

IRIDACEAE

NOTES ON *MORAEA* SUBG. *VISCIRAMOSA* (IRIDOIDEAE), INCLUDING THE NEW SPECIES *MORAEA SALDANHENSIS* FROM THE ATLANTIC COAST OF SOUTH AFRICA, RECOGNITION OF *M. INCONSPICUA* SUBSP. *NAMAQUENSIS*, AND POLLINATION BIOLOGY IN *M. RIVULICOLA*

Novelties in the largely sub-Saharan genus *Moraea* Mill. (Iridaceae: Iridoideae), now comprising over 215 species (Goldblatt & Manning 2009), are still being regularly discovered in southern Africa. Florally diverse, *Moraea* is recognized in Iridoideae by a bifacial and channelled (rarely terete or plane) leaf blade, and corms of a single internode derived from a lateral bud. Most species have *Iris*-like flowers with flattened, petaloid style branches to which the stamens are appressed (Goldblatt 1986), but the occurrence of a variety of other floral types (Goldblatt 1998) makes exact floral definition of the genus impractical, although most species have free tepals and partially to completely united filaments.

One of the more distinctive groups in the genus is subg. *Visciramosa* Goldblatt, distinguished by its well-branched stems sticky below the nodes. *Moraea saldanhensis*, the new species described here, a recently discovered local endemic of sandy coastal flats and hills north and east of Saldanha Bay in Western Cape, is unusual in subg. *Visciramosa* (now with 8 species) in its slate blue-grey tepals with off-white markings, and with the claws longer than the limbs. Other species in the subgenus have yellow to buff or brown flowers although *M. viscaria* (L.f.) Ker Gawl. is characterized by its white flowers. We report the existence of a population of *M. bituminosa* (L.f.) Ker Gawl. with blue-mauve tepals, as well as white-flowered populations of *M. elsiae* Goldblatt and *M. inconspicua* Goldblatt, both until now recorded as having yellow or, in *M. inconspicua*, also buff to brown flowers. Namaqualand populations of the widespread winter rainfall species *M. inconspicua* are distinctive in their coiled leaves and paler flowers, and we distinguish them here as subsp. *namaquensis*. The current key to the subgenus (Goldblatt 1986) included only five species and was already outdated by the recognition of *M. vespertina* Goldblatt & J.C.Manning in 2000 and *M. simplex* Goldblatt & J.C.Manning in 2004 (Goldblatt & Manning 2000, 2004). We provide a new key to all eight species and one subspecies now recognised in subgen. *Visciramosa*.

In addition, we report an unusual pollination system in *Moraea rivulicola* Goldblatt & J.C.Manning (subg. *Vieusseuxia*). Pollination strategies in *Moraea* are diverse, and include large-bodied anthophorine and honey bees foraging for nectar, female bees of several families foraging for pollen, hopliine beetles, muscid, flesh and blow flies, and eumenine wasps (in one species to date: Goldblatt *et al.* 2005). In *M. rivulicola* pollen transfer is accomplished by species of eumenine wasps in a system that closely matches that reported in three species of *Ferraria* (Goldblatt *et al.* 2009), which have similar floral odours and nectar characteristics.

We examined all relevant collections at BOL, NBG, PRE, and SAM, the primary southern African herbaria (acronyms after Holmgren *et al.* 1990). The distribution

of *M. inconspicua* subsp. *inconspicua* (Figure 2) is based on this material although collections for this taxon are not cited.

New taxa

1. *Moraea saldanhensis* Goldblatt & J.C.Manning, sp. nov.

TYPE.—Western Cape. 3217 (Vredenburg): rocky coastal sandveld near Jacobsbaai at Mauritzbaai, (–DD), 20 Oct. 2011, Manning 3310 (NBG, holo.; MO, iso.).

Plants 150–350 mm high. *Corm* obconic–subglobose, 25–40 mm diam., bearing numerous small cormlets at base; tunics pale brown, becoming fibrous, with strong vertical ribs joined by fine fibres in herringbone pattern. *Stem* ± erect, firm, sticky below nodes, usually branching at all nodes, with 2, rarely 3, branches per node; branches sharply flexed outward above sheaths and then ± horizontal, flexed upward at apex. *Foliage leaves* 2, lowermost inserted below ground, linear, channelled, lowermost longest, initially suberect, trailing above, up to 400 mm long, 4–6 mm wide when opened flat, second leaf somewhat shorter; sheathing leaves up to 28 mm long, distal 5–6 mm dry and brown, ± truncate or subacute. *Rhipidia* several-flowered; spathes green, apices subacute to ± truncate, purple near tips and turning dry and brown with age in upper 5 mm, inner 22–25 mm long, outer ± 1/2 to 2/3 as long, completely sheathing. *Flowers* slate blue-grey to purple, outer tepals coppery pink outside and with off-white nectar guides minutely speckled with blue dots, claws whitish, minutely speckled grey-blue, nectar guide at base of outer tepal limbs dark blue-grey; tepals free, smooth, outer ± 18 × 5.5–7.0 mm, initially spreading, later half-reflexed sometimes recurving distally, claws narrow, ± 10 mm long, thus slightly exceeding limbs, suberect; inner tepals up to 14 × 3 mm, oblanceolate, limbs spreading horizontally or later half reflexed. *Stamens* with filaments ± 8 mm long, free but closely adhering in smooth, cylindrical column ± 6.5 mm long, free and diverging distally; anthers 3–4 mm long, appressed to style branches, dark purple, pollen orange-red. *Ovary* ± 8 mm long, usually included in spathes; style dividing at apex of filament column, branches ± 6 × 2 mm, sharply diverging and extended horizontally, white, flushed purple distally; stigma lobe transverse, with prominent central cusp ± 2 mm long, acute or bifid at apex, crests arching upward distally and 4–5 mm long, purple, intensely so in distal half. *Capsules* and *seeds* unknown. *Chromosome number* unknown. *Flowering time*: late Sept.–Nov. Figure 1.

Distribution and ecology: *Moraea saldanhensis* is currently known from two sites in sandy ground among granite rocks along the coast of Western Cape, one between Jacobsbaai and Saldanha and a second near Vredenburg (Figure 2). Unusually late flowering in the area, it blooms after most of the spring flora, and the



FIGURE 1.—*Moraea saldanhensis*, Goldblatt & Manning 13405 (NBG). A, plant; B, outer tepal, with detail of nectary; C, inner tepal; D, stamens and style; E, detached style branch. Scale bar: A, 10 mm; B–E, 2 mm. Artist: John Manning.

slate-blue flowers are inconspicuous among the drab green or dry vegetation. The first record was made by the Cape botanist, N.A. Helme, in November 2006, and two years later the Jacobsbaai site was discovered by

local resident Koos Claasens, who helped us make the type collection in October 2010. The narrow distribution of the species, in an area undergoing rapid development along the coast and inland, leaves it in a parlous conser-

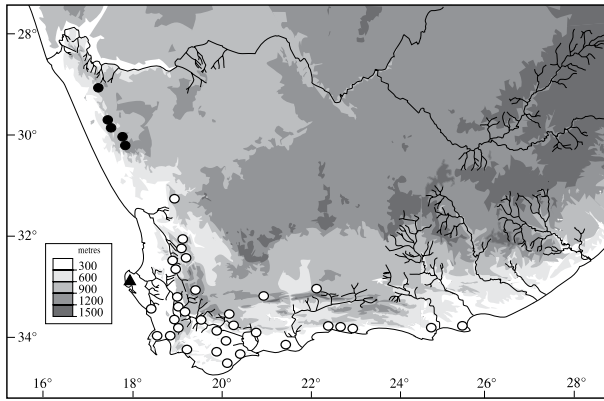


FIGURE 2.—Distribution of *Moraea saldanhensis*, ▲; *M. inconspicua* subsp. *inconspicua*, ○; *M. inconspicua* subsp. *namaquensis*, ●.

vation state and it must be regarded as vulnerable (VU) if not endangered (EN) using the definitions and terminology of Raimondo *et al.* (2009).

Diagnosis and relationships: clearly a member of subgen. *Viscramosa* Goldblatt of *Moraea* (Goldblatt 1976a), *M. saldanhensis* has the large obconic corms with brown tunics, stems sticky below the nodes, relatively blunt rhipidial spathes and multi-branched stems characteristic of the alliance. Vegetatively, the relatively short spathes recall *M. elsiae* and *M. inconspicua* and it is with the latter that *M. saldanhensis* is most easily confused. Both have small flowers with well-developed style branches and prominent style crests. The flowers of *M. inconspicua* are yellow or partly to largely brown or occasionally white, and the tepal limbs of both whorls are half to fully reflexed (Goldblatt 1986). The larger outer tepals of *M. inconspicua* are 12–18 mm long with undulate to \pm plane limbs 9–12 \times 6–7(8) mm and claws 4–7 mm, thus \pm one third to half as long as the limbs (Figure 3; Table 1). This stands in marked contrast to the flowers of *M. saldanhensis*, which has outer tepals \pm 18 mm long initially spreading, later half-reflexed and distally recurving, and narrow erect claws \pm 10 mm long, slightly longer than the limbs, the opposite of the situation in *M. inconspicua*. *Moraea saldanhensis* also has a slightly longer filament column, \pm 6.5 mm long (vs. 3.5–6.0 mm in southern populations of *M. inconspicua*, i.e. subsp. *inconspicua*). Pollen in *M. saldanhensis* is orange-red and the ovary is included whereas in *M. inconspicua* the ovary is usually exserted and the pollen is typically yellow, although populations with red pollen are known, notably among the Namaqualand populations, segregated as subsp. *namaquensis* (see below).

Additional specimen

WESTERN CAPE.—3217 (Saldanha): western edge of Vreden-

burg, just S of road to De Klip, Saldanha Granite Strandveld, (–DD), 5 Oct. 2006, *Helme 4162* (NBG, photo).

2. Namaqualand populations of *Moraea inconspicua* are immediately recognized by their tightly coiled leaves, dull cream-coloured, ivory to buff or brown flowers with the tepal limbs usually reflexed to lie in a vertical plane, and by their bright orange pollen. Plants from south of Namaqualand have channelled, ascending to trailing leaves and usually smaller flowers (Table 2), mostly bright yellow to buff, sometimes brown or rarely white, with the tepal limbs either fully reflexed or spreading to lie \pm 45° from the horizontal, and usually yellow, rarely red pollen. The Namaqualand plants typically grow with their corms tightly wedged among rocks whereas plants from the south occupy a diverse range of habitats but mostly open stony or sandy flats. The combination of morphological and geographical differentiation are consistent with the recognition of the Namaqualand populations as a distinct subspecies, and with similar taxonomic treatments that we have applied to races of *Freesia viridis* (Aiton) Goldblatt & J.C.Manning (Manning & Goldblatt 2010) and *Tritonia securigera* (Aiton) Ker Gawl. (Goldblatt & Manning 2006).

***Moraea inconspicua* subsp. *namaquensis* Goldblatt & J.C.Manning**, subsp. nov.

TYPE.—Northern Cape. 2917 (Springbok): southeast of Driekoppie farmhouse, (–DB), 3 Oct. 1981, *Van Berkel 439* (NBG, holo.; MO, iso.)

Like subsp. *inconspicua* but foliage leaves coiled with surface plane, 2–3 mm wide. *Rhipidia* with outer spathes mostly 20–28 mm long. *Flowers* ivory, creamy yellow, creamy pink, pale yellow or brown; tepals usually reflexed to lie vertically, outer 15–18 mm long, claws 5–7 mm long. *Stamens* with filaments 6–8 mm long; anthers 3–4 mm long, pollen usually red. *Style branches* 5–6 mm long, crests 3–4 mm long. *Flowering time*: mid-Sept.–late Nov.

Distribution and ecology: restricted to the higher-lying edge of the western escarpment in Namaqualand, between the Kamiesberg and Steinkopf (Figure 2).

Diagnosis: distinguished from typical forms by the coiled leaves with flat blades up to 3 mm wide. Plants of subsp. *inconspicua*, which occurs south of Namaqualand, from the Bokkeveld Mtns to Port Elizabeth, have channelled leaves that are initially erect later trailing but never coiled. Other vegetative and floral features differ only quantitatively, with considerable overlap but on average subsp. *namaquensis* has slightly larger rhipidial spathes and floral features than the typical

TABLE 1.—Selected features of *Moraea inconspicua* subsp. *inconspicua*, subsp. *namaquensis*, and *M. saldanhensis*.

Taxon	Inner rhipidial spathe length (mm)	Outer tepal length (claw) (mm)	Filament length (mm)	Anther length (mm)	Style branch length (mm)
<i>M. inconspicua</i> subsp. <i>inconspicua</i>	15–26	12–15(–18) (4–6)	3.5–6.0	2.0–3.3	3.5–5.0
<i>M. inconspicua</i> subsp. <i>namaquensis</i>	19–28	15–18 (5–7)	6–8	3–4	5–6
<i>M. saldanhensis</i>	22–25	\pm 18 (\pm 10)	8	3–4	\pm 6

TABLE 2.—Selected floral characteristics of typical, yellow-flowered *Moraea bituminosa* and the mauve blue-flowered morph. Only living plants or well-pressed, fully open flowers were measured.

Taxon	Outer tepal length × width (mm)	Outer tepal claw length (mm)	Filament length (free part) (mm)	Anther length (mm); pollen colour	Style branch length (mm)	Style crest length (mm)
Yellow-flowered morph	23–31 × 8–11	5.0–7.5	6.0–9.5 (1.0–1.5)	4–6; yellow	4–6	6–10
Mauve blue-flow- ered morph	27–31 × 10–12	± 8	7–12 (2)	5–6; red	± 6	12–15

subspecies. In subsp. *namaquensis* the outer rhipidial spathes are 20–28 mm long, outer tepals 15–18 mm long, and anthers 3–4 mm long compared with rhipidial spathes 15–26 mm long, outer tepals 12–15 mm long and anthers 2.0–3.3 mm long in subsp. *inconspicua* (Table 1). *M. inconspicua* has not, to date, been recorded between the Bokkeveld Mtns and the Kamiesberg, an unexpected gap in its range that evidently represents the geographical disjunction separating the two subspecies.

Additional specimens

NORTHERN CAPE.—**2917** (Springbok): Steinkopf, (–BC), Oct. 1934. *Herre* s.n. (BOL, PRE); ± 5 km W of Steinkopf, (–BC), 10 Oct. 1987, *Williamson 3776* (NBG); near top of Spektakel Pass, (–DA), 11 Sept 1993, *Goldblatt & Manning 9714* (MO, NBG); 7 km S of Springbok on Camping Ground, (–DB), 12 Oct. 1989, *Greuter 21661* (PRE); hills E of Nababeep, (–DB), 14 Oct. 1974, *Goldblatt 3054* (MO, NBG, PRE). **3018** (Kamiesberg): 2 km E of Kamieskroon, (–AA), 28 Sept. 1976, *Goldblatt 4255* (MO, NBG); Kamiesberg, Farm Damsland, (–AC), 19 Oct. 2007, *Snijman 2206* (NBG).

Notes on divergent flower colour morphs in other species of subgen. *Visciramosa*

1. *Moraea bituminosa*: with pale to deep yellow flowers over most of its range, which stretches from Tulbagh and the Cape Peninsula eastward to the Bredasdorp Mtns, *M. bituminosa* has the largest flowers in subgen. *Visciramosa*, with tepals up to 30 mm long and open flowers up to 40 mm in diameter (Goldblatt 1976b). Unusual for the species and subgenus, a population of *M. bituminosa* from Jonkershoek has blue-mauve flowers. In November 2011 we found a second site for the blue-mauve-flowered morph of the species and we were able to investigate these alive. The outer tepals have nectar guides consisting of a band of fine black dots at the limb bases edged with a broad white band, the anthers are dark purple-black and the pollen is bright red. Yellow-flowered plants have nectar guides consisting of a patch of black spots on a dark yellow background and invariably yellow anthers and pollen. The blue-mauve flowers closely match those of yellow-flowered plants except that the filament column is mostly longer, the tepal claws slightly longer, and the style crests significantly longer than the typical yellow morph (Table 2).

We are uncertain about the significance of the blue mauve-flowered morph of *Moraea bituminosa* and assume that the Jonkershoek and Tulbagh Valley plants are the same genetic race. The morph is embedded within the range of the yellow-flowered morph, and at the Tulbagh valley site yellow-flowered plants grew adjacent to those with blue-mauve flowers (which at this locality had smaller flowers) with no evidence of intermediates. At this juncture we merely report the biological situation. The sympatry in the Tulbagh Valley of

yellow and blue-mauve-flowered morphs raises the possibility that the latter may be a separate species.

2. *Moraea elsiae*: with relatively small flowers, *M. elsiae* stands out in subgen. *Visciramosa* in having the style branches much reduced in size and lacking style crests, and narrower than the subtending anthers, the tips of which exceed the style branches (Goldblatt 1976b; 1986). The tepals have until now been reported as yellow and the limbs of both whorls spread slightly below the horizontal; anthers and pollen are also yellow. Plants from near Elim and Kleinmond, however, stand out in having white tepals, the outer ± 16 × 5–6 mm, somewhat smaller than elsewhere in the species, and with anthers 2.5–3.0 mm long. In yellow-flowered plants the outer tepals are 15–22 × 9 mm and anthers are 3–4 mm long.

The recorded range of *Moraea elsiae* is from near Mamre and the Cape Peninsula to Still Bay (Goldblatt & Manning 2009). The white flowered populations thus fall within the range of the species and are evidently a distinct regional race. At one locality white-flowered *M. elsiae* grew intermixed with plants of *M. inconspicua* but flowers opened in the mid- to late afternoon, whereas those of *M. inconspicua* opened in the morning and wilted at about the time those of *M. elsiae* opened.

White-flowered specimens

WESTERN CAPE.—**3419** (Caledon): Kleinmond, (–AC), 26 Nov. 1949, *de Vos 1531* (NBG); clay slope ± 4 km W of Elim, (–DA), 9 Nov. 2011, *Goldblatt & Porter 13740* (MO, NBG).

3. *Moraea inconspicua*: as circumscribed at present, *M. inconspicua* is widespread in the southern African winter rainfall zone, extending from northern Namaqualand to Port Elizabeth (see subsp. *namaquensis* described above). Flowers in the species are variable in colour but mostly yellowish to brown, buff, occasionally ivory, and pollen is yellow or reddish. Plants from Elim, west of Bredasdorp, that have come to our attention, have white tepals and the anthers are ± 2.5 mm long, the style branches ± 3 mm long, and the style crests ± 1.5 mm long, thus as small or smaller than previously recorded for the species (anthers 2–4 mm, style branches mostly 4–5 mm, style crests 3–4 mm long). The pollen is red. The white-flowered populations from the near Elim fall within the geographic range of yellow to brown-flowered plants and do not in our opinion merit taxonomic recognition although they evidently represent a distinct race of the species, distinguished by tepal colour and in the smaller size of the anthers, style branches and crests and red pollen. Superficially similar to white-flowered *M. viscaria*, these populations are distinguished by the reduced size of the style crests, which in *M. viscaria* are well developed and at least half as long as the branches.

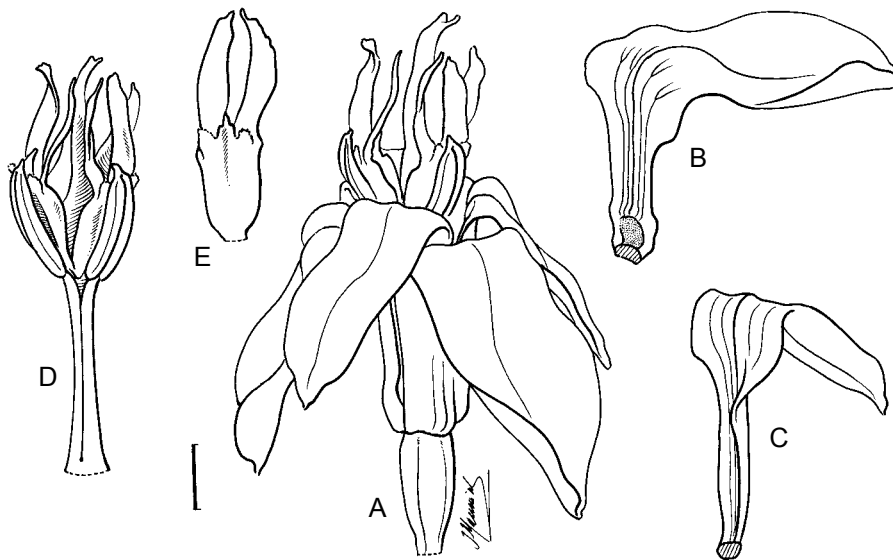


FIGURE 3.—*Moraea inconspicua* subsp. *inconspicua*, Bo-Hermon, Elandsberg Farm, without voucher. A, flower; B, outer tepal; C, inner tepal; D, stamens and style branches; E, detached style branch. Scale bar: 2 mm. Artist: John Manning.

White-flowered specimen

WESTERN CAPE.—3419 (Caledon): clay slope \pm 4 km W of Elim, (–DA), 9 Nov. 2011, Goldblatt & Porter 13743 (MO, NBG).

Key to taxa of subg. *Visciramosa*

1. Style crests absent or rudimentary:
2. Style branches plane and appressed to opposed anther; flowers yellow or white *M. elsiae*
- 2.' Style branches filiform, terete, extending between stamens; flowers pale yellow *M. simplex*
- 1.' Style crests moderately to well developed, at least half as long as style branches and usually $>$ 2 mm long:
3. Flowers relatively small, outer tepals 13–23 mm long; anthers 2.5–4.0 mm long; inner rhipidial spathes usually 18–25 mm long:
4. Flowers slate blue; outer tepal limbs \pm 8 mm long, slightly shorter than claws *M. saldanhensis*
- 4.' Flowers white, yellow, buff or \pm brown; outer tepal limbs 9–15 mm long, usually \pm twice as long as claws:
5. Flowers white, sweetly scented and opening mid- to late afternoon; tepals 16–23 mm long with limbs laxly spreading *M. viscaria*
- 5.' Flowers usually yellow, buff or \pm brown, occasionally white, not noticeably scented or with spicy odour and opening mid- to late morning; tepals 13–18 mm long with limbs spreading to reflexed *M. inconspicua*
6. Leaves trailing, conduplicate; tepals brown to yellow, rarely white; plants from Cape Floristic Region subsp. *inconspicua*
- 6.' Leaves coiled, \pm flat; tepals pale whitish to buff or brown; plants from Namaqualand subsp. *namaquensis*
- 3.' Flowers large, outer tepals (22–)26–40 long; anthers at least 4 mm long; inner rhipidial spathes (23–)25–40(–55) mm long:
7. Foliage leaves usually 4–6, lower 3–5 basal; flowers white, sometimes fading blue-grey, or pale slate blue and opening at dusk *M. vespertina*
- 7.' Foliage leaves 2 or 3, lower 1 or 2 basal; flowers yellow, blue-mauve or light brown to buff with yellow nectar guides and opening at or before midday:
8. Flowers bright yellow with yellow anthers and pollen, or blue-mauve with blackish anthers and red pollen; only outer tepals with nectar guides *M. bituminosa*
- 8.' Flowers predominantly buff to light brown with light brown anthers and pollen; inner and outer tepals with yellow nectar guides at base of limbs *M. bubalina*

Pollination of *Moraea rivulicola*

Endemic to central and northern Namaqualand, *M. rivulicola* Goldblatt & J.C.Manning (subgen. *Viussieuxia*) is restricted to locally wet sites along streams, seeps and the edges of seasonal marshes. Among species

of subgen. *Viussieuxia* it is distinguished by a relatively robust habit, taller plants reaching over 1 m, comparatively large, dull coloured flowers with outer tepals dull cream to pale yellow-green, sometimes flushed with pink and the trilobed inner tepals and style branches are light brown. Plants flower from late August through September to early November at higher elevations. At a site in the higher Kamiesberg, central Namaqualand, on the Farm Karas, plants were in flower in the last days of October (Goldblatt & Porter 13683, MO, NBG) when by chance, we had the opportunity to observe pollinator activity.

Flowers open in mid-morning, last three days, and during the day have an unusual, unpleasant scent, a sour, aminoid odour mixed with faint notes of molasses. From 10:00 to 12:00 flowers were actively visited by moderate-sized, black eumenine wasps, *Allepipona* sp. and *Knemodynerus* sp. Both species of wasp were frequent visitors, individuals entering the flowers by crawling down the channel formed by the claw of an outer tepal and closely opposed style branch. When individuals emerged white pollen could clearly be seen in the dorsum. We infer that the wasps were foraging for nectar contained at the base of the outer tepal limbs. Nectar is secreted from shiny nectaries both at the limb base and on the abaxial surface of small ridges of tissue at the limb bases. When examined with a hand lens the nectary surfaces of freshly opened flowers carried minute spots of liquid (as glistening spots). Overnight the tepal bases accumulated a large droplet of fluid, which when tasted on the tongue had no trace of sweet flavour.

Pollination by eumenine and masarine wasps (Eumenidae: Eumeninae and Masarinae) in Iridaceae is known in just one species of *Moraea* and three species of the related genus, *Ferraria* (Gess & Gess 1989; Goldblatt *et al.* 2009; Goldblatt & Manning 2011). The wasp pollinated *Ferraria* species, *F. divaricata* Sweet, *F. macrochlamys* (Baker) Goldblatt & J.C.Manning, and *F. variabilis* Goldblatt & J.C.Manning, also have dull-coloured flowers, unusual, aminoid-type odours, and produce watery nectar of low sugar concentrations (usually less than 10% sucrose equivalents). Wasp species involved in pollination of these *Ferraria* species included the

eumenines *Delta caffer*, *Delta* sp. and *Allepipona erythrospina* and the masarines *Celonites capensis* and *Jugurtia koeroegabensis*. Wasp pollination very similar to that in species of *Ferraria* has evidently evolved independently in *Moraea rivulicola*. This is the second example of eumenine wasp pollination in *Moraea*. Two species of *Tricarindynerus* and one of *Parachilus* were reported by Goldblatt *et al.* (2005) as pollinators of *M. inconspicua* Goldblatt (subgen. *Visciramosa*) in northern Namaqualand.

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REFERENCES

- GESS, S.K. & GESS, F.W. 1989. Flower visiting by masarid wasps in southern Africa (Hymenoptera: Vespoidea: Masaridae). *Annals of the Cape Provincial Museums, Natural History* 18: 95–134.
- GOLDBLATT, P. 1976a. Evolution, cytology and subgeneric classification in *Moraea* (Iridaceae). *Annals of the Missouri Botanical Garden* 63: 1–23.
- GOLDBLATT, P. 1976b. The genus *Moraea* in the winter rainfall region of southern Africa. *Annals of the Missouri Botanical Garden* 63: 657–786.
- GOLDBLATT, P. 1986. The moraeas of southern Africa. *Annals of Kirstenbosch Botanical Garden* 14: 1–224.
- GOLDBLATT, P. 1998. Reduction of *Barnardiella*, *Galaxia*, *Gynandriris*, *Hexaglottis*, *Homeria* and *Roggeveldia* in *Moraea* (Iridaceae: Irideae). *Novon* 8: 371–377.
- GOLDBLATT, P., BERNHARDT, P. & MANNING, J.C. 2005. Pollination mechanisms in the African genus *Moraea* (Iridaceae: Iridoideae): floral divergence and adaptation for pollen vector variability. *Adansonia* 27: 21–46.
- GOLDBLATT, P., BERNHARDT, P. & MANNING, J.C. 2009. Adaptive radiation of the putrid perianth: *Ferraria* (Iridaceae: Irideae) and its unusual pollinators. *Plant Systematics and Evolution* 278: 53–65.
- GOLDBLATT, P. & MANNING, J.C. 2000. New species of *Moraea* (Iridaceae–Iridoideae) from southern Africa. *Novon*: 10: 14–22.
- GOLDBLATT, P. & MANNING, J.C. 2004. New species of *Ixia* (Crocoidae) and *Moraea* (Iridoideae), and taxonomic notes on some other African Iridaceae. *Novon* 14: 288–298.
- GOLDBLATT, P. & MANNING, J.C. 2006. Notes on the systematics and nomenclature of *Tritonia* (Iridaceae: Crocoidae). *Bothalia* 36: 57–61.
- GOLDBLATT, P. & MANNING, J.C. 2009. New species of *Moraea* (Iridaceae: Iridoideae), with range extensions and miscellaneous notes for southern African species. *Bothalia* 39: 1–10.
- GOLDBLATT, P. & MANNING, J.C. 2011. Systematics and biology of the African genus *Ferraria* (Iridaceae: Irideae). *Bothalia* 41: 1–40.
- HOLMGREN, P.K., HOLMGREN, N.H. & BARNETT, L.C. 1990. *Index Herbariorum. Part. 1: The Herbaria of the World*. New York Botanical Garden, New York.
- MANNING, J.C. GOLDBLATT, P. 2010. Botany and horticulture of the genus *Freesia* (Iridaceae). *Strelitzia* 27. South African National Biodiversity Institute.
- RAIMONDO, D., VON STADEN, L., FODEN, W., VICTOR, J.E., HELME, N.A., TURNER, R.C., KAMUNDI, D.A. & MANYAMA, P.A. (eds). 2009. Red List of South African Plants. *Strelitzia* 25.

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