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IN THIS ISSUE...

Dr. Narain provides a look into *Gloriosa*. Other Indian researchers discuss the Tuberose. Dr. Lehmilller contributes a commentary following his trip to the Indian Ocean islands of Seychelles and Mauritius. Another Texan, Dr. Howard, narrates his trip to Argentina and Brazil. Charles Menzel gives information on pollination and growing *Hippeastrum* from seed. Another Australian, Kevin Walters, gives us some background on *Clivia*. Silvia Arroyo, an Editorial Board member from Argentina, and Beat Leuenberger, of the Botanical Garden, Berlin-Dahlem, have prepared a note on the unusual *Luzuriaga marginata*. Another German contributor, Helmut Kerndorff, has developed a paper on his work with *Crocus*.

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Cover: *Muscari mcbeathianum*, from a color slide by Kit Tan.

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GLORIOSA: CULTIVARS AND NATURAL SPECIES

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IN ornamental horticulture, *Gloriosa* has contributed considerably with its bright flowers and wiry, climbing stems. The genus was established by Linnaeus (1737, 1798) and its taxonomic identity has been maintained since then (Thiselton-Dyer, 1898; Bailey, 1913; Ridley, 1924; Hutchinson, 1959).

Percy-Lancaster and Percy-Lancaster (1966) provided an account of the horticultural taxonomy and also cultural practice of the genus which forms the basic information medium for the present study.

MATERIALS AND METHOD

This study considers the 40 garden cultivars belonging to: *Gloriosa superba* Linn. (Figure 1 a,b); *G. lutea* Hort. (Figure 2); *G. plantii* Loud. (Figure 3); *G. richmondensis* Hort. (Anonymous, 1928, 1929, Figure 4); *G. virescens* Lindl. (Figure 5); *G. rothschildiana* O' Brien, (Figure 6); *G. magnifica* Percy-Lan. (Figure 7); *G. latifolia* Percy-Lan. (Figure 8); *G. longifolia* Percy-Lan. (Figure 9). The plants were grown at the National Botanical Research Institute (NBRI), Lucknow. The majority of the *Gloriosa* species and cultivars are exotic, collected from southern Rhodesia and other contiguous areas of South Africa and were introduced into the NBRI by the late Mr. S. Percy-Lancaster. A list of these taxa, together with their source, wherever possible, has been given in Table 1. This NBRI collection was further enriched by material obtained from Messrs. Chandra and Pradhan Nurseries, Kalimpong, West Bengal and Sikkim. The cultivar names are unregistered and have been given either on the basis of their floral-morphological characteristics and/or based on their collection sites (Percy-Lancaster, 1958 and personal communication). Further, in the absence of a regular name, the cultivars were numbered.

Morphological analysis was made from fresh material of comparable ages from plants grown under nearly the same conditions. Flower color charts I and II issued by the British Color Council in collaboration with the Royal Horticultural Society, London were used to determine colors. The illustrations used in this article were originally drawn by Mr. S.S. Rana.

OBSERVATIONS

Gloriosa was described by Linnaeus (1737) on the basis of the type species *G. superba*, which he placed near *Littonia* and listed *G. superba* as the only species in the genus. However, in *Systema Vegetabilium* (Linnaeus 1798), he added another species, *G. simplex* to the genus. Since Linnaeus there have been several revisions and many additions in the genus. The descriptions for most of the species are inadequate and inaccurate. This has led to a considerable degree of confusion within the genus. Different names were being applied to the same plant, while at the other extreme, the species with even very diversified characters have been considered as synonymous. Thiselton-Dyer

(1898) listed six *Gloriosa* species in the **Flora of Tropical Africa. Index Kewensis** lists 16 species in the genus. These include *G. abyssinica*, *G. simplex*, *G. superba*, *G. minor*, *G. graminifolia*, *G. virescens*, *G. rothschildiana*, *G. lutea*, *G. carsonii*, *G. baudii*, *G. grandiflora*, *G. leopoldii*, *G. sudanica*, *G. sampiana*, *G. aurea*, and *G. verschuurii*. Most are native to African countries except *G. superba* (Figure 1 a,b) which is also found in tropical Asia and several other regions. Bailey (1913) described five species distributed in tropical Africa and Asia. Percy-Lancaster and Percy-Lancaster (1966) described 20 species including three new species which lack Latin diagnoses and which were collected from various regions of South Africa. To facilitate referencing, these species have been attributed to Mr. S. Percy-Lancaster. These are *G. magnifica* Percy-Lan. (Figure 7), *G. latifolia* Percy-Lan. (Figure 8), and *G. longifolia* Percy-Lan. (Figure 9).

Although the genus is a natural assemblage, characterized as a climbing, tuberous-rhizomatous herbaceous perennial with simple, stalkless tendrillar leaves and large, showy, reflexed flowers that change color, there is still much variation between the species. In the present investigation, an analysis of plant height, stem, leaf and flower with regard to variation in size, shape and color was made from plants grown under uniform conditions.

Habitat

Species of *Gloriosa* grow in a variety of soils. For vigorous growth and greater blooms, a mixture of sand and leaf mold or farm-yard manure is recommended. However, according to Percy-Lancaster and Percy-Lancaster (1966) some species have marked preferences for fairly open, well drained soils (*G. simplex*), black stiff soil (*G. latifolia*) and sandy soil as well as stiff black clays (*G. virescens*).

Seed Germination

Seeds remain dormant for 8-9 months and, due to a hard seed coat, about 20-30 days are required for germination. There is no significant difference in the time taken for germination by the different species. During the first year, a small seedling with 3-5 leaves remains alive for 3-4 months and then the aerial shoot dies back, leaving a very small tuberous rhizome which sprouts the next season and increases in size, further requiring three to four years before it can flower.

Stem

The stem is herbaceous, slender and arises from perennial, fleshy, tuberous rhizomes during the rainy season. *G. superba*, *G. virescens* and *G. richmondensis* are among the taller species, being about 300-800cm in height. These are followed in a descending order by *G. lutea* (190-200cm), *G. latifolia* (150-200cm), *G. longifolia* (150-200cm), *G. magnifica* (130-180cm) and *G. rothschildiana* (100-150cm). The smallest in the present collection is *G. plantii*, being only 90-100cm in height. The octoploids are comparatively short statured and constitute a medium-sized group of plants.

Leaf

Leaf arrangement on the main stem is variable. In *G. superba*, *G. lutea*, *G. virescens* and *G. richmondensis* leaves are arranged irregularly (Figure 11), while in *G. plantii*, *G. rothschildiana*, *G. latifolia*, *G. longifolia*, and *G. magnifica* leaves are opposite (Figure 12).

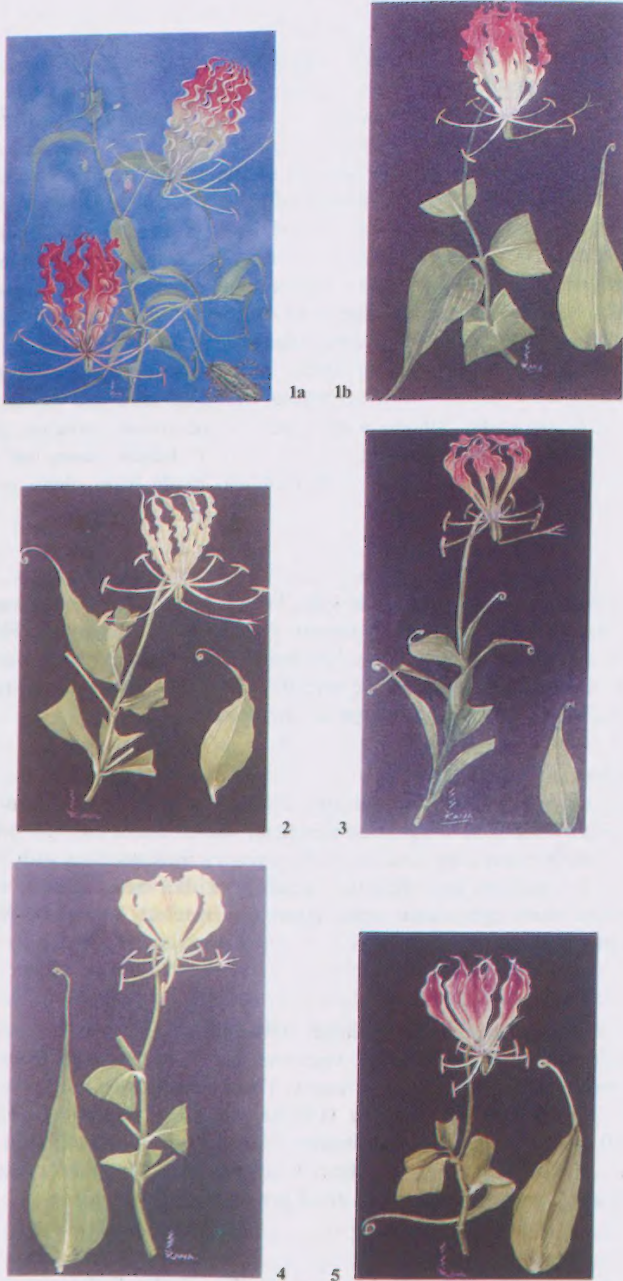


Figure 1. (a) An Indian specimen of *G. superba* Linn. (b) An African specimen of *G. superba* Linn. Figure 2. *G. lutea* Hort. Figure 3. *G. plantii* Loud. Figure 4. *G. richmondensis* Hort. Figure 5. *G. virescens* Lindl.



6



7



8



9



10

Figure 6. *G. rothschildiana* O'Brien. Figure 7. *G. magnifica* Percy-Lan. Figure 8. *G. latifolia* Percy-Lan. Figure 9. *G. longifolia* Percy-Lan. Figure 10. Seeds of *G. rothschildiana*.

In some cultivars like cvs. 7 and 16, leaves are produced in a whorl of three to four at a node throughout the stem (Figure 13).

For morphological analysis, leaves from the middle part of the stem were compared for size, shape and color. The leaves are generally sessile (Figures 14-18); however, in rare cases (cvs. 19 and 29) short pedicellated leaves have also been recorded (Figure 19). Apices of the leaves are modified into tendril-like structures which usually help the plants to climb upward.

There is much variation in the shape and size of leaves in the natural species. In *G. superba*, the leaves are lanceolate (Figure 14), while in *G. lutea*, *G. virescens* and *G. richmondensis* they range from linear to lanceolate (Figure 15). Furthermore, in *G. plantii* (Figure 16), *G. rothschildiana*, *G. longifolia*, *G. latifolia* (Figure 18) and *G. magnifica* and octoploid cultivars (Figures 16-17), leaves are ovate to lanceo-cordate.

Leaves are comparatively larger in *G. superba*, than *G. lutea*, *G. plantii*, *G. virescens* and *G. richmondensis*. The smallest leaves are found in *G. plantii* while the largest are in *G. latifolia* (Figure 18). Others fall in between (Figures 14-19).

In general, the octoploid forms, have broader, ovate or lanceo-cordate leaves while diploid and tetraploid types have smaller, linear to linear-lanceolate leaves. The length/width ratio does not bear any definite relationship to the level of polyploidy.

The leaves of *G. superba*, *G. lutea*, *G. virescens* and *G. richmondensis* are rough and green to dark green, while in octoploid cultivars and species and also *G. plantii*, these are shining, yellowish-green and smooth in texture.

Flower

Flowers are showy, large and borne solitary or in lax, corymbose inflorescences. The basic color in the genus *Gloriosa* appears to be yellow but in natural species, a great deal of color variability has been observed. Flowers may be single or bicolored. When bicolored, they are striped, blotched or margined. Self-colored flowers are only met within diploid (*G. lutea*) and tetraploid cultivars (cvs. 'Lemon King', cvs. 38 and 77). In octoploid plants, flowers were always bicolored with yellow margins with the rest of the perianth being red colored.

In general, the color pattern in the genus shows some correlation with the level of polyploidy. In diploid taxa, yellow is associated with signal red (719) or crimson (22) vermilion (18/2) in varying intensity. In *G. superba* this combination is Napples yellow (403) and signal red (719), while in *G. plantii* and cvs. 29 and 57, it is vermilion (18/2) and crimson (22) respectively. In some cultivars (cv. 37) a few streaks of the red (signal red, 719) are found over the straw yellow (604). In tetraploids, combinations of yellow (604) and signal red (719) colors were never observed. In this group, flowers are characterized by crythride red (0027) instead of signal red (719) color. However in *G. richmondensis* a few streaks of rather inconspicuous red color were observed. In the majority of the tetraploid taxa, purple color (crythride red, 0027) varied from a few streaks to an area of about 3/4 of the perianth. In higher polyploid taxa (8x), again, red and its related colors were the dominant flower color. The largest flowers were found in octoploids, followed by tetraploids, and then diploids. The smallest flowers were found in *G. plantii*, (Figure 3) while the largest, in octoploid *G. rothschildiana* (Figure 6).

Fruit

Fruits vary considerably in their size and shape from species to species, and typically all have three equal lobes. In malformed fruits one or two lobes may be shorter than the other. They remain green till they dry to pale and then to black color. When a dried capsule dehisces, the three sections become reflexed and display the seeds attached to the edges (Figure 10).

In diploid species, the fruits are elongated with dark green and coarse fruit wall, while in polyploids they are shining, pale green and oval or egg shaped.

Seed

The number of seeds per capsule varies from 30-150. The seeds are oval and attached to the sutures. The color of the seeds varies from pale orange (*G. superba*, *G. lutea* and *G. plantii*) to deep carmine (*G. virescens*, *G. richmondensis*, *G. rothschildiana*, *G. longifolia*, *G. latifolia* and *G. magnifica*).

Rhizome

A period of three to four years is required to reach the mature rhizome stage from a seedling. When mature the rhizome is cylindrical, usually V-shaped, with the two limbs equal or subequal in length, pointed at the ends.

G. lutea and *G. plantii* have the smallest (6-8cm long) rhizomes while the largest (30.0cm) is recorded for *G. virescens*.

TAXONOMIC TREATMENT OF GARDEN CULTIVARS

Some of the cultivars are of hybrid origin, but there is no authentic record of their ancestry. However, *G. superba* (Figure 1 a,b), *G. virescens* (Figure 5), *G. simplex*, *G. plantii* (Figure 3), *G. rothschildiana* (Figure 6) and *G. longifolia* (Figure 9) seem to have been involved, often indiscriminately, in cultivar origins (Narain, 1972). On the basis of morphological analysis of flower and perianth characteristics, the following six groups may be differentiated.

Group A

In this type, the flowers are erect, perianth segments are narrow, linear to lanceolate and highly crisped (Figures 1,20,26). All these features, along with foliage and color characteristics, exhibit influence of *G. superba* (Figure 1 a,b) and *G. lutea* (Figure 2). This type includes cvs. 'African Chief', 'Orange Gem', 19, 37, 40, and 76.

Group B

This type has the floral characteristics of group A, except that the perianth is reflexed (Figure 21). This group includes cvs. 2, 13, 42, 56, and 76.

Group C

Flowers of this group are recurved as usual with narrow linear-lanceolate, erect and non-crisped perianth lobes (Figure 22). The margins are planed or sometimes slightly wavy. This group shows influence of *G. virescens* (Figure 5) and includes cvs. 26, 'Purple Prince', 'Orange Gift', and 61.

Plate II: Arrangements of leaves in *Gloriosa*

Figure 11. *G. superba*—irregular. Figure 12. *G. plantii*—opposite. Figure 13. *G. superba* (African types) cv.16, whorl. of 3.

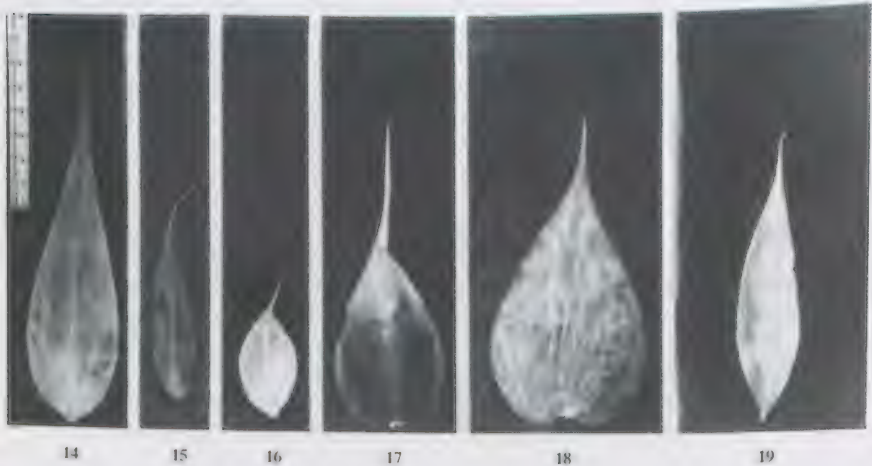
Plate III: Leaves of *Gloriosa*

Figure 14. *G. superba*—lanceolate. Figure 15. *G. lutea*—linear-lanceolate. Figure 16. *G. plantii*—ovate. Figure 17. *G. magnifica*—ovate. Figure 18. *G. latifolia*—lanceo-cordate. Figure 19. *G.* cultivar #19—pedicellate.

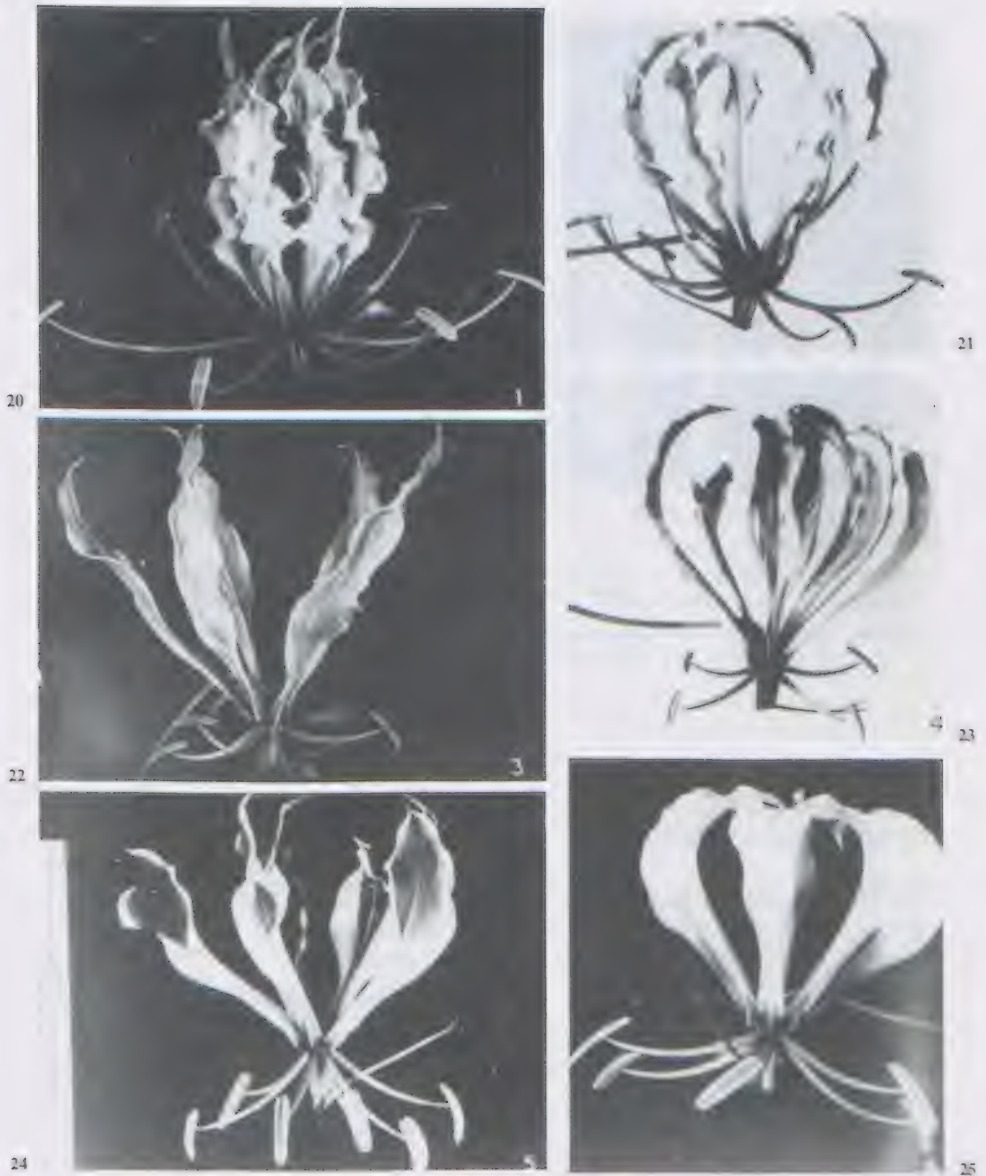


Plate IV: Types of *Gloriosa* Flowers

Figure 20. Group A. Narrow, crisped and erect perianth. (*G. superba* and *G. lutea*). Figure 21. Group B. Narrow, crisped and undulate perianth. Figure 22. Group C. Narrow, plane and erect perianth. (*G. virescens*). Figure 23. Group D. Narrow, plane and undulate perianth. Figure 24. Group E. Wide, plane and erect perianth. (*G. magnifica* and *G. latifolia*). Figure 25. Group F. Wide, plane and undulate perianth. (*G. plantii*, *G. richmondensis*, *G. rothschildiana*).

Plate V: Shape of Perianth in *Gloriosa*

Figure 26. Linear and crisped—(*G. superba* and *G. lutea*). Figure 27. Linear and plane—(*G. virescens*). Figure 28. Oblanceolate—(*G. magnifica*, *G. latifolia*). Figure 29. Oblong—(*G. plantii*, *G. richmondensis* and *G. rothschildiana*).

TABLE 1

Sources of *Gloriosa* Species and Cultivars

Species	Chromosome Number $2n =$	Source of Collection
<i>G. superba</i> Linn.	22	India
	88	South Africa
<i>G. lutea</i> Hort.	22	Messrs. Chandra Nursery, Sikkim
<i>G. plantii</i> Loud.	22	Messrs. Chandra Nursery, Sikkim
<i>G. virescens</i> Lindl.	44	Salisbury, South Africa
<i>G. richmondensis</i> Hort.	44	Messrs. Chandra Nursery, Kalimpong
<i>G. rothschildiana</i> O'Brien	88	Messrs. Chandra Nursery, Kalimpong
<i>G. magnifica</i> Percy-Lan.	88	South Africa
<i>G. longifolia</i> Percy-Lan.	88	South Africa
<i>G. latifolia</i> Percy-Lan.	88	South Africa
40 Cultivars	22, 33, 44 66, 88	Mostly of unknown origin collected from different sources, including South Africa and various nurseries.

Group D

In this group (Figure 23), flowers possess all the characteristics described in group C, except that their perianths are undulate or reflexed. This group includes cvs. 'Mauve Beauty', 'Lilae Lady', 50 and 62.

Group E

This includes plants with wide, oblanceolate perianths and erect or rarely undulate segments. However, a very slight waving in the margins in some plants has also been seen. A typical flower is represented in Figure 24. This type depicts the influence of *G. magnifica* and *G. latiflora* and includes cvs. 'Lemon King' and 'Lavender Lady'.

Group F

This is a very wide and diversified group of *Gloriosa* cultivars, (Figure 25) and the influence of *G. plantii* and *G. rothschildiana* is apparent. Flowers are very showy with variable color. The perianth is very wide, oblong or oblanceolate (Figure 28). The segments are equal and very often with wavy or entire margin. The flowers are highly undulate and represent the typical shape of *Gloriosa*. This includes cvs. 1,2,3,4,12,17 'Orange Ball' and 75.

CONCLUSIONS

A few general conclusions emerge from the foregoing analysis of the morphological characteristics. Of nine natural species studied here, *G. superba*, *G. lutea*, and *G. plantii* are diploid; *G. virescens*, and *G. richmondensis* are tetraploid; and *G. rothschildiana*, *G. longifolia*, *G. latifolia* and *G. magnifica* are octoploid.

There is also a very marked variation in the size and shape of leaves in the natural species. This is very conspicuous in diploids. The leaves in *G. superba* are lanceolate and comparatively larger than the other diploids, (*G. lutea* and *G. plantii*) and tetraploids (*G. virescens*, and *G. richmondensis*). The octoploid taxa always have broader and ovate to lanceo-cordate leaves. In leaf character *G. plantii* is very near to the octoploid taxa.

Leaf arrangement in diploid species also varies significantly. In *G. plantii* the leaves are opposite, while in *G. superba* and *G. lutea* they are irregular. In tetraploids leaves are arranged alternately but closely resemble *G. superba* and *G. lutea*, but differ significantly from *G. plantii*, *G. rothschildiana*, *G. longifolia* and *G. magnifica*, both in shape and arrangements.

Octoploid species (*G. rothschildiana*, *G. longifolia*, *G. latifolia*, and *G. magnifica*) differ in many morphological characteristics from tetraploids, (*G. virescens* and *G. richmondensis*) and diploid species (*G. superba* and *G. lutea*) but resemble *G. plantii* in having opposite and ovate or lanceo-cordate leaves.

In view of the morphological similarities between *G. plantii* (2x) and octoploid species (8x), the former species may have been closely involved in the origin of the latter.

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CRINUM OF THE SEYCHELLES AND MAURITIUS

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THE Seychelles form an archipelago of small mountainous islands in the Indian Ocean 1100km northeast of Madagascar. Mahe, the largest island, is approximately 35km long and has a surface area of 142 sq km. Total population of the nation has nearly doubled during the last 17 years, and it now numbers in excess of 100,000.

The islands were uninhabited until colonized by the French in 1768. Soon afterwards large tracts of virgin tropical forest were cleared for agricultural purposes. Cotton temporarily became a major export crop until slavery was outlawed. Unfortunately the ecological balance had been significantly altered, and considerable quantities of fertile soil subsequently washed away, especially on Mahe. Although today coconut oil, cinnamon and vanilla are harvested for export, arable land is woefully scarce, and the economy is heavily dependent upon imported foodstuffs.

The botany of the Seychelles was studied in detail by Horne circa 1870. He made two collecting expeditions and sent nearly seven hundred specimens, accompanied by detailed notes, to the Kew Herbarium. Horne's specimens and field observations constituted the major reference materials on Seychelles flora cited by Baker in **Flora of Mauritius and the Seychelles**, published at Kew in 1877. There were three native *Crinum* species listed: *C. bracteatum* (a variety of *C. asiaticum*), *C. careyanum* (a variety of *C. zeylanicum*) and *C. augustum*, although the last was later recognized to be a sterile hybrid. Horne's notes related that *C. bracteatum* was common on the sandy beaches of the western coast of Mahe, *C. careyanum* was endemic to the beach at the capital city of Victoria, and *C. augustum* was found in poor light sandy soils in Mahe.

In January 1988, I visited Mahe for three days with the specific intent to observe and photograph indigenous *Crinum*. Alas! Without question the introductory chapters of Baker had filled my mind with romantic thoughts of an 1877 tropical paradise, and I had failed to consider the impact of modern technology and overpopulation on an island ecology. For instance, there was no longer a beach at Victoria; a massive land reclamation project had extended the port area outward into the harbor approximately one kilometer beyond the 1877 shoreline.

The central region of Mahe was mountainous, quite rocky and heavily wooded. Scattered along the coastline were narrow strips of sandy beaches dotted with numerous palm trees. In between the mountains and the beaches were shallow plateaus and transition zones where the bulk of the population resided. A winding beachfront highway nearly encircled the island, and there were several cross-country roads which dissected the central mountains.

Crinum was frequently observed in cultivation, and I was able to identify the three varieties described by Baker. My residence was the Reef Hotel. Just outside my room

were two plantings of a stately *C. asiaticum* variety. Its lightly variegated leaves reached at least 2m above ground level. Axial offsets were often carried above ground in the leaf column, thus leaving their exposed roots dangling in the air. There was a large cluster of *C. augustum* in flower across the street on the golf course. The bulbs were encased in thick papery tunics. Scapes were unable to support the umbels and were sprawling on the ground, a phenomenon frequently occurring in this hybrid. I also saw both of these varieties at the U.S. Satellite Tracking Station and in the yards of private residences. The only site I observed *C. careyanum* was in a vacant lot next to the business district in downtown Victoria. Quite likely the location was near the original beach area of 1877 since it was adjacent to the current port facility. The latter was a presumed identification since the plants were not in flower, but the evidence was overwhelmingly in favor of a *C. zeylanicum* variety: suberect pointed leaves with scabrous margins and a midrib, recent scapes containing 8 and 9 seed pods on pedicels 2-3cm long, and a soon-to-open scape harboring immature buds with prominent apiculates and maroon dorsal stripes extending to the tepal tips.

A fourth *Crinum* was encountered (Figure 1). It was naturalized alongside a stream bordering the Botanical Garden in Victoria and had also escaped cultivation into ditches along the highway north of Victoria and at La Misere. Scapes held 3 to 9 white tulip-shaped flowers which emitted a strong vanilla odor. Leaves were semipetiolated with a depressed midrib effect, distal veins and an acute point. In shaded locations the leaves were arching, whereas in sunny spots they tended to be semierect. The largest leaf on a plant containing 11 leaves was measured and recorded to be 105cm in length by 11cm in maximum width. Plump flower buds displayed a green stripe on the proximal dorsal keels of tepals, but the stripe faded to yellow in mature flowers. No measurable pedicels were evident, and tepal tubes were approximately 16cm long. The style was light waxy green, while the shorter filaments were entirely white. The black anthers stood out in marked contrast. Seed capsules bore short apical projections less than a centimeter in length and contained up to six shiny, dark-green seeds. The overall morphology correlated best with a large variety of *C. jagus*. This species did not freely produce offsets, a strikingly dissimilarity to the multiple varieties of *Crinum* exhibiting near identical white tulip-shaped flowers that I have seen in cultivation in the United States.

I traveled all the highways outside the capital city and closely scrutinized the beach areas. On one occasion I found a solitary *C. asiaticum* surrounded by several small offsets in a remote sandy beach. Much to my dismay, it was the only plant I observed which even suggested a native origin. Undeniably much of the ecology had been altered by man, but if *Crinum* were as common as reported in 1877, surely a few would still exist outside cultivation. There were ample remote beach areas on Mahe, but *Crinums* were noticeably absent.

After analyzing the botanical collections from the Seychelles, Baker commented that there were fewer unique species and families represented than what would have been expected from such an isolated island setting. Had a century of land clearing and agriculture prior to Horne's expeditions completely destroyed a portion of the indigenous flora? Apropos, had overpopulation and technology altered the ecology during the last century such that *Crinum* could no longer survive outside cultivation?

The current absence of Horne's *Crinums* on the beaches of Mahe raises a serious question: "Were *Crinum* truly indigenous to the Seychelles?" Possibly they were introduced

during the slavery period prior to Horne's survey. Such a sequel, being directly related to the practices of herbal medicine and witchcraft among African slaves, was likely the route whereby certain African *Crinum* species came to populate Central and South America (Hannibal and Howard, personal communications). Once a foreign plant had been introduced into an environment and become naturalized, it would be very difficult for a subsequent investigator not to accept it as native, especially if no prior botanical records existed. For example, many beaches on Mahe are currently rank with *Hymenocallis*, probably *H. caribaea*. These have multiplied and naturalized to such an extent that they certainly appear native, yet *Hymenocallis* are not indigenous to the regions bordering the Indian Ocean. Not a single *Hymenocallis* species was described by Baker, so this represents a classic instance of a foreign plant masquerading as indigenous flora. The *C. jagus* variety thriving on Mahe was also not present at the time of Horne, and it is the only *Crinum* which is currently naturalized on Mahe.

Mauritius is an island nation 800km east of Madagascar which has an ecological history very similar to the Seychelles. The aboriginal forests were cut down and the land cleared very soon following colonization. Its botany had been extensively investigated prior to the time of Baker's writing, with specimen collections dating into the seventeenth century. Consequently it was possible for Baker to make a partial assessment into the impact of foreign plants on the environment; he estimated that in 1877, 24% of the 1138 plant species recorded on Mauritius were naturalized and not truly indigenous. The three *Crinum* varieties recorded in the Seychelles were also to be found on Mauritius, but Baker specified that both *C. asiaticum* and *C. careyanum* were naturalized plants on Mauritius and not true inhabitants. (Note: *C. augustum* would be excluded as a possible native plant since it is a hybrid.) Baker could not accurately make such a distinction concerning *Crinum* in the Seychelles because they were present when Horne compiled his collections. However, their absence outside cultivation in the Seychelles today strongly hints at a history similar to Mauritius.

I visited Mauritius for only one day. The small island had a population in excess of one million. Virtually every square meter of tillable land was under cultivation for sugar cane. It was a disappointment to visit the famous Pamplemousses Gardens. A caretaker informed me he was familiar with the genus *Crinum*, but that none were grown at the Gardens. He stated it might still be possible to locate a few naturalized plants growing alongside a nearby river, but finding them in January (summertime) would be unlikely because they were winter flowering in Mauritius. I showed him a copy of Baker and inquired about the marshes at Flacq where *C. augustum* had been sighted. He replied he lived in Flacq, and the marshes had been drained long ago in order to grow sugar cane. Although my stay was brief, I departed Mauritius without observing a single *Crinum*.

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Figure 1. *C. jagus* variety. La Misere, Seychelles. January 25, 1988. Photo by the author.

A NOTE ON
LUZURIAGA MARGINATA (PHILESIACEAE) FROM PATAGONIA

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SUMMARY

Some notes on the habitat, phenology, distribution and cultivation of *Luzuriaga marginata* are made and a brief description of the species is given.

INTRODUCTION

THE genus *Luzuriaga* comprises only four species, three from Western Patagonia and subantarctic South America (*L. marginata*, *L. polyphylla*, and *L. radicans*), and one from New Zealand (*L. parviflora*). The genus is a striking example of the connection between the floras of distant land masses of the southern hemisphere.



Figure 1. *L. marginata* (Leuenberger et Arroyo 3677), plants with pendulous flowers growing on a mossy stream bank in *Nothofagus* forest near Perito Moreno glacier in the province of Santa Cruz, Argentina. Photograph by Leuenberger.

A review of the taxonomic history of *Luzuriaga* Ruiz and Pavón and some morphological data together with a detailed bibliography are given in a recent paper by Arroyo and Leuenberger (1988).

HABITAT

Luzuriaga marginata occurs in mixed wet *Drimys-Notofagus* forests, mainly along stream margins, in coastal woodlands, but also in open cyperaceous or sphagnum bogs (Figure 1). In the forest habitat it is often associated with bryophytes on leafmould substrate. It occurs usually in half-shaded sites of varying exposure. It has been recorded from localities between sea level to about 200m altitude.

GEOGRAPHICAL DISTRIBUTION

The species has a restricted area ranging from about 41 degrees south in Argentina (southwestern corner of the Province of Neuquen on the Brazo Blest of Lake Nahuel Huapi) and 50 degrees 50' south in Chile to the western and southern part of Tierra del Fuego and the Falkland Islands (Malvinas).

PHENOLOGY

Flowering occurs from November to February and immature fruits can also be found in January/February according to data compiled from herbarium labels (Figure 2). According to Skottsberg (1913), berries can be seen in December from flowers of the previous season. In some herbarium specimens, mature fruit are recorded for late October, i.e. in spring on the southern hemisphere. This would mean that fruit development takes place after a long winter dormancy in postfloral stage. Further field observations are necessary to confirm this.

SPECIAL CHARACTERS

As in other related genera, i.e. *Philesia*, *Lapageria*, the twisted petiole causes the inverted position of the leaf blade. Therefore, the adaxial surface of the leaf is the underside, showing a pale and papillate surface, while the abaxial is the upperside, have a green color and smooth surface (Figures 3 and 4). Transversal veins connecting the parallel primary veins occur, which allows inclusion of *Luzuriaga* in the reticulate monocotyledonous leaf type. The stomata are always in the papillate areas, i.e. on the adaxial side of the blade.

In the pendulous white flowers, two green spots at the base of each tepal are conspicuous. Sweet fragrance was reported on one herbarium label (Dollenz, Moore & Pisano, TBPA 1443, BAB).

CULTIVATION

According to the published literature, two other South American *Luzuriaga* species have been in cultivation at the Royal Botanical Gardens, Kew, since W.J. Hooker (1860) mentioned *L. polyphylla* (= *Callixene polyphylla*) and later on J.D. Hooker (1879) mentioned *L. radicans*. Robinson (1899) cited *L. radicans* as one of the evergreen Liliaceae growing in English rock-gardens, among the larger alpine shrubs. More currently, *L. radicans* is also cited as one of the contributions from the southern hemisphere to the

Irish garden (Morley, 1979). Since *Luzuriaga marginata* is not mentioned in the European Garden Flora (Yeo, 1986), it is apparently rare in cultivation, contrary to the other two South American species, *L. radicans* and *L. polyphylla*, which are included there. Nevertheless, in the Catalogue of Plants of the Royal Botanic Garden, Edinburgh (1986), all three South American species are mentioned. On the other hand, in the New York Botanical Garden Illustrated Encyclopedia of Horticulture (Everett, 1981) no *Luzuriaga* species are listed. Therefore, they can be considered to be rare in cultivation.

SYNONYMY AND BRIEF DESCRIPTION

Luzuriaga marginata (Gaertner)Bentham, in Bentham & Hooker f., Gen. Pl. 3:768, 1883.

Synonyms: *Enargea marginata* Gaertner, Fruct. sem. pl. 1:283, t. 59. 1789.

Callixene marginata (Gaertner)Lamarck, Tabl. encycl. 387, t. 248. 1793.

Perennial, semi-herbaceous. Stem ca. 50cm long, ca. 2-3mm in diameter, branched, woody, glabrous, rooted and with small scales at lower nodes. Leaves alternating, ca. 6-20mm long and ca. 4.5-7mm wide, blade ovate, coriaceous, with revolute, setulose-spinulose margin, pale with small green bands below and green shiny above; petiole short and twisted. Peduncle ca. 4mm long, with a few bracts at base. Flowers solitary, pendulous. Perianth campanulate, white, each tepal with two green spots at the base; tepals ca. 10-16mm long and ca. 5-9mm wide. Style filiform, stigma capitate. Mature fruit ca. 1cm diam., elliptic to subglobose, dark purple.

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Figure 2. *L. marginata* (Leuenberger et Arroyo 3677), flowering and fruiting twigs, showing the white tepals with two green spots at the base, the immature purplish spotted berry, the leaves with short and twisted petiole, and the pale underside of the leaf-blade with narrow green bands. Photograph by Leuenberger.

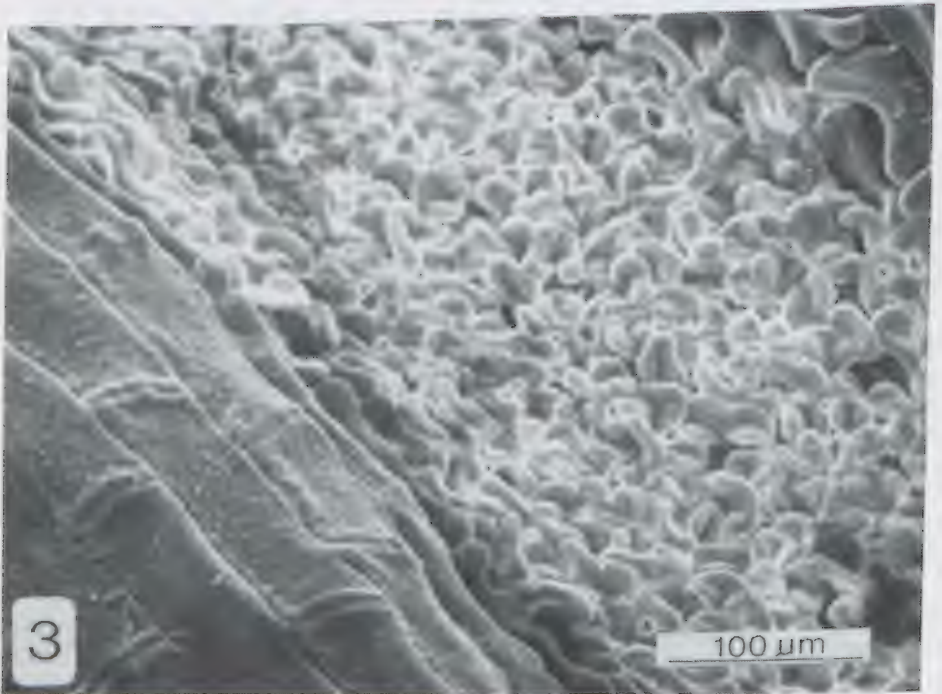


Figure 3. *L. marginata* (Leuenberger et Arroyo 3677), adaxial leaf surface (SEM) showing the transition from non-papillate cells over midvein to papillate area.

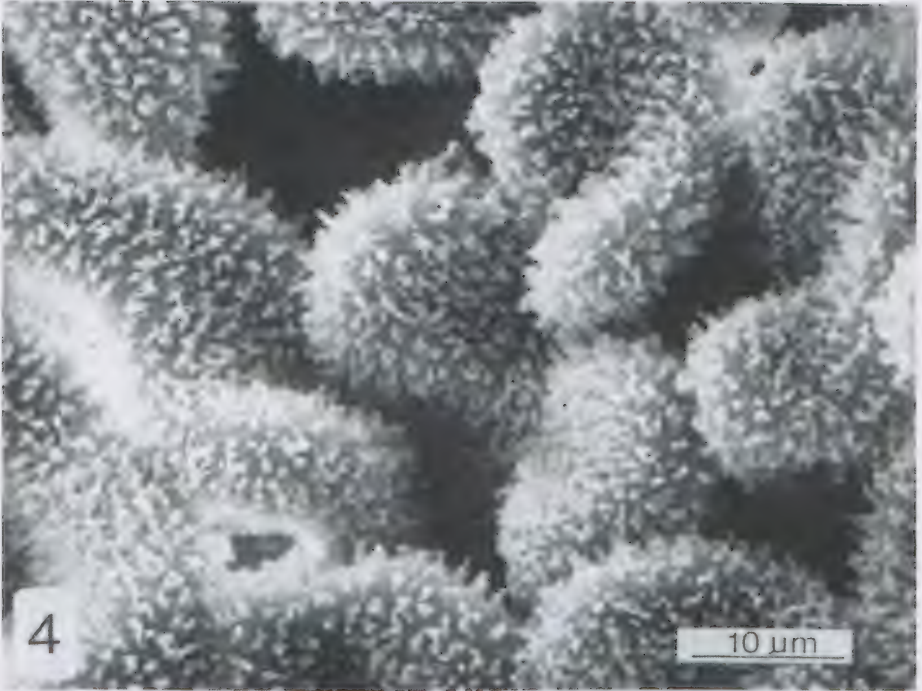


Figure 4. *L. marginata* (Leuenberger et Arroyo 3677), adaxial leaf surface (SEM) showing the outer stomatal aperture and papillate cells covered by wax crystalloids. The technical assistance of Mrs. M. Schroder, Berlin, for the SEM micrographs is gratefully acknowledged.

RAISING *HIPPEASTRUM* BULBS FROM SEED

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THERE are several interesting and practical ways of varying the range of *Hippeastrum* stock by self pollination or cross-breeding. For those who already have a supply of quality flowering bulbs, the urge to improve or increase the hybrid stock demands some observations in promoting these changes.

In general terms this involves the transfer of pollen from one flower to the ripening stigma of another. Precise fertilization is the deliberate choice of the breeder as self-pollination reduces the inherited vigor of resultant seedlings.

For those who are satisfied with the form, size, or color of their flowers, self-fertilization is one option, except where the plant is self-sterile. Cross-fertilizing is best practiced when both seed and pollen parents have similar qualities of good flower form and comparative flower size. Color is not necessarily the major factor.

POLLEN MANIPULATION

To achieve one or a blend of those qualities, the exchange of pollen from other sources is sometimes essential. The fact that *Hippeastrum* pollen can be collected, transmitted and then stored for extended periods adds to the interest of cross-breeding. Bulbs that flower beyond the normal time range can therefore be cross-fertilized "out of season" if quality pollen is available under domestic refrigeration.

This means that pollen from both sides of the Equator may be exchanged and stored and used for breeding. Properly collected pollen can remain viable in transit for more than a week and then be refrigerated, even if delivered by post.

A collecting system using paper backed tinfoil (NOT aluminium) with a thin polyurethane receptor pad has proved quite satisfactory. These small unbreakable pads fold to an area approximating one lens of a pair of spectacles.

The descriptive details of the pollen-parent and date can be written legibly on the paper side and the pads stored in a closed glass jar in the freezer section of a household refrigerator.

There is an affinity between the receptor pad and the tinfoil which indicates that pollen may be transferred directly to the stigma of the seed parent at the matured receptive stage.

SEED GERMINATION

A productive method of raising *Hippeastrum* seed has been used for a few years by the writer in Western Australia. Basically the system involves the formation of a micro-climate, using two-liter ice cream containers. No drainage holes are required and the lid must be close-fitting. Fresh seeds will emerge in sixteen to thirty days, older seeds can take up to seventy days. The lid must be removed before the leaf touches that height. No

additional watering, after the initial watering program, is required until the final removal of the lid. Partial lifting of the lid with a wedge over a two to three day period will permit gradual climatic adjustments to the maturing seedlings.

Direct sunlight at this stage must be avoided, but filtered sun early and late in the day is recommended during fifty to sixty days growth.

Daily watering by mist-spraying of exposed seedlings is essential in hot, dry and windy conditions. The dull surface color of the growing medium (peat-moss) is a sure indication of dryness.

The second leaf stage should be evident about fifty days after seed planting of fresh seeds. The transfer to pots of young seedlings may be delayed until the third leaf shows, but there need be no great urgency in potting up young seedlings if watering care is kept up. Mist-sprayed weak fertilizers may be used about sixty days after planting.

Having described the system and its potential, the important factors of the growing mix and its preparation are noteworthy.

According to the number of seeds to be raised—recommending about forty per two-liter tub—a quantity of fairly dry German peat moss is rubbed through a garden sieve into a barrow. The prepared quantity involved is then placed in a plastic bucket and flooded with clean water. The water is then squeezed out and the “buns” of peat stored for a short time in a dry bucket. Final recovery of the remaining wet peat can be made with a meshed household strainer.

The “buns” of peat moss must be teased apart. About two tablespoons of finely ground dolomite limestone to a ratio of four liters of the peat must be thoroughly mixed together. To that quantity are then added two cups of washed clean sand. The sand gives weight to the mix because the growing seeds tend to turn over as their roots push into the peat moss.



Figure 1. Thirty-three day old seedlings of *Hippeastrum*. Photo by the author.

The mix is now ready for placing in the tubs and these are now filled to a depth of 6cm. If selected seeds are to be group labelled, this work is done by dividing the planting mix with cut strips of venetian blind slats, pushed edgeways into the peat mix. The surface of the mix is levelled so that the seeds may be laid flat thereon—use of tweezers is recommended.

This activity must be performed in a draught-free area otherwise the seeds will blow away. When each subsection is planted and labelled, a cover of 1cm of additional peat soil is placed on top of the seeds.

When this operation is completed, the surface is “mist-sprayed”, using about $\frac{1}{4}$ of a cup of clean water to dampen the contents. The lid is then firmly placed and the container located in a well-lighted position out of doors and subject to some early and late sunlight each day.

If night temperatures are low, the tubs may be relocated indoors overnight. High day temperatures in protected areas are beneficial to seed development. After 21 days or so the lid may be lifted for inspection and replaced tightly.

Incidental inspection of the tubs will show precipitation of water under the lid. If this appears excessive, shake the water off before replacing the lid.

As *Hippeastrum* seeds can be raised by floating them on water, any excess within reason is not detrimental. Dryness will be a problem after lid removal if mist spraying of developing foliage is ignored. Therefore neglect over the initial sixty days can be fatal. Proper care can establish leaf growth up to 10cm in fifty days after seed planting.

Successful seed raising of selected hybrid stock is an interesting and rewarding exercise. Subsequent bulb development and growth to the flowering stage is satisfying evidence of your skill and dedication, three years ahead.

A NEW *MUSCARI* (LILIACEAE) FROM TURKEY

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ABSTRACT. *Muscari mcbeathianum* Kit Tan, endemic to south-central Anatolia, is described and illustrated; it is related to *M. coeleste* Fomin and *M. pallens* (Beib.) Fischer.

INCLUDED in the living and herbarium material from Turkey brought for identification to the Royal Botanic Garden, Edinburgh in 1985 by Jim and Jenny Archibald (a husband and wife team of commercial seed distributors from Wales) were two small *Muscari* bulbs. Several plants in full flower of the same species had been dug up during one of their collecting forays in a botanically interesting area of northeast Adana near to the Kahramanmaraş border. The plants were growing in an open situation under *Pinus nigra* ssp. *pallasiana* forest, in fine damp sand. The pressed specimens accompanying the living material bore only 2-3 leaves per bulb, the rest of the leaves having unintentionally become detached when the fleshy bulb was split to facilitate drying. Labelled as *M. coeleste* Fomin by Jim Archibald, the specimens were laid as such into the Edinburgh herbarium without further note.



Figure 2. *Muscari mcbeathianum* in cultivation at Edinburgh. Photo by Kit Tan.

During a particularly mild and early spring for 1988 and throughout March and April, Ronald McBeath, an assistant curator at the RBG, had been assiduously bringing me *Muscari* in pots and polythene bags, hoping for quick and accurate identifications for the Herbaceous and Alpine Department. Specimen *Archibald* 6155 (Accession number 851491), in cultivation for nearly three years, still unnamed and now at the first stage of flowering, was brought in as part of the identification routine. Having recently completed a large batch of boring 'armeniicum' cultivars and 'neglectums', neither plant nor bringer received an enthusiastic gaze. It was with some surprise and delight that I found myself unable to match the plant with any known species, Turkish or otherwise, and after careful examination, concluded it represents a hitherto undescribed *Muscari*, new to science. Unfortunately it has not been possible to observe mature capsules and seeds at this stage.

Muscari mcbeathianum Kit Tan, *sp. nov.* Figure 1A-C.

Affinis *M. coelesti* Fomin a quo foliis numerosibus (8-9, non 2-3) multo etiam angustioribus (1-2mm latis, non 3-12mm), perianthioque late tubuloso-campanulato sine fasciis atrocoeruleis facile distinguitur.

Bulb ca. 2cm diam., without offsets; tunics grayish to ivory; roots slender. Leaves erecto-divergent, 8(-9), narrowly linear, 1-2mm broad, canaliculate, tapering subacute, glabrous, green, subglabrous on upper surface, not sheathing below. Scapes 1(-2), 5-12cm tall, (including inflorescence), as long as or overtopping leaves, elongating in fruit. Raceme \pm ovoid-cylindrical at early anthesis, 1.5-2.5 \times 1.5-2cm, (10-)15-20 flowered. Pedicels 1.5-2mm, recurved-deflexed in flower, elongating to 3mm. Bracts minute, deltoid, membranous. Flowers all fertile, ovoid and amethyst to bluish-lilac in bud. Perianth not constricted, broadly tubular-campanulate, 5-6.5mm long, ca. 6mm broad at apex; tube 3.5-4.5mm, pale sky blue without narrow darker-coloured fasciae; lobes ovate, ca. 1.5-2mm, patent-recurved, white, also without blue median fasciae; perianth deciduous at base. Stamens biseriate, attached at and below middle of tube; filaments 0.5-0.6mm; anthers 0.8-1mm, dark blackish-violet, positioned well within tube. Ovary globose, ca. 1.5mm; style 1mm; stigma capitate. Capsule unknown. *Flowering in the wild and in cultivation: early May.* Type: a specimen taken in May 1988 from material flowered at the Royal Botanic Garden, Edinburgh, originating from Turkey: B6 Adana: west of Yalak (Yeşilkent) towards Tufanbeyli, on moist fine sand, open areas among *Pinus*, 1200m, 6 May 1985, *J.C. Archibald* 6155 (holo. E), Figure 2.

Muscari mcbeathianum is a rare Turkish endemic known at the moment from the type locality. It is without doubt a true *Muscari*, bearing the characters often cited for a group of *Muscari* previously defined as a separate genus, *Pseudomuscari* Garbari & Greuter. Amongst the Turkish species, it most closely resembles *M. coeleste* Fomin in its delicate flowers of the palest blue but differs markedly in its more numerous, narrowly linear leaves and absence of dark blue fasciae on the broadly tubular-campanulate perianth. *M. coeleste* which occurs much further east, in northeastern Anatolia to be precise, has only 2-3, linear-lanceolate leaves which are much broader (3-12mm), a campanulate perianth more 'open' or flared at the apex and slender, dark bluish fasciae running from the base of the perianth into the lobes. The new species also shows similarity in habit and perianth shape to *M. pallens* (Bieb.) Fischer (Cat. Gorenk 9, 1812), a species endemic to the high Caucasus and geographically remote.

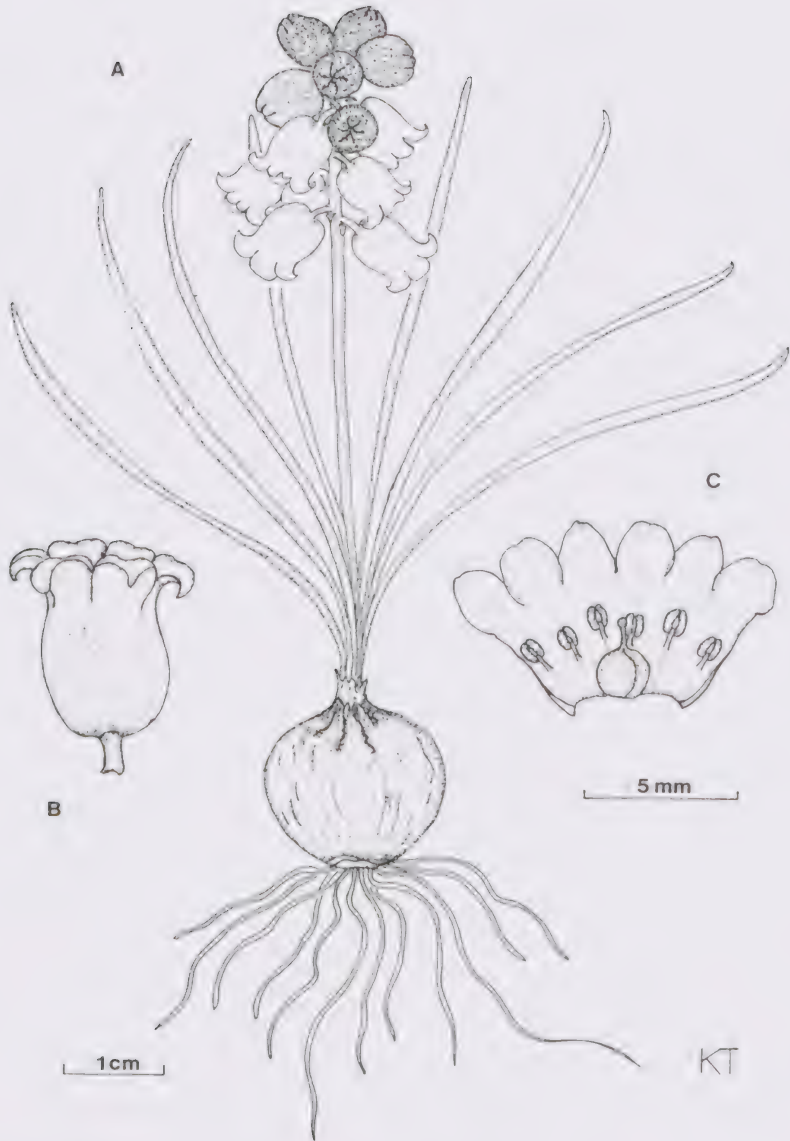


Figure 1. *Muscari mcbeathianum* Kit Tan: A, habit (with 1cm scale); B and C, flowers, entire and dissected (with 5mm scale).

The addition of *M. mcbeathianum* brings the number of *Muscari* in the *Flora of Turkey* area to 23; half of them are endemic, with 11 occurring on the Turkish mainland and one on the island of Samos (present-day political Greece). It is possible that a few more representatives of the *Pseudomuscari* group may await discovery; these are the rarer members of a most difficult genus.

It gives me great pleasure to name this sand-inhabiting little *Muscari* after Ron McBeath. His devoted concern, almost bordering on anxiety lest I miss out on my *Muscari* identifications, is here rewarded and gratefully acknowledged in this paper.

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QUEENSLAND, AUSTRALIA

(Reprinted from Australian Garden Journal)

ORANGE is the color of exuberance and vitality and that enlivening splash of orange in the spring garden colorscape means that old favorite *Clivia miniata* is in bloom. *Clivia* belong to the *Amaryllis* family, and were introduced into Europe from South Africa in 1854. They were named in honor of a member of the famed Clive of India family, a Duchess of Northumberland in whose conservatory, so it is believed, *Clivia* first bloomed in England.

Resembling their counterparts in the Lily family, *Agapanthus*, *Clivia* do not form proper bulbs but build up layers of fleshy leaf bases which become bulb-like in time. Their strong fibrous roots are designed to double as storage organs, tiding the plants over the dry season and enforced period of rest in their native habitat. The flowers are borne in umbels in all *Clivia* species, of which three are widely known. *Clivia gardenii* has 10 to 14 flowers per umbel, reddish-orange or yellow, curved downward. *C. nobilis* has up to 40 to 60 flowers per umbel, drooping, reddish-yellow with green tips. This species should not be confused with the hybrid *C. × cyrtanthiflora*, which is a cross between *C. nobilis* and *C. miniata* and which provides welcome flowers during the winter, and sometimes in spring as well.

C. miniata has 12 to 20 flowers per umbel, erect, bright scarlet with a yellow throat. As all *Clivia* forms, excluding *C. miniata*, have slender pendent blossoms there is some question about separate species being involved, or whether they are merely geographical variants. *C. miniata* occurs in Natal in light woodland from near the coast to at least 1,000 meters in elevation, growing in a humus soil on top of freely draining subsoil. *Clivia* are rather tough plants, and culture is not difficult if one appreciates how they grow in the wild. A noted U. S. plantsman, Mr. Les Hannibal, of Fair Oaks, California, who has had about fifty years of experience with Amaryllids, and who has studied them in their native habitats, notes that *Clivia* may be found growing over moss covered rocky outcroppings, and in the case of *C. caulescens*, the least common species, plants often grow in trees, along with other epiphytes in the cloud-moistened areas. So good drainage is essential, and the plants enjoy crowding of the root system. A sick looking potted *Clivia* is probably suffering from the effects of bad drainage. They may resent disturbance and should be allowed to remain in the pot or tub for a number of years. Mr. Hannibal suggests that the container be part filled with a good loam over adequate drainage material and the root tips be worked into the loam, then filled in under the root crown and around the roots with fine gravel sufficient to hold the stalk upright. He finds that normally a fine moss will form about the semi-exposed roots and he suggests that symbiotic soil bacteria are involved in growth. Earth worms must be kept out of the pots as they reduce the mix to a very fine condition, thus reducing or eliminating drainage. Seasonal variations in

temperature are necessary for consistent flowering. In summer moderate warmth is preferred, in the 16 to 21 degree Celsius range. During winter the temperature should not rise above 14 degrees C. and is better kept nearer to 10 degrees Celsius. Much lower temperatures are tolerated if the plants are not kept wet.

Flowering plants have a high potassium requirement and *Clivia* are no exception. Although they like being root-bound and in a sense starved, they cannot be expected to flower year after year in a nutrient-deficient milieu, whether performing solo or gregariously clumped in the ground.

Clivia are rightly considered shade lovers, and are extremely useful as plants for large shady areas. A site exposed to the northern sun in winter is detrimental to the appearance of the plants as the sunlight from that angle will bleach the leaves and also the flowers when they appear. A clump in an open exposed position is a sorry sight; they are best positioned in a frost-free situation on the south (shaded) side of a fence or building, or where they receive some sun during the early morning or late afternoon; or else under large trees where filtered sunlight will not burn the leaves. Growing them in pots in a fernery or similar position presents no problems, and leaving the pot in exactly the same favorable position all the time gives the best results.

True *C. miniata* must be rare in cultivation, as a bright scarlet flowered form is rarely, if ever, encountered. *Clivia* in the wild have no scent and yet on a warm spring day the perfume from *C. miniata* can be quite strong. So the *C. miniata* so common in the temperate parts of eastern Australia and so variable in flower shape and color, varying from light to dark orange with narrow or broad petals, is likely to be a hybrid. It has been suggested that the scent is derived from genes from the Eucharis lily when *Clivia* × *Eucharis* crosses were attempted in Europe in the last century; experts in the U.S., however, think that such a cross is impossible. It is reported that in the wild strong plants of this species often flower three or four times a year; recurrent flowering, however, has not been noted in cultivated plants.

There are a few varieties of *C. miniata*, e.g. *C. miniata* var. *striata*, which has variegated leaves, and the much sought-after yellow flowered form, var. *C. citrina*. The latter is variable, with both narrow and wide petals which may be recurved or straight. The form *citrina* grown at Kirstenbosch in South Africa has narrow petals. Some clones may exhibit very little yellow in the throat and so the flowers appear white or cream rather than yellow. The yellow *Clivia* is self-sterile but crosses readily with [♀]. *miniata*. The F1 hybrids of such a cross may yield a small percentage of yellow flowered plants, but when back-crossed with the parental yellow about 50% of the seedlings should be self-fertile, thus breaking the existing breeding barrier for further yellow flowered forms from seed.

In the commercial horticultural world of Europe *Clivia* hybrids are grown for the flowering pot plant and cut flower trades. Several strains have been developed, varying from large flowered forms of various shades of orange and red to dwarf early flowering forms eminently suited as pot plants. Growers are reluctant to grow for the seed trade as more money can be made from plant and flower sales. Since the last century *Clivia* fanciers around the world have endeavored to improve color and shape in hybridizing programs. One line of endeavour lies in the development of flower heads of good color, spherical or hemi-spherical in shape, without any overcrowding of the individual evenly spaced florets, and held clear of the foliage on a sufficiently robust stem. Such types might

form the basis of "exhibition" forms as distinct from "bedding" forms which may produce wonderful color in the garden, but the flower heads do not bear close examination.

Gladys Blackbeard has written (Blackbeard 1939) of how she, in her youth, was introduced to the genus *Clivia* via her mother's plant collection. In my early teens I was given my first *Clivia* by my paternal grandmother, Charlotte, who had been given two by her son Joseph, my uncle, a locally noted dahlia breeder. These two orange *Clivias* were in flower when I saw them for the first time and I think I must have asked for one then and there. Grandmother Charlotte was very generous with plants, notably bulbs, and more than 30 years later the descendants of that *Clivia* given to a budding bulb fancier are still in my garden in a small clump, and have been distributed far and wide. For me that *Clivia* was, of course, *Clivia miniata*, and it was not until many years later that I was perplexed to read that *C. miniata* should have a scarlet flower. This need not be so as I was to learn that a species cannot be defined absolutely.

I have been "pudding around" with *Clivia* hybridizing for about fifteen years, but did not achieve much in the way of character in the flower head until I started using a good form of the yellow *Clivia* with wide recurved petals and a spherical flower head as the seed parent, pollinated from quality orange flowered forms grown from imported seed. *C.* × 'Relly Williams' and *C.* × 'Valerie Martin' are the results of such a cross. *C.* × 'Daphne Loddington' is a chance seedling of unknown parentage, but is noteworthy for its large florets, with petals 45 mm wide, and a hemi-spherical head 23 cm across.

Another effort in this direction was obtaining pollen from a special *Clivia* growing in the splendid garden of Mrs. Margaret Griffiths (1979). This particular *Clivia* had been grown from seed abducted in a handbag from Kew Gardens many years previously by an acquaintance of the above mentioned and could be described as a pale salmon orange. It had been thought that crossing with the yellow would produce 100% pale colored flower heads of good form. However it turned out that the orange progeny were in no way equal or superior to the pollen parent, but the cross did present one big surprise—an extremely high percentage of the seedlings were replicas in form (but perhaps not genetically) of the yellow seed parent, although one of these has noticeably wider petals.

Most *Clivia* will set seed unaided and effecting a desired cross is a simple matter of transferring pollen from the pollen parent to the stigma of the other member of the cross. The sexual parts of the flowers are of easy access, at least those in the *C. miniata*. Unfortunately one must wait after pollination and fertilization for six to twelve months for the seed to ripen; this is heralded by the seed capsule changing color from green to orange or red or cream, depending on the species or ancestry of the hybrid. The sparse flesh of the seed capsule or berry will then be soft and yielding to the touch. The large seeds are easy to clean, if squeezed from the berry and then allowed to dry for a few days. Germination is not a problem if one remembers an open mix is required. I get the best results from planting the seeds in sphagnum moss, lightly covering them. Good drainage is provided by mattress fibre in the bottom third to half of the pot; this gives good aeration and so encourages strong root growth. It is advisable to use a fungicide in such a wet medium. Mature *Clivia* berries thrown on to mulch under a shrub or tree will germinate and grow into mature plants there, thus replicating the conditions under which *Clivia* spread from seed in their native habitat. Another drawback to raising *Clivia* from seed is that one will have to wait five or six years for the first flower under ordinary conditions. The process can be speeded up, as in a heated planthouse.

Seed of this Griffiths' pollen cross planted in 1980 gave 39 plants, seven of which flowered in September 1985. Of these seven, five were yellow and two, orange. In

September 1986, 23 flowered, of which eleven were yellow and twelve, orange. Three which flowered in 1985 did not do so in 1986; of these two were yellow and one, orange. At the time of writing 26 of this cross have flowered—13 yellow and 13 orange. There are 13 left to flower and none of these have bronze pigment in the leaf bases. Thus the proportion of yellow progeny stands at 33% and could rise higher. Some of the F1 orange have been crossed among themselves to see if the seeds will yield any yellows, and as recommended by Les Hannibal (1984) the F1 yellows have been, and will be, crossed with the parent yellow in the hope that this back-crossing will yield some yellows that are self-fertile and which do not show any of the genetic weaknesses which have been observed by breeders in California and which appear to be linked to the elimination of the red pigmentation gene. These experiments of mine should be completed in 5 to 10 years.

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OBSERVATIONS ON CROCUS (IRIDACEAE) IN JORDAN WITH SPECIAL REFERENCE TO *CROCUS MOABITICUS*

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ABSTRACT

A RECENT collection of *Crocus* in Jordan adds a new location and new information to the knowledge of the little known *C. moabiticus* Bornm. & Dinsm. ex Bornm.. A detailed comparison of *C. moabiticus* with the closely allied species *C. cartwrightianus* Herbert is given and problems concerning the record of *C. cartwrightianus* in Jordan are discussed. *C. hermoneus* Kotschy ex Maw, *C. aleppicus* Baker, *C. pallasii* ssp. *hausknechtii* (Boiss. & Reuter ex Maw) Mathew and *C. hyemalis* Boiss. & Blanche are studied in known habitats. A new locality is described for *C. cancellatus* ssp. *damascenus* (Herbert) Mathew.

INTRODUCTION

The occurrence of *Crocus* species in areas belonging to the southern limit of the genus' distribution is characterized by disjunct distribution patterns. This can be explained by several climate changes during various parts of glacial and interglacial periods (Wrm and as late as Prehistoric or Early Historic times after Feinbrun & Shmida, 1977). Vegetation which adapted to those changes avoided extinction.

Today in Jordan large areas, especially in the eastern and southeastern parts, are desert country and only few climatic and edaphic enclaves exist which provide appropriate conditions for crocuses and other species of ancient plant communities to survive. Typical in this respect are the mountainous areas east of the Jordan Valley and Wadi Araba. They are approximately 1000m in height or higher and belong mainly to the Mediterranean climate zone of Jordan which receives sufficient precipitation at least during the winter months. So it is not surprising that the *Crocus* of Jordan are known to exist in those areas (Figure 1). The extension of this landscape in a north-south direction is to about 300km from the Syrian border to the mountain ridge of Ras en Naqb, some 100km in distance to the Gulf of Aqaba, and to 20-40 (45)km from west to east, reaching at Jebel Mubrak a maximum elevation of 1736m above sea level.

The more southerly parts of those areas are still remote and no roads or tracks give access to them, thus making it difficult to search for and investigate relict habitats. This remoteness is, in general, a benefit for the harassed flora of the country. In the environs of the capital, Amman, almost all the natural landscape is destroyed, mainly by the very rapid and uncontrolled urban spread, extensive grazing, and even more extensive agriculture not sparing the smallest spot.

This habitat destruction may seem necessary for a small country like Jordan which has over 90% desert area, when its national goal is to rise economically and to increase its living standard. Presently this destruction of the original landscape may be a minor problem

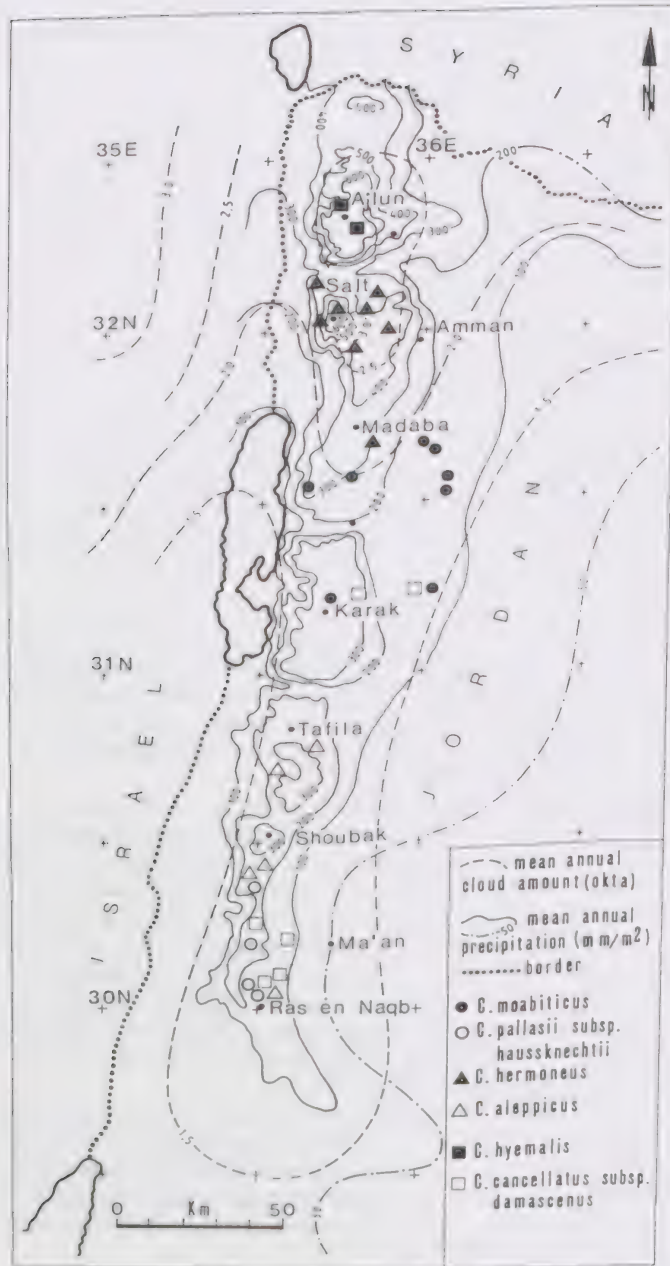


Figure 1. Habitats of *Crocus* species in Jordan in comparison with mean annual cloud (okta) and precipitation (mm/m²) amount (based on data from the Meteorological Department, 1971).

but it pushes a large part of the extant Mediterranean plant life once again into a struggle for survival. It can be assumed with certainty that without establishing several larger conservation areas many species (including *Crocus*) in this beautiful country are threatened with extinction.

In December 1986 I had the opportunity to travel widely in Jordan. With the intention of making field studies, I visited a number of known localities of *Crocus* species and even found two new localities. In some populations I was lucky to see many plants in flower. I was able to take colour slides and field notes which enabled me to complete morphological descriptions and to add additional information on the distribution of *Crocus* in Jordan.

CROCUS MOABITICUS

Crocus moabiticus is a little known species which is, as far as is known, endemic to Jordan and its collection records are mostly in the region of Moab (numbers in brackets refer to Figure 2).

Type locality: (1) Jordan, Moab, near Zizeh in fields, 720 meters, 18 November 1910, F.S. Meyers & J.E. Dinsmore M. 1537. Leaves added in spring 1911 from corms of this collection cultivated in Jerusalem (specimen in Berlin).

Feinbrun (1957) : (1) Transjordan: Moab Ziza Dinsmore (specimens grown in Jerusalem by Dinsmore from corms coll. at Ziza H.U.J.).

(2) Moab, near Karak, 5.11.1925 W.K. Bigger, under *Crocus sativus* var. *cartwrightianus*. "Flower appears before leaves. Semi-desert country. Perigonium white, veined purple, styles scarlet" (BM).

Feinbrun (1977): Jordanie Nord, Khanasiri, enclos protege, 26.X.1954 (2 sheets), Park 911 JR 224 (6) (this locality is not in Figure 2); (1) Belka, ca. 9km from Ziza, compact steppe soil, ca. 700m, *Haloxyletum articulati*, 27.III.1936 (leaves), Eig, Zohary, Feinbrun.

Mathew (1982): ? (3) Collection of Al-Eisawi, 33km south of Madaba (Jordan) (this was revoked by Al-Eisawi in 1986 and published as *C. cartwrightianus*).

Al-Eisawi (1986): (4) Dab'a Reserve; ca. 50km S of Amman, along road to Aqaba, Al-Eisawi 9741; 10230 (AMM, K, RNG); Al-Eisawi & R.Jarrar 8860 (5) Karak: 4-5 km W of Qatrana, along the road to Karak city, Al-Eisawi 9741.

Kerndorff (this paper): (6) HKJ (The Hashemite Kingdom of the Jordan), Moab, Madaba, 20km south of Madaba, 680-750m, 35° 47.5'E / 31° 34.5'N, 22.12.1986; Kerndorff, HK 1986/12.

With the aim to observe *C. moabiticus* in the field, I visited several of the localities known to be habitats of the species. The type locality near Zizeh (Dinsmore) (now Ziza) 30km south of Amman seems to have been destroyed by agricultural activities and it is unlikely that a crocus would be found there nowadays. The same findings can be reported from the areas along the road between Madaba and Ziza (20km) where I looked for it in that semi-desert country on stony ground and compact steppe soil. Furthermore, inspection of the more or less undisturbed hillsides around Karak showed not a trace of *C. moabiticus* even when looking only for leaves! After these failures I began to investigate localities which seemed to be more appropriate for *Crocus* species, such as open rocky hillsides with limestone formations and heavy reddish soil of 'terra rossa'-type, covered with dryish scrub, sparse grass or maquis. In Moab those are comparatively rare, but I was successful at the first attempt and found a relatively large area of this habitat type described above about 20km south of Madaba.

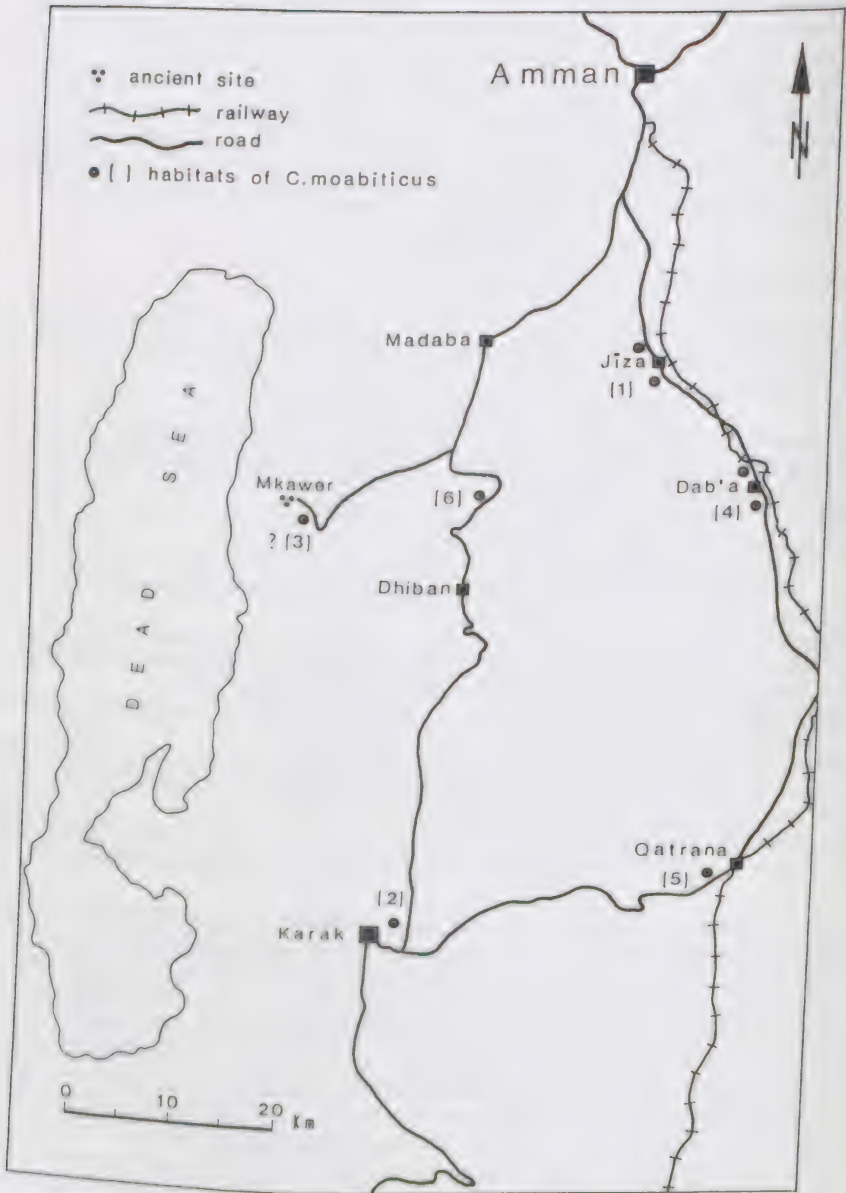


Figure 2. Habitats of *C. moabiticus*.

The observed individuals of *C. moabiticus* were widely scattered. The greatest number observed on a spot of approximately one square meter was five, suggesting great rarity. After further unsuccessful inspections of another four similar localities some 3, 5, 6 and 10km in distance from the new recorded habitat, it can be assumed that *C. moabiticus* is a very rare crocus in both number of populations and individuals.

Information from most of the previous collections of *C. moabiticus* led to descriptions of the species which are summarized by Mathew (1982) as "... a rather small, pale and starry crocus which cannot be classed as a particularly garden worthy subject ..."!

After a statistical inspection of some 25 randomly selected flowering individuals of the particularly fine population 20km south of Madaba it can be clearly stated that this is not the case. To the contrary, *C. moabiticus* can be regarded as one of the most beautiful species of the Series (f) (Crocus) of Section A in Subgenus 1 (after Mathew 1982).

One of the more distinct morphological features of *C. moabiticus* is the very conspicuous 'neck' of the corm, usually 6-7cm but often up to almost 10cm long (previously known only 4-5cm long) (Figure 3A). It consists of coarse, parallel fibres which split into small or broad pieces or stripes which are reminiscent of cinnamon bark. In old and strong individuals all the underground parts of the plant (except the corm) can be entirely and thickly enveloped by the neck which not occasionally reaches or slightly overtops the soil surface. The corm can reach up to 3.5cm in diameter, a character shared with *C. pallasii* ssp. *turcicus* Mathew, the largest of the genus.

The number of leaves of *C. moabiticus* is very variable as shown in their frequency distribution in Figure 3B. Leaf number varies from 6 to 24, with a mean value of 15 ± 4.5 . Most of the 26 investigated mature individuals had 14-17 leaves, which is much more than all the other members of the series (f) of the genus (Table 1). Indeed, the 24 leaves produced from a single crocus corm can be regarded as the maximum count, not only for a member of series (f), but also for the entire genus. The leaves seem to appear much earlier than previously thought. Most of the leaves are above ground at anthesis because they apparently develop very quickly during the flowering period and have a length of at least 8-12cm at maturity but this is certainly dependent upon local factors.

The flowers of *C. moabiticus* have generally a white background colour but in most specimens they are veined or feathered, more or less heavily and give, at least from a distance, the appearance of a purple-violet flower of different shades. In some individuals with very conspicuous feathering the 'feathers' are uniformly strong on both surfaces of all perianth segments. This is a very unusual feature in the genus (colour plate, G). In less striped specimens the outside of the outer perianth segments can be whitish or buff coloured (Figure 7, A, F, H) as is the case in *C. oreoreticus* B. L. Burt from Central Crete, a link to this distant relative. In all other respects *C. moabiticus* is clearly distinguishable from *C. oreoreticus*.

Perianth segment length (up to 3.2cm, Figure 7, B, E) and width (up to 1.2cm, colour plate, G) vary considerably, producing a wide range of flower shapes. Segments can be small and starry as known, but normally they are rather substantial as can be seen from Figure 7. Soil fertility and climatic factors are supposed to have significant influence as growth parameters because most of the previously collected plants have been reported to grow in compact steppe soil in areas with lower precipitation rates and were characterized as small and starry. Under more suitable growth conditions, e.g. terra rossa, higher humidity and precipitation (Figure 1), most of the individuals of a population may reach their optimum appearance.

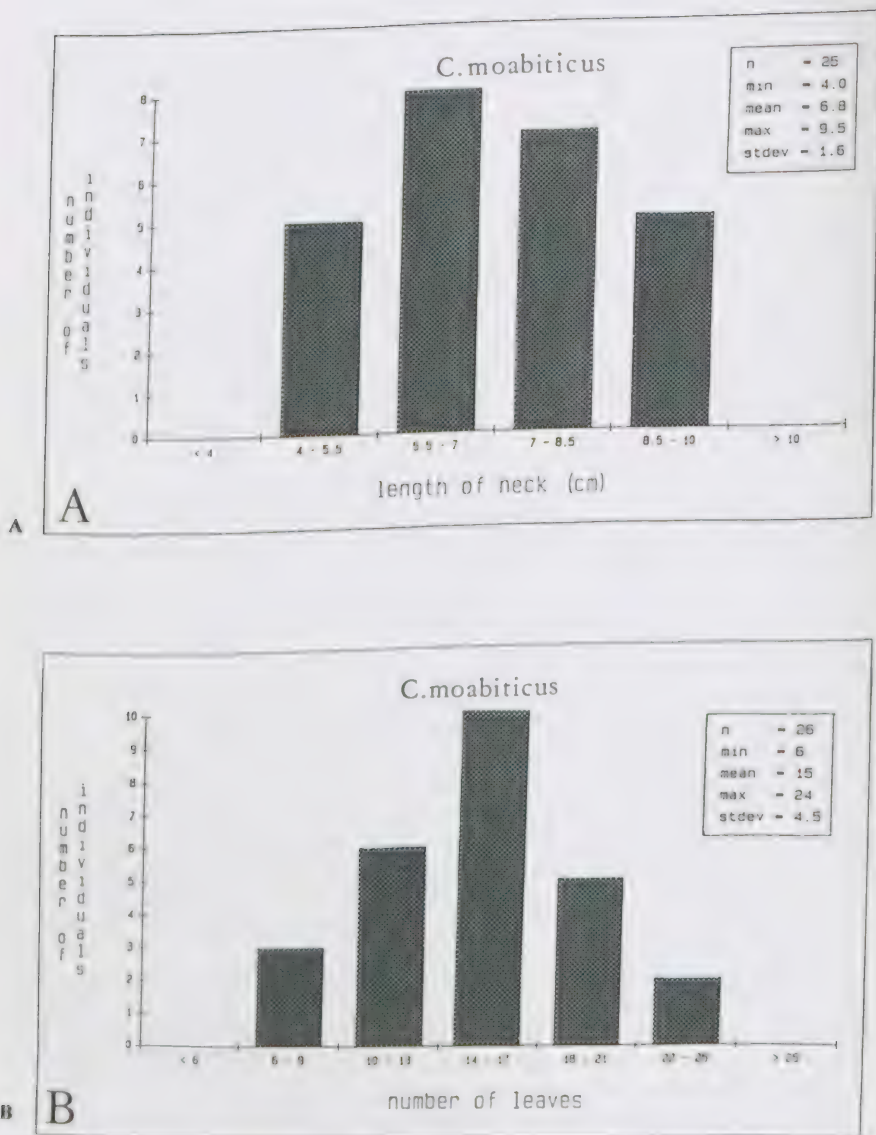
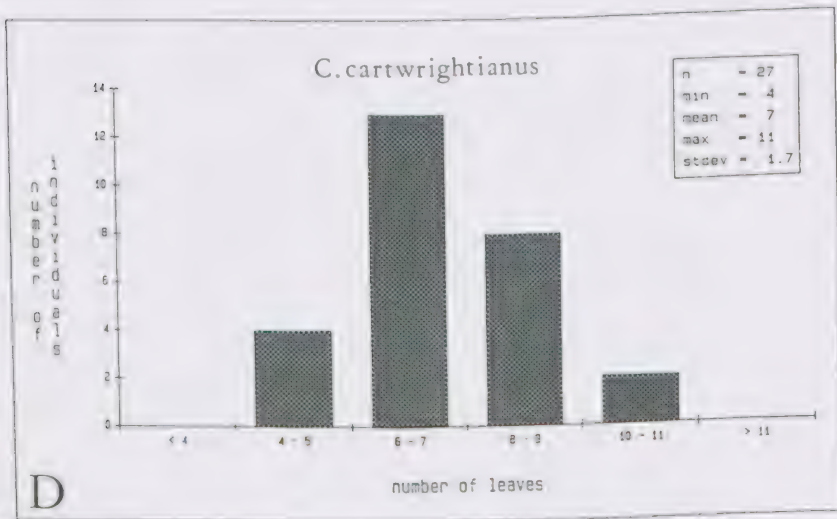
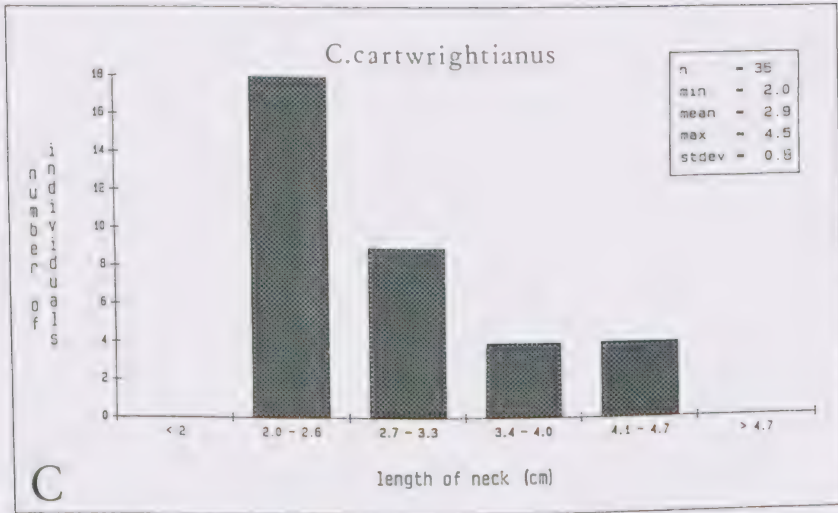


Figure 3. Frequency distributions of (A) corm-neck extension and (B) number of leaves of *C. moabiticus*, respectively (C) corm-neck extension and (D) number of leaves of *C. cartwrightianus*.



species of series (f) CROCUS	no. of leaves
<i>asumaniae</i> Mathew & Baytop	5 - 6
<i>hadriaticus</i> Herbert	5 - 9
<i>thomasii</i> Ten.	5 - 10
<i>cartwrightianus</i> Herbert	7 - 12
<i>oreocreticus</i> B.L. Burtt	7 - 15
<i>pallasii</i> Goldb.	(5) 7 - 17
<i>moabiticus</i> Bornm. & Dinsm.	(6) 14 - 17 (24)

Table 1. Comparison of leaf number of species in Series (f) (Crocus) of Section (A) (Crocus) in subgenus (I) (Crocus). (Classification after Mathew, 1982)

Another peculiarity of the flowers of *C. moabiticus* is noteworthy. It is one of three crocus species known whose flowers, once they have opened, do not close up at night or in dull weather until they shrivel away. Some flowers open nearly flat, others stay more or less bowl-shaped. The other two species showing this feature of anthesis are *C. tournefortii* Gay and *C. cartwrightianus*. Pollinators, which could be observed, were ants and flies (Diptera) but no reason could be found for the flower to stay open. Some flowers have a slight smell of honey but this is not a constant feature.

The conspicuous, dark red style of *C. moabiticus* is comparable to that of *C. cartwrightianus*, divided well below the base of the anthers, gradually thickened and lobed at the apex and in most cases clearly exceeding the anthers. In some cases the branches reach the length of the perianth segments sometimes hanging out of the flower (Figure 7, C).

The filaments are approximately 2.5mm long and glabrous, whitish in freshly opened flowers but becoming grayish-violet before flowers wilt.

The anthers are about 1-1.5cm long and very deep yellow. Before dehiscence they start to bend down their tips to the centre of the flower, looking like the handle of a walking-stick after dehiscence. Then, in old flowers they straighten and shrivel significantly.

Several seed capsules of the previous season could be found inside the corm-necks of older specimens indicating that the pedicel does not always reach the soil surface. The capsules gathered were about 1.5-2.5cm long and 0.5-0.7cm wide, oblong and beige coloured.

The seeds have been found to be dark brown, irregular subglobose, 3-3.5mm long with a pointed caruncle of 0.5mm or less. The testa of a seed is shown on scanning electron micrographs (Figure 4, C and D). As a last point, it is worth noting that, as a result of an x-ray fluorescent analysis, high amounts of potassium could be detected evenly distributed in the testa.

Considering all new information it can be summarized that *C. moabiticus* is a very variable species in length, width and colour markings of the perianth segments from

which very different flower types derive, particularly with respect to size and shape. It is also very variable in number of leaves and length of corm-neck. In its best forms it is a very beautiful crocus which was much underrated due to insufficient knowledge about it.

The description of *C. moabiticus* given by Mathew (1982) may be renewed on the basis of the gathered information as follows:

Corm 2-3.5cm diameter, subglobose, flattened at base; tunics finely fibrous, the fibres parallel at base, slightly reticulated in a small zone in the upper third of the corm, joined at the apex and extended into a very conspicuous neck (4) 6.8 ± 1.6 (9.5) cm long rather barky in old and strong individuals, covering the perianth tubes and leaves often reaching or slightly overtopping the soil surface. Cataphylls 3, membranous, white. Leaves (6) 15 ± 4.5 (24) subhysteranthous, appearing before anthesis, developing up to 12cm in length at the end of flowering period, 1-2mm wide, grey-green, furnished with papillae on the margin of the keel. Flowers 1-6, autumnal, white always with purplish-lilac veins or very heavy feathering on all perianth segments. Throat white but always veined purple or purplish-violet, pubescent. Prophyll present. Bract and bracteole membranous, white, the bracteole narrower and slightly shorter than the bract. Perianth tube 2-5cm long (above ground), white; segments subequal 1.5-3.2cm long, 0.3- 1.2cm wide, narrowly to broadly elliptic or narrowly to broadly oblanceolate or obovate; subacute or obtuse; Filaments 2-5mm long, young whitish, old grayish-violet, glabrous; anthers 1-1.5cm long, deep yellow, curved to the middle of the flower at anthesis; Style dividing in the throat of the perianth into 3 very deep red branches, each 1.5-2cm long, in most cases clearly exceeding the anthers often as long as perianth segments, sometimes hanging out of the flower, each branch gradually thickened to the lobed apex. Capsule 1.5-2.5cm long, 0.5-0.7cm wide, oblong, beige. Seeds dark brown, irregularly subglobose 3-3.5mm long with a prominent caruncle of 0.5mm or less.

The recent collections of Al-Eisawi (1986) and myself (this paper) add several localities and new data to an understanding of this species, although a problem has now arisen concerning *C. moabiticus* and *C. cartwrightianus* which has been recorded by Al-Eisawi as new to Jordan. This may be due to some confusion and I will try to shed some light on this problem in the following discussion.

In December 1979 two corms labelled as *C. moabiticus*, collected 33km southwest of Madaba (near the ancient site of Mkawer, Figure 2) were sent by Al-Eisawi to Mathew at Kew who mentioned this in his monograph (1982). Al-Eisawi rejected this in his publication (1986) and stated that the locality given by Mathew for *C. moabiticus* was cited in error because two specimens of *C. moabiticus* and *C. cartwrightianus* were sent at the same time to Kew from Jordan. The specimens collected from Mkawer are *C. cartwrightianus*, not *C. moabiticus*.

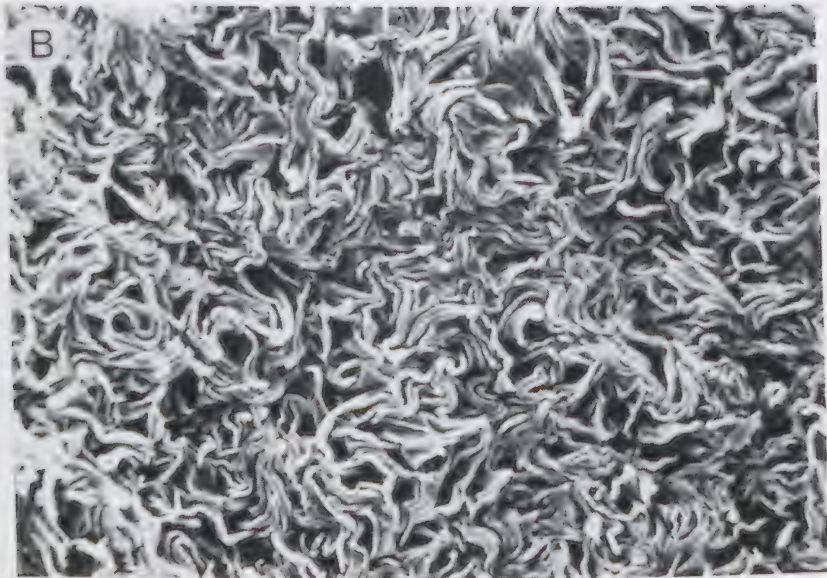
Distinction is difficult, even for a specialist, between only two specimens of two species which are known to be of a very close relationship. Furthermore, Al-Eisawi reported only one locality where he found *C. cartwrightianus* and he speculated that the species might have been introduced to Jordan by ancient (? Hellenic) civilizations as a source of Saffron because the habitat is situated near an archaeological site ((3) in Figure 2).

Another record which is interesting under this aspect comes from near Karak by Bigger as *C. sativus* var. *cartwrightianus* (see listed localities). This herbarium specimen was examined by Feinbrun (1957) and identified as *C. moabiticus*.

Mathew (personal communication) mentions few older records of *C. cartwrightianus* (? or very similar material) from the Jena (... 'if labels are correct') and Paris herbarium said to be from Lebanon, although he considers this unlikely due to the fact that no other such records exist from those comparatively well-known areas.



Figure 4. Seed surface structure of (A, B) *C. cartwrightianus* and (C, D) *C. moabiticus* by scanning electron micrographs. A and C horizontal—B and D vertical viewpoints to the seed surface



B



D

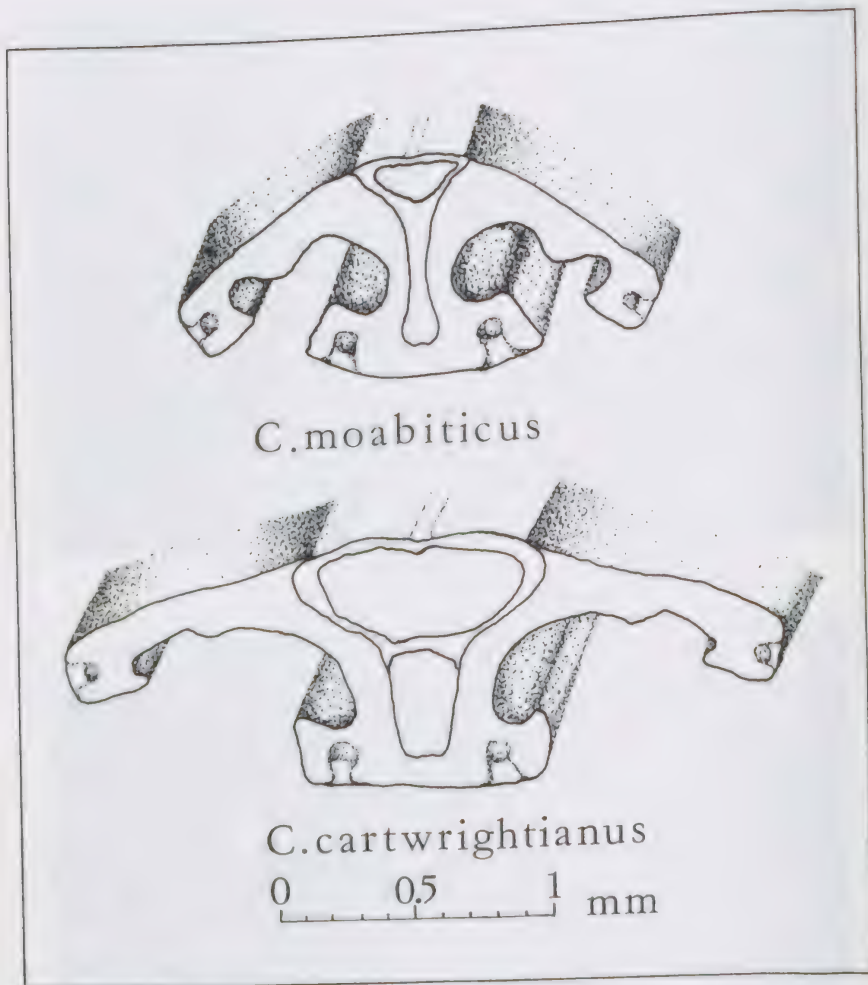


Figure 5. Cross-sectional shapes of leaves from *C. moabiticus* and *C. cartwrightianus*.

Indeed, it would be very surprising to find *C. cartwrightianus* in such a disjunct site, far from its otherwise restricted distribution area centered in the Cyclades. Therefore, if one takes these aspects into consideration, it seems not impossible that the two species might have been mixed-up in several cases. This becomes even more probable due to the fact that, in overall appearance, *C. moabiticus* is very similar to *C. cartwrightianus* and the two species are not easily distinguished in some individuals if one compares only flowers. However, a closer look at other taxonomically relevant parameters of the two species reveals several significant differences between them (Table 2). Plants of *C. cartwrightianus* used for this comparison were derived from my collection (random sa samples) at the Akrotiri and Rodopou peninsulas on Western Crete in November 1986 (HK 1986/1). This material agrees favourably with that from the Cyclades and Attica and can be regarded as a typical *C. cartwrightianus*.

Beside very significant morphological differences between the two species, such as corm diameter, length of neck (Figure 3, A and C), length, width, colour, cross-section (Figure 5) and number of leaves (Figure 3, B and D), appearance of bract/bracteole, colour and surface-structure of seeds (Figure 4, C and D) it is noteworthy that the chromosome number of *C. cartwrightianus* in Greece does not vary from $2n = 16$ (Brighton, 1977), whereas those of *C. moabiticus* have $2n = 14$. Mathew indicated (personal communication) that the Madaba (Mkawer) plant sent to him by Al-Eisawi also has $2n = 14$!

If all these presently available data are taken into consideration, it can be concluded that *C. moabiticus* is extremely variable and some individuals of it come close to *C. cartwrightianus* in flower shape and colour which obviously has caused confusion for previous collectors. However, *C. moabiticus* is clearly distinguished from *C. cartwrightianus* (Table 2) and its status as a species can definitely be confirmed. On the other hand, it now seems very questionable whether the plant recorded by Al-Eisawi from Madaba (Mkawer) is *C. cartwrightianus* and it is more probable that, after closer inspection, it may prove to be *C. moabiticus*.

CROCUS HERMONEUS

Crocus hermoneus was first collected on Mt. Hermon by Th. Kotschy in 1855 and described by Maw (1881) who regarded it, incorrectly, as a spring-flowering plant which caused some confusion to further collectors. In any case, it has been a little known species until Feinbrun & Shmida (1977) and Al-Eisawi (1986) added new data about it. Based on ecological, morphological and cytological characteristics, Feinbrun & Shmida distinguished between *C. h. ssp. hermoneus* and *C. h. ssp. palaestinus*. They suppose *C. h. ssp. hermoneus* was confined to high altitudes of Mt. Hermon and *C. s. ssp. palaestinus* to restricted areas in the Judean Hills (Israel) and to Ammon province of Jordan.

The proposed subdivision derived mainly from differences in the length of style, number of leaves, neck-extension of corm, flowering time and chromosome number. However, Mathew (1982) investigated plants from Jordan, collected by Al-Eisawi, which do not entirely agree with this differentiation, especially in cytological respect and, therefore, he dealt with *C. hermoneus* in the broad sense.

Several localities of *C. hermoneus* are known from Jordan; i.e.

Feinbrun (1957): Transjordan: Feinbrun (1957): Transjordan: Moab, between Madaba and Ziza, 3.11.1926 Eig (HUJ), El Hummar, between Amman and es Sueli, 3.11.1926, Eig (HUJ)

Parameter		<i>Crocus cartwrightianus</i>	<i>Crocus moabiticus</i>
corm	diameter (cm)	1-1.5 (2)	2 - 3.5
	neck extension (cm)	(2) 2.9 ± 0.8 (4.5)	(4) 6.8 ± 1.6 (9.5)
stamophylls		3 - 5 membranous, white	3 membranous, white
leaves	number	(8) 7 ± 1.7 (11)	(6) 15 ± 4.5 (24)
	length (cm)	15 - 28 (± straight)	12 - 19 (± curved)
	width (mm)	3 - 2.5	1 - 1.5
	colour	green	grey - green
	visibility at flowering time	±synanthous	± subhysteranthous
flowers	number per corm	1 - 5	1 - 8
	length of perianth tube (cm)	3 - 5 (7)	2 - 5
	length of perianth segments (cm)	1.4 - 3.2	1.5 - 3.2
	width of perianth segments (cm)	1.2 - 1.2	0.5 - 1.2
	stay open	yes	yes
	albino:	some, in Crete frequent	none observed
stamynyll		present	present
bract / bracteole		membranous, white, very unequal with long-tapering rather flaccid tips	membranous, white, narrower and slightly shorter than bract
filaments	colour	white / purple	white / purplish when old
	length (cm)	3 - 7	2 - 5
style	colour	deep red	deep red
	length (cm)	(0.7) 1 - 2.7	1.5 - 2
anthers	colour	deep yellow	deep yellow
	length (cm)	1 - 1.5 ±straight at anthesis	1 - 1.5 curved at anthesis
capsule	length (cm)	1.5 - 2.5	1.5 - 2.5
	width (cm)	0.8 - 0.7	0.5 - 0.7
seeds	colour	red - brown	dark brown
	length (mm)	3 - 4	3 - 3.5
chromosome number (2n)		16	16

Table 2. Comparison of taxonomically relevant parameters of *C. moabiticus* and *C. cartwrightianus*.

Feinbrun (1977): Transjordan, 20km between es-Salt and Amman, 27.XI.1925, Meyers & Dinsmore E of es-Salt, 20.XI.1930, Meyers & Dinsmore 9867

Mathew (1982): Collection of Al-Eisawi near Salt and Amman (no further details), Al-Eisawi (1986): Amman: Na'our triangular, near Marj Al-Hamam, calcareous hills, Al-Eisawi 4449; Um Uthaina, near Al-Husain Estate, Al-Eisawi 7624, 9552 (AMM, K); midway between Wadi As-Sair and Marj Al-Hamam, waste land, Al-Eisawi 10229 (AMM, K, RNG); Salt; Ras as-Salt; near Salt triangular, along Arda road, Al-Eisawi 7623A, 9650 (AMM, K, RNG); near Salt Community College, N. Hiary 10234 (AMM, K, RNG).

Al-Eisawi considers *C. hermoneus* as the most endangered crocus, although it is regarded as the commonest one in Jordan. The urbanized areas north-west of Amman are extended as far as Suweilih and the reported habitat of this area is probably destroyed. The situation in the vicinity of Salt is not so bad and some hills are still likely to provide suitable conditions for native plant life. After an intensive search east of Salt, some populations of *C. hermoneus* could be found, mainly by looking for leaves. The locality was typical for a crocus habitat with heavy reddish soil, limestone outcrops and small shrubs (*Sarcopoterium batha*).

Despite consideration of the habitat east of Salt by Feinbrun (1977) and Al-Eisawi (1986) I have some supplemental details about the locality I investigated in the same area:

HKJ/Ammon/Salt: Suweilih to Salt, 2km after junction to Salt, 900-1000m, 35° 44'E/32° 2.5'N, 23.12.1986 (Kerndorff, HK 1986/13)

At the time of my visit the flowering period was near its end and only seven flowering plants could be investigated. In three specimens, the styles clearly exceeded the tips of the anthers. Admittedly, the number of investigated flowers was too small to provide solid statistical statements but following Feinbrun & Shmida (1977), the style should not exceed the anthers in *C. h. ssp. palaestinus* which stands in contradiction to the reported findings. To check further morphological features (despite missing flowers) the width and number of leaves and the neck-extension of the corm was investigated in some 25 random samples of the above-described locality. Statistically the leaves had been found to be 2-3(4)mm wide which also contradicts the description given for *C. h. ssp. palaestinus* (1.5-2mm) but perfectly agrees with the one of *C. h. ssp. hermoneus*.

In contrast, the frequency distributions of the neck extension and the number of leaves (Figure 6, A and B) show results which come close to the description given for *C. h. ssp. palaestinus*, that is (1.5) 2.2 ± 0.6 (3.5)cm for the neck extension and (3) 4.4 ± 1.1 (6) for the number of leaves.

Considering the available information about the species I tend to agree with Mathew (1982) who regarded *C. hermoneus* as a highly variable species. In fact, with the present state of knowledge, it seems that the subdivision of the species into two subspecies encounters too many contradictions and maintaining their subspecies status is doubtful.

CROCUS ALEPPICUS

Records from Jordan of *C. aleppicus* Baker which belongs to the East Mediterranean floristic element, are given by Feinbrun (1957): Transjordan, Edom, Wadi Musa to Shaubek 5000ft. P.H. Davis 2225 (HUJ) and by Al-Eisawi (1986) who found it in the same area and farther north at Thana, Al-Illamy, along the road to Shaubak and at



Figure 7. Examples of flower-colour and shape of *C. moabiticus*.



G



H

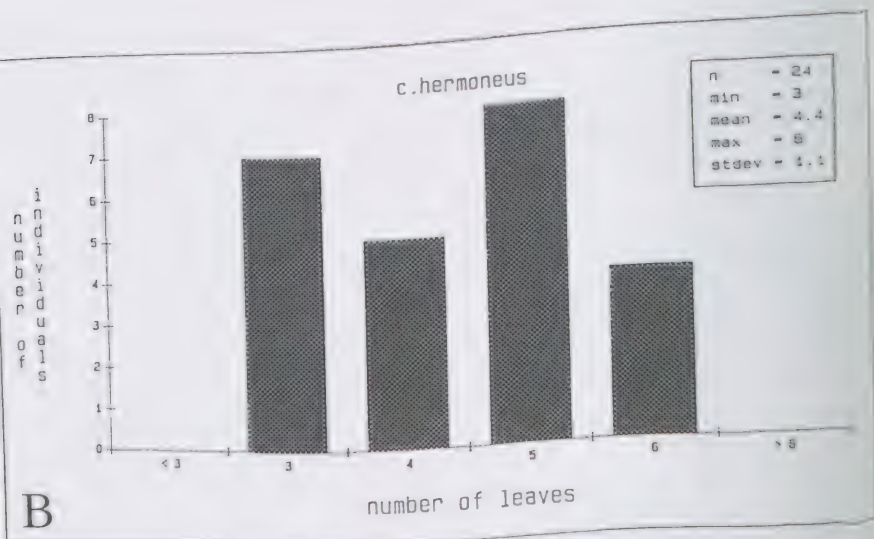
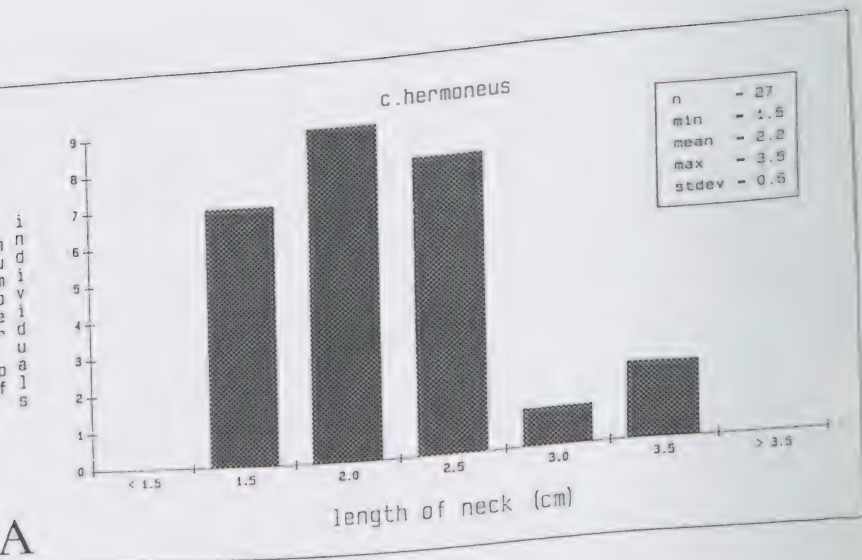


Figure 6. Frequency distributions of (A) corm-neck extension and (B) number of leaves of *C. hermoneus*.

Tafila near Al-Husain Agricultural Station, 15km E of Tafila. Al-Eisawi considers this species confined to the highlands of the Ash-Sharah mountains. Mathew (1982) mentioned Ras en Naqb as the most southerly locality and I was able to find *C. aleppicus* in this area. Ras en Naqb, a mountain ridge, respectively a small village with the same name in Edom province, is in fact the most southerly known habitat of this crocus species. The hills of this area are between 1400 and 1650m in height. The slopes are rather dry (Figure 1) and stony and covered by sparse scrub only. The geological situation varies somewhat but Mesozoic formations are predominantly being found, consisting mainly of limestone which is locally sandy with marls, cherts and dolomites. In general, crocuses are to be found more frequently on calcareous soils over pure limestones or dolomites. The investigated habitats (appr. 2km in distance) are located on a comparatively high altitude of about 1550 to 1600m in the northern vicinity of the village of Ras en Naqb:

HKJ/Edom/Ras en Naqb: 2km north of Ras en Naqb, 1550-1600 m, 35° 29.5 E / 30° 1.5 N, 30.12.1986; Kerndorff, HK 1986/15

CROCUS PALLASII SSP. HAUSSKNECHTII

A specimen of *C. pallasii* ssp. *haussknechtii* (Boiss. & Reuter ex Maw) Mathew collected by Birkenshaw (s.n.) in Ras en Naqb, Edom province has been investigated by Brighton (1977) and Mathew (1977). Recently, Al-Eisawi recorded it also from midway between Wadi Musa and Eil, along the road to Petra and Eil, 20km south of Ma'an, along the road to Petra. I can now report it from Ras en Naqb at the same locality given for *C. aleppicus*. Several dried flowers of *C. pallasii* ssp. *haussknechtii* have been found indicating that the flowering period was over some weeks ago. All the localities are, as far as is known, the westernmost habitats of this Irano-Turanian subspecies of *C. pallasii* which has its main distribution in northeastern Iraq and western Iran.

CROCUS CANCELLATUS SSP. DAMASCENUS

Three records of *C. cancellatus* ssp. *damascenus* (Herbert) Mathew in Jordan of this likewise Irano-Turanian taxon were given by Feinbrun (1957): Transjordan, Edom, 29km E of Wadi Musa, 1300m, 29.3.1936; 8km E of Wadi Musa, 1400m, 29.3.1936; 33km SW of Ma'an, 1400m, 30.3.1936; all localities in Artem. herbae-albae, described by Eig, Feinbrun and Zohary (leaves; H.U.J.).

Two localities were given by Al-Eisawi as far north as Qatrana, 4-5km and 28km W of Qatrana, along the road to Karak city. A new locality for this subspecies of *C. cancellatus* is recorded by myself which is exactly the one already described under *C. aleppicus* and *C. pallasii* ssp. *haussknechtii*, that is north of the village of Ras en Naqb. At this place completely mixed populations of the three species occurred. In the case of *C. cancellatus* ssp. *damascenus*, only the leaves were aboveground and just a few specimens of *C. aleppicus* had flower buds visible but not yet open. Both the species were relatively scattered on the ground and their number seem to have an even distribution. Unfortunately, no further investigations could be undertaken to find more aspects or particularities of this interesting habitat due to very inclement weather.

CROCUS HYEMALIS

The principal range of *C. hyemalis* Boiss. & Blanche coincides with the Mediterranean territory of Israel and crosses the northern boundary into Lebanon (Feinbrun & Shmida, 1977). The first record from the Mediterranean territory of Jordan was published by Al-Eisawi in 1986.

In the search for crocuses, I made an excursion from Jarash to Ajlun which lies in the northern part of this climate zone, some 50km northwest of Amman. After several search failures in clearings of remarkable wooded localities, I found one fine habitat of a *Crocus* species adjacent to the village of Anjara. The locality can be described as a steep, open hillside with big, calcareous rock outcrops and a very deep, red type of 'terra rossa', sparse grass and small shrubs: HKJ/Gilead/Anjara: 16km west of Jarash to Ajlun, (Jebel Ajlun) 850-900m, 35° 46.5'E/32° 18.5'N, 23.12.1986 (Kerndorff, HK 1986/14).

At first sight the relatively small white flowers (length of perianth tubes between 1-3cm) slightly striped and veined purple outside seemed to be *C. aleppicus*. After a closer inspection of several flowering individuals it proved to be *C. hyemalis*. The leaves have a dark green colour with a noticeable white stripe and their number per individual ranged between 3 and 6 (5 to 9 in *C. aleppicus*). Measurement of their width showed results from 2-3mm (0.5-1.5 in *C. aleppicus*). The corm tunic was found to be membranous, splitting into parallel stripes at the base. These findings are indicative of *C. hyemalis*. Compared to the mostly larger flowered races, with perianth tubes between 4-6cm in length, which I could observe in many localities in Israel, this one is generally less striking.

Another interesting observation must be mentioned since it has long been a matter of controversy. Originally it was thought that *C. hyemalis* has yellow anthers (Boissier 1884 and Maw 1886) with only a few individuals in a population being black-anthered (*C. h.* var. *foxii* Maw). In contrary to this, the findings of Feinbrun (1957) verified that, in Israel, *C. hyemalis* is mainly black-anthered and only a few specimens with yellow anthers could be traced by her in populations from Jerusalem and western Galilee. However, in the case of the described population, most of the individuals have yellow anthers, sometimes with black tips or margins half of the length of the anthers which agrees more with the findings of Boissier and Maw.

ACKNOWLEDGEMENTS

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COLLECTING BULBS IN SOUTHERN BRAZIL AND NORTHEASTERN ARGENTINA

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AN invitation to come to Argentina to collect bulbs! A longtime dream come true! I did not hesitate to accept. I arrived in Buenos Aires, Argentina at the Ezeiza airport in early October of 1986. Unfortunately my luggage containing valuable bulbs and seeds along with clothes, shoes, maps, books, binoculars, etc. failed to arrive with me and was lost. Luckily I had my camera and accessories.

My companion-hosts were Alberto Castillo, Patrick O'Farrel, and Javier Serra, all residents of Buenos Aires and environs. I had corresponded with Alberto for several years, and we had exchanged many bulbs. Patrick and Javier were friends of Alberto. As Patrick was associated with Ford Motor Company, our auto was a shiny new silver Ford Taurus station wagon. Patrick was a fourth generation Irish Argentinian, and Javier's family, of Catalan descent, owned a large cattle ranch (estancia) in northeastern Argentina. Patrick did the driving, and Alberto and I sat in the back, talking and peering out the windows at the passing landscape. Normally our little Taurus would have had plenty of space for passengers and luggage, but it would soon be cramped as we began collecting plants. It seemed ironic, but it was almost a blessing in disguise that I had lost my luggage. I'm not sure how I would have made space for them after a few days.

We left Buenos Aires in the rain. It was spring below the equator, and the weather was cold and damp and windy, just as it had been the day before, in Texas. By early afternoon, the rain had passed and we were in sunshine when we reached the town of Colon, in the state of Entre Ríos. There we made our first collections. In a large open field we dug a *Habranthus* species allegedly with pink flowers, which were in leaf only. These grew with *Nothoscordum bivalve* (the same as the one that grows in Texas and the southeast USA), *Oxalis*, and an unusual *Nothoscordum* that I had never seen before, which Alberto identified as *N. macrostemon*. This was in flower and was quite tall, with large white flowers in loose umbels. Its bulbs were fairly large (for the genus) and formed relatively few, large offsets. These were dug along with the *Habranthus*.

Months later (in Texas) I flowered the *Habranthus* and it proved to be a fine light pink trumpet with darker throat. Foliage was narrow and glossy green. In cultivation these were self-sterile, but set seed abundantly when crossed with other clones of the same collection.

I was relieved that *Nothoscordum macrostemon* (syn. *N. inodorum* ssp. *macrostemon* Rav.) produced only a few bulbs, of large size, compared to the weedy ones of *N. inodorum* which were like tiny rice grains and produced in incredible abundance around the mother bulb. Indeed, *N. inodorum*, though sweetly scented, is considered to be one of the most frightful weeds of the bulb world. Once established, this invasive plant is difficult to eradicate. So it was a relief to see that *N. macrostemon* showed restraint and minded its manners. Although *N. macrostemon* is regarded as a subspecies of *N. inodorum* by some, there are others who do not accept this hypothesis, feeling that *N. inodorum* may be a natural hybrid of *N. macrostemon* and another allied species. The

reasons are many. *N. macrostemon* is a night bloomer, with larger flowers having longer pedicles, spatulate petals, broader, flatter filaments, different fragrance, and, of course, larger bulbs with fewer and larger offsets. There is no question about the two taxon being related. It is only a matter of agreeing upon which came from which. Horticulturally, they are miles apart, should anyone consider bringing them into cultivation.

The evening of the first day was spent in a charming little hotel at Paso de los Libres. A dinner was given in our honor, complete with musicians, excellent food and wine. The next morning we walked about the hotel and found an Irid, *Herbertia lahue*, in several forms. Strangely, *H. lahue* also grows in Texas, around the Gulf Coast. It was in considerable abundance and grew deeply in the gravelly sandy loam alongside *Habranthus teretifolius*. The *Habranthus* were in leaf only, as they flower in late summer. I only dug a few as I had some at home in San Antonio, Texas, and also because they were just too difficult to dig. Most *Herbertia lahue* were identical to the Texas forms, but some were larger and of a prettier, cleaner shade of blue. Since *Herbertia amatorum* is found on the other side of the Rio Uruguay, in Brazil, there is a possibility that both species may hybridize where they overlap. In the USA I have heard the name lahue pronounced as "la-hooey", but Alberto informed me that it is a Chilean Indian word and that these flowers are called "lahues" and pronounced "la-wher".

We entered Uruguaiana, state of Rio Grande do Sul, Brazil, after crossing the Rio Uruguay. The contrast between the Spanish architecture we had just left behind, and the Portugese architecture was startling. Once outside the city, we saw our first important Brazilian bulbous plants, consisting of an Irid (*Calydorea* sp.) with small white flowers with a purple center, and looking much like an *Ixia*, and another interesting *Nothoscordum* species, new to me. Alberto told me that it was a member of the *macrostemon* alliance, of which there are several. The white flowers were fragrant, with broadly flattish filaments, and few to no offsets, certainly not suggesting a weedy type. The *Calydorea* were scarce.

We picnicked at a roadside park, and found a couple of very interesting Irids flowering. *Cypella fucata* was tall, with lovely orange-yellow flowers on wiry stems above the grasses. The plants were scattered here and there. On the other hand *Onira unguiculata* grew on stems only a few inches tall with very large flowers, looking somewhat like *Cypella* in form, but of purplish-blue color. *Onira* was in fairly good supply, but *Cypella* seemed endangered in their paltry numbers. If these are to be preserved in horticulture, they will have to be grown from seed. In order to assure a seed crop, at least two clones will have to be intercrossed.

Obviously Alberto was as impressed with *Onira unguiculata* as I was, but my favorite was *Kelissa brasiliensis* which was incredibly lovely. I was totally unprepared for this one. It is another small bulbous irid of the same general size as *Herbertia lahue* but the flowers are larger, with spectacular, upfacing, purple, and heavily spotted corollas. They are paired in the spathe, but there can be as many as five spathes per plant, and they have ephemeral flowers that last less than a day. A half dozen bulbs in an 8" pot would be a sight to behold. Though *Kelissa* is rare, we were able to find them in fair numbers where they grew. We found more *Cypella fucata* growing with *Kelissa brasiliensis*, and in sufficiently larger numbers, though still leaving me with a feeling that it is endangered.

Growing with these irids were two more *Nothoscordum* species. One was quite delicate while the other was our old friend, *N. macrostemon*. Both had white flowers. The delicate one grew in small numbers and had small bulbs without any bulblets.

Later that afternoon, we stopped at Santa Margarida for fuel. A lawn next to the filling station had a good quantity of a yellow *Nothoscordum* in flower. I was elated to finally see yellow-flowered *Nothoscordum*. Later I was able to identify these as *N. minarum*. Aside from the bright yellow color, the plant and flowers are very similar to the Texas forms of *N. bivalve*. Foliage was erect to suberect, narrow and flat, and a glossy green. There were three to five flowers in the umbel. I understand that they can flower in autumn and again in spring, and that the flowers are very sweetly scented with a honey-like perfume. The bud-count also increases in the umbel. These seem not to make any offsets (so far) but increase by the bulbs dividing in half. *Nothoscordum minarum* is considered a subspecies of *N. montevidense* by some authorities, while others regard it as a different species. Regardless of this, the yellow-flowered species are among the choicest in this genus for horticulture, either in gardens or as potted plants, resembling both *Allium moly* and *A. coryi* in overall appearance, but smaller.

Another portion of my trip involved the small Atlantic coastal city, Capao de Canoa. *Crinum erubescens* grew in a courtyard in front of the hotel where I was staying. These plants were virused, though robust. They were also growing very much on the dry side in reddish dirt. Bulbs were smallish and stoloniferous. None were flowering at this season.

On the other hand, the season was ripe for *Hippeastrum*, and I found a small colony of pink trumpets of uncertain identity. These grew along the roadside in a mixed company of terrestrial orchids (*Stenorrhochos* sp.) in front of a wooded area along the roadside. These were my first introduction to wild *Hippeastrum*, and they looked very similar to situations in which I might find wild *Hymenocallis* in Texas. A bit later I found a larger colony, similar in all respects, except that the flowers were essentially white, with reddish lines. Alberto, my host, said that he thought these were *H. vittatum*. I noted that, aside from the color difference, they were essentially the same as the first collection in leaf, habit, and flower form. In *Hippeastrum* situations, I was a novice, however, and my intent was only to learn. Unfortunately we found no more colonies of this species complex. In this instance, the colony was a large one, in a woodland situation, growing in sandy loam. I had always thought that *Hippeastrum* grew very shallowly. Perhaps it is because we choose to grow them that way in cultivation.

Early in the afternoon we arrived at Torres. It is a surprisingly lovely coastal city with a rocky landscape along the Atlantic Ocean. I have forgotten exactly what plant my companions were looking for, but it did not matter, for in a matter of minutes we were near the ocean, and found a very lovely *Habranthus* species in flower. Alberto told me it was *H. estensis*.

The type form of *H. estensis* grows at Punta del Este, Uruguay, and perhaps we had a new location for it. These grew in very sandy soil less than a kilometer from the ocean and had lovely rose-pink flowers with a green center and expanding very widely for *Habranthus*. Umbels varied from one-flowered, to two, and three-flowered. The foliage was a dull, light green, and surprisingly oval-shaped in cross section. There was a distinctive groove in the center of each leaf, longitudinally. The multiflowered habit and leaf form suggested (to me) an affinity to *H. teretifolia* from Argentina.

The following spring I had the opportunity to intercross several clones, enabling me to obtain a respectable seed-set. It is well known that certain members of this group are self-sterile and require pollen from another clone. Only two flowers were not cross-pollinated, and these two were the only ones that did not set seed. Seed capsules ripened normally but I noticed that capsules and seeds were about a third smaller than the *Habranthus* sp. collected a few days earlier at Colon, in the state of Entre Ríos, Argen-

rina. Some of the seed was planted and the rest reserved for distribution. If these prove to be of easy culture, I feel that *H. estensis* will eventually prove to be a very popular *Habranthus* species in horticulture. Certainly, it is among the more attractive ones.

Growing nearby the *Habranthus* was a fine colony of *Crinum erubescens*. These grew in a dryish swale, and it was too early to find them flowering. Nearby was a rose-pink *Oxalis* species with true scaly bulbs.

When we reached the state of Santa Catarina, Brazil, circumstances forced us to return home. Apparently we had missed out on seeing one of the *Habranthus* species. For me, it did not matter, as I was thoroughly enjoying it *all*. I had been watching the various *Crinum* in cultivation in the towns we passed through. One in particular caught my eye. It turned out to be *C. × augustum*, as described by Herbert. This was a lower, stubbier form than *C. amabile* cultivated in coastal Texas and Mexico. *C. × augustum* is much squattier than *C. × amabile*. I was always aware of the differences (as given by Herbert) but never had a chance to compare these two clones side by side. Now for the first time, I think I understood the whole picture.

Later in cultivation in my garden I saw that the flowers of *C. × augustum* are indeed very similar to those of *C. × amabile*, fragrances are identical, as are the overall habits, just as Herbert reported. Since Herbert was unquestionably correct, it appears that Henry Nehrling could have been confused and had the two clones reversed in his 1915 *Crinum* discussion in Bailey's **Standard Cyclopaedia of Horticulture**. Nehrling, a fine horticulturist and aficionado of *Crinum*, was not the taxonomist that Herbert was, and in any conflict on *Crinum* nomenclature I would have to defer to Dean Herbert as the authority. Apparently the plant that Nehrling described as 'The Great Mogul' was in reality *C. × amabile* rather than *C. × augustum*, if we are to believe what Herbert had to say on the matter.

On our return to Argentina, we made several more stops to see bulbs. Our first stop by the roadside yielded a fine colony of *Herbertia pulchella*, a charming lavender-blue irid. Growing with these were yellow-flowered *Nothoscordum* with erect, filiform leaves. These formed small clumps, and the small bulbs had small basal offsets. I thought the golden-yellow, starry flowers reminded me a lot of our West Texas native *Allium caryi*. Also present was an especially attractive yellow-flowered *Oxalis*. The flowers were quite large, and the leaves were fuzzy and trailing from a tuberous root. There was also attractive *Sisyrinchium ostenianum* with small yellow flowers and thin cylindrical leaves. These were left undisturbed, as they had fibrous roots.

At Río Pardo we found a small colony of *Cypella herbertii*. Flowers were orange yellow, and on quite tall scapes. I am not quite certain of the distinction between *C. herbertii* and *C. fucata*, as they are casually very similar.

North of Cacapava we found more *Kelissa brasiliensis*, the showy spotted irid, growing with a white-flowered *Nothoscordum* of the macrostemma alliance. These were tall and fragrant, without bulblets, but making only seed. Apparently this is not one of the weedy kinds.

Our highlight of this day was at hand when Alberto spotted a large colony of *Hippochaeris angustifolium* flowering in a swampy situation about 75 meters from the highway. I had once flowered this plant about twenty-five years earlier, and it was less than half as large as these. These were enormous plants! The word "angustifolium" means narrow-leaved, which tells you something about normal leaf width. The largest of these had leaves about 3" wide, and scapes were easily a meter tall. Even the bud com-

was up, with some having nine buds per scape. With more time, and more specimens I think it could easily be given the added name of var. *robustum*.

An hour or so later we were approaching Uruguaiana and the Uruguay River. We stopped at the outskirts just long enough to find *Herbertia amatum*. Alberto said they were plentiful there, but we did not take time to look for them. We did find a yellow-flowered *Nothoscordum* which I thought was the finest of the yellows. It made large bulbs which seemed to increase only with division. The umbels and flowers were considerably larger than those of the other yellow species or forms I had encountered, with bud counts of 7-12.

Crossing back into Argentina was uneventful, and we then drove toward the state of Corrientes to the estancia of Javier Serra's family. Eventually we left the pavement and drove the last miles to the ranch over a dirt road. We passed several gauchos on horseback. About thirty or more people work on the ranch and cattle and sheep are the main livestock, but there are horses as well. We spent two memorable days at the estancia, which allowed us time to see native bulbs and other plants. The bird life was magnificent!

We found *Zephyranthes mesochloa* growing in sandy loam under bushes in sylvan wilderness. As they were not flowering, we thought they might be *Habranthus*, and it was not until months later when they flowered that the identity could be verified. Two *Nothoscordum* species grew about the estancia headquarters. One was the dreaded *N. inodorum*, which has been previously discussed, and the other was a variety of it, which had pretty whitish fragrant flowers. It was much less robust appearing than the type, and the olive tinges of the flowers was appealing. The foliage is much narrower than the type. It is modestly pretty, but I fear it could be potentially invasive, as it had a fair number of basal offsets. It grew in the Serra's vegetable garden in company with *Herbertia lahue*. Neither seemed much of a threat to the lettuce growing there.

We left the estancia Sunday morning to return southward to Buenos Aires. We did not collect until mid-afternoon, when we stopped to dig *Nothoscordum bivalve* (common in Texas as well), an *Oxalis* sp., which might be a form of *O. crassipes*, but with larger, richer colored flowers, and a small, yellow-flowered *Nothoscordum*, *N. montevidensis*. I was intrigued by the tiny starry flowers, only 1 to 3 per umbel. A few had narrow segments, but some had fairly wide segments. I made a point to collect both forms. These had small basally-attached offsets and I wondered how it might behave in cultivation. Would they be inclined to be invasive? Would they be hardy in our winters? Later, in cultivation, I found them to be not only hardy but perhaps the showiest of the four yellow-flowered plants I saw in South America. In cultivation the bud count jumped to 4 or 5 in only two years, and the flowers not only became larger, indeed they are the largest of all in this color range! The wider petaled forms were stunning. And of course the perfume from them in the afternoon in greenhouse culture is exceedingly sweet. A few bulbs set out in the garden in a sunny, well-drained situation, have survived Texas winters with flying colors, and have shown no sign of increase. In pots, given better care and feeding, they have increased into small clumps, flowering in both autumn and spring. It is this twice-a-year flowering habit that has endeared me to many *Nothoscordum*.

Nothoscordum bivalve grows in Texas and Argentina, along with *Habranthus tubispatus*, *Herbertia lahue*, and *Anemone decapetala*. Indeed the landscape of parts of Texas and Argentina are quite similar, right down to the mesquite trees and prickly-pear cactus.

I visited with Alberto's family while in Ezeiza. *Nothoscordum inodorum* grew at Ezeiza, but they did not seem to be inclined to be weedy, compared to the form that we battle in the United States. The flowers are also slightly different, and if anything, more attractive. But the rice-grain offsets are there, so I would only recommend it as a pot plant. A friend of Alberto's gave me a few bulbs of the lovely yellow-flowered *Ipheion sellowianum*, which I have since learned to treasure. The starry little yellow flowers are sweetly scented, and resemble *Zephranthes* or species tulips, as much as they do *I. uniflorum*.

I left Buenos Aires, with hopes of returning someday. The last part of my trip was spent in returning to Brazil to check out the *Crinum* situation in Rio de Janeiro. *Crinum* are much used for landscaping in downtown Rio, along with *Hymenocallis speciosa*. Mosaic virus seems to be a problem and it was hard to find groups of healthy plants.

I hope to return again someday to both Brazil and Argentina, as well as check out other South American countries for native bulbs.

CHANGES IN GROWTH, FLOWERING AND CHEMICAL COMPOSITION OF THE TUBEROSE CV. 'SINGLE'

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THERE are a number of Indian research workers who have studied the effects of transplant size, depth of planting of transplant and planting density on tuberose *Polygonum tuberosum* growth and flowering (Ramaswamy and Chockalingam, 1977, Sadhu and Das, 1978, Bhattacharjee *et al.* 1979, Mukhopadhyay and Bankar, 1981 and Mukhopadhyay *et al.*, 1986). Outside India, Lopes (1971) also studied the effects of transplant size on growth and flowering of tuberose. However, none of the above workers had investigated the chemical changes that might be taking place in the tuberose plant, as a result of varying the above physical parameters.

EXPERIMENTAL METHODS

Tuberose 'Single' was used for the experiments. The experiment was a 2x2x2 factorial consisting of 2 bulb (transplant) sizes with average diameter of 1cm and 3cm, 2 planting densities of 15 × 15cm and 30 × 30cm (i.e. plant to plant × row to row), and 2 depths of plantings of bulbs (3cm and 7cm deep planting). The depth of planting was measured from the tip of the bulb planted, to the surface of the field. After each of the bulbs was planted in the respective hole, the proper depth of planting was ensured by measuring the distance from the tip of the planted bulb to the surface level of the hole with a 3 or 7cm stick. Each plot size was 1m × 1m. There were 8 treatment combinations with 5 replications. There were 36 plants for 15 × 15cm spacing and 16 for 30 × 30cm spacing. The data was statistically analyzed by the Analysis of Variance technique (Panse and Sukhatme, 1967).

Five plants from each treatment were selected randomly for taking leaf, bulb and bulblet samples for chemical analysis. The nitrogen was estimated by micro-kjeldahl method (Piper, 1950). Both reducing and non-reducing sugars were determined by Nelson-Somogyi and micro copper method (Nelson, 1944 and Somogyi, 1952).

RESULTS AND DISCUSSION

The work done earlier on tuberose cv. 'Single' by various workers (Sadhu and Das, 1978; Bhattacharjee *et al.* 1979; and Mukhopadhyay *et al.* 1986) indicated that it is better to plant bulbs of larger diameter at wider spacing to obtain better growth and flower yield. However, these earlier workers did not study the chemical changes occurring in the tuberose plant as a consequence of varying the transplant size, planting density or depth of planting of bulb.

Vegetative Growth

The experimental result showed that neither transplant size nor planting density affected the number of days taken for sprouting of bulb. It was noticed that transplants planted at deeper depth sprouted late compared to those planted at shallow depth. The results obtained here are in agreement with those of Sadhu and Das (1978), in tuberose 'Single'. Contrary to the earlier findings of Bhattacharjee *et al.* (1979) that bulbs of larger diameter produce plants of better height compared to smaller bulbs, in the present investigation no such significant association was observed (Table 1). However, it may be noted that Mukhopadhyay and Bankar (1981) also did not observe any effect of bulb size on plant height in tuberose cv. 'Double'. The effect of spacing was also not reflected on this parameter. However, increased plant height was obtained when bulbs were planted deeper. Sadhu and Das (1978) reported similar findings earlier.

It is further observed that the bulbs planted at wider spacing of deeper depth of planting produced more number of leaves compared to close spacing or shallow planting. The results tally with the findings of Sadhu and Das (1978) with tuberose 'Single' and are in partial agreement with those of Bhattacharjee *et al.* (1979), with the same cultivar, and Mukhopadhyay and Bankar (1981) in cv. 'Double'. Both the latter workers concluded that more leaves were produced at shallow depth of planting and thus are in variation with the results obtained in the present investigation. Lopes (1971) observed that the weight of tuberose plant did not increase as a result of variation in planting density.

Flower Yield

The flower spike yield improved appreciably as a result of using larger transplant size at planting. The review of literature shows that a good number of workers obtained beneficial effects of larger bulbs on flower yield of tuberose (Lopes, 1971; Kale and Bhujbal, 1972; Ramaswamy and Chockalingam, 1977; Sadhu and Das, 1978; Bhattacharjee *et al.* 1979; Mukhopadhyay and Bankar, 1981 and Mukhopadhyay *et al.* 1986). The findings of Rodrigues (1962) indicated that larger bulbs of Wedgewood iris contained more amounts of total gibberellins compared to smaller ones and as a result produced more flowers. Although this could be a major factor for better yield of flowers in many bulbous plants, another factor may be that the larger bulbs contain more amounts of total metabolites, which helps to promote vigorous plant growth and consequently better flower yield.

The flower yield was also improved as a result of increasing the spacing between the rows and plants within the rows. The finding is in agreement with earlier workers (Bhattacharjee *et al.* 1979; Sadhu and Das 1978; and Mukhopadhyay and Bankar 1981). Lopes (1971) on the contrary did not observe any effect of plant density on flower production of tuberose.

Bulb Yield

The bulb yield data indicated that larger bulb size used at planting time and wider spacing improved the production of bulbs per original bulb planted, compared to small bulbs and closer spacing. It is apparent that at wider spacing the plants face less competition from each other for light, water or nutrients, and as a consequence show better

physiological activity, which in turn is reflected in the improvement of some plant attributes like flower or bulb yield. Mukhopadhyay *et al.* (1986) reported that larger bulbs of tuberose 'Single' used at planting time had improved the production of bulbs and bulblets per mother bulb, compared to small bulbs.

Interactions

Several interactions involving bulb size \times spacing, bulb size \times depth of planting, spacing \times depth of planting and bulb size \times spacing \times depth of planting were noticed. The first three orders of interactions mostly affected bulb or bulblet yield, while the last interaction involving bulb size \times spacing \times depth of planting improved the number of florets produced per plant. In general, it was observed that better interaction results were obtained when larger-sized bulbs were planted, irrespective of the other factors like spacing or depth of planting.

Nitrogen Percentage

The larger transplants used at planting did not influence significantly the total nitrogen contents of bulbs or leaves (Table 2). However, larger transplant size used at planting influenced positively the total nitrogen contents of the bulblets produced. On the other hand, the planting density significantly affected nitrogen content in both bulblets and leaves. More total nitrogen reserves were observed in bulblets at closer spacing, while analysis of the leaves showed opposite result. It is difficult to explain this phenomenon, since no previous literature on chemical analysis of tuberose in relation to cultural practices is available. However, the present results indicate that this may be due to greater translocation of nitrogen from bulblets to leaves at wider spacing, which is reflected in higher nitrogen percentage in the leaves at wider spacing. However, Mukhopadhyay (1963) reported earlier that tuberose bulbs contained total nitrogen almost similar to the amounts observed here. Shoushan *et al.* (1978) observed that in *Hippeastrum* the maximum level of nitrogen was found just before flowering. Hoogsterp (1979) concluded that about 1 percent nitrogen in the tulip bulb at harvest time is sufficient for good plant growth.

Sugar Percentage

The sugar contents of leaves and bulbs were studied to find out if the leaves and bulbs of plants produced from larger bulbs had more sugar contents than those from smaller bulbs (Table 3). The results of chemical analysis indicated that the leaves of larger bulbs had more reducing and total sugars compared to smaller bulbs, which in turn might have influenced flower yield and quality.

The reducing, non-reducing, and total sugar contents in bulbs at high density planting were higher compared to low density planting. The depth of planting had no effect on nitrogen or sugar contents of bulbs, bulblets, or leaves.

Table 1. Effect of bulb size, spacing and depth of planting on vegetative growth and flowering of tuberoses 'Single.' Data were taken from 5 randomly selected plants in each treatment.

Treatments	No. of days taken for sprouting of bulb	Plant height (cm)	No. of leaves per plant	No. of bulbs per plant	No. of flower spikes produced per plant
<u>Bulb size</u>					
B ₁	41.92	58.66	79.46	10.60	3.15
B ₂	39.86	59.82	82.76	12.65	5.23
SEm	0.74	1.36	2.72	0.41	0.23
CD at 5%	NS	NS	NS	1.21	0.68
<u>Spacing</u>					
S ₁	41.79	59.21	56.66	8.15	3.63
S ₂	39.99	59.27	105.67	15.00	4.76
SEm	0.74	1.36	2.72	0.41	0.23
CD at 5%	NS	NS	7.87	1.21	0.68
<u>Depth of planting</u>					
D ₁	33.52	56.12	79.68	11.95	3.89
D ₂	48.26	62.36	82.54	11.20	4.49
SEm	0.74	1.36	2.72	0.41	0.23
CD at 5%	2.1	3.93	NS	NS	NS

NS = not significant

B₁ = 1cm bulb size

B₂ = 3cm bulb size

S₁ = 15cm spacing

S₂ = 30cm spacing

CD = Critical Difference

D₁ = Depth 3cm

D₂ = Depth 7cm

Table 2. Effect of bulb size, spacing and depth of planting on the total nitrogen content of bulbs, bulblets and leaves of tuberose (per cent). Data were taken from 5 randomly selected plants from each treatment.

Treatments	Bulbs	Bulblets	Leaves
<u>Bulb size</u>			
B ¹	1.07	1.20	4.09
B ₂	1.13	1.36	3.99
SEm	0.03	0.04	1.08
CD at 5%	NS	0.14	NS
<u>Spacing</u>			
S ₁	1.10	1.42	3.82
S ₂	1.10	1.14	4.26
SEm	0.03	0.04	1.08
CD at 5%	NS	0.14	0.31
<u>Depth of Planting</u>			
D ₁	1.07	1.34	3.94
D ₂	1.14	1.34	3.94
SEm	0.03	0.04	1.08
CD at 5%	NS	NS	NS

Table 3. Effect of bulb size, spacing and depth of planting on the percentages of reducing, non reducing and total sugars of bulbs, bulblets and leaves of tuberose. Samples of leaf, bulb and bulblets for chemical analysis were taken from 5 randomly selected plants in each treatment.

Treatments	Bulbs			Bulblets			Leaves		
	RS	NRS	TS	RS	NRS	TS	RS	NRS	TS
<u>Bulb size</u>									
B ₁	0.68	0.68	1.36	1.30	1.02	2.35	0.74	0.71	1.45
B ₂	0.64	0.53	1.17	1.30	0.96	2.28	0.86	0.78	1.65
SEm	0.03	0.49	0.08	0.55	0.89	1.11	0.02	2.98	0.04
CD at 5%	NS	NS	NS	NS	NS	NS	0.07	NS	0.12
<u>Spacing</u>									
S ₁	0.74	0.73	1.47	1.38	1.08	2.41	0.81	0.75	1.56
S ₂	0.58	0.47	1.05	1.34	0.93	2.22	0.80	0.73	1.53
SEm	0.03	0.49	0.08	0.55	0.89	1.11	0.02	2.98	0.04
CD at 5%	0.11	0.14	0.26	NS	NS	NS	NS	NS	NS
<u>Depth of planting</u>									
D ₁	0.68	0.65	1.31	1.35	0.96	2.26	0.81	0.75	1.51
D ₂	0.65	0.86	1.21	1.37	1.02	2.37	0.79	0.74	1.53
SEm	0.03	0.49	0.08	0.55	0.89	1.11	0.02	2.98	0.04
CD at 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS
RS = Reducing Sugars						NRS = Non-reducing Sugars			
TS = Total Sugars						NS = Not Significant			

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