophila*.

The pale perianth, attentuate tepals, evening anthesis and spicy floral fragrance are typical of moth-pollinated species (Goldblatt and Manning, 2002) and we infer that *G. halophila* is also adapted to moth pollination, although seed set is primarily through self-pollination. This combination of outcrossing and selfing is an evident adaptation to infrequent or unpredictable visits by pollinators, presumably associated with its arid habitat and flowering period in the middle of the dry season when few other plants are in bloom. A few plants of the presumptively moth-pollinated *Rogeria longiflora* J.Gay (Pedaliaceae) were observed still in flower along the roadside some distance from the *Gladiolus* localities but we noted no other potential host flowers in the area. In years of heavier rainfall, however, it is likely that at least *R. longiflora* will be more common but it is probable that the unreliable rainfall patterns that characterize the region will affect pollinator availability.

### *2.1.2. Diagnosis and relationships*

The stiffly erect stem bearing three, superposed leaves, the lowermost longest and with a well-developed, cruciform blade, combined with moderately-sized, funnel-shaped flowers evidently adapted to moth-pollination, and unusual, oblong–ellipsoid capsules, place *G. halophila* in sect. *Homoglossum* series *Tristis*. The broad, translucent lower margins of the tepals are also characteristic of this alliance. This small series includes just five species, three of which are endemic or nearly endemic to the South African winter rainfall region, with the remaining two species endemic or nearly endemic to the eastern southern African summer rainfall region. Morphologically, *G. halophila* is very similar to *G. longicollis* Baker and *G. tristis*, both of which also have pale, whitish flowers and centric leaves, X-shaped in cross section, but its ecology, distribution, and short-lived flowers are unique (Table 1). There are several small morphological differences between the three species, mainly in the length of the floral bracts, perianth tube, and filaments, with *G. halophila* having the shortest bracts and tube.

Although evidently part of the *G. longicollis–G. tristis* alliance, it is not possible at this stage to infer a possible sister-species relationship of *G. halophila* to either, although its unusually long

Table 1
Selected comparison between *G. halophila, G. longicollis* and *G. tristis*.

| | *G. halophila* | *G. longicollis* | *G. tristis* |
|---|---|---|---|
| Distribution | Southern Namibia: Fish River | Eastern South Africa and Lesotho | Southwestern South Africa |
| Habitat | Saline seeps | Grassland and open fynbos | Marshes, seeps, moist fynbos |
| Phenology | Winter-growing | Spring-growing | Winter-growing |
| Flowering | Aug. | Oct.–Feb. | (Aug.) Sept.–Nov. (−Dec.) |
| Flower longevity | 1 day | Several days | Several days |
| Breeding system | Self-compatible | Self-incompatible | Self-compatible |
| Perianth colour | Pale mauve/opalescent | White/pale yellowish, often mottled brown | Pale yellow or cream-coloured |
| Outer bract length | 22–25 mm | 35–50(−65) mm | (25–)40–50 mm |
| Perianth tube length | 35–40 mm | 45–110 mm | 40–63 mm |
| Filament length | ±14 mm | 5–13 mm | (15–)18–25 mm |
| Capsule shape | Oblong–ellipsoid | Oblong–ellipsoid | Oblong–ellipsoid |
| Capsule length | 35–40 mm | 20–25 mm | 34–36 mm |

capsules, 35–40 mm long, suggest that it might be more closely allied to the winter rainfall *G. tristis*, with which it also agrees in both its wetland habitat and in its self-compatibility. *G. longicollis*, in contrast, has been shown to be self-incompatible (Johnson et al., 2009). In either event, *G. halophila* is widely separated geographically from both species. *G. tristis*, which is distributed almost throughout the South African winter-rainfall region, has been recorded as far north as the Bokkeveld Mountains in Northern Cape, over 500 km south of Keetmanshoop, although it is possible that it may still be located in the Kamiesberg in central Namaqualand. *G. longicollis*, one of the most widespread of the southern African species, has been recorded throughout the eastern part of the subcontinent but its westernmost records, along the Nuweveldberge and in the Swartberg, are still more than 800 km southeast of *G. halophila*. Two possible scenarios may account for this disjunction: long-distance dispersal of seeds, and vicariance associated with expansions and contractions of the ranges of ancestral species during the pleistocene glaciations. In either event, *G. halophila* has subsequently evolved several specialized ecological adaptations that are unique or very uncommon in the genus, notably a halophytic ecology, short-lived flowers, and facultative self-pollination. The species represents an extraordinary example of ecological adaptation to an extremely harsh environment.

## 3. Conservation

### 3.1. Status

*G. halophila* has been assigned a conservation status of Endangered A3c+4c according to the IUCN 3.1 (2001) Red List Categories.

### 3.2. History

In August 2009 an environmental consulting company was appointed by the Ministry of Agriculture, Water and Forestry of the Government of the Republic of Namibia to undertake a brief field survey for the scoping report prior to a full Environmental Impact Assessment (EIA) on the proposed Neckartal Dam and Irrigation Project, located on the Fish River west of Keetmanshoop in the Karas Region, southern Namibia.

During this brief field visit an unknown *Gladiolus* species was photographed in flower, growing in a very saline seep in the vicinity of the Ururusis fountain. This photograph was subsequently determined to be of an undescribed species. Because the only recorded locality of the species lay within the inundation area of the proposed dam, the consultants immediately compiled and distributed a poster asking local people in the area to contact Rural Water Supply if they had ever seen the plant anywhere else. Two reports were received. The first proved inconclusive but the second resulted in a positive location.

Extermination of any species should be regarded as a fatal flaw in any planned project. Under advice from the consultants, the Namibian Ministry of Agriculture commissioned a desktop assessment of satellite imagery in order to identify possible additional survey sites for the new species, and to carry out site inspections with a view to locating populations of the species that fell outside the area of inundation. The area within 100 km radius around the area of inundation was surveyed using Google Earth for habitat similar to that in which the *Gladiolus* had originally been found. The original locality at Ururusis is clearly visible on Google Earth due to its high salinity. In this way, fourteen potential sites were identified.

Fieldwork was undertaken during August 2010 to coincide with the flowering period. The original location and thirteen additional potential sites were visited. Seeps and pools along the Fish River below the proposed dam wall site, where species associated with the *Gladiolus* in its original site occurred (e.g. *Scirpoides dioecus, Cyperus marginatus*), were also searched for the presence of the *Gladiolus*. The river near the Canyon Roadhouse was also checked because it is known to harbor *Limonium dregeanum,* a species that also occurs with the *Gladiolus,* and seeps harbouring sedges along the road from Bethanie to Kalkrand were also checked, although if this species occurred in such commonly accessed localities it would likely have been recorded before.

This field work resulted in the identification of just one additional locality, bringing to two the known sites of occurrence of the species. Fortunately for the survival of the species, the second site lies just above the planned dam inundation level, although below the 200 year maximum flood level. Some corms and seeds were collected at the time, with further seed collected by the Namibian National Genebank in September 2010.

As a result of the intensive field surveys it is now evident that although the type locality of *G. halophila* is due to be exterminated by the planned dam, at least one site will escape and the short-term survival of the species is thus likely. Additional collection of seed will be undertaken to facilitate *ex situ* conservation of the species.

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