

# Systematics of the southern African genus *Ixia* (Iridaceae). 1. The *I. rapunculoides* complex

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## ABSTRACT

Field and laboratory investigation of the six varieties of *Ixia rapunculoides* Delile (recognized in the current revisions and flora accounts of this southern African genus of some 65 species) show that a revised taxonomy better reflects the biology of the complex. The complex is defined by the funnel-shaped perianth tube, filaments fully and anthers partly included in the perianth tube. Our conclusions indicate that *I. rapunculoides* (currently var. *rapunculoides*) is restricted to the western Karoo and has broad, leathery leaves, a short perianth tube, mostly 5.5–8.0 mm long, and half nodding blue-mauve flowers. Plants currently referred to *I. rapunculoides* var. *flaccida* G.J.Lewis, include four sets of populations that we regard as two separate species. These are: *I. flaccida* with small, short-tubed white- or pale blue-flushed flowers, soft-textured leaves and corms with basal cormlets from the Olifants River Valley and nearby; and *I. sobolifera* from the Western and Little Karoo, which has linear leaves, nodding spikes and flowers and corms with stolons. We divide *I. sobolifera* into three subspecies: subsp. *carnea* with pink flowers, is restricted to the Bokkeveld Plateau and nearby; subsp. *sobolifera* with slate-blue flowers occurs in the Klein Roggeveld and nearby; and subsp. *albiflora* with strongly scented white flowers occurs in the central Little Karoo. The taxon called *I. rapunculoides* var. *namaquana* (L.Bolus) G.J.Lewis, defined by a longer perianth tube, mostly 13–16 mm long, horizontally oriented, white, pale lilac or pink flowers and few-flowered lateral branchlets, is treated as *I. namaquana*, first described by H.M.L. Bolus in 1931. Plants referred to this taxon from south of its range at Hex River Pass and nearby, however, have fully included anthers, a longer perianth tube, 16–20 mm, and ascending purple-pink flowers with a white cup and are referred to the new *I. oxalidiflora*. Two more varieties, *I. rapunculoides* var. *subpendula* G.J.Lewis and var. *rigida* sensu G.J.Lewis, which have upright flowers and distinctively branched stems are treated here as *I. divaricata* and *I. contorta*. Plants in the past included in var. *rapunculoides* from the Klein Roggeveld, south of the range of typical *I. rapunculoides*, have a longer perianth tube, 10–14 mm long, and attenuate, slightly lacerate, 5-veined, dry, rust-tipped bracts and comprise the new *I. lacerata*. In addition, plants from streambeds in the Roggeveld that have large, white flowers, are not included in current accounts of the genus, and also represent a novel taxon, *I. rivulicola*. Lastly, *I. rapunculoides* var. *robusta* G.J.Lewis, the range of which falls entirely within that of var. *rapunculoides* and is usually sympatric with it, has pink flowers of similar structure, but four or five leaves and deep-seated corms with a collar of coarse fibres around the stem base. We raise this plant to species rank as *I. robusta*.

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## INTRODUCTION

As currently circumscribed, *Ixia rapunculoides* Delile (Iridaceae: Crocoideae) is a widespread species of the southern African winter rainfall zone. It is a member of *Ixia* subgenus *Morphixia* (G.J.Lewis) J.C.Manning & Goldblatt, one of two subgenera of this southern African genus of some 65 species (Goldblatt & Manning 1999). The species is variable and comprises six varieties, which together constitute a complex that may be defined by its specialized bell-like flowers with unusually short stamens and short style branches, often less than 1 mm long. The filaments are included in the funnel-shaped perianth tube, and the anthers are usually partly included. Whether partly included in the tube or exerted, the anthers remain enclosed within a cup formed by the lower half of the tepals. The upper half of the tepals spreads outward ± horizontally, except in *I. rapunculoides* var. *subpendula*, in which the upper half of the tepals is often not fully patent. As treated by Lewis (1962), whose account was followed exactly by M.P. de Vos (1999), the complex included just *I. rapunculoides* with its six varieties. The range of *I. rapunculoides* as understood by Lewis extended from the Richtersveld of northern Namaqualand in the northwest, through interior Northern and Western Cape Provinces of South Africa to the Kammanassie Mountains of the Little Karoo in the southeast, a distance of over 800 km, and covering almost the entire range of the genus. One more species that has been described in the complex, *I. namaquana* L.Bolus (Bolus 1931), was reduced to varietal rank in *I. rapun-*

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*culoides* by Lewis (1962) on the basis of its included filaments and partly included anthers.

Vegetatively, all members of the complex have slender, erect flowering stems bearing few to many, short,  $\pm$  wiry, often thread-like lateral branchlets and typically, but not exclusively, just three (rarely two or four to six) foliage leaves. The lower two (rarely one or up to four) leaves have well-developed blades, and the upper one (or two) completely sheath the stem and reach to between the middle of the stem and the base of the spike. The main spike bears relatively few flowers and the lateral spikes have fewer, sometimes only a single flower. Plants referred to *I. rapunculoides* var. *robusta* normally have four leaves but sometimes up to six, with three or four basal and one or two sheathing the stem, and two other varieties rarely have three expanded foliage leaves. None of these vegetative features are, however, unique to the complex, but are shared by several other species of subgenus *Morphixia* (Goldblatt & Manning 1999), notably *Ixia latifolia* D.Delaroche and *I. marginifolia* G.J.Lewis.

Lewis's taxonomic treatment seems to reflect a perception that the morphological variation within the complex was less significant than that encountered between species elsewhere in the genus, presumably because the distinctive flowers of the complex were given undue weight in a genus that is relatively conservative in floral morphology. Some of the variation, especially floral scent, corm features, and the nature of the bracts subtending the branchlets was simply overlooked. The morphological variation in the complex is, nevertheless, extensive and includes: 1, corm tunics that range from coarsely to finely fibrous, or softly papery; 2, cornlets that are either sessile at the base of the main corm or borne on flattened, ribbon-like stolons; 3, flower colour that is often blue to blue-mauve, but also purple, pink or white; 4, leaf shape, which may be narrow, linear, and erect, or sword-shaped and erect, or arching outward and falcate; 5, degree of thickening of the margins of the basal leaves, which is least developed in *I. rapunculoides* var. *flaccida* and most pronounced in var. *robusta* and var. *rapunculoides*; 6, shape and degree of development of the bracts and prophylls subtending the thread-like, lateral branches (here called branchlets when short, or branches when well-developed); 7, length of the perianth tube, mostly 5.5–8.0 mm in var. *rapunculoides*, and 12–16(–18) mm in var. *namaquana*; 8, length of the filaments and anthers, features linked to tube length, and together range from 4.3–6.5 mm in var. *rapunculoides* to a maximum of 9.5 mm in var. *namaquana* and 10.5 mm in var. *subpendula*.

The morphological variation often correlates with ecological and geographical differences but the patterns have until now been inadequately understood. Particularly noteworthy, and from a systematic point of view unsatisfactory, is the local sympatry of some varieties or the parapatric and edaphic or geographic separation of others, in all cases without the occurrence of plants of intermediate morphology.

For example, on dolerite-derived clay soils on the Bokkeveld Plateau and on the Hantamsberg at Calvinia in Northern Cape, both *Ixia rapunculoides* var. *rapun-*

*culoides* and plants that conform to var. *flaccida* (sensu Lewis 1962), flower contemporaneously within a few metres of one another with no intermediates, indicating complete genetic isolation. Sympatry and synchrony of flowering of two distinct races without the presence of intermediate individuals is usually accepted as an indication of genetic isolation and therefore evidence for their recognition as separate species. Similarly, Lewis (1962) noted that at one of its two localities then known, var. *robusta* grew on rocky dolerite slopes a few metres from typical var. *rapunculoides*, growing on flat, stony loam near a seasonal watercourse. We have confirmed Lewis's observation and amplify it, having seen var. *robusta* growing side by side with var. *rapunculoides*, both taxa maintaining their typical morphology. A comparable situation occurs on the Bokkeveld Plateau near Nieuwoudtville, where typical var. *rapunculoides* grows on tillite-derived clay soils and var. *namaquana* on adjacent sandy soils.

These examples are particularly surprising because the flowers of all these taxa are apparently adapted for pollination by the same insects, a range of medium- and large-bodied bees, mostly Apidae: Anthophorinae, that forage for nectar and acquire loads of pollen while probing the perianth tube (Goldblatt *et al.* 2000 and confirmed here).

Field observations suggest to us that varietal separation within *Ixia rapunculoides* of var. *namaquana*, var. *flaccida* and var. *robusta* is unsatisfactory because the biological situation is not concordant with this taxonomy. The recognition of varieties of a single species is notoriously unevenly applied (Stuessy 1990), but is most often used to denote trivial regional variation, and sometimes only small genetic differences such as flower colour or leaf shape. In our estimation it should never be associated with genetic isolation and effective crossing barriers at the microgeographic level. Raising the rank at which members of the complex are separated to that of subspecies has similar problems. The rank of subspecies is most often used for sets of populations that are isolated geographically and have relatively modest, and often overlapping, morphological differences (Davis & Heywood 1973). As with varietal rank, subspecific rank is inconsistently applied. The examples in *I. rapunculoides* listed above thus accord poorly with treatment at either varietal or subspecific rank.

#### MATERIALS AND METHODS

We have attempted to resolve this unsatisfactory taxonomic situation outlined above where so-called varieties of a species co-occur and flower synchronously yet maintain their morphological differences by examination of the morphology and ecology of plant populations in the field. These studies were complemented by a study of herbarium collections of the genus at BOL, K, MO, NBG and PRE, the herbaria with the most complete collections of species from the southern African winter rainfall zone. Then, using a morphological species concept, we have compared all significant taxonomic characters of the different sets of populations with their ecology and geography to establish a revised taxonomy of the complex.

## RESULTS

Our results, obtained from measuring both living plants in the field and carefully preserved specimens with laid out flowers are presented in tabular form (Table 1). We do not use Lewis's (1962) or De Vos's (1999) measures for any taxa because we apply names in different ways. We have also been careful to include measurements of only well-pressed herbarium specimens because floral parts are particularly susceptible to distortion and can shrink by as much as 20% as they dry, less so when rapidly pressed on glue-covered paper or between the pages of a heavy book.

Members of the *Ixia rapunculoides* complex are not reported in the literature to have scented flowers (Lewis 1962; De Vos 1999; Manning *et al.* 2002). Nevertheless, we have found that plants of most populations have distinctive floral odours. Plants from the eastern part of the range of the complex with nodding white flowers have a particularly intensely sweet, carnation-like odour; typical var. *rapunculoides* has a faint rose scent; var. *namaquana* usually has a violet scent or are occasionally unscented; and var. *robusta* has a faint, unpleasant chemical odour. A population of white-flowered plants allied to var. *rapunculoides* from the Roggeveld Escarpment has a strong fruity odour recalling a combi-

nation of banana and grenadilla, very similar to *Virgilia oroboides* (Fabaceae).

Another feature ignored in the past, is the nature of the bracts and prophylls subtending the branchlets. These range from minute and truncate (var. *rapunculoides*, var. *robusta*) to forked with attenuate tips (Western Karoo plants assigned to var. *flaccida*), to filiform, elongate and recurved (plants from the Klein Roggeveld referred by Lewis (1962) to var. *rapunculoides* or var. *namaquana*).

Corms of members of the complex have until now been described as 'having fairly coarse, often subligneous, reticulate fibres' (Lewis 1962) and neither Lewis nor De Vos (1999) mention the presence of cormlets (cormels) or underground stolons. Texture and composition of the tunics, however, varies considerably and more so than is ever found within a single species of any allied genus of Iridaceae. Hard, coarsely fibrous tunics, matching Lewis's description, are characteristic of var. *rapunculoides*, var. *robusta* and var. *namaquana* and these taxa bear  $\pm$  sessile cormlets at the base of the main corm. Soft, short-lived tunics of  $\pm$  membranous layers characterize some plants included in var. *flaccida* and the southern populations of pink-flowered plants referred to var. *namaquana*, and in addition these plants produce

TABLE 1.—Characteristics of members of *Ixia rapunculoides* complex. All varieties recognized by short stamens with filaments and at least bases of anthers included in floral tube (var. *subpendula* is exceptional in this respect as anthers are usually fully exerted). Data are taken from new collections and well-pressed herbarium specimens

Taxon (according to Lewis 1962 in parentheses)	Perianth		Perianth colour	Stamens length mm	Flower		Leaf	
	tube length mm	tepal length mm			orientation	no.	shape	width mm
<i>I. rapunculoides</i> (var. <i>rapunculoides</i> in part)	5.5–8.0(–10.0)	11–16	blue-mauve or pink	fil: 2–3 anth: 2.3–3.5	$\pm$ horizontal	3–5	falcate	(3–)7–12
<i>I. robusta</i> (var. <i>robusta</i> )	7.5–10.2	(15–)17–20	pink	fil: $\pm$ 4 anth: 3.5–4.0	$\pm$ horizontal	4–6	lanceolate	8–14
<i>I. rivulicola</i> (Sutherland white)	8–9	17–18	white	fil: 3–4 anth: 4.5–5.5	suberect	2 or 3	linear to narrow sword	3–7
<i>I. flaccida</i> (var. <i>flaccida</i> in part)	7–9	$\pm$ 14	white or flushed pale blue	fil: 2.5–3 anth: $\pm$ 2.5	$\pm$ horizontal		linear to narrow sword	4–9
<i>I. lacerata</i> (var. <i>rapunculoides</i> in part)	10–12(–14)	(10–)12–14	pale blue-mauve	fil: $\pm$ 3 anth: $\pm$ 3	$\pm$ horizontal	2–6	falcate to lanceolate	5–10
<i>I. namaquana</i> (var. <i>namaquana</i> )	12–16(–18)	(12–)14–17	cream to pale mauve or pink	fil: 4–5 anth: 3.5–4.5	$\pm$ horizontal	2 or 3	sword(–falcate)	mostly 8–18
<i>I. oxalidiflora</i> (var. <i>namaquana</i> )	16–22	14–18	pink	fil: $\pm$ 4 anth: $\pm$ 3.5	mostly ascending	3	linear, erect	6–12(–15)
<i>I. sobolifera</i> subsp. <i>sobolifera</i>	5–6	10–12	slate- or grey-blue	fil: 2–3 anth: 4.0–4.5	$\pm$ nodding	2 or 3	linear	1.5–3.0
<i>I. sobolifera</i> subsp. <i>carnea</i> (var. <i>flaccida</i> in part)	9–10	12–16	pink	fil: $\pm$ 3 anth: 3–4	$\pm$ nodding	2–4	linear	1.5–3.5
<i>I. sobolifera</i> subsp. <i>albiflora</i> (var. <i>flaccida</i> in part)	6–7	12–17	white	fil: $\pm$ 3 anth: $\pm$ 3	nodding	2 or 3	linear-sword	4–8
<i>I. contorta</i> (var. <i>rigida</i> excluding the type)	9–13(–14)	9–12	purple	fil: $\pm$ 3 anth: 3–4	upright	3	falcate	2–5
<i>I. divaricata</i> (var. <i>subpendula</i> and var. <i>rigida</i> )	8–11	11–14	white, pink or purple	fil: 4–5 anth: 4.0–5.5	upright	4–7	narrow sword	mostly 3–5

fil, filaments; anth, anthers.

long, flattened, ribbon-like stolons each terminating in a large cormlet. Typical var. *flaccida* has tunics of fine to medium textured, netted fibres and produces cormlets at the base of the parent corm.

1. Var. **rapunculoides**: the typical form of the species is based on a painting in P.J. Redouté's *Les Liliacées* (Delile 1816), and we associate *Ixia rapunculoides* (the campanula-like *Ixia*) with plants from the Bokkeveld Plateau and Hantamsberg with a blue perianth and pale yellow cup. The painting, not known to be associated with any preserved material, shows the characteristic blue-mauve perianth with a yellow cup,  $\pm$  horizontally oriented flower, numerous multi-flowered branchlets, and most important, the short, funnel-shaped perianth tube with a wide upper half. Measurements of fresh, field-collected flowers from the Bokkeveld Plateau (e.g. *Goldblatt & Porter 12162*) show a perianth tube 7–8 mm long (but only 5.5 mm at the southern end of its range on the Roggeveld Escarpment), filaments  $\pm$  2 mm long, and anthers 2.3–3.5 mm long. Well-grown plants typically have three leaves, occasionally four. The lower two (or three) are usually relatively broad and lanceolate to falcate, with hyaline margins that appear thickened when dry, and the upper leaf is entirely sheathing. The corm tunics are coarse-textured and accumulate in a thick mass with age, occasionally extending upward as a collar around the stem base. A few small cormlets are usually developed at the base of the main corm.

The taxon favours clay soils, either heavy red clay derived from dolerite or lighter Ecca shale- or Dwyka tillite-derived soils and grows in renosterveld or karroid scrub. Plants conforming to these features extend from the Langberg near Loeriesfontein in the Western Karoo through the Bokkeveld Plateau to the Roggeveld Escarpment near Sutherland and are morphologically fairly uniform throughout this range. Plants from the Kamiesberg in Namaqualand that were included by Lewis in var. *rapunculoides* have well-exserted anthers and are actually a local, blue- or mauve-flowered variant of the plant currently called *I. latifolia* var. *ramulosa* G.J.Lewis.

2. Var. **robusta**: *Ixia rapunculoides* var. *robusta* G.J.Lewis was known to Lewis (1962) from two localities around the Hantamsberg Massif at Calvinia. The taxon exhibits two features associated with dry habitats: thick, almost succulent, leathery leaves with thickened, hyaline margins and deeply seated corms with a collar of fibres around the underground part of the stem. The flowers are similar to those of var. *rapunculoides*, but are consistently pale pink with a white cup, and are slightly to much larger than those of var. *rapunculoides* growing nearby. They have a somewhat longer perianth tube, 7.5–10.2 mm long, and tepals 17–20 mm long. Plants also differ sharply from var. *rapunculoides* in having three or occasionally four leaves with expanded blades in addition to one, or sometimes two, sheathing upper leaves. Most other variants of *I. rapunculoides*, including var. *rapunculoides*, normally have two expanded foliage leaves (rarely one or three are present) and the latter has a perianth tube usually 5.5–8.0 mm long. Plants with large pink flowers, at least four leaves and a fibrous collar occur at numerous sites east and north of

the Hantamsberg at the northern end of the Bokkeveld Plateau and plants with four leaves and a fibrous collar are also recorded at the southern end of the Roggeveld Escarpment (see exsiccatae listed below under *I. rapunculoides*). Flowers of these plants are fairly large, and have anthers  $\pm$  4 mm long and tepals (15–)17–20  $\times$  5.0–9.5 mm, thus in the upper range for var. *rapunculoides*. Plants of the type collection of var. *robusta* from Moordenaarspoort, 38 km northwest of Calvinia, have bracts with blunt tips that contrast with the toothed tips of other varieties of *I. rapunculoides* but we note that some populations of typical var. *rapunculoides* also have blunt-tipped inner and outer bracts (see illustration by Lewis 1962).

3. Var. **namaquana**: first described by H.M.L. Bolus in 1931 as *Ixia namaquana*, the species was based on pink-flowered plants from Klipfontein near Steinkopf in northern Namaqualand in Northern Cape. It was reduced to varietal rank by Lewis (1962), who included not only plants from Namaqualand in the taxon, but also collections from the Bokkeveld and the Cedarberg as well as from the Worcester and Laingsburg Districts. Except for these southern populations, var. *namaquana* has flowers held horizontally or slightly above the horizontal and a relatively long perianth tube, (12–)14–16(–18) mm, and anthers 3.5–4.5 mm long. The flowers are whitish, mostly oyster-coloured flushed pale mauve, or deep pink, and the pale yellow throat has a ring of dark lines at the top of the perianth tube. Plants we have examined in the wild from the Kamiesberg and the Bokkeveld Mtns have the style dividing at  $\pm$  mid-anther level and this feature is confirmed in the few preserved specimens that show the character. Some plants we have examined alive have flowers with a strong scent of violets (e.g. Grasberg road, northwest of Nieuwoudtville, *Goldblatt & Porter 12407A*; *Goldblatt 12684*), whereas others appear scentless (e.g. 10 km west of Nieuwoudtville, *Goldblatt 12680*). The taxon is consistently different from other varieties of *I. rapunculoides* and does not overlap them in the critical feature of perianth tube length and differs from most others in anther length. We regarded it as a separate species.

Southern populations of *Ixia namaquana* from the Bokkeveld Mtns to the Cedarberg favour sandstone-derived soils, whereas those in the north, in the Kamiesberg, occur in gritty granitic gravel, typical of central Namaqualand habitats. Both soil types are nutrient-poor and well drained. The type population and several more from the Steinkopf area of northern Namaqualand and the southern Richtersveld apparently grow on clay, an odd ecological shift. The latter populations also differ in their deep pink flowers.

Among specimens until now included in the taxon, those from the south of the range, in the Hex River Mtns and nearby, stand out in having unusually large, pink flowers that are either ascending or upright and have the stamens fully included in the funnel-shaped tube, itself unusually long, 16–22 mm. These plants are also unlike typical *Ixia namaquana* in their narrow, soft-textured leaves and small corms, about 8 mm in diameter. The corms have tunics of fine fibres, and produce conspicuous stolons. These plants cannot be included in *I. nama-*

*quana* but represent a novel species, which we describe below as *I. oxalidiflora*.

4. Var. **flaccida**: the type of this variety, from the Olifants River Valley near Clanwilliam in Western Cape, is distinguished by the fairly thin-textured, narrowly lanceolate leaves less than 10 mm wide and  $\pm$  half as long as the stem. The white to palest blue flowers are carried  $\pm$  horizontally, have a perianth tube 7–9 mm long, while the stamens are inserted  $\pm$  2 mm from the base of the tube, the filaments are 2.5–3.0 mm long and the anthers  $\pm$  2.5 mm long. Plants have three or four leaves, the uppermost one (or sometimes the upper two when four leaves are present) is typically entirely sheathing. The corms have tunics composed of fine or medium-textured, netted fibres and bear cormlets at the base. Plants grow in light sandy soil, among sandstone rocks, on south-trending slopes, in light shade, in thicket communities. They most closely match var. *rapunculoides* in tube and stamen length but apart from differences in leaf shape and texture, they have narrower tepals and corm tunics of finer fibres. Dimensions given by Lewis (1962) and De Vos (1999) for the variety have a wider range because they included additional sets of populations within the taxon.

The first of these populations comprises slender, pink-flowered plants from the Bokkeveld Plateau, the second slate-blue-flowered plants from the Klein Roggeveld, and the third represents white-flowered plants from the central Little Karoo. These variants are recognized by the taller than usual flowering stem, up to 750 mm long when growing under conditions of adequate rainfall, a half or fully nodding flower, and perianth with a pale yellow cup. The leaves of these plants are narrow, linear to narrowly sword-shaped, slightly twisted and often trailing above. Most significantly, the corms differ from all other populations of *I. rapunculoides* sensu Lewis including typical var. *flaccida*, in having soft, soft-papery corm tunics and broad, flat stolons 30–100 mm long terminating in a large cormlet.

At two sites where we have seen the pink-flowered variant, at Glenlyon near Nieuwoudtville and on the Hantamsberg at Calvinia, plants were sympatric with typical var. *rapunculoides*. At a third site, near Grasberg Farm, northwest of Nieuwoudtville, pink-flowered plants were sympatric with var. *namaquana*. The taller pink-flowered plants grew in grass tufts or in bush clumps, whereas var. *rapunculoides* and var. *namaquana* grew on open ground. We conclude that these pink-flowered plants represent an unnamed taxon. Apart from the nodding flower, pink perianth and narrow tepals, flowers of this plant have a tube  $\pm$  9 mm long, filaments  $\pm$  3 mm long, and anthers  $\pm$  4 mm long. The style divides at the anther apices in fully open flowers and the style branches are short, slightly exceeding 1 mm long, thus visible above the anthers. Blue-flowered var. *rapunculoides* growing nearby has a perianth tube 7–8 mm long, filaments  $\pm$  2 mm long, and anthers  $\pm$  3 mm long, whereas var. *namaquana* has a tube (12–)14–16 mm long, anthers  $\pm$  4 mm long and a shorter style.

We have also re-collected and examined the grey-blue- and the white-flowered plants referred by Lewis to var. *flaccida* at sites in the Klein Roggeveld and Little

Karoo. Plants from the latter area grow on south-trending shale slopes in light loamy ground near Oudtshoorn and in the foothills of the Kammanassie Mountains (e.g. *Goldblatt & Porter 12291*, MO, NBG; *Vlok & Schutte 494*, MO, NBG), and at a few other sites. These plants resemble most closely the pink-flowered plants from the Bokkeveld Plateau in their tall stature, and narrow,  $\pm$  linear leaves and, most significantly in their soft, somewhat papery corm tunics and long, slender stolons bearing a terminal cormlet. The Klein Roggeveld plants, which also have corms with soft tunics and stolons, favour clay or sandy soils in more mesic sites in this semi-arid area, often south-facing slopes. Because these three sets of populations of stoloniferous plants differ in flower colour, branching pattern, and in the strength and quality of their scents, as well as in small differences in size of floral parts, they are probably best regarded as subspecies of a single species, which we call *I. sobolifera*. We propose the names subsp. *albiflora* for the Little Karoo populations, subsp. *carnea* for those from the Bokkeveld Plateau, while the Klein Roggeveld populations constitute subsp. *sobolifera*. The disjunction between the northern subsp. *carnea* and Klein Roggeveld subsp. *sobolifera* may prove to be apparent rather than real as more collecting on the Roggeveld Escarpment is done. Likewise the disjunction between the ranges of subsp. *sobolifera* and the central Little Karoo subsp. *albiflora* will likely be bridged when more exploration at suitable sites between their ranges is undertaken.

5. Var. **subpendula**: plants assigned to this taxon have a discrete ecogeographic range, encompassing the Cold Bokkeveld and surrounding Grootwinterhoek and Hex River Mtns where they grow in seasonally waterlogged sandstone-derived soils. They also comprise a coherent morphological unit, having moderate-sized, white to pale pink flowers with a perianth tube 8–11 mm long, subequal tepals 11–14  $\times$  6–7 mm, anthers that are 4.0–5.5 mm long and usually fully exerted from the floral tube (sometimes the bases are included), and style branches 1–2 mm long. The narrow leaves are typically 3–5 mm wide (but sometimes up to 10 mm). The remarkable long, straight lateral branches diverge at more than 45° from the main axis and bear flowers in the distal half. These populations seem out of place in the *Ixia rapunculoides* complex, particularly in the large, excluded anthers and relatively longer style branches, and the flowers match most closely those of the related *I. capillaris* which is distinguished not only by the shortly exerted anthers but by the narrow, linear leaves, and particularly by the slender lateral branchlets, which are fairly short, rarely exceeding 10 mm, and usually bearing only one or two, rarely three, flowers. We suspect that var. *subpendula* is not immediately allied to *I. rapunculoides*. While its flowers resemble most closely those of *I. capillaris*, the unusual branching pattern recalls the pink- or red-flowered *I. latifolia*.

Whereas *Ixia capillaris* and *I. latifolia* favour clay soils and are fairly widespread in the southwestern Cape, *I. rapunculoides* var. *subpendula* is restricted to seasonally waterlogged, sandy, stony flats and rocky sites. We recognize var. *subpendula* as a separate species, which we call *I. divaricata* for the unusual, stiff, straight lateral branches that diverge at a sharp angle from the main

axis. Use of the epithet *subpendula* seems inappropriate, for the lateral branches are rarely subpendulous, and usually held above the horizontal.

6. Var. **rigida**: the type of var. *rigida* from the Hex River Valley, does not differ in any significant respect from var. *subpendula* and we therefore include it in that taxon. Other collections from the Cedarberg and Cold Bokkeveld that were assigned to var. *rigida* by Lewis (1962), however, appear to represent a different species. Despite Lewis's comment that the androecium and gynoecium are like those of var. *rapunculoides*, we find the stamens of these plants rather different: the filaments are  $\pm 3$  mm long (versus  $\pm 2$ –3 mm in var. *rapunculoides*), and the anthers are 3–4 mm long, again longer than is usual for var. *rapunculoides*. The flowers also differ from typical var. *rapunculoides* (Table 1) in their upright orientation, and the slightly longer perianth tube, 9–12 mm long (versus 5.5–8(–10) mm in var. *rapunculoides*). We see no particularly close relationship of these plants to typical *I. rapunculoides* or any other member of the complex and treat them as a separate species, *I. contorta*.

**Additional variants:** there are two more sets of populations allied to *Ixia rapunculoides*. The first of these comprises white-flowered plants from the Roggeveld Escarpment, unknown to Lewis when she revised *Ixia* in 1962. Flowering in October (when all other members of the *I. rapunculoides* complex in the Western Karoo and Roggeveld are in fruit), these plants are confined to the edges of streams that usually have running water until October and remain moist at least until December. Plants are tall, up to 1.2 m high, have membranous corm tunics

that do not accumulate with age, and bear small cormlets at the base of the main corm. The relatively large, nodding flowers have a tube 8–9 mm long, tepals 17–18  $\times$  5.0–7.5 mm, and anthers 4.5–5.5 mm long, the lower halves included in the perianth tube. The flowers have a strong fruity odour, reminiscent of banana and grenadilla (passion fruit), unique in *Ixia*, but closely matched by the scent produced by *Virgilia oroboides*.

We suggest that the most appropriate treatment for this plant is recognition at species rank and propose the name *Ixia rivulicola*. While its features recall other varieties of the *I. rapunculoides* complex, notably var. *rapunculoides* and var. *flaccida*, it is distinct in flower colour and fragrance, leaf number and shape, in the poorly developed corm tunics, and in the unique riparian habitat.

The second set of populations comprises short plants from the Klein Roggeveld with pale bluish grey flowers. Assigned previously either to var. *rapunculoides* or to var. *namaquana* (Lewis 1962; De Vos 1999) the two lower leaves of the plant have expanded blades and a third sheathing leaf, flowers with a narrowly funnel-shaped perianth tube 10–14 mm long, branchlets subtended by long, recurved, thread-like bracts and prophylls that are bifurcate, and unusual floral bracts with dry, often torn tips, the outer usually with five veins and the inner with three or four. The corms bear basal cormlets and have tunics composed of coarse fibres typical of *Ixia rapunculoides*. We treat these plants as the new species, *I. lacerata*.

#### Key to *Ixia rapunculoides* and its close allies in subgenus *Morphixia*

Note: care must be taken in measuring floral parts of preserved specimens: depending on the method of drying, the perianth can shrink as much as 20%. Presence of stolons is difficult to establish as they are often left in the ground unless corms are removed with particular care. Filaments are measured from point of insertion on the perianth tube (although they are decurrent) to the base of the anther. The perianth tube is measured from the top of the ovary to the point at which the tepals separate from the upper portion of the tube.

- 1a Foliage leaves linear-filiform, less than 2 mm wide when alive; midvein lying closer to abaxial margin but not evident when alive unless held to the light ..... *I. capillaris* complex
- 1b Foliage leaves linear to lanceolate or falcate but never leathery and filiform, usually more than 2 mm wide in mature plants; midvein evident when alive, central or slightly displaced toward abaxial margin:
  - 2a Filaments reaching at least to top of perianth tube or exerted, thus anthers always completely exerted ..... *I. latifolia* and close allies including *I. divaricata* (= *I. rapunculoides* var. *subpendula*), *I. marginifolia*, and most of the remaining members of subgenus *Morphixia*
  - 2b Filaments included and anthers partly or sometimes also fully included within perianth tube (*I. rapunculoides* complex):
    - 3a Flowers upright; perianth tube 8–13 mm long:
      - 4a Flowers purple with pale yellow cup; main spike and branchlets twisted and flexuose, inclined to nearly horizontal; plants up to 150 mm high ..... *I. contorta*
      - 4b Flowers white, pink or rarely purple with white or pale yellow cup; main spike long, straight and erect, lateral spikes ascending to spreading, with flowers crowded in distal half; plants mostly 300–600 mm high (this taxon does not correctly belong to the complex as filaments are normally exerted 1–2 mm but occasionally reach to just short of mouth of tube) ..... *I. divaricata*
    - 3b Flowers ascending, horizontal or nodding; perianth tube 5–22 mm long:
      - 5a Perianth tube (12–)13–20 mm long; anthers partially or fully included in perianth tube:
        - 6a Anthers half exerted from perianth tube; perianth tube (12–)13–16(–18) mm long; flowers  $\pm$  horizontally oriented; corm mostly 12–14 mm diam., with tunics of medium to coarse fibres; cormlets borne at base of main corm ..... *I. namaquana*
        - 6b Anthers fully included in perianth tube; perianth tube 16–22 mm long; flowers mostly ascending; corm mostly 8–10 mm diam., with tunics of fine fibres; cormlets borne at ends of flattened stolons ..... *I. oxalidiflora*
      - 5b Perianth tube 5–12(–14) mm long; anthers partly included in perianth tube:
        - 7a Leaf blades of lower two or three leaves sword-shaped to falcate (rarely sublinear), mostly 8–15 mm wide (rarely 3–7 mm wide), usually less than one third as long as stem (longer if growing through bush); flowers ascending to horizontal; filaments 2–4 mm long; anthers 2.3–4.0 mm long:
          - 8a Bracts and prophylls subtending branchlets bifurcate and attenuate, often directed downward distally; leaves 2(1) with well-developed blades; perianth tube 10–12(–14) mm long; outer bracts with (4)5 major veins, 5-toothed, teeth attenuate ..... *I. lacerata*
          - 8b Bracts and prophylls subtending branchlets short, obtuse to truncate, less than 2 mm long; leaves 2 or 3(4) with well-developed blades; perianth tube 5.5–8.0(–10.2) mm long; outer bracts with 3 major veins, shortly 3-toothed to bluntly 3-lobed:
            - 9a Flowers blue-mauve, occasionally pale pink, with yellow to white throat; expanded foliage leaves 2(3); blades usually falcate;

- base of stem rarely with fibrous collar; perianth tube (5.5–)8.0–10 mm long; anthers 2.3–3.5 mm long ..... *I. rapunculoides*
- 9b Flowers pale pink with white throat; expanded foliage leaves 3(4); blades usually sword-shaped; base of stem covered by collar of fibres; perianth tube 7.5–10.2 mm long; anthers 3.5–4.0 mm ..... *I. robusta*
- 7b Leaf blades linear or narrowly sword-shaped, erect, weakly twisted or trailing distally, mostly 1.5–3.5 mm wide; flowers ascending to horizontal or nodding; filaments 3–4 mm long, inserted at least 4 mm from base of tube; anthers 2.5–5.5 mm long:
- 10a Plants of streambanks and marshes, often growing in water; perianth tube 8–9 mm long; flowers white with yellow throat ..... *I. rivulicola*
- 10b Plants of hillsides and flats; perianth tube 5–10 mm long; flowers white, pale blue, pale pink or slate-blue with white or yellow throat, horizontal or nodding:
- 11a Corm tunics of fine to medium-textured, netted fibres; corms bearing sessile cormlets at base (rarely on slender stolons); perianth whitish or flushed palest blue with white throat; style dividing opposite middle of anthers, style branches extending between them ..... *I. flaccida*
- 11b Corm tunics of soft, ± papery (not fibrous) layers, not accumulating significantly; corms bearing flattened, ribbon-like stolons; perianth pink, bluish grey, slate blue or white; style dividing opposite anther tips, rarely beyond, style branches extending above them ..... *I. sobolifera*

#### Key to subspecies of *Ixia sobolifera*

- 1a Perianth pink with yellow throat; perianth tube 9–10 mm long; anthers 3–4 mm long, yellow with dark longitudinal lines on anther lobes ..... subsp. *carnea*
- 1b Perianth white with pale yellow throat or slate-blue with white throat; perianth tube 5–7 mm long; anthers 2–3 mm long, uniformly yellow:
- 2a Perianth white with yellow throat; perianth tube 6–7 mm long ..... subsp. *albiflora*
- 2b Perianth slate-blue with white or pale yellow throat; perianth tube 5–6 mm long ..... subsp. *sobolifera*

#### TAXONOMY

1. *Ixia rapunculoides* Delile in Redouté, Les Liliacées 8: t. 431 (1816). Type: South Africa, without precise locality, collector unknown, illustration in Redouté, Les Liliacées 8: t. 431 (1816). Epitype: South Africa, Northern Cape, Klipkoppies, red clay, 9 August 1961, G.J. Lewis 5853 (NBG, epi., here designated; K, PRE, iso.).

Plants mostly 150–400 mm high. *Corm* subglobose, mostly 14–18 mm diam., with tunics of firm, wiry fibres accumulating in dense mass, bearing small cormlets at base. *Leaves* (2)3(4), lower 2 lanceolate to falcate, mostly (3–)7–12 mm wide, ± one quarter to half as long as stem, margins thickened, plane or lightly crisped, uppermost leaf sheathing stem below spike, rarely unifacial in upper 10–30 mm. *Stem* erect, nodding above, with several to many (up to 10) short, thread-like, ascending to horizontal branchlets subtended by obtuse bracts and prophylls ± 1(–2) mm long. *Main spike* half-nodding, mostly 3–5-flowered, lateral spikes (1)2–5-flowered; bracts translucent sometimes tinged brown especially in fruit, outer with three dark veins, mostly 5–6 mm long, 3-toothed or bluntly 3-lobed, inner about as long, with two dark veins and forked apically. *Flowers* ± horizontally oriented to half nodding, pale blue (mauve or blue-grey) with pale yellow cup, or pink with white cup, faintly rose-scented or evidently unscented; perianth tube 5.5–8.0(–10.0) mm long, widely funnel-shaped, flaring in upper 3–5 mm; tepals subequal, ovate, 11–16 × 4.5–6.0 mm, proximal ± 3 mm forming part of floral cup, spreading at right angles to tube distally. *Stamens* parallel; filaments 2–3 mm long, inserted 2–4 mm above base of tube; anthers 2.3–3.5 mm long, upper half exerted from tube but included in floral cup, pale yellow. *Style* dividing shortly below anther tips, branches 0.7–1.2 mm long, not reaching anther tips. *Flowering time*: August to mid-September, sometimes July. Figure 1A–C.

*Distribution*: widespread across the Western Karoo, from the Langberg west of Loeriesfontein and the Hantamsberg in the north across the Bokkeveld Plateau

and Roggeveld Escarpment as far south as Sutherland (Figure 2).

*Diagnosis and variation*: *Ixia rapunculoides*, as circumscribed here, is fairly uniform across its range: it is recognized by the horizontally oriented, mostly blue flowers with a yellow cup (locally pale pink with a white cup), short perianth tube mostly 5.5–8.0 mm long, short filaments 2–3 mm long and anthers 2.3–3.5 mm long and half included in the perianth tube. In the vicinity of the Hantamsberg, the species co-occurs with *I. robusta*, another member of the complex, which was distinguished at the varietal level by Lewis (1962) by the presence of a short collar of fibres sheathing the base of the stem, and three or sometimes four, rather than the usual two leaves with expanded blades. These plants are restricted to dolerite outcrops along the eastern and northern end of the Hantamsberg and wherever we have seen them, typical *I. rapunculoides* grew nearby or among the *I. robusta* plants but was always shorter in stature and with grey-blue flowers, in marked contrast to the tall, pink-flowered *I. robusta*. The occasional presence of three, rather than the usual two expanded leaves, must be regarded as no more than part of the pattern of variation and not as evidence for intergradation with *I. robusta*. Leaf number occasionally varies in typical *I. rapunculoides*, thus some specimens of Lewis 5808 have three broad basal leaves (in two specimens the uppermost of these partly sheaths the stem) very like those of *I. robusta*; and all four specimens of De Vos 2561 have four leaves, the penultimate one partly to almost entirely sheathing the stem. Some plants from the northeastern end of the Hantamsberg (Moordenaarspoort and the Farm Vanrhynshoek) stand out in the species in their unusually narrow leaves (± 3 mm wide), narrow tepals and single flowered branchlets (e.g. Snijman 2068) but at present seem merely to be depauperate rather than representing a separate race or genotype.

In order to fix the application of the name *Ixia rapunculoides*, the type of which is a painting in Redouté's *Les Liliacées* that is not, as far as we know, associated with preserved specimens and possibly of doubtful identity, we have designated an epitype. Plants from the



FIGURE 1.—A–C, *Ixia rapunculoides*, Goldblatt & Porter 12730 (MO, NBG): A, whole plant; B, l/s flower; C, bracts: outer (left), inner (right). D–F, *Ixia robusta*, Goldblatt & Porter 12738 (MO, NBG): D, whole plant; E, l/s flower; F, bracts: outer (left), inner (right). Scale bars: 10 mm. Artist: J.C. Manning.

Bokkeveld Escarpment near Nieuwoudtville match the illustration best and of the collections available from there, *Lewis 5853* is representative of the species and distributed in several herbaria.

Flowers of *Ixia rapunculoides* have been shown to be pollinated by large-bodied Anthophorine bees, including *Anthophora diversipes* and *Pachymelus peringueyi* (Goldblatt *et al.* 2000). We have confirmed this initial report at a second population of the species, south of Nieuwoudtville, where only female *Anthophora diversipes* individuals were captured visiting the flowers. The reward for visiting bees is nectar, moderate amounts of which are secreted from septal nectaries and retained in the base of the perianth tube.

#### *Selected specimens*

(Collections marked with an asterisk\* have a collar of fibres around the stem base; those marked with a + denote gatherings with at least one plant with four leaves.)

NORTHERN CAPE.—3018 (Kamiesberg): summit of Langberg, among dolerite boulders, 3 563' [ $\pm$  1 050 m], (–DB), 5 September 2006, Goldblatt & Porter 12769 (MO, NBG, PRE). 3019 (Loeriesfontein): Farm Taaiboskloof, NW of Loeriesfontein, clay flats, (–CA), 2 September 1982, Snijman 465 (NBG). 3119 (Calvinia): near Nieuwoudtville, (–AC), September 1930, *L. Bolus s.n.* (BOL19590); Farm Rietfontein, dolerite hill next to road, (–BC), 5 September 2006, \*Goldblatt & Porter 12774 (MO, NBG); 51 km on road from Nieuwoudtville to Calvinia, (–BC), 1 September 2006, Goldblatt & Porter 12730 (MO, NBG, PRE); Agter Hantam, near Groot Toring, (–BC), 1 September 2006, \*Goldblatt & Porter 12754 (MO, NBG); 5



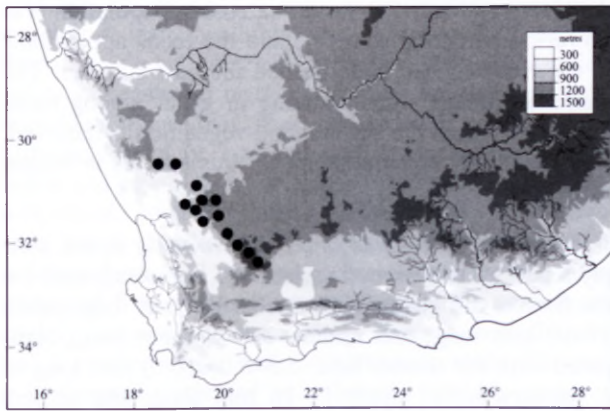


FIGURE 2. —Known distribution of *Ixia rapunculoides*.

miles [8 km] S of Calvinia. (–BD), 21 July 1961, *Lewis 5791* (BOL, K, NBG, PRE); Hantamsberg slopes, (–BD), 4 September 2002, *Goldblatt & Porter 12162* (MO); Farm Vanrhynshoek, east base of Hantamsberg, (–BD), 5 Sept. 2006, *Snijman 2068* (NBG); Farm Wilgebos, S of Calvinia, 10 August 1961, *Lewis 5879* (K, NBG); Kareeboomfontein, SW of Calvinia, (–DA), *Hanekom 2364* (K, MO, PRE); Bloukransberge, Farm Kneu east of escarpment, (–DB), 21 August 1975, *Thompson 2501* (NBG, PRE). 3120 (Williston): near Elandsfontein [between Middelpoos and Calvinia], (–AD), 10 October 1928, *+Hutchinson 731* (K); Perdekloof SE of Calvinia to Middelpoos, (–DD), *Goldblatt & Porter 12786* (MO, NBG, PRE). 3220 (Sutherland): Farm Kompromis, between Middelpoos and Sutherland, (–AB), 5 September 1986, *+De Vos 2561* (NBG); Roggeveld, Bo-Visrivier road opposite Noudrif Farm, (–AB), 8 September 2006, *\*+Goldblatt & Porter 12800* (MO, NBG); Roggeveld Escarpment, Farm Kruisrivier, 3 km past Ouberg Pass turnoff, stony red-brown clay, 1 270 m, (–AD), August 1986, *\*+Cloete & Haselau 81* (NBG); Houdenbek, NW of Sutherland, 1 311 m, (–AD), 2 September 1973, *\*+Oliver 4409* (NBG, PRE); Roggeveld, Sneeukrans, Uitkyk, 1 600 m, (–AD), October 1920, *Marloth 9876* (NBG, PRE).

## 2. *Ixia robusta* (G.J.Lewis) Goldblatt & J.C.Manning, comb. et stat. nov.

*I. rapunculoides* var. *robusta* G.J.Lewis in *Journal of South African Botany* 27: 74 (1962). Type: South Africa, [Northern Cape], Moordenaarspoort, 26 miles NE of Calvinia, 26 September 1952, *G.J. Lewis 2503* (BOL!, PRE!, SAM!).

Plants mostly 0.5–1.0 m high. *Corm* subglobose, mostly 14–18 mm diam., tunics of firm, wiry fibres accumulating in dense mass, bearing small cormlets at base. *Leaves* usually 4(5 or 6), lower 3 or 4 lanceolate to sub-falcate, mostly 8–14 mm wide,  $\pm$  one quarter to one third as long as stem, margins thickened, usually plane, uppermost 1 or 2 leaves sheathing stem below spike. *Stem* erect, sheathed below ground by collar of fibres, with up to 10 short, slender, ascending branchlets subtended by truncate-apiculate bracts and prophylls 0.5–1.0(–2.0) mm long. *Main spike* suberect, mostly 4–6-flowered, lateral spikes ascending, mostly 2–6-flowered; bracts translucent becoming tinged brown at tips in fruit, outer with three dark veins, (6–)8–10 mm long, 3-toothed or bluntly 3-lobed, subequal or inner slightly longer, with two dark veins and forked apically. *Flowers*  $\pm$  horizontally oriented, pale pink with white cup, faintly acrid-metallic-scented or apparently unscented; perianth tube 7.5–10.2 mm long, widely funnel-shaped, flaring in upper 4–5 mm; tepals subequal, narrowly ovate to subspathulate, (15–)17–20  $\times$  7–9 mm, proximal  $\pm$  3 mm forming part of floral cup, spreading at right angles to tube distally. *Stamens* parallel; filaments  $\pm$  4 mm long, inserted  $\pm$  3.5

mm above base of tube; anthers 3.5–4.0 mm long, half exerted from tube but included in floral cup, yellow. *Style* dividing opposite middle third of anthers, branches 1.5–2.0 mm long, extending between anthers. *Flowering time*: late August to late September. Figure 1D–F.

*Distribution*: locally in the western Karoo east and north of the Hantamsberg, on flats and lower slopes in heavy, dolerite clay, among dolerite boulders (Figure 3).

*Diagnosis and variation*: *Ixia robusta* is recognized by its tall stature, pink flowers with a white cup, and at least three (and often four) lanceolate basal leaves that are thick and leathery to almost succulent in texture. The corms, which are difficult to remove from the rocky ground, are large, and covered with wiry tunics, and the underground part of the stem is enclosed by a collar of fibres, a feature often not preserved when the deep-seated corms are removed from the rocky ground.

Wherever we have seen *Ixia robusta*, typical *I. rapunculoides* has been growing nearby and sometimes among plants of *I. robusta*, never with any sign of intergradation. *Ixia robusta* is always taller, has 3 or 4 expanded leaf blades, and branches with more and larger, pink flowers. Associated with the larger flower, the anthers are  $\pm$  4 mm long, the perianth tube is 7.5–10.2 mm long and the style branches are 1.5–2.0 mm long, contrasting with anthers 2.3–3.5 mm long and style branches 0.7–1.0 mm long in *I. rapunculoides*. Lewis's comment that what she called var. *robusta* and var. *rapunculoides* favoured different habitats, the latter in flatter, more sandy situations, is not fully borne out by our observations. We could usually find *I. rapunculoides* growing among *I. robusta* plants, although *I. rapunculoides* also grew in flat, less rocky places where *I. robusta* did not occur. The morphological differences between Lewis's var. *rapunculoides* and var. *robusta*, combined with their sympatry, synchronous flowering and the absence of morphological intermediates, provides convincing evidence that they are separate species.

Although *Ixia rapunculoides* usually has blue-mauve to grey-blue flowers, plants from west of the Hamtamsberg and near Loeriesfontein have a pale pink perianth, identically coloured to *I. robusta* and care must be taken not to confuse *I. robusta* with pink-flowered *I. rapunculoides*: the latter always has short, falcate leaves, usually only two with expanded blades, and lacks a collar of fibres around the stem base. Flower colour alone is not a consistent difference between the two species but where they co-occur, flower colour and scent always differ.

### *Additional specimens*

NORTHERN CAPE.—3119 (Calvinia): Calvinia District, near Elandskop, Agter Hantam, 765 m, (–BB), 17 September 1956, *Acoccks 19038* (BOL, K, PRE); Agter Hantam, between Moordenaarspoort and Klipwerf, (–BB), 1 September 2006, *Goldblatt & Porter 12746* (MO, NBG); Moordenaarspoort, northeast of the Hantamsberg, among dolerite boulders, (–BD), 1 September 2006, *Goldblatt & Porter 12738* (K, MO, NBG, PRE, S), *12741* (K, MO).

## 3. *Ixia rivulicola* Goldblatt & J.C.Manning, sp. nov.

Plantae 450–800 mm altae, cormo tunicis submembranosis basi cormo sessile ferenti, foliis (3)4 vel 5, inferioribus 2–4 anguste ensiformibus ad linearibus 3–7 mm

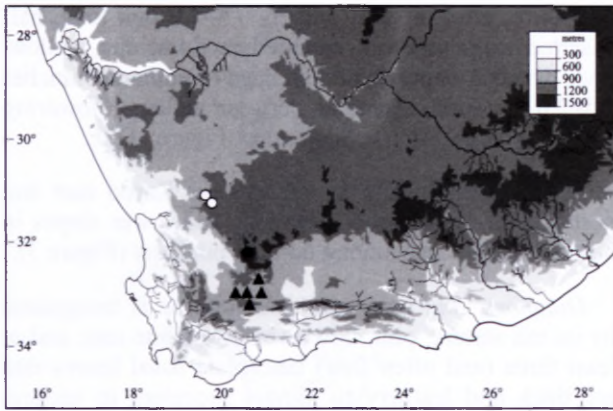


FIGURE 3.—Known distribution of *Ixia robusta*, ○; *I. rivulicola*, ●; and *I. lacerata*, ▲.

latis, spica 2 vel 3-flora, floribus albidis cupula pallide flava intense odoratis, tubo perianthii campanulato 8–9 mm longo, tepalis subaequalibus 17–18 × 5.0–7.5 mm, filamentis 3–4 mm longis, antheris 4.5–5.5 mm longis, stylo tertiam partem superam antherarum adversus dividenti, ramis ± 0.8 mm longis.

TYPE.—Northern Cape, 3220 (Sutherland): Roggeveld Escarpment, drift across Bo-Vis River at Noudrif Farm, in muddy ground, (–AB), 11 October 2004, Goldblatt & Porter 12666 (NBG, holo.; K, MO, PRE, iso.).

Plants 450–800 mm high. *Corm* subglobose, tunics of submembranous fibres soon disintegrating, bearing 1–few sessile cormlets at base. *Leaves* 3(4 or 5), lower 2–4 narrowly sword-shaped to linear, 3–7 mm wide, margins moderately thickened, hyaline when dry, straight, usually ± one third to half as long as stem, uppermost leaf sheathing stem, penultimate leaf often sheathing in lower half. *Stem* with 3–5 straight lateral branchlets mostly held at ± 30° to main axis, filiform, bearing flowers in upper half. *Main spike* mostly 2- or 3-flowered; lateral spikes 1- or 2-flowered; bracts translucent, outer with three dark veins, mostly ± 8 mm long, inner with two dark veins and forked apically. *Flowers* ascending to nearly horizontal, white with pale yellow cup, with strong fruity scent; perianth tube funnel-shaped, 8–9 mm long; tepals subequal, 17–18 × 5.0–7.5 mm, proximal 3–4 mm forming part of floral cup, spreading at right angles to tube distally. *Stamens* parallel; filaments 3–4 mm long, included, inserted ± 3 mm above base of tube; anthers 4.5–5.5 mm long, lower half included in tube. *Style* dividing opposite upper third of anthers, branches ± 0.8 mm long, extending between anthers. *Capsules* and *seeds* unknown. *Flowering time*: mainly October. Figure 4A–C.

*Distribution*: *Ixia rivulicola* is apparently restricted to the upper reaches of the Bo-Visrivier (Upper Fish River) on the Roggeveld Escarpment (Figure 3). First collected in 1981 by Harry Hall, this plant was not known to Lewis (1962) at the time that she completed her revision of *Ixia*, nor was it dealt with by De Vos (1999). Revisiting Hall's locality in the Roggeveld in October 2004 we found plants growing in shallow water close to the banks of the Visrivier near the entrance to Voëlfontein Farm. Further downstream at the drift across

the river at Noudrif Farm an extensive population was flowering particularly well where the reeds and cattails in the riverbed had been burned the past summer. The plants are tallest when growing in water among reeds but shorter when the surrounding vegetation is removed. The essentially aquatic habitat of this species is unique in the genus.

*Diagnosis and variation*: *Ixia rivulicola* is not simply a tall, white-flowered variant of *I. rapunculoides*, for the flowers are larger, with a tube 8–9 mm long, tepals 17–18 mm long, and anthers 4.5–5.5 mm long, compared with the shorter tube, 5.5–8.0(–10.0) mm long in *I. rapunculoides*, tepals 11–16 mm long, and anthers 2.3–3.5 mm long. The ascending to horizontally oriented flowers are white with a pale yellow cup and are particularly sweetly scented, the odour like that of *Virgilia oroboides* (Fabaceae), a combination of grenadilla fruit and violets. Typical blue-flowered *I. rapunculoides* grows on the slopes above the Visrivier and blooms in August and early September, and is in fruit by the time *I. rivulicola* comes into flower at the end of September or in early October. *Ixia rivulicola* responds well to cultivation, and survives outdoors in several degrees of freezing. Plants reproduce liberally by vegetative reproduction, unlike typical *I. rapunculoides*, although both produce cormlets at the base of the main corm.

Like other members of the *Ixia rapunculoides* complex, the flowers of *I. rivulicola* are pollinated by bees. At the type locality they were actively visited by a range of medium-sized and large-bodied bees, including *Apis mellifera*, *Amegilla spilostoma* (both Apidae), *Melitta capensis* (Melittidae), *Megachile* sp. (Megachilidae), *Plesanthidium calvini* and *Patellapis* sp. (both Halictidae). Male and female bees were captured as well as *Apis* workers, and all were found to carry *Ixia*-type pollen on their bodies.

#### *Additional specimens*

NORTHERN CAPE.—3220 (Sutherland): Roggeveld Escarpment, Farm Voëlfontein, in vlei in several inches of water, (–AB), 21 October 1981, Hall 5165 (MO, NBG).

#### 4. *Ixia lacerata* Goldblatt & J.C.Manning, sp. nov.

Plantae 150–350 mm altae, cormo tunics fibrosis, foliis 3, inferioribus 2 linearibus 5–10 mm latis, floribus ± horizontaliter extensis pallide caeruleis in cupula pallide flavis, tubo perianthii 10–12(–14) mm longis anguste campanulato, tepalis subaequalibus ovatis (10–)12–14 × 5–6 mm, filamentis ± 3 mm longis ± 6 mm supra basin tubi insertis, antheris ± 3 mm longis partim supra ex tubo exsertis, stylo mediam antherarum adversus dividenti, ramis ± 1 mm longis.

TYPE.—Western Cape, 3320 (Montagu): Klein Roggeveld, about 24 km north of N1 on road to Sutherland, dolerite slope, (–BA), 26 August 2006, Goldblatt & Porter 12702 (NBG, holo.; K, MO, PRE, iso.).

Plants 150–350 mm high. *Corm* subglobose, 14–20 mm diam., with tunics of firm-textured, coarse fibres, bearing small cormlets at base. *Leaves* 3, lower 2 lanceolate to falcate, 5–10 mm wide, plane, sometimes slightly twisted distally, ± one third to one quarter as

long as stem, margins slightly to moderately thickened, uppermost leaf sheathing stem in lower half to two thirds. *Stem* erect, wiry and sometimes somewhat coiled below spike, simple or with 1–3 short lateral branchlets, branchlets thread-like, short and twisted, subtended by filiform, forked or lacerate, distally spreading, silvery bracts and prophylls up to 5 mm long. *Main spike* (2)3–6-flowered, suberect, lateral spikes (1–)3- or 4-flowered; bracts translucent below, becoming rust-coloured in upper third, 6–7 mm long, outer mostly with 5 main veins and 5-toothed at apex, teeth attenuate, sometimes slightly lacerate, inner  $\pm$  as long as outer, with 2 main and 2 smaller veins, with 2–4 attenuate teeth. *Flowers*  $\pm$  horizontally oriented or suberect, pale blue-mauve, often whitish at base, with pale yellow cup, weakly rose-scented; perianth tube 10–12(–14) mm long; tepals subequal, (10–)12–14  $\times$  5–6 mm. *Stamens* parallel; filaments  $\pm$  3 mm long, inserted  $\pm$  6 mm from base of tube; anthers  $\pm$  3 mm long, yellow. *Style* dividing opposite middle of anthers, branches  $\pm$  1 mm long. *Capsules* globose,  $\pm$  4 mm long. *Seeds* subglobose, shiny,  $\pm$  1.5 mm at longest axis. *Flowering time*: mainly August to early September. Figure 4D–F.

*Distribution*: *Ixia lacerata* is restricted to slopes and flats in the Klein Roggeveld, which lies south of the main Roggeveld Escarpment, and the Koedoes Mountains to the west (Figure 3). Plants mostly grow on shales or mudstones of the Ecca System, and only occasionally on rocky, dolerite slopes in heavy clay, the habitat in which typical *I. rapunculoides* most frequently occurs.

*Diagnosis and variation*: until now the handful of specimens resembling typical *Ixia rapunculoides* from the Klein Roggeveld and Koedoes Mountains have been referred either to this taxon or to *I. namaquana*. Careful examination of flowers and bracts, however, shows that these plants differ consistently in several respects. The perianth tube is 10–14 mm long (vs 5.5–8(–10) mm in var. *rapunculoides* and (12–)13–16(–18) mm in *I. namaquana*); the outer bracts usually have five major veins and the inner, two main and often two smaller veins, with the veins terminating in attenuate teeth; and the margins are dry and often somewhat torn. The bracts in particular are highly diagnostic, contrasting with *I. rapunculoides* and most other species of *Ixia* subgenus *Morphixia*, which have 1- or 3-veined outer bracts and 2-veined inner bracts, the veins terminating in short, acute or blunt teeth. In addition to the floral differences, the flowering stem has only 1–3 branchlets, each bearing 1–3(4) flowers, and the branchlets are subtended by forked, thread-like bracts and prophylls that are spreading or directed downward distally, unlike the short, truncate and inconspicuous bracts in most other members of the *I. rapunculoides* complex, including *I. namaquana* and *I. rapunculoides* itself.

*Ixia lacerata* is poorly represented in herbaria and appears to have first been collected by the traveller-explorer William Burchell, who found the species on the Windheuwel in the Koedoes Mountains in July, 1811. Surprisingly, Burchell's collection attracted no botanical attention, although at the time the only *Ixia* known with short stamens and included filaments was *I. rapunculoides*, described in 1816 and not then known from any wild locality.

Our observations on the pollination of *Ixia lacerata* made in September 2006 at two sites showed that the most common insect visitor was an unnamed long-proboscid fly, *Prosoeca* sp. (Nemestrinidae). This fly, also the main pollinator of the long-tubed *Romulea syringodeoflora* M.P.de Vos (Goldblatt & Manning 2007), has a proboscis 10.5–11.5 mm long, a close fit for the perianth tube of *I. lacerata*, the base of which contains concentrated nectar, of 38–49% sucrose equivalents. Because of the short stamens in the species, contact between the anthers and the fly's body would be limited to the base of the proboscis. A less frequent visitor was the bee *Anthophora diversipes* (Apidae: Anthophorinae). Anthophorine bees are common visitors to flowers of members of the *I. rapunculoides* complex (Goldblatt *et al.* 2000) and are assumed to be their most important pollinators. The significance of the visits by *Prosoeca* species remains to be determined.

#### Selected specimens

NORTHERN CAPE.—3220 (Sutherland): Houthoek, Sutherland, (–CA), 13 August 1968, *Hanekom 1069* (K, PRE); Roggeveld Escarpment, Farm Kraairivier, 5 km from Ceres turnoff on Sutherland–Matjiesfontein road, yellow clay-gravel, (–CB), 25 August 1986, *Cloete & Haselau 8* (NBG); Windheuwel, Koedoes Mountains, (–CC–CD), 22 July 1811, *Burchell 1285* (K); 82 km S of Sutherland, rocky ridge, (–DC), 31 August 1993, *Goldblatt & Manning 9658* (NBG, MO); valley  $\pm$  9.5 km below Komsberg Pass, Klein Roggeveld, (–DB), 8 September 2006, *Goldblatt & Porter 12802* (MO, NBG, PRE); Klein Roggeveld, Farm De Hoop S of Komsberg Pass, (–DC), 30 September 2004 (fruiting), *Goldblatt & Porter 12659* (MO, NBG).

WESTERN CAPE.—3220 (Sutherland): 19 miles [ $\pm$  30 km] N of Matjiesfontein, (–DC), 15 September 1955, *Acocks 18440* (K, PRE); 1 km along turnoff to Komsberg Pass, (–DC), 26 August 2006, *Goldblatt & Porter 12708* (MO, NBG); north of Matjiesfontein on road to Sutherland, Farm Nuwerus, (–DC), 14 September 2004, *Snijman 1929* (NBG).

#### 5. *Ixia sobolifera* Goldblatt & J.C.Manning, sp. nov.

Plantae (150–)250–750 mm altae, cormo stolonifero tunicis  $\pm$  papyraceis, foliis 3, inferioribus 2 laminiis linearibus vel anguste ensiformibus (1.5–)2.0–5.0(–8.0) mm latis, floribus nutantibus carneis vel ardesiaco-caeruleis cupula alba vel pallide flava usitate fragrantibus, tubo perianthii 5–10 mm longo infundibulari, tepalis subaequalibus ovatis 10–17  $\times$  4.5–7.5 mm, filamentis 2–3 mm longis 3–4 mm supra basem tubi insertis, antheris 3.0–4.5 mm longis partis supra ex tubo exsertis, stylo apicem antherarum adversus dividenti, ramis styli 1.0–1.5 mm longis.

TYPE.—Northern Cape, 3320 (Montagu): north of Matjiesfontein on road to Sutherland, (–BA), 9 September 2006, *Goldblatt & Porter 12809* (NBG, holo.; MO, PRE, iso.).

Plants (150–)250–750 mm high. *Corm* subglobose, 8–12 mm diam., with soft,  $\pm$  papery tunics, producing flattened, corm-bearing stolons from base. *Leaves* 3, lower 2 linear, often trailing above, (1.5–)2.0–5.0(–8.0) mm wide,  $\pm$  half as long as stem, margins plane, barely thickened, edges flat or concave, uppermost leaf sheathing stem below spike. *Stem* erect, with 1–5 twisted, filiform branchlets subtended by forked, attenuate bracts and prophylls 2–5 mm long. *Main spike* nodding, 2–5(–7)-flowered, lateral spikes nodding, (1)2–4(5)-flowered;



FIGURE 4.—A–C, *Ixia rivulicola*, Goldblatt & Porter 12665 (MO, NBG): A, whole plant; B, 1/5 flower; C, bracts: outer (left), inner (right). D–F, *Ixia lacerata*, Goldblatt & Porter 12702 (MO, NBG): D, whole plant; E, 1/5 flower; F, bracts: outer (left), inner (right). G–I, *Ixia sobolifera* subsp. *carnea*, Goldblatt & Porter 11810 (MO, NBG): G, whole plant; H, 1/5 flower; I, bracts: outer (left), inner (right). Scale bars: 10 mm. Artist: J.C. Manning.

bracts translucent, or becoming dry and brown distally with age, outer with three dark veins, 6–10 mm long, inner similar but with two dark veins and forked apically. *Flowers* half to fully nodding, pink or slate blue with white cup, or white with pale yellow cup, faintly rose- to strongly carnation-scented; perianth tube 5–10 mm long, funnel-shaped, flaring in upper  $\pm$  5 mm; tepals subequal, ovate or narrowly ovate, 10–17  $\times$  4.5–7.0 mm, proximal  $\pm$  3 mm forming part of floral cup, spreading at right angles to tube distally. *Stamens* parallel; filaments 2–3 mm long, inserted 3–4 mm above base of tube; anthers 3.0–4.5 mm long, included or half exserted from tube but included in floral cup, uniformly pale yellow or

marked with dark, longitudinal streaks. *Style* dividing opposite or slightly beyond anther tips, branches 1.0–1.5 mm long, usually exceeding anthers when mature. *Flowering time*: August to mid-September.

*Distribution*: *Ixia sobolifera* extends from the Langberg and Kubiskou ranges northwest of Loeriesfontein in Northern Cape though the western Karoo and interior Western Cape to the Little Karoo (Figure 5). More detailed distribution and habitat information is provided under the subspecies.

*Diagnosis and variation*: included by Lewis (1962) in *Ixia rapunculoides* var. *flaccida*, *I. sobolifera* is rec-

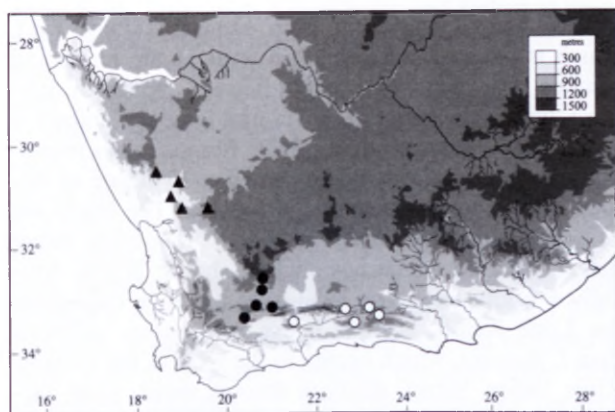


FIGURE 5.—Known distribution of *Ixia sobolifera* subsp. *albiflora*, ○; subsp. *carnea*, ▲; and subsp. *sobolifera*, ●.

ognized by the combination of corms with soft papery (rather than fibrous) tunics, producing prominent, ribbon-like stolons from the base; a main spike bearing 2–5(–7), half to fully nodding flowers; filiform bracts and prophylls subtending the branchlets; pink, slate-blue or white flowers with a white or yellow cup; and a perianth tube 6–10 mm long. We recognize three subspecies, each with a separate geographic range and minor distinguishing characters. Subsp. *carnea* from the Bokkeveld Plateau and its extensions, the Kubiskou and Langberg, has a pink perianth with white cup, bracts somewhat dry and dark brown at the tips with age, and anthers marked with dark longitudinal lines; subsp. *sobolifera*, from the Klein Roggeveld and nearby, has slate blue flowers and particularly slender stems; and subsp. *albiflora* from the Little Karoo has white, intensely fragrant flowers.

So-called *Ixia rapunculoides* var. *flaccida* from the Olifants River Valley, to which collections of *I. sobolifera* have until now been referred (Lewis 1962), has horizontally oriented, white or pale blue flowers, a stem with longer branchlets, and short floral bracts 5–7 mm long (vs 6–10 mm in *I. sobolifera*). The corm bears sessile cormlets at the base and has tunics of medium-textured, netted fibres.

#### 5a. subsp. *sobolifera*

Stems slender and drooping above, branchlets mostly 1- or 2-flowered; bracts 7–9 mm long, translucent with dark veins, not turning rust-coloured above with age. *Flowers* slate or grey-blue with white cup, faintly scented; perianth tube 5–6 mm long; tepals 10–12 × 4.5–5.5 mm. *Filaments* 2–3 mm long; anthers 4.0–4.5 mm long, uniformly yellow; style reaching or exceeding anther tips, style branches 1.0–1.5 mm long.

*Distribution*: so far recorded only from the Klein Roggeveld and adjacent hills between the Witteberg in the south and the Komsberg and Verlate Kloof in the north (Figure 5). Until now, subsp. *sobolifera* was hardly known, and we have found just three earlier collections, *Compton* 9272 and *Snijman* 539, both from Ngaap (Gwaap) Kop near Matjiesfontein, and *Levy* 1368 from Verlate Kloof, in the several herbaria that we have consulted. Our field research in 2006, a year of ample rainfall in the Western Karoo, yielded small populations at five separate sites, from Komsberg Pass in the north to

Memorial west of Matjiesfontein in the south. Additional collecting in the Koedoes Mtns and on the Roggeveld Escarpment will likely extend the known range of subsp. *sobolifera*.

*Diagnosis and variation*: subsp. *sobolifera* is distinguished from the two other subspecies of *Ixia sobolifera* by its nodding, slate-blue flowers borne on very slender, distally arching stems. Unlike pink-flowered subsp. *carnea*, the bracts do not turn dark brown above with age, and the spike and branchlets have one or two, rarely three flowers, fewer than either subsp. *carnea* or the white-flowered subsp. *albiflora*. A distinctive feature of the southern populations of the subspecies is the longer style, which overtops the anthers, and not known elsewhere in the species.

#### *Additional specimens*

**NORTHERN CAPE**.—3220 (Sutherland): Sutherland, Verlate Kloof, (–DA), 5 Sept. 1926, *Levy* 1638 (BOL); 2 km below top of Komsberg Pass, (–DB), 9 September 2006, *Goldblatt & Porter* 12804 (MO, NBG); De Kom Valley, 9.5 km south of Komsberg Pass [sympatric and blooming with *I. lacerata*], (–DB), 9 September 2006, *Goldblatt & Porter* 12804A (MO).

**WESTERN CAPE**.—3320 (Montagu): Ngaap Kop, (–BA), 2 September 1940, *Compton* 9272 (NBG); summit of Gwaapkop near Matjiesfontein, 24 September 1981, (–BA), *D. Snijman* 539 (NBG); Klein Roggeveld, ± 24 km north of N1 on road to Sutherland, dolerite slope, (–BA), 26 August 2006, *Goldblatt & Porter* 12701 (MO); Memorial Siding, west of Matjiesfontein along N1 [sympatric and blooming with *I. lacerata*], (–AB), 9 September 2006, *Goldblatt & Porter* 12810 (MO, NBG).

5b. subsp. *carnea* *Goldblatt & J.C. Manning*, subsp. nov.

Plantae (150–)250–750 mm altae, laminis foliorum (1.5–)2.0–3.5 mm latis, caule erecto ramis 1–3 filiformibus contortis, spica 1–3(4) flora, bracteis translucenibus aetate ferrugineis in dimidio superiore, bracteis exterioribus 8–10 mm longis, floribus carneis cupula alba, tubo perianthii 9–10 mm longa, tepalis 12–16 × 4.5–6.0 mm, antheris 3–4 mm longis pallide flavis atrolineatis.

*TYPE*.—Northern Cape, 3119 (Calvinia): Nieuwoudtville, Glenlyon Farm, dolerite koppies, in bush, (–AC), 2 September 2001, *Goldblatt & Porter* 11810 (NBG, holo.; MO, PRE, iso.).

Plants (150–)250–750 mm high. *Leaves* 3, blades linear, often trailing above, 1.5–3.5 mm wide. *Stem* with 1–3 twisted, filiform branchlets. *Main spike* mostly 2–4-flowered, lateral spikes 1–3(4)-flowered; bracts translucent, becoming brown with age in upper half, outer 8–10 mm long. *Flowers* pale to deep pink with white cup, faintly rose-scented; perianth tube 9–10 mm long, tepals 12–16 × 4.5–6.0 mm. *Filaments* ± 3 mm long, inserted ± 4 mm above base of tube; anthers 3–4 mm long, pale yellow with dark longitudinal lines on thecae; style reaching anther tips. Figure 4G–I.

*Distribution*: subsp. *carnea* is restricted to the northern end of the range of *Ixia sobolifera*, where it has been recorded from a few sites on the Bokkeveld Plateau, mostly near Nieuwoudtville, on the Hantamsberg some 80 km to the east, and also on Kubiskou Mountain near Loeriesfontein and the Langberg to the west (Figure 5). Plants are most often found on dolerite-derived clay or

on shale slopes but northwest of Nieuwoudtville, near the Farm Biekoes, plants grow on sandy tillite soils among sandstone rocks. The species is fairly common in the rocky dolerite hills of the Nieuwoudtville Wildflower Reserve and in similar habitats to the south on the farms Glenlyon and Oorlogskloof.

*Diagnosis and variation:* apart from the distinctive pink perianth, for which the taxon is named, an odd feature of subsp. *carnea* is the presence of dark longitudinal lines on the anthers that contrast with the otherwise yellow colour. Plants are sympatric and bloom at the same time as the longer-tubed *I. namaquana* northwest of Nieuwoudtville and with *I. rapunculoides* in the dolerite hills east of Nieuwoudtville and on the Hantamsberg.

#### *Additional specimens*

NORTHERN CAPE.—3018 (Kamiesberg): Langberg W of Loeriesfontein, wet gully, on shale, (–DB), 5 September 2006, *Goldblatt & Porter 12764* (MO, NBG, PRE). 3019 (Loeriesfontein): upper slopes and summit of Kubiskou, in shale or dolerite, (–CD), 14 September 2006, *Goldblatt & Porter 12820* (MO, NBG, PRE). 3119 (Calvinia): Klipkoppies, among rocks, (–AC), 9 September 1961, *Lewis 5862* (NBG); 4 miles [6.4 km] N of Nieuwoudtville, (–AC), September 1930, *L. Bolus s.n. (BOL19589)*; between Grasberg and Nieuwoudtville, (–AC), 8 August 1961, *Lewis 5840* (NBG), [co-blooming with *I. namaquana*], 11 September 2004, *Goldblatt & Porter 12406* (MO, NBG); dolerite koppies, Nieuwoudtville Wildflower Reserve, (–AC), 12 September 2004, *Goldblatt & Porter 12422* (MO, NBG); Hantamsberg, lower S-facing slopes, (–BC), 4 September 1991, *Goldblatt 9169* (MO, NBG); Hantamsberg slopes, after fire, in tufts of grass and among shrubs [sympatric and blooming with *I. rapunculoides*], (–BD), 4 September 2002, *Goldblatt & Porter 12161* (MO, NBG).

5c. subsp. **albiflora** *Goldblatt & J.C.Manning*, subsp. nov.

Plantae 400–650 mm altae, laminis foliorum anguste ensiformibus vel linearibus 4–8 mm latis, caule 2 vel 3(–5) ramoso, spica 4– vel 5(–7) flora, bracteis usitate 6–8 mm longis, floribus albis cupula pallide flava intense fragrantibus, tubo perianthii 6–7 mm longo, tepalis 12–17 × 5.0–7.5 mm, antheris ± 3 mm longis flavis.

TYPE.—Western Cape, 3322 (Oudtshoorn): Farm Buffelskloof, 35 km from Dysveldorp on Laudina road, south-facing shale hillside, (–DA), 12 September 2003, *Goldblatt & Porter 12291* (NBG, holo.; K, MO, PRE, iso.).

Plants 400–650 mm high. *Leaves* linear to narrowly sword-shaped, 4–8 mm wide. *Stem* erect, with 2 or 3(–5) suberect to spreading, filiform branchlets subtended by silvery-translucent bracts mostly 3–4 mm long. *Main spike* 4- or 5(–7)-flowered, lateral spikes (1)2- or 3(–5)-flowered; bracts membranous and translucent, mostly 6–8 mm long. *Flowers* creamy white with pale yellow cup, sometimes flushed grey-mauve outside, nodding, intensely carnation-scented; perianth tube 6–7 mm long, tepals 12–17 × 5.0–7.5 mm. *Filaments* ± 3 mm long; anthers ± 3 mm, uniformly pale yellow; style reaching anther tips. *Flowering time:* August to mid-September.

*Distribution:* mainly restricted to the central Little Karoo, subsp. *albiflora* is known from just a handful of sites, mostly south and east of Oudtshoorn, with one record from the northern foothills of the Swartberg, east of Prince Albert (Figure 5). We also provisionally

include here a collection from Montagu (*Page s.n.*), which is isolated some 150 km west of the remaining stations. The plants have white flowers, typical of *albiflora*, with a perianth tube ± 7.5 mm long and anthers ± 4 mm long, but the corm has finely fibrous tunics resembling those of *I. flaccida* and shows no evidence of stolons, critical in recognizing *I. sobolifera*. The bracts are ± 7 mm long, also consistent with *I. sobolifera* rather than *I. flaccida* which has slightly shorter bracts, typically ± 6 mm long. The locality of the Page collection, the Little Karoo, accords better with subsp. *albiflora* than *I. flaccida*, which occurs to the west in the Olifants River Valley. Subsp. *albiflora* favours moist, south-facing slopes and grows in pockets of loamy soil on shale in renosterveld. The habitat for the collection from Montagu is from rocky slopes and cliffs, but the rock type is not recorded.

*Diagnosis and variation:* subsp. *albiflora* is distinguished from its sister subspecies mainly by the white, strongly carnation-scented flowers with a yellow cup, and also by the 4- or 5(–7)-flowered main spike, perianth tube 6–7 mm long (perianth tube 9–10 mm long in subsp. *carnea* and 5–6 mm in subsp. *sobolifera*), and often broader leaves, 4–8 mm wide.

Lewis (1962) included the two collections of *Ixia sobolifera* subsp. *albiflora* known to her (*Page s.n.* and *Thorne s.n.*) in *I. rapunculoides* var. *flaccida* (now *I. flaccida*), which occurs in the Olifants River Valley, well to the west. As we have discussed above, this is distinct from the stoloniferous *I. sobolifera*, which also has larger flowers with a longer perianth tube and longer anthers.

#### *Additional specimens*

WESTERN CAPE.—3320 (Montagu): Montagu Baths, common on rocky slopes and cliffs in gorge, (–CC), August 1920, *Page s.n. (BOL)*. 3321 (Ladismith): SW of Oudtshoorn near Perdebont, (–DB), 12 August 2004, *Vlok & Schutte 494* (MO, NBG). 3322 (Oudtshoorn): lower north slopes of the Swartberg, Farm Frisgewaagd, burned S-facing slope, 900 m. in loamy soil, (–AD), 12 September 1986, *Vlok 1586* (MO, NBG, PRE); Oudtshoorn, Grootkop, 440 m, deep loamy soil on S-facing slope, rare, (–CA), 18 August 2005, *Vlok & Schutte 506* (NBG); Oudtshoorn, Kleinfontein, (–CA), August 1931, *Thorne s.n. (SAM51702)*; Farm Buffelskloof, 35 km from Dysveldorp on Laudina road, south-facing shale hillside, (–DA), 12 September 2004, *Goldblatt & Porter 12484A* (MO, NBG).

6. *Ixia namaquana* *L.Bolus*, South African Gardening and Country Life 21: 368 (1931). *I. rapunculoides* var. *namaquana* (*L.Bolus*) *G.J.Lewis*: 76 (1962). Type: South Africa, [Northern Cape], Klipfontein, September 1883, *H. Bolus* as Herbario Normale Austro-Africana 698 (*BOL!*, lecto., designated by *De Vos* (1999: 15); *B*, *G*, *K!*, *PRE!*, *SAM!*, *Z*, isolecto.).

Plants mostly 300–500 mm high. *Corm* 12–15 mm diam., with tunics of medium-textured to coarse fibres. *Leaves* 3, lower 2 sword-shaped to falcate, mostly 8–18 mm wide (particularly broad in the type), margins thickened and hyaline, sometimes minutely crisped, usually ± one third as long as stem but sometimes much shorter, uppermost leaf sheathing stem. *Stem* with several short, filiform, twisted lateral branchlets, subtended by short bracts ± 2 mm long. *Main spike* erect, 2- or 3-flowered, lateral spikes 1- or 2-flowered; bracts translucent, outer with 3 dark veins, ± 10 mm long, with 3 short, sub-

equal teeth, inner with 2 dark veins and forked at apex. *Flowers* held  $\pm$  horizontally, whitish to pale mauve, lilac, pale blue or pink with yellow cup, rim of cup marked with a band of short vertical lines, often flushed lilac to mauve outside, violet-scented or unscented; perianth tube 12–16(–18) mm long, narrowly funnel-shaped; tepals subequal, ovate, (12–)14–17  $\times$  5–7 mm (inner), 6–8 mm (outer), proximal 4–6 mm forming part of floral cup, spreading at right angles to tube in distal 10–12 mm. *Stamens* parallel; filaments erect, 4–5 mm long, inserted  $\pm$  6–10 mm above base of tube; anthers 3.5–4.5 mm long, upper half exerted from tube but included in floral cup. *Style* mostly dividing opposite upper third of anthers, branches  $\pm$  1 mm long, extending between anthers (in the type, dividing at anther tips with branches arching above anthers and 1.5 mm long). *Capsules* ovoid,  $\pm$  9 mm long. *Seeds* unknown. *Flowering time*: mainly August to mid-September, rarely October. Figure 6A–D.

*Distribution*: *Ixia namaquana* has a scattered distribution in Northern and Western Cape, and has been recorded from the Richtersveld and the high ground around Steinkopf in northern Namaqualand, from the southern Kamiesberg in central Namaqualand, and from the Bokkeveld Mtns and northern Cedarberg to the south (Figure 7). The disjunct distribution between the Steinkopf area of Namaqualand and the southern Kamiesberg is a pattern shared by *Brunsvigia pulchra* (Amaryllidaceae) and is probably related to the somewhat lower altitude and associated reduction in precipitation of the country between these two high-lying points. Another species pair with this distribution is *Hessea pilosula* (Amaryllidaceae) from the Steinkopf area and its sister species *H. incana* from the Kamiesberg. There are no significant differences between the northern Namaqualand populations of *I. namaquana* and those from the south except for the bright pink flower colour (rather than pale mauve to blue) in the type form, which occurs on clay soils. In the Kamiesberg, *I. namaquana* occurs on granitic gravel but in the Bokkeveld Mtns, Gifberg and Cedarberg it grows in sands derived from Cape Sandstone formations. Plants that we assign to *I. namaquana* from the Wiedouw River (Lewis 1980), south of Vanrhynsdorp, probably grow on loam among limestone outcrops, the main formation there but we have not seen the species at this site ourselves.

*Diagnosis and variation*: *Ixia namaquana* is readily distinguished from other members of the *I. rapunculoides* complex by the longer perianth tube, mostly 13–16 mm, short branchlets bearing 1 or 2 flowers each, and corn with tunics of coarse, netted fibres. The flowers are relatively large with tepals mostly 14–16 mm long and anthers 3.5–4.5 mm long. The proximal part of the tepals is directed forward, forming part of the floral cup, which fully encloses the stamens. The flowers are usually sweetly scented but are apparently unscented in plants from Vanrhyn's Pass and Nieuwoudtville in the Bokkeveld Mtns. Pink-flowered plants with a perianth tube 16–22 mm long from the Hex River Pass and nearby that were identified as *I. namaquana* by De Vos (1999) and others, are here referred to the new *I. oxalidiflora*. This species can be distinguished from *I. namaquana* by the longer perianth tube, suberect rather than

horizontally spreading flowers, fully included anthers, and perhaps most significant, by the corms with papery to finely fibrous tunics and bearing ribbon-like stolons.

Plants from a seasonally wet site near Leliefontein in the Kamiesberg, referred to *Ixia namaquana* by De Vos in various herbaria, differ in their later flowering time, October and November, and in having a white perianth with tepals pale blue at the tips, filaments shortly exerted, a perianth tube  $\pm$  7 mm long, and narrow leaves. They are obviously misplaced in *Ixia namaquana* and apparently represent a late-flowering ecotype of *I. latifolia* var. *ramulosa* from moist habitats.

First collected by Harry Bolus in 1883 at Klipfontein near Steinkopf in northern Namaqualand, *Ixia namaquana* was described by his niece, H.M.L. Bolus in 1931. The species was based on the Bolus collection and one more (*Herre s.n.*) from nearby, both having the large, pink flowers that characterize the northern populations of the species. The presence of pale lilac- to almost white-flowered plants otherwise resembling *I. namaquana* from the Bokkeveld Mountains, well to the south, was only established later and Lewis (1962) included these as well as the northern Namaqualand plants in *I. rapunculoides* var. *namaquana*. In De Vos's (1999) account of var. *namaquana*, its range is extended to include the northern Cedarberg (*Compton 24239*), and the Laingsburg and Worcester Districts, but no species are cited from the latter two areas, and we do not recognize the taxon from south of the Cedarberg. The presence of *I. namaquana* in the Kamiesberg of central Namaqualand was first recognized by De Vos (1999); some plants from there were referred by Lewis to the shorter-tubed var. *rapunculoides*. The Kamiesberg plants more closely resemble those from the Bokkeveld Mountains rather than those from northern Namaqualand. The type of *I. namaquana* has particularly large flowers, with the tube up to 18 mm long, and the style divides opposite the anther tips with the branches extending above them. Specimens of other northern Namaqualand collections are less well pressed and it is impossible to say if the features of the type plants are shared with all other specimens from the area. The northern populations need more careful study.

#### *Selected specimens*

NORTHERN CAPE.—2917 (Springbok): Richtersveld, Kalkfontein, (–AA), without date, *Meyer s.n.* (NBG178595); Klipfontein, (–BA), without date, *Marloth 12678* (PRE), 29 August 1935, *Compton 5411* (BOL, K, NBG); Kasteelpoort, Steinkopf, (–BA), 7 September 1929 (NBG); Steinkopf, western mountains, (–BA), 9 September 1929, *Herre s.n.* (*STEU11846* in BOL, K, PRE); Steinkopf, (–BA), 24 August 1959, *Lewis 5494* (NBG); 4 km W of Steinkopf, (–BA), September 1993, *Williamson 5301* (NBG). 3018 (Kamiesberg): Leliefontein, (–AC), 2 October 1947, *Rodin 1474* (PRE); Kamiesberg, Rondefontein, slopes south of Nartjiesdam, (–CA), 1 September 1975, *Oliver 5972* (NBG, PRE). 3119 (Calvinia): between top of Vanrhyn's Pass and Nieuwoudtville, (–CA), 23 August 1950, *Lewis 2287* (SAM); Nieuwoudtville, Glenridge, (–AC), 18 August 1960, *Lewis 5725* (BOL, K, NBG); Grasberg, NW of Nieuwoudtville, (–AC), 16 September 1961, *Barker 9553* (BOL, MO, NBG, PRE); Grasberg road, NW of Nieuwoudtville, Farm Biekoes, (–AC), 11 September 2004, *Goldblatt & Porter 12407A* (MO); Lokenburg, (–CA), 29 August 1941, *Esterhuysen 5755* (BOL, PRE); Oorlogskloof Nature Reserve (grid A6), 680 m, sandy loam, (–CA), 4 August 1988, *Pretorius 75* (MO, NBG, PRE); top of Botterkloof Pass, (–CC), 21 July 1961, *Lewis 5789* (BOL, K, NBG, PRE).

WESTERN CAPE.—3119 (Calvinia): Kobee Valley, (–CA), 1 September 2001, *Goldblatt & Porter 11805* (MO, NBG). 3118

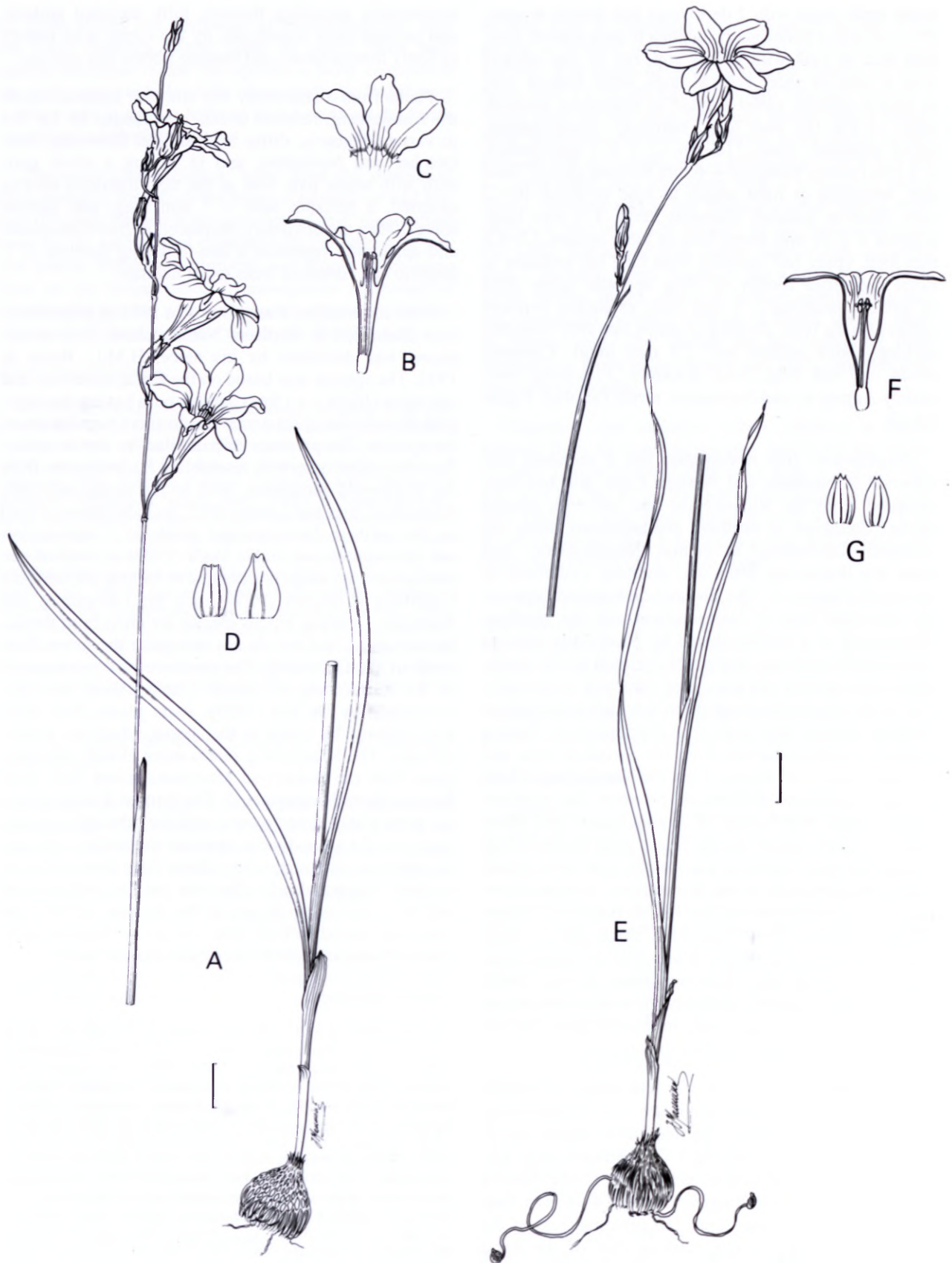


FIGURE 6.—A–D, *Ixia namaquana*, Goldblatt 12680 (MO, NBG): A, whole plant; B, l/s flower; C, detail of tepals showing markings; D, bracts: outer (left), inner (right). E–G, *Ixia oxalidiflora*, Manning & Goldblatt 2293 (MO, NBG): E, whole plant; F, l/s flower; G, bracts: outer (left), inner (right). Scale bars: 10 mm. Artist: J.C. Manning.

(Vanhynsdorp): Gifberg, (–BB), 11 September 1911, *Phillips* 7507 (NBG); 17 miles [25 km] NE of Vanhynsdorp on road to pass, (–BD), 28 August 1950, *Lewis s.n.* (PRE, SAM60851). 3218 (Clanwilliam): 7 km S of Clanwilliam Dam, shady S-facing slope, (–BB), 18 July 1984, *Goldblatt* 7130 (MO); Pakhuis Pass, steep

rocky S-facing slopes below cliffs above Kliphuis campsite, (–BB), 11 August 1994, *Goldblatt & Manning* 9922 (MO). 3219 (Wuppertal): Citadel Kop, (–AA), 2 September 1953, *Compton* 24239 (NBG, PRE); Wuppertal, (–AA), August 1916, *Marloth* 9550 (PRE).



7. *Ixia flaccida* (G.J.Lewis) Goldblatt & J.C.Manning, comb. et stat. nov.

*I. rapunculoides* var. *flaccida* G.J.Lewis in Journal of South African Botany 27: 74 (1962). Type: South Africa, [Western Cape], Boschklouf, 7 Aug 1896, R. Schlechter 8432 (BM, BOL!, G, K!, L, MO!, PRE (two sheets)!, S, Z, syn.).

Plants 200–350 mm high. *Corm* subglobose, tunics of medium-textured, netted fibres, bearing 1–few sessile, basal cormlets and rarely a short stolon. *Leaves* 3(4), lower 2(3) sword-shaped to linear, 4–9 mm wide, margins hardly thickened, straight, usually about half as long as stem, uppermost leaf sheathing stem. *Stem* erect, slender-filiform, with 4–6 loosely twisted, filiform branchlets up to 35 mm long, spreading at right angles to main axis, subtended by minute, acute bracts and prophylls  $\pm$  1 mm long. *Main spike* 2–4-flowered, lateral spikes 1–3-flowered; bracts translucent light brown, outer with three dark veins, mostly 5–6 mm long, inner as long or slightly longer than outer, with two dark veins and forked at apex. *Flowers* horizontally oriented, white or pale blue with white to greenish cup, apparently unscented; perianth tube funnel-shaped, 7–9 mm long; tepals subequal,  $\pm$  14.0  $\times$  3.5–4.5 mm, proximal 3–4 mm forming part of floral cup, spreading at right angles to cup distally. *Stamens* parallel; filaments 2.5–3.0 mm long, included in tube, inserted 3–4 mm above base of tube; anthers  $\pm$  2.5 mm long, lower half included in tube. *Style* dividing at mid-anther level, branches  $\pm$  1 mm long, extending between anthers. *Capsules* and *seeds* unknown. *Flowering time*: late July to early September.

*Distribution*: restricted to the Olifants River Valley and nearby, *Ixia flaccida* grows on seasonally moist, south-facing, sandy, or sometimes light, loamy clay slopes, among rocks usually in the shade of shrubs and small trees (Figure 8).

*Diagnosis and variation*: the flowers of *Ixia flaccida* are relatively small, with tepals  $\pm$  14  $\times$  3.4–4.5 mm, perianth tube 7–9 mm long, and anthers  $\pm$  2.5 mm long. The tunics of medium-textured to fine fibres and the  $\pm$  linear or narrowly sword-shaped, soft-textured leaves, as well as the white or pale blue flowers, readily distinguish the species from typical *I. rapunculoides*, which has blue to blue-mauve or sometimes pink flowers with a yellow cup.

In addition to the Olifants River Valley collections that closely match the type of *I. rapunculoides* var. *flac-*

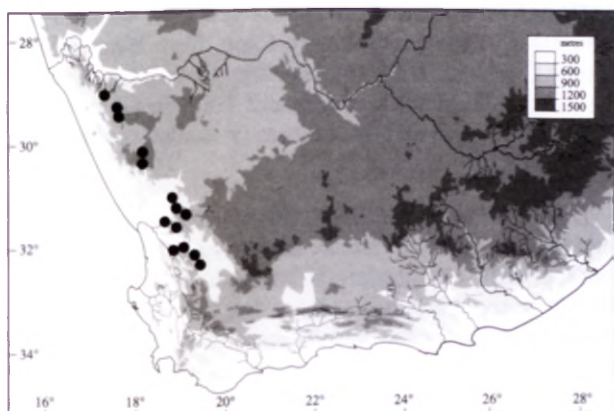


FIGURE 7.—Known distribution of *Ixia namaquana*.

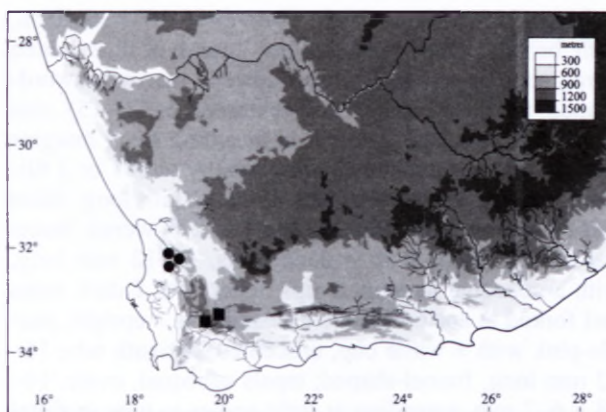


FIGURE 8.—Known distribution of *Ixia flaccida*, ●; *I. oxalidiflora*, ■.

*cida*, Lewis (1962) included pink-flowered plants from the Bokkeveld Plateau and white-flowered plants from the Little Karoo in the taxon. As outlined above, we regard the Bokkeveld plants as *I. sobolifera* subsp. *carnea* and the Little Karoo plants as *I. sobolifera* subsp. *albiflora*. Both differ from var. *flaccida* in their corms, which have soft-textured, short-lived tunics and produce long, ribbon-like stolons. They also differ in some floral features, notably the longer bracts, 6–10 mm long (vs 5–6 mm long in *I. flaccida*) and, in subsp. *carnea*, a longer perianth tube 9–10 mm long and longer anthers 3–4 mm long.

The earliest record we have found of the species is the collection made by P.A. Mader near Clanwilliam,  $\pm$  1874. A later collection made by Rudolf Schlechter in 1894 is from an unlikely locality, near Porterville, that requires confirmation. These collections and the few made later were referred to *Ixia rapunculoides* until 1962 when Lewis (1962) chose a second Schlechter collection, made in 1896, from Boschklouf [Boschkloof] east of Clanwilliam, as the type of her new *I. rapunculoides* var. *flaccida*.

*Selected specimens*

WESTERN CAPE.—3218 (Clanwilliam): Clanwilliam, (–BB), without date, Mader 193 (K), August 1905, H. Bolus 10619 (BOL); near Clanwilliam Dam, (–BB), July 1948, Lewis 1981 (SAM); 9 miles [21 km] S of Clanwilliam, damp slopes above road, (–BB), 26 August 1957, Lewis 5210 (NBG); N of Citrusdal at Marcuskraal turnoff, sandy, S-facing bank, (–BD), 31 August 2005, Goldblatt 12678 (MO, NBG). 3219 (Wuppertal): Cedarberg, Langrug Farm, moist sand in shade, (–AC), 21 August 1982, Viviers 508 (PRE). Doubtful locality: 3218 (Clanwilliam): sandy places near Porterville, 240 m, (–DD), 20 August 1894, Schlechter 4913 (MO, PRE).

8. *Ixia oxalidiflora* Goldblatt & J.C.Manning, sp. nov.

Plantae 200–450 mm altae, cormo 6–8(–10) mm diam. stolonifero, tunicis fibrosis tenuibus, foliis 3, inferioribus 2 anguste ensiformibus 6–12(–15) mm latis, spica 2–4-flora, floribus pallide purpureo-carneis cupula alba, inodoris, tubo perianthii 16–22 mm longo, tepalis subaequalibus 14–18  $\times$  6–7 mm, filamentis  $\pm$  4 mm longis, antheris  $\pm$  3.5 mm longis in tubo inclusis, stylo bases antherarum adversus dividenti, ramis  $\pm$  1 mm longis.

TYPE.—Western Cape, 3319 (Worcester): Hex River Pass, south-facing clay slopes, (–BC), 2 September 1992, Goldblatt & Manning 9397 (NBG, holo.; MO, iso.).

Plants 200–450 mm high. *Corm* 6–8(–10) mm diam., with broad, compressed stolons, tunics of fine netted fibres, soon decaying. *Leaves* 3, lower 2 narrowly sword-shaped to linear, fairly soft-textured, 6–12(–15) mm wide, attenuate, uppermost leaf sheathing stem, margins straight and not thickened. *Stem* usually with 1 or 2 filiform, twisted lateral branches up to 12 mm long. *Main spike* 2–4-flowered, lateral spikes 1 or 2-flowered; bracts translucent, outer with 3 dark veins, 10–12 mm long, with 3 subequal acuminate tips, inner with 2 dark veins and forked at apex. *Flowers* ascending to ± upright, purple-pink with ± white cup, unscented; perianth tube 16–22 mm long, funnel-shaped; tepals subequal, ovate, 14–18 × 6–7 mm, spreading at right angles to tube in distal 10–12 mm. *Stamens* parallel; filaments erect, ± 4 mm long, inserted 8–10 mm above base of tube; anthers ± 3.5 mm long, included in tube, tips reaching up to 0.5–2.0 mm below mouth of tube. *Style* dividing opposite middle of anthers, branches ± 1 mm long, extending between anthers. *Capsules* and *seeds* unknown. *Flowering time*: mid-August to mid-September. Figure 6E–G.

*Distribution*: *Ixia oxalidiflora* is currently known from two sites, the top of Hex River Pass, and near Tweedside Station, ± 60 km to the east (Figure 8). It favours south-trending slopes and clay or loamy soils, where it typically grows wedged in crevices of shale outcrops. The purple-pink flowers with a white cup (the latter sometimes described as pale yellow) closely resemble in shape and colouring those of co-occurring *Oxalis heterophylla* (Oxalidaceae) which blooms at the same time.

*Diagnosis and variation*: the earliest record of the species that we have traced is one made by F.A. Rogers in 1915. Early collections of *Ixia oxalidiflora* were referred to *I. rapunculoides* var. *namaquana* without comment by Lewis (1962) and De Vos (1999), although these specimens equally resemble similarly large-flowered *I. pauciflora* G.J.Lewis in general aspect. Careful examination of the flowers, however, shows that they differ markedly from both taxa in having the stamens fully included in the perianth tube, with the anther tips reaching 0.2–0.5 mm below the tube apex, and a perianth tube 16–22 mm long. In *I. namaquana*, only the filaments and bases of the anthers are included in the tube, which is shorter, mostly 13–16 mm long, and in *I. pauciflora*, the tips of the filaments are typically exerted from the tube. The corms, which have soft-textured tunics and long stolons, resemble neither species, and the lanceolate, soft-textured leaves are quite different to the linear, very narrow, firm leaves of *I. pauciflora* or the broader, leathery leaves of *I. namaquana*. *Ixia oxalidiflora* is thus recognized by the combination of fully included stamens, a perianth tube 16–22 mm long, soft-textured leaves, 6–12(–15) mm wide, and the small corms that bear long, flat stolons. The flowers are also held upright, a feature only apparent when plants are seen alive, thus unlike the horizontal flowers of *I. namaquana* and *I. pauciflora*.

#### Selected specimens

WESTERN CAPE—3319 (Worcester): Hex River Pass, south-facing shale slopes, (–BC), 13 September 2005 (late flowering), Manning & Goldblatt 2992 (MO, NBG), 1 September 1963, Hardy 48 (BOL, K, PRE); below summit of Hex River Pass, SE slopes on shale, 625 m, (–BC), 16 September 1974, Mauve & I. Oliver 152 (NBG, PRE); between Osplaats and Tunnel Sidings, (–BC), August 1915, Rogers

16743 (BOL). 3320 (Montagu): hill approx. 2 km W of Tweedside Station, in loam among rocks, 1 200 m, (–AB), 12 August 1988, Vlok 1989 (NBG, PRE); south-facing slopes of Memorial hill above cemetery, in light clay, (–AB), 31 Aug. 2007, Goldblatt & Porter 12924 (K, MO, NBG, PRE).

9. *Ixia divaricata* Goldblatt & J.C.Manning, nom. nov., pro *I. latifolia* var. *angustifolia* G.J.Lewis in Journal of South African Botany 28: 86 (1962). Type: South Africa, [Western Cape] Witzenberg, middle east face opposite Farm Rosendal, 26 November 1941, N.S. Pillans 9790 (BOL, holo.!).

*I. scariosa* var. *longifolia* Baker: 165 (1892), in part. Types: South Africa, [Western Cape], near Ceres, October 1873, H. Bolus 2621 (K!, BOL!, SAM!); Avontuur, H. Bolus 2487 (BOL!, lecto., designated by De Vos (1999), K!, = *I. orientalis* L.Bolus).

*I. rapunculoides* var. *rigida* G.J.Lewis: 77 (1962), syn. nov. Type: South Africa, [Western Cape], Hex River Valley, 1 October 1893, P. MacOwan in Herbario Normale Austro-Africana 1653 (BOL! [as Hex River Pass, Bolus s.n. in Guthrie 3077], G, K! [as near Hex River East, 1500' (± 460 m)], MO! [as Hex River Valley, De Doorns, Oct. 1893, H. Bolus s.n.], SAM!, Z).

*I. rapunculoides* var. *subpendula* G.J.Lewis: 77 (1962), syn. nov. Type: South Africa, [Western Cape], between Groot River and Elands Kloof, Oct. 1939, C.L. Leipoldt 3026 (BOL, holo.!).

Plants 300–500 mm high. *Corm* subglobose, tunics of medium-textured, netted fibres, bearing 1–few sessile cormllets at base. *Leaves* 3–5, lower 2–4 narrowly sword-shaped to linear, (1.5–)3.0–5.0 mm wide, margins moderately thickened, hyaline when dry, straight, usually about one third to half as long as stem, uppermost 1 or 2 leaves sheathing stem. *Stem* with (1–)3 straight lateral branches mostly held at 30–45(–50)° to main axis, filiform, bearing flowers in upper half. *Main spike* 4–7-flowered, lateral spikes (1–)3–5-flowered; bracts translucent, outer with 3 dark veins, mostly 6–7 mm long, inner with 2 dark veins and forked apically. *Flowers* upright, whitish or pale to deep pink or light purple with pale yellow cup, unscented or with faint sweet scent; perianth tube funnel-shaped, 8–11 mm long; tepals subequal, 11–14 × 5.5–7.0 mm, proximal 3–4 mm forming part of floral cup, subpatent. *Stamens* parallel; filaments 4–5 mm long, distal 1–2 mm exerted from tube, rarely reaching only to top of tube, inserted ± 5 mm above tube base; anthers 4.0–5.5 mm long, fully exerted from tube, tips exerted from floral cup. *Style* dividing opposite middle of anthers, branches 1–2 mm long, extending between anthers. *Flowering time*: from late August at low elevations to October, November and December at higher elevations. Figure 9.

*Distribution*: *Ixia divaricata* is scattered through the mountains of the southwestern Cape, from Elands-kloof, east of Citrusdal in the southwestern Cedarberg, through the Cold Bokkeveld to Ceres and Tulbagh (Figure 10). Plants favour seasonally wet, stony sandstone flats and rocky sites.

*Diagnosis and variation*: *Ixia divaricata* is unmistakable in its unusual, divaricate branching pattern, with distinctive, stiff, straight lateral branches held at angles of 30–50° to the main axis and bearing mostly 3–5 flowers crowded in the distal half. The white or pink, or really purple flowers are held erect, with the tepals loosely spreading but not fully patent. Why this plant was treated as var. *subpendula* of *I. rapunculoides* is puzzling for not only is it distinctive in its branching pattern but the flow-



FIGURE 9.—*Ixia divaricata*, Goldblatt & Porter 12610 (MO, NBG). A, whole plant; B, 1/5 flower; C, bracts: outer (left), inner (right). Scale bar: 10 mm. Artist: J.C. Manning.

ers are upright, not horizontal, and the anthers, 4.0–5.5 mm long, are usually fully exerted from the tube or rarely have their bases included. Specimens with anthers exerted 1–2 mm were often included in *I. latifolia* by De Vos (1999) but true *I. latifolia* has larger, deep pink

flowers with a perianth tube 14–17 mm long, filaments  $\pm$  10 mm long, and broad basal leaves, mostly 10–18 mm wide. We regard var. *subpendula* as a separate species, which we name *I. divaricata* for the divaricate branching pattern. Although valid synonyms at varietal rank

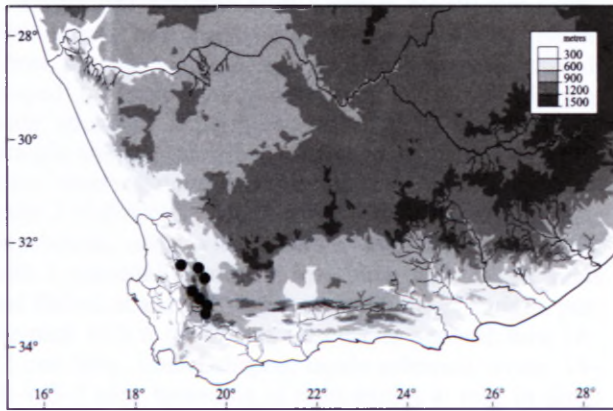


FIGURE 10.—Known distribution of *Ixia divaricata*.

exist for the species (see above), we have chosen the new name *divaricata* at species rank. The name *I. angustifolia* is preoccupied in the genus by *I. angustifolia* (Andrews) Klatt (1895), a later synonym of *I. monadelpha* (Lewis 1962). We prefer not to use the epithets *subpendula* (based on *I. latifolia* var. *subpendula*) or *rigida* (based on *I. rapunculoides* var. *rigida*) for the species because the former is misleading and the latter is based on an atypical type specimen.

The immediate relationships of *Ixia divaricata* are most likely with *I. latifolia*. Confusion with that species is due in part to some longer-tubed collections with the tube 12–14 mm long (e.g. *De Vos 2693* and *Leipoldt 4070*) that also have relatively short, broad leaves, up to 18 mm wide (a feature of *I. latifolia*) but fairly slender branches (characteristic of *I. divaricata*). These are almost certainly hybrids between the two species, which grow within sight of one another, although always on different soils, *I. latifolia* favouring heavy clay or loam.

*Ixia divaricata* was associated historically with *I. latifolia*, and one of the two specimens cited by Baker (1892) under var. *longifolia* of *I. scariosa*, the name by which *I. latifolia* was then known (the other specimen is *I. orientalis* and is the lectotype of the name) is *I. divaricata*. Although the type of *I. latifolia* var. *angustifolia*, from the Witzenberg is *I. divaricata*, several other specimens assigned here by Lewis (1962) and De Vos (1999) are a different species, *I. monticola*, which we describe elsewhere (Goldblatt & Manning in prep.). Although these two taxa have been confused in the literature they may not be particularly closely allied. The most important differences are that *I. monticola* has a corm with membranous, non-accumulating tunics, few or no branches, and four or five leaves. *I. divaricata*, in contrast, has fibrous tunics of medium texture and a distinctive branching pattern, and plants from high elevations typically have two or three leaves in most specimens, although sometimes more in those from middle elevations.

Another synonym may be *Ixia stellata* (Andrews) Klatt (1882), based on *I. capitata* var. *stellata* Andrews (1802), but the quality and detail in the painting on which the taxon must be based makes a firm identification impossible and no preserved material has been found at K and BM, the herbaria where they would most likely have been preserved.

We also include the type of *Ixia rapunculoides* var. *rigida* from the Hex River Valley in *I. divaricata*, which it closely resembles in the relatively long straight branches with distally crowded flowers, unlike the remaining specimens assigned to var. *rigida*, which have shorter, flexuose, horizontal branchlets and flowers evenly spaced along their length. This collection is the only record from the Hex River Valley, where we assume it no longer occurs as a result of intensive viticulture there. *Ixia divaricata* is still common in the Cold Bokkeveld, where it is found in sites presently protected from agriculture, although below Gydo Pass in the Warm Bokkeveld, it is now threatened by the expansion of orchards from Ceres and Prince Alfred's Hamlet to the foot of the Pass.

Provisionally we also include in *Ixia divaricata* plants from upper Moraine Kloof in the Hex River Mountains (*Helme 2864*), flowering in January. They have a similar branching pattern but somewhat smaller, purple flowers with a tube  $\pm 5$  mm long, tepals  $\pm 10$  mm long, and anthers  $\pm 3.2$  mm long. The style divides at the top of the anthers and has branches  $\pm 1.3$  mm long that extend above the anther tips, whereas in typical *I. divaricata* the style divides opposite the middle of the anthers. Unfortunately, the specimens lack corms and leaves without which a fair decision about the status of this plant, flowering some two months after other collections of *I. divaricata*, cannot be made.

Pollination of *Ixia divaricata* accords with that for other species of the *I. rapunculoides* complex. At our study site for the species at Waboomsrivier in the Cold Bokkeveld, flowers were visited and presumably pollinated by a range of medium-sized and large bees including *Lasioglossum* sp. (Halictidae) and *Anthophora diversipes* and *Amegilla spilostoma* (Apidae).

#### Selected specimens

WESTERN CAPE.—3219 (Wuppertal): Cedarberg, valley between Sneeuweberg and Tafelberg, wet sandy flats, (–AC), 19 October 1923, *Pocock 408* (NBG); Elandskloof, Ceres, (–CA), 30 September 1944, *Barker 3094* (BOL, NBG); Cold Bokkeveld, Waboomsrivier, sandy vlakke, (–CC), 4 October 1966, *Hanekom 776* (K, PRE); Cold Bokkeveld, 3 miles S of Leeurivier, (–CD), September 1952, *Lewis 2512* (PRE, SAM). 3319 (Worcester): Great Winterhoek, Sneeuat, (–AA), November 1916, *Phillips 1874* (NBG); Steindaal, Tulbagh, October–November 1858, *Pappe s.n. SAM20937* (NBG); Tulbaghskloof (Neuwekloof), Tulbaghsthal, foot of the Winterhoeksberg, Witsenberg and Vogelvalei, (–AA), November 1830, *Ecklon & Zeyher Irid. 94* (BOL, K, PRE); Cold Bokkeveld, roadside at Farm Wadriif, in rocky sandstone ground, (–AB), 30 September 2004, *Goldblatt & Porter 12604* (MO, NBG); Schurfdeberg Pass, wet place, (–AB), 30 October 1950, *Compton 22277* (NBG); stony flats at the foot of Gydo Pass, (–AB), 4 October 2004, *Goldblatt & Porter 12610* (MO, NBG, PRE); Witzenberg, Visgat Valley, Farm Wakkerstroom, (–AC), 5 November 2003, *Low 9376* (NBG); near Ceres Nature Reserve in wet ground, (–AD), 8 October 1986, *De Vos 2675* (NBG, PRE); top of Mitchell's Pass, (–AD), without date, *Marloth 10692* (PRE); Matroosberg, near Lakenvlei, (–AD), without date, *Phillips s.n. SAM11876* (NBG); Ceres, Schoonvlei Industrial Area, (–AD), 28 September 1987, *Cloete & Cillie 103* (NBG, PRE); Hex River Mtns, upper Moraine Kloof Amphitheatre south of Milner Peak, 1 050 m, (–AD), 4 January 2004, *Helme 2864* (NBG).

Putative hybrids with *Ixia latifolia*: 3319 (Worcester): Ceres, Gydouw, (–AB), 3 October 1942, *Leipoldt 4070* (PRE); between Ceres and Hottentotskloof, on Conradie farm, (–AD), 18 September 1987, *De Vos 2693* (PRE).

10. *Ixia contorta* Goldblatt & J.C.Manning, sp. nov.

*Ixia rapunculoides* var. *rigida* sensu G.J.Lewis: 77 (1962), but excluding the type.

Plantae (70–)100–300 mm altae, cormo subgloboso 10–14 mm diam. tunicis fibrosis duris nigrescentibus persistentibus, foliis 3 inferioribus 2 anguste ensiformibus vel falcatis (2)3–5 mm latis marginibus moderate incrassatis, caule 1–3-ramoso, ramis contortis, spica flexuosa inclinata vel subhorizontali, 2–6 flora, floribus purpureis cupula flava, tubo perianthii 9–13 mm longo, tepalis subaequalibus 9–12 × (4.5–)6.0–8.0 mm, filamentis ± 3 mm longis in tubo inclusis, antheris 3–4 mm longis.

TYPE.—Western Cape, 3219 (Wuppertal): Cold Bokkeveld, low hill east of Farm Waboomsrivier, well-drained sandy ground, (–CD), 17 September 2006, Goldblatt & Porter 12854 (NMG, holo.; MO, PRE, iso.).

Plants (70–)100–300 mm high. *Corm* subglobose, 10–14 mm diam., with tunics of medium-textured to fine, dark, wiry, netted fibres, bearing 1–few sessile cormlets at base. *Leaves* 3, lower 2 linear to narrowly sword-shaped or falcate, (2–)3–5 mm wide, margins and midrib moderately thickened, straight, about one third as long as stem, uppermost leaf sheathing lower half of stem. *Stem* suberect, usually with 1–3 short, twisted branchlets mostly held at 60–90° to main axis. *Main spike* conspicuously flexuose, bent at base and inclined to ± horizontal, 2–6-flowered, lateral spikes 1–6-flowered; bracts translucent, often flushed brown or purple, outer with three dark veins, mostly 7–9 mm long, bluntly 3-lobed apically, inner with two dark veins and forked apically. *Flowers* upright, purple (or said to be blue) with a yellow cup sometimes edged with a band of dark purple, unscented; perianth tube funnel-shaped, 9–13(–14) mm long; tepals subequal, 9–12 × (4.5–)6.0–8.0 mm. *Stamens* parallel; filaments ± 3 mm long, included, inserted 4–5 mm above base of tube; anthers 3–4 mm long, lower half to one third included in tube. *Style* dividing opposite middle of anthers, branches ± 1 mm long, extending between anthers. *Flowering time*: mid-September to October. Figure 11.

*Distribution*: *Ixia contorta* is centred in the Cold Bokkeveld but extends north to the Cedarberg and east to Touws River, growing in well-drained, sandy ground (Figure 12).

*Diagnosis and variation*: treated by Lewis (1962) as *Ixia rapunculoides* var. *rigida*, this plant from the interior Western Cape mountains is recognized among those species with included filaments by the markedly flexuose spikes and by the main axis strongly flexed below the first flower, thus inclined to nearly horizontal. The purple flowers (also sometimes described as blue or lilac) have a yellow cup sometimes edged in dark purple, and are held upright on the spikes, unique among the species with included filaments and anthers held partly within the perianth tube. The perianth tube is 9–13(–14) mm long and the tepals are 9–12 mm long. The very different appearance of the flowers suggests that these plants are not immediately allied to *I. rapunculoides* and we not only regard them as representing a separate species, but

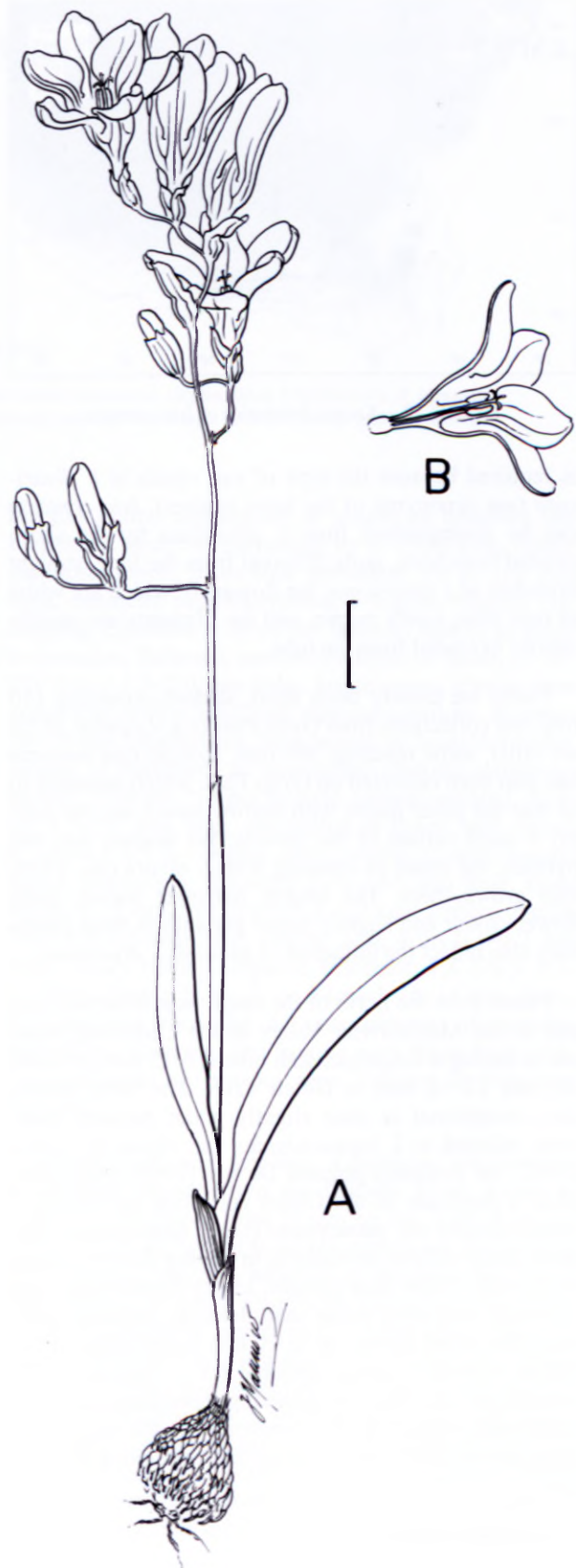


FIGURE 11.—*Ixia contorta*, Goldblatt & Porter 12854 (MO, NMG). A, whole plant; B, 1/5 flower. Scale bar: 10 mm. Artist: J.C. Manning.

question their relationship to the complex. We describe this plant here as *I. contorta*, so named for the twisted lateral branchlets and flexuose spike, a feature particularly well-developed in this species. The new name

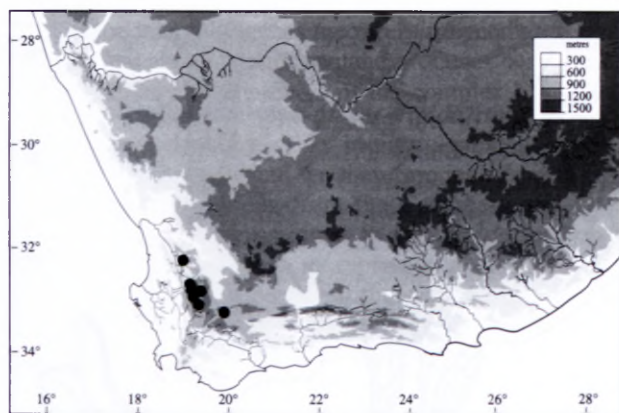


FIGURE 12.—Known distribution of *Ixia contorta*.

is required because the type of var. *rigida* is *I. divaricata* (see synonymy of the latter species). *Ixia contorta* can be distinguished from *I. divaricata* by the short, twisted branchlets, quite different from the long, straight branches of *I. divaricata*, the flowers of which are white to pale pink, rarely purple, and the filaments are usually shortly excluded from the tube.

Plants are usually fairly short, seldom exceeding 150 mm, but collections from Gydo Pass (e.g. *Leipoldt 3023*) are taller, some reaching 300 mm. Typical *Ixia contorta* has also been collected on Gydo Pass, which indicates to us that the taller plants with narrow leaves are not simply a local variant of the species. We suspect they are hybrids, the result of crossing with *I. divaricata*, which also grows there. The longer, narrower leaves, paler flower colour and slightly larger perianth in these plants may also reflect the influence of genes of *I. divaricata*.

Plants from the north of the range near Alberta Farm, and in the Matjiesrivier Valley in the Cedarberg stand out in having a longer perianth tube, 12–13 mm in *Nänni 81*, and 12–14 mm in *Gillett 4108*. The latter plants, also exceptional in their slightly wider perianth tube, were referred to *I. rapunculoides* var. *rigida* by Lewis (1962) but evidently puzzled De Vos (1999), who identified a duplicate of the Gillett collection at PRE as *I. rapunculoides* var. *namaquana* (i.e. *I. namaquana*). The latter taxon differs particularly in having flowers facing to the side, rather than upright, longer floral bracts, and a straight and erect rather than flexuose, inclined spike axis. The broad leaves, up to 10 mm in one plant of the Gillett collection, are exceptional for *I. contorta* and it remains possible that the gathering represents a novelty. Additional collections of *I. contorta* from the north of its range are needed to better assess the variation in the species.

#### Selected specimens

WESTERN CAPE.—3219 (Wuppertal): Clanwilliam, 2 miles [3.2 km] from top of Uitkyk Pass in Matjies River Valley, (–AC), 9 October 1938, *Gillett 4108* (BOL, K, PRE); Cold Bokkeveld, Farm Onverwagt on road to Alberta, (–BA), 14 October 1994, *Nänni 81* (MO); Ceres District, Luiperdskloof 4x4 route near Bloukop, 1 350 m, (–CB), 13 September 2002, *Steyn 174* (PRE); Koue Bokkeveld, Farm

Bokkenfontein, sandy flats near Leeu River, flowers blue, (–CC), 16 September 1976, *M. Thompson 2953* (NBG, PRE); Cold Bokkeveld, Farm Houdenbek, 850 m, (–CD), 13 October 1921, *Marloth 10613* (PRE). 3319 (Worcester): Gydouw Pass, (–AB), October 1926, *Marloth 12965* (PRE); Gydouw, (–AB), September 1941, *Leipoldt 3821* (BOL); Cold Bokkeveld, between Loch Lynne and Winkelhaak, sandy flats, (–AB), 11 October 1974, *Oliver 5122A* (NBG, PRE). 3320 (Montagu): Touws River, sandstone koppie, (–AC), September 1924, *Levy's 858* (BOL); dry sandy flats W of Touws River, (–AC), 27 September 1924, *Rennie s.n.* (BOL).

Putative hybrids with *Ixia divaricata*: 3319 (Worcester): Ceres, Gydouw, (–AB), October 1939, *Leipoldt 3023* (BOL, K, NBG, PRE, SAM).

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