



Pharmacognosy Review

Botany, Taxonomy and Cytology of *Crocus sativus* series

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Abstract

Saffron is produced from the dried styles of *Crocus sativus* L. (Iridaceae) which is unknown as wild plant, representing a sterile triploid. These belong to subgenus *Crocus* series *Crocus sativus* – series are closely related species; and are difficult to be separated taxonomically and have a complex cytology. Botany of *C. sativus* – series, taxonomy of their species and their infraspecific taxa are presented, and their distribution, ecology and phenology; full description and chromosome counts are provided with key to their identification.

Key words: Chromosome, classification, *Crocus*, cytology, geographic area, *sativus* series

Introduction

The genus *Crocus* (family Iridaceae) comprises some 85–100 species having an old world distribution, primarily in the Mediterranean – Europe and Western Asia. The limits of the entire genus lie within the longitude 10°W to 80°E and latitude 30°N to 50°N. Phytogeographically, the majority of species occur within the Mediterranean floristic region, extending eastward into the Irano-Turanian region; both of these areas are characterized by cool to cold winters with autumn–winter–spring precipitation and warm summers with very little rainfall; the genus *Crocus* is well adapted to such conditions, with the plants actively growing from autumn to late spring and surviving the summer drought below ground by means of a compact corm. Many species have their above ground growth at the onset of autumn rains and flower almost immediately; some of these produce their leaves and flowers concurrently, or nearly so, while others bloom without leaves and delay their leaf production until the onset of warmer weather, usually in spring.^[1]

A species evolution is generally accompanied or followed by partial changes in the chromosome complement and there can be few genera where such a wide range of variation occurs. This variation is, however, difficult to deal with without information on breeding systems, hybridization potential and the production of hybrids. So far, it has only been possible to make a comparative analysis of chromosome number and morphology, but these differences and similarities can be significant, and may well indicate barriers to successful interbreeding. Although similar karyotypes do not reveal the presence of symmetrical structural changes, it may generally be assumed that if the

phenotypes are also alike, there is a probability that there are no barriers to gene exchange. On the other hand, when karyotypes are observably different, successful interbreeding is less likely.^[2] Such chromosome barriers are of obvious importance and can lead on to further divergence which may eventually give rise to acceptable species. The closely related species have been difficult to separate taxonomically and have also been found to be complex cytologically, and have been treated as a series.^[3] These physiological characteristics, together with cytological information and morphological features of the corm tunics, bracts, bracteoles, leaves, flowers and seed, have been discussed by the genus into a hierarchy of sub-genera, sections and series of *C. sativus*.

Botany

The taxonomic classification of *C. sativus* series is as follows:

1. Division: Spermatophyta
2. Sub-division: Angiospermae
3. Class: Monocotyledonae
4. Sub-class: Liliidae
5. Order: Liliales
6. Family: Iridaceae
7. Genus: *Crocus*
 - a. Sub-genus: Anthers with extrorse dehiscence
 - b. Section *Crocus*: Scape subtended by a membranous prophyll
 - c. Series *Crocus*: Corm tunics finely fibrous, usually reticulate; flowers autumnal; leaves rather numerous, usually 5–30, appearing with the flowers or shortly after; bracts flaccid, usually not closely sheathing the perianth-tube, membranous, white or transparent with no marking; anther yellow; style branches 3, usually red and often expended at the apex, entire or at most fimbriate; seed coats covered with dense mat of papillae. $2n = 12, 14, 16, 26$.^[4]

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Case descriptions

Crocus asumaniae B. Mathew and T. Bay Top (1976)^[5]

Corms ovoid, c 15–20 mm diameter, tunics fibrous, the fibers very slender and finely reticulated, extended at the apex of the corm into a neck 3–4 cm long. Cataphylls 2–3, white, membranous. Leaves 5–6, hysteranthos or with the tips just showing at anthesis, slightly grayish-green, 0.5–1 mm wide, glabrous. Flowers autumnal, 1–3, white, occasionally white dark veins near the base of the segments, rarely very pale lilac; throat whitish or pale yellow, glabrous. Prophyll (? absent acc to the *Crocus*) present. Bract and bracteole present unequal, white, membranous white, long-tapering, rather flaccid tips. Perianth tube 5–8 cm long, white; segments subequal, 2.5–3 cm long, 0.5–1 cm wide, oblanceolate or narrowly elliptic, obtuse to acute, the inner slightly smaller than the outer. Filaments 2–5 mm long, white or pale yellow, glabrous; anthers 10–20 mm long, yellow, style divided into reddish-orange clavate branches, each branch 13–20 mm long and considerably exceeding the anthers and at least half the length of the perianth segments, arising at a point well above the base of the anthers. Capsule ellipsoid, c. 1 cm long; seeds reddish-purple, subglobose, 2–3 mm long, with a pointed caruncle about 1 mm long; raphe, a rather indistinct ridge running the length of the seed; testa covered a dense mat of long papillae. $2n = 26$. Phenology: Flowering October–November.

Crocus cartwrightianus (Herb) Maw (1881)^[6]

Corms 10–15 (–20) mm in diameter, depressed globose, rather flattened at the base; tunics fibrous, the fibers very slender and finely reticulated, extended at the apex of the corm into a neck (2–) 2.5–3 (4.5) cm long. Cataphylls 3–5, white, membranous. Leaves (4–) 7–12, normally synanthous and equaling the flower at anthesis, spreading, green, 1.5–2.5 mm wide, glabrous or ciliate. Flowers autumnal, fragrant, 1–5, pale to deep lilac-purple or white, strongly veined darker, sometimes stained darker at the base of the segments and on the tube, sometimes pure white with no veining (albinos are frequent in the species); throat white or lilac, pubescent, prophyll present. Bract and bracteole present, very unequal, white, membranous with long-tapering, rather flaccid tips. Perianth tube 3–5 (–7) cm long; segments subequal, 1.4–3.2 cm long, 0.7–1.2 cm wide, oblanceolate or obovate. Filaments 3–7 mm long, white or purplish, glabrous or slightly papillose at the base; anther 10–15 mm long, yellow. Style divided into three red clavate branches, each branch (7–) 10–27 mm long, equaling or exceeding the anther and at least half of the length of the perianth segments, arising at a point well below the base of the anthers and usually in the throat of the flower. Capsule ellipsoid, 1.5–2.5 cm long, 0.6–0.7 cm wide, raised on a pedicel to 4 cm long (above ground level) at maturity; seeds reddish brown, irregularly subglobose 3–4 mm diameter, the raphe showing as an irregular ridge running the length of the seed and ending in a small, pointed caruncle less than 1 mm long; testa covered with dense mat of long papillae. $2n = 16$.

Phenology: flowering October–December.

Crocus elwesii (Maw)^[7] O. Schwarz (1886)

Synonyms

Crocus thibautii

Crocus hermoneus

This species was known only from Asia Minor and remained

one of the last known species of the *sativus* group. Maw described it as a plant with large corm and flower, but with short stigmata of *Crocus pallasii*. In the monograph of Maw,^[6] it is closely allied with the well-known and widely distributed form, var. *pallasii*, but is a plant of larger structure. The pistil in short, scarcely exceeding the stamens, as in var. *pallasii*. According to Maw, there was no difference between *C. elwesii* and *C. pallasii*, except for the size of the plant. Maw's plates clearly show that the style of *C. elwesii* divides at the level of the middle of the anthers while in *C. pallasii* the style divides below the anther. A significant difference in the *sativus* group is in the absolute length of the astigmatic branches which may vary intraspecifically to a great extent. The style of *C. elwesii* divides higher than in any other species of this group and this form is the extreme end of the range of variability.^[8]

The structure of the plant of *C. elwesii* varies considerably in the specimens from Palestine, Lebanon and Syria. Some of the specimens approach the size of those from Asia Minor (ca. 20 cm); others resemble middle-sized *C. pallasii*. The size of *C. pallasii* ranges from 7.5 to 16 cm.^[9]

Another character varying within the species *C. elwesii* is the scabrosity of leaves. In some specimens, the leaves are scabrous at margins, and in others, they are smooth or only the tips of the leaves are somewhat scabrous. Mouterde described the leaves of *Crocus thiebauti* as smooth and those of *Crocus libanoticus* as denticulate.^[10] It is fact that *C. elwesii* was never clearly differentiated from other species; several species from the eastern Mediterranean were described to be synonymous with *C. elwesii*. They are given below.

- i. *Crocus olbanus* Siehe from Cilica^[11]: This type of specimen does not seem to differ from *C. elwesii* except for having paler flowers and narrower perigonium segments.
- ii. *Crocus oreoreticus* Burt from crete^[12]: Burt differentiated his cretan plants from *Crocus thomasii* and *C. pallasii*, but did not mention *C. elwesii*. Some of the specimens of *C. oreoreticus* were examined and found to be small-sized specimens of *C. elwesii*.
- iii. *Crocus thiebauti* Mouterde^[10] from Syria and *Crocus libanoticus* Mouterde from Lebanon: Mouterde differentiated *C. thiebauti* only from *Crocus moabiticus*. As to *C. libanoticus*, he says “Se rapprochant per le port general du precedent (*C. thiebauti*), ce *crocus* sen femilles denticulees, I absence de spathe basale”. Later, he recognized that his “bracteola minute” of *C. libanoticus* was actually a short-based spathe.
- iv. About *C. libanoticus*, one reads “Stylus una cum stigmatibus dimidiam anthram vix superat”. Indeed in one specimen each of *C. libanoticus* and *C. thiebauti*, the styles were shorter than is usually found in *C. elwesii*. However, the division of the style is much above the bases of the anthers, as in the rest of *C. elwesii* from other parts of its area.^[8]

Corm flattish, 1.5–2.5 cm in diameter. Tunics numerous, finely reticulate, somewhat produced along the scape, sheathing leaves 2 or 3, basal spathe present, sometime short, proper spathe diphyllous. Leaves numerous, 6–12,

appearing toward the end of anthesis, scabrous or smooth at margins, about 1 mm broad. Flowers 2–5, tube much longer than limb. Tepals 3–6 cm long, 5–10 mm broad, usually lilac with darker veins. Filaments short, anthers yellow, linear, 1.5–2.5 cm long. Style dividing above the bases of the anthers, at above 0.33 cm or 0.50 cm the anther's length; stigmatic branches orange, gradually thickening toward apex, reaching the tips of anthers or shorter. $2n = 14, 15$.^[8] Phenology: Flowering October–November.

***Crocus badriaticus* Herbert^[13] (1845)**

Synonyms

Crocus badriaticus var. *cbrysobelonicus* Herb.

Crocus peloponnensiacus (1895)

Crocus nivalis (1865–1866), partly as to syn. *Peloponnensiacus* Orph and specimens Orphanides.

Corms 10–15 mm diameter, depressed globose, rather flattened at the base; tunics fibrous, the fibers very slender and finely reticulated, extended at the apex of the corm into a short neck. Cataphylls 3–4, white, membranous. Leaves 5–9, normally synanthous, sometimes equaling the flower at anthesis, but sometimes very short and occasionally absent, but then appearing immediately after the flowers, gray-green, 0.5–1 mm wide, ciliate. Flowers autumnal, fragrant, 1–3, white, often stained externally brownish, yellowish or violet at the base of the segments, rarely flushed throughout pale lilac, throat yellow or rarely white, pubescent. Prophyll present. Bract and bracteole present, subequal or with the bracteole much narrower, white, membranous with long, tapering, rather flaccid tips. Perianth tube 3–9 cm long, white, yellow, brownish or violet; segments equal or the inner slightly smaller, 2–4.5 cm long, 0.7–2 cm wide, elliptic–oblanceolate, obtuse. Filaments 3–11 cm long, yellow or white, glabrous or sparsely and minutely pubescent just at the base; anthers 7–15 mm long, yellow. Style divided into three slender branches, each branch 10–16 (–20) mm long, slightly shorter than or exceeding the anthers, less than half the length of the perianth segments arising at a point above the throat of the flower. Capsule ellipsoid, 1.2–2 cm long, 0.6–0.8 cm wide, raised on a pedicel to 4.5 cm length (above ground level) at maturity; seed reddish-brown, subglobose, 2–3 mm long, the raphe narrow and poorly developed, caruncle pointed, less than 1 mm long; testa covered with a dense mat of papillae. $2n = 16$.

Phenology: Flowering September–November.

***Crocus mathewii* Kerndorff and Pasche^[14] (1994)**

Corms (13–) 16 (–24) mm diameter, depressed globose, flattened at the base, tunics fibrous, the fibers slender and parallel in the lower part, slightly reticulate near the apex of corm, extended into a neck (10–) 19 (–32) cm long. Cataphylls 2–4, silvery-white, membranous, suffused brown near the apex. Leaves (4) 7 (10), hysteranthous, dark green, slightly grayish, 1–2 mm wide, sparsely ciliate. Flowers autumnal, fragrant, 1–3, white or rarely pale lilac-tube, often stained deep violet, pubescent. Prophyll present. Bract and bracteole present, subequal, silvery-white, membranous with long-tapering, rather flaccid tips. Perianth tube (4) 7 (–12) cm long, usually violet in the upper part, paler to almost white lower down; segments subequal, 1.9–3 cm long, 0.7–1.3 cm wide, ovate to obovate, obtuse to slightly acuminate,

the inner slightly smaller than the outer. Filaments 3–4 mm long, white, glabrous; anthers 10–12 mm long, yellow. Style divided into three orange to red branches, each branch 6–10 mm long, usually clearly exceeding, but sometimes equaling or rarely shorter than the anthers and less than half as long (rarely half as long) as the length of the perianth segments, arising at a point well above the base of the anthers. Capsule ellipsoid, c. 2 cm long and 1 cm wide, raised on a short pedicel above the ground level at maturity, seeds purplish brown, globose, 4–5 mm diameter, the raphe an indistinct ridge, caruncle pointed, less than 1 mm long, testa covered with a dense mat of papillae. $2n = 16$.

Phenology: Flowering October–November.

***Crocus moabiticus* Bornmuller^[15] (1912)**

Corms 20–30 mm diameter, subglobose, flattened at the base; tunics finely fibrous, the fibers are parallel at the base and weakly reticulate at the apex, extended into distinct neck (4–) 5.5–8.5 (–9.5) cm long. Cataphylls 3, white, membranous. Leaves (6–) 14–24 (–30), usually present but short at flowering time, gray-green, 1–1.5 mm wide, sparsely papillose on the margin of the keel. Flowers 1–6, autumnal, fragrant, veined purple to varying degrees on all six segments on a white ground color, sometimes so heavily as to appear purple, sometimes stained darker at the base of the segments and on the tube; throat white or purple, pubescent. Prophyll present. Bract and bracteole present, unequal, the bracteole narrower and slightly shorter than the bract, white, membranous with long-tapering, rather flaccid tips. Perianth tube 2–5 cm long, white or purple; segment subequal, 1.5–3.2 cm long, 0.3–1.2 cm wide, narrowly elliptic to oblanceolate or obovate, acute to obtuse. Filaments 2.5 mm long, white aging to purple; anthers 10–15 mm long, yellow. Style divided into three deep red clavate branches 15–20 mm long, equaling to much exceeding the anthers and at least half the length of the perianth segments, arising at a point well below the base of the anthers in throat of the flower. Capsule ellipsoid, 1.5–2.5 cm long, 0.5–0.7 cm wide, carried on a very short pedicel at maturity, sometimes not exceeding the ground level; seeds dark brown, irregularly subglobose, 3–3.5 mm diameter, covered with dense mat of long papillae. $2n = 14$.

Phenology: Flowering November–December.

***C. oreocreticus* B. L. Burt^[12] (1948)**

Corms ovoid, c. 10–15 mm diameter, depressed globose and flattened at the base; tunics fibrous, the fibers finely reticulated. Cataphylls 3–4, white or pinkish stained, membranous. Leaves 7–15, subhyteranthous or synanthous but if absent at anthesis then developing immediately after flowering, green or slightly grayish, 0.5–1 mm wide, glabrous. Flowers autumnal, 1–2, rarely more, mid-lilac to purple with darker veining, the extensor pale silvery or buff colored (very rarely albino), throat lilac, glabrous. Prophyll present. Bract and bracteole present, subequal in length but the bracteole narrower, white and some what flaccid, tapering gradually to an acute apex. Perianth tube usually 4–5 cm long, white or lilac; segments subequal, 1.4–3.3 cm long, 0.4–1.1 cm wide, oblanceolate, obtuse, the inner usually slightly smaller than the outer. Filaments 5–8 mm long, white, glabrous; anthers 10–17 mm long, yellow, style divided into three red (rarely

yellow), apically thickened branches, each branch (5–) 13–20 (–21) mm long and equaling the tips of the anthers, arising at a point at or just above the throat of the flower, below the base of the anthers. Capsule oblong, c. 15 cm long, 7 mm wide, produced on a short pedicel just above the ground level; seeds reddish-purple, subglobose, c. 3–4 mm long, with a pointed caruncle; raphe, a rather low ridge running the length of the seed; testa covered with dense mat of papillae. $2n = 16$.

Phenology: Flowering October–December.

C. pallasii Goldb.^[16] (1817)

A very widespread and variable species, five subspecies are recognized as follows:

a) *C. pallasii* subsp. *pallasii* Goldb.^[16] (1817)

Synonyms

Crocus serotinus Ker- Gawl (1816) partly as a syn. *C. autumnalis compestris*

Crocus campestris Pall (1841)

Crocus bybermus Friv. In Griseb (1844)

Crocus pallasianus Herb (1844)

Crocus sativus Siche in Allg (1906)

Crocus sativus Maw (1934)

Crocus thiebautii Mouterde (1954)

Crocus libanoticus Mouterde (1954)

Crocus hausknechtii Sensus (1966)

Corms ovoid, c. 10–20 (25) mm diameter, depressed globose; tunics fibrous, the fibers finely reticulated, extended at the apex into a neck up to 2 cm long. Cataphylls 3–5, white, membranous. Leaves (5–) 7–17, synanthous or subsynanthous but if absent at anthesis then developing immediately after flowering, grayish-green, 0.5–1.5 mm wide, glabrous or scabrid to papillose on the margins of keel and blade. Flowers fragrant, autumnal, 1–6, pale pinkish lilac to deep lilac-blue or purplish-blue, usually slightly veined darker; throat white or lilac, pubescent. Prophyll prossent. Bract and braceole present, unequal, membranous, white tapering gradually to acute, flaccid tips. Perianth tube 4–7 (–10) cm long, white, lilac or purplish; segments (1–9) 2.5–5 cm long, (5–8)–16 cm wide, elliptic, oblanceolate or obovate, acute or subacute, the inner often slightly smaller than the outer. Filaments 2–5 mm long, white, glabrous or sparsely papillose–pubescent; anthers 9–20 mm long, white, glabrous or sparsely papillose–pubescent; anthers 9–20 mm long, yellow. Style divided into three red (occasionally yellow) branches, each branch 3–15 mm long and half as long as the perianth segments, rather slender and tapering gradually to the expanded apex. Capsule ellipsoid, 15–25 mm long, 7–10 mm wide, produced on a short pedicel at or just above the ground level at maturity, seed reddish-purple, irregularly subglobose, 3–4 mm diameter, with a small, pointed caruncle; raphe, usually a small ridge running the length of the seed but occasionally wing-like; testa covered with dense mat of papillae. $2n = 14$.

Phenology: Flowering October–November.

b) *C. pallasii* subsp. *dispathaceus* (Bowles)^[17] B. Mathew (1982)

Synonym

C. dispathaceus Bowles (1924)

Description as for subsp. *pallasii* except for the following. Corms up to 30 mm diameter with fibrous neck (2–) 3–7 cm long. Flowers deep reddish-purple or mauve-pink. Perianth segments 4–7 mm wide, ligulate or very narrowly oblanceolate, style branches in conspicuous, very slender, yellow or sometimes pale orange. $2n = 14$.

Phenology: Flowering September–November.

c) *C. pallasii* subsp. E. B. Mathew^[1]

Description same as subsp. of *pallasii* except for the following. Corms almost without a fibrous neck, the tunics weakly reticulate. Leaves 5–10, green. Flowers bright lilac; style branches orange, arising at a point near or above the top of the anther. $2n = ?$

Phenology: Flowering October–November.

Note: Field studies are required; at first this appeared to be close to *C. pallasii* and was tentatively placed here as a further subspecies. However, recent studies suggest that it should be regarded as a subsp. of *C. badriaticus*.

d) *C. pallasii* subsp. *hausknechtii* Boiss and Reut.^[18] ex Maw^[7] (1884)

Synonyms

Crocus sativus var. *hausknechtii* Boiss and Reut ex Maw (181)

Crocus hausknechtii Boiss (1882)

Description same as for subsp. *pallasii* except the following. Corms up to 30 mm diameter with a fibrous neck upto 10 cm length. Perianth segments obovate, rounded or obtuse, often emarginate or retuse, rarely acute, 3.5–4.2 cm long, 0.8–1.4 cm wide. Filaments 3–6 mm long, clavate, markedly and abruptly expanded at the apex, the point of the anthers to just below their tips. $2n = 16$.

Phenology: Flowering October–November.

e) *C. pallasii* subsp. *turcicus* B. Mathew^[19] (1977)

Synonym

Crocus macrobolbos Jovet and Gomb (1956)

Description same as for subsp. *pallasii* except for the following. Corm 15–35 mm diameter; tunics extended into a neck (2–) 3.5–6 cm long. Leaves absent at flowering time but the dried remains of the previous seasons sometimes persisting until anthesis. Perianth segments 2.5–5 cm long, 4–10 (–12) mm wide, narrowly oblanceolate, acute to acuminate. Filaments 2–4 mm long; anthers 10–12 mm long. $2n = 12$.

Phenology: Flowering October–November.

C. sativus Linn. *species plantarum* (1753)

Synonyms

C. sativus var. *officinalis* Linn. (1762)

Crocus officinalis var. *sativus* Huds (1778)

Crocus autumnalis Smith (1796)

Crocus sativus var. *casbmiruanus* Royle (1836)

Crocus orsinii parl (1856)

Crocus sativus var. *orsinii* (1881)

Corms to c. 5 cm in diameter, depressed globose, flattened at the base; tunica fibrous, the fibers very slender and finely reticulated, extended at the apex of the corm into the neck

upto 5 cm long. Cataphylls 3–5, white, membranous. Leaves 5–11, normally synanthous, exsect, green, 1.5–2.5 mm wide, glabrous or ciliate. Flowers autumnal, fragrant, 1–4, deep lilac-purple with darker veins and a darker violet stain in the throat; throat white or lilac, pubescent. Prophyll present. Bract and bracteole present, very unequal white, membranous with long-tapering, rather flaccid tips. Perianth tube 4–5 (–8) cm long; segments subequal, 3.5–5 cm long, 1–2 cm wide, oblanceolate or obovate, obtuse. Filaments 7–10 mm long, purplish, glabrous; anther 15–20 mm long, yellow. Style divided into three deep red clavate branches, each branch 25–32 mm long, much exceeding the anthers and, at least half the length of the perianth segments, arising at a point well below the base of the anthers in the throat of the flowers. Capsules and seeds rarely produced (a triploid of low fertility). $3n = 24$.

Phenology: Flowering October–November.

C. thomasii Ten^[1] (1826)

Synonyms

Crocus thomasianus Herb (1844)

Crocus visianicus Herbert (1845)

Corms 8–12 (–15) mm diameter, depressed globose, flattened at the base; tunics fibrous, the fibers very slender and finely reticulated, extended at the apex of the corm into a neck upto 1 cm long. Cataphylls 3–5, papery, white. Leaves 5–10, synanthous, usually equaling the flower at anthesis, but sometimes only the tips showing green, 0.5–1.5 mm wide, glabrous or papillose on the margins. Flowers autumnal, fragrant, 1–2 (–3), pale to deep lilac, stained violet toward the base of the segments; throat pale yellow, pubescent. Prophyll present. Bract and bracteole present, very unequal, white, membranous with long-tapering flaccid tips. Perianth tube 3–6 (–8) cm long; segments 2–4.5 cm long, 0.7–1.5 cm wide, elliptic, obovate or oblanceolate, acute or obtuse. Filaments 5–8 cm long, usually pale yellow, glabrous or finely pubescent at the base; anthers 9–13 mm long, yellow. Style divided at a variable point, usually ranging from just below or leveled with the base of the anthers to about a quarter of the way up the anthers, into three bright red branches each of 0.7–2 cm length, half or less than half the length of the perianth segments, expanded gradually to the apex. Capsule ellipsoid, 1–1.5 cm long, 0.5–0.7 cm wide, raised on a pedicel to 2.5 cm length (above ground level) at maturity, seed globose, about 2 mm diameter with a poorly developed raphe and pointed caruncle. $2n = 16$.

Phenology: Flowering October–November.

Identification key to species of *Crocus*, *C. sativus* Series

- Style branches more than half as long (actual measurements) as the perianth segments — 2 Style branches as long (actual measurements) as the perianth segments 6
- Perianth segments 1.4–3.3 cm long; style branches (0.5–) 1–2.7 cm long — 3. Perianth segments 3.5–5 cm long; style branches 2.5–3.2 cm long. Triploid, $3n = 24$. Cultivated or of cultivation. *C. sativus*
- Throat glabrous; style divided above or below the base of anthers 4 Throat pubescent at a point of insertion of

- filaments; style divided well below the base of anthers, in the throat of the flowers 5
- Flowers white, rarely faintly lilac; style divided well above the base of anthers. $2n = 26$. S. Turkey *Crocus asumaniae* Flowers mid lilac to purple (albinos rare), often with a silver or buff exterior; style divided below base of anthers. $2n = 16$. Crete *C. oreocreticus*
- Flowers small, vinous purple; perigonium segments, 1.5–2.0 cm long, 3–7 mm broad. Style dividing below the bases of the anthers; stigmatic branches longer than anthers and usually about as long as perigonium (rarely shorter); leaves appearing after flowers, (6–) 14–24 (–30), scarcely 1 mm broad, margins smooth; gray-green; corm with fibrous neck usually 5–8.5 cm long. $2n = 14$. Jordon *C. moabiticus*
- Style dividing in the throat of perigonium, much below the bases of the anthers; stigmatic branches overtopping the anthers and about as long as the perigonium segments. Throat of perigonium bearded, not yellow; leaves (4–) 7–12, green; corm with a fibrous neck usually 2–4 cm long. $2n = 16$ Greece. *C. cartwrightianus*
- Flowers white, often stained violet-blue or brown base of segments, inside or out, but occasionally white throughout, rarely tinged pale lilac—7. Flowers lilac to reddish-purple throughout (albinos very rare) 8
- Corms tunic parallel, lower part is fibrous, weakly reticulate at apex; style branches 6–10 mm long; center (throat) of flower not yellow, often with a conspicuous violet-blue zone on the inside. $2n = 16$. S. Turkey. *C. mathewii*
- Corm tunic reticulate, fibrous through, style branches 10–19 (–20) mm long; throat of flower usually yellow, occasionally white; if dark stained, usually confined to the exterior of the flower. $2n = 16$. Greece. *C. badriaticus*
- Throat, and often the filaments, pale yellow. $2n = 16$. Italy, Dalmatia *C. thomasii*
- Style dividing much above the bases of the anthers, throat of perigonium not yellow or bearded; leaves usually glabrous. $2n = 14$. Asia Minor to the Judean mountains. *C. elwesii*
- Style dividing at the level of the bases of anthers or below; throat of perigonium yellow, bearded; leaves ciliate at margins and keel 3–4 mm broad. $2n = 12, 14, 16$, Italy to Dalmatia and Balcan Peninsula to Crimea. *C. pallasii*
- Tunics of corm produced about 7–9 cm along the spathe; flowers pale yellow, beared at throat; leaves scabrous, appearing after or during flowering; stigmata somewhat shorter than anthers $2n = 16$. Plants of alpine altitude in W. Persia. *C. haussknechtii*.
- Style very short, dividing below the bases of the anthers; tips of stigmatic branches reaching about the middle of the anthers; leaves appearing after flowering; tunics and delapidated leaves of previous years produced into a thick mat along the spathe; a second basal spathe, lorate in shape, present; flowers deep vinous-purple, segments of perigonium usually narrow, acute. Plants with different sets of characters and usually a longer style. $2n = 14$ Syria and Lebanon. *C. dispathaceus*

Geographical area and intraspecific chromosome variation of *C. sativus* Series

The locality, habitat, distance from sea level, basic number,

somatic number, degree of ploidy and meiotic behavior of *C. sativus* series are given in Table 1.

Classification and cytology of saffron group

Figure 1 shows the classification and cytology of saffron group.

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Table 1: Geographical area and intraspecific chromosome variation of *Crocus sativus* series

Species	Locality	Habitat	Distance (m)	Basic number (n)	Somatic number (2n)	Degree of ploidy	Meiotic behavior
<i>C. asumaniae</i> B. Mathew and T. Bay Top	Turkey, Antalya	Open spaces in <i>Quercus cerris</i> and <i>Quercus coccifera</i> scrub, in stony ground with limestone out crops	900–1250	13	26	2x	—
<i>C. cartwrightianus</i> (Herbert) Maw	Greece, Crete	Open rocky hillside, sometimes in short turf or in scrub or sparse pine woods on schist, shale, granite or limestone formations	1000	08	16	2x	—
<i>C. elwesii</i> (Maw) O. Schwarsz	Asia Minor, Crete, Lebanon, Syria, Palestine, Judean, Moutains, Jerusalem, and Hebron	Rocky ground, open spaces in Maquis	500–1100	08	16	2x	—
<i>C. hadriaticus</i> Herbert	Greece, Pindus, Peloponnese, Albania	Open scrub or short turf or rock hillside of limestone or shale	250–1500	08	16	2x	—
<i>C. mathewii</i> Kerndorff and Pasche	Turkey, Antalya	In <i>quercus coccifera</i> scrub, between dolomite and calcareous rocks	450–1000	08	16	2x	—
<i>C. moabiticus</i> Boenm et. Disnm	Jordan, Moab	Open rocky hillside on limestone formation in scrub, sparse grass and maquis	680–950	07	14	2x	—
<i>C. creocreticus</i> Burt.	Crete, Jordan	Open rocky mountains with <i>Astragalus</i> , <i>Phlomis sarcopoterium spionsum</i> and <i>Berberis cretica</i> in heavy reddish soil on limestone formation	900–2000	08	16	2x	—
<i>C. pallasii</i> (a) <i>C. pallasii</i> Goldb.	Italy, Balkan, Penins, Turkey, USSR, Crimea	Open stony or rocky hillside, often an sparse scrub or spiny vegetation, on limestone or basalt formation	700–2820	07	14	2x	—
(b) <i>C. dispathaceus</i> Bowles	Turkey, Syria	Dry <i>Quercus coccifera</i> scrub or in sparse <i>Juniperus/Quercus/Pinus</i> wood, in tetra rossa on limestone formation	350–2000	07	14	2x	—
(c) <i>C. haussknechtii</i>	Iran, Iraq, South Jordan	Dry fields or rocky hillside or in sparse <i>Quercus</i> scrub	1300–2100	07	14	2x	—
(d) <i>C. turcicus</i> B. Mathew	Turkey	Dry regions, usually in rocky places with steppe vegetation	600–1700	06	12	2x	—
(e) <i>C. "E". B.</i> Mathew	Greece, Peloponnese	Open rock scrubland	1500	—	—	—	—
<i>C. sativus</i> subsp. <i>planterum</i>	Ancient origin	Cultivated	800–1500	08	16, 24, 40	2x, 3x, 5x	8-II, 8-III, 8-IV
<i>C. thomasi</i>	Ten Italy, Yugoslavia	Open rocky or stony slopes or in sparse scrub	1000	08	16	2x	—

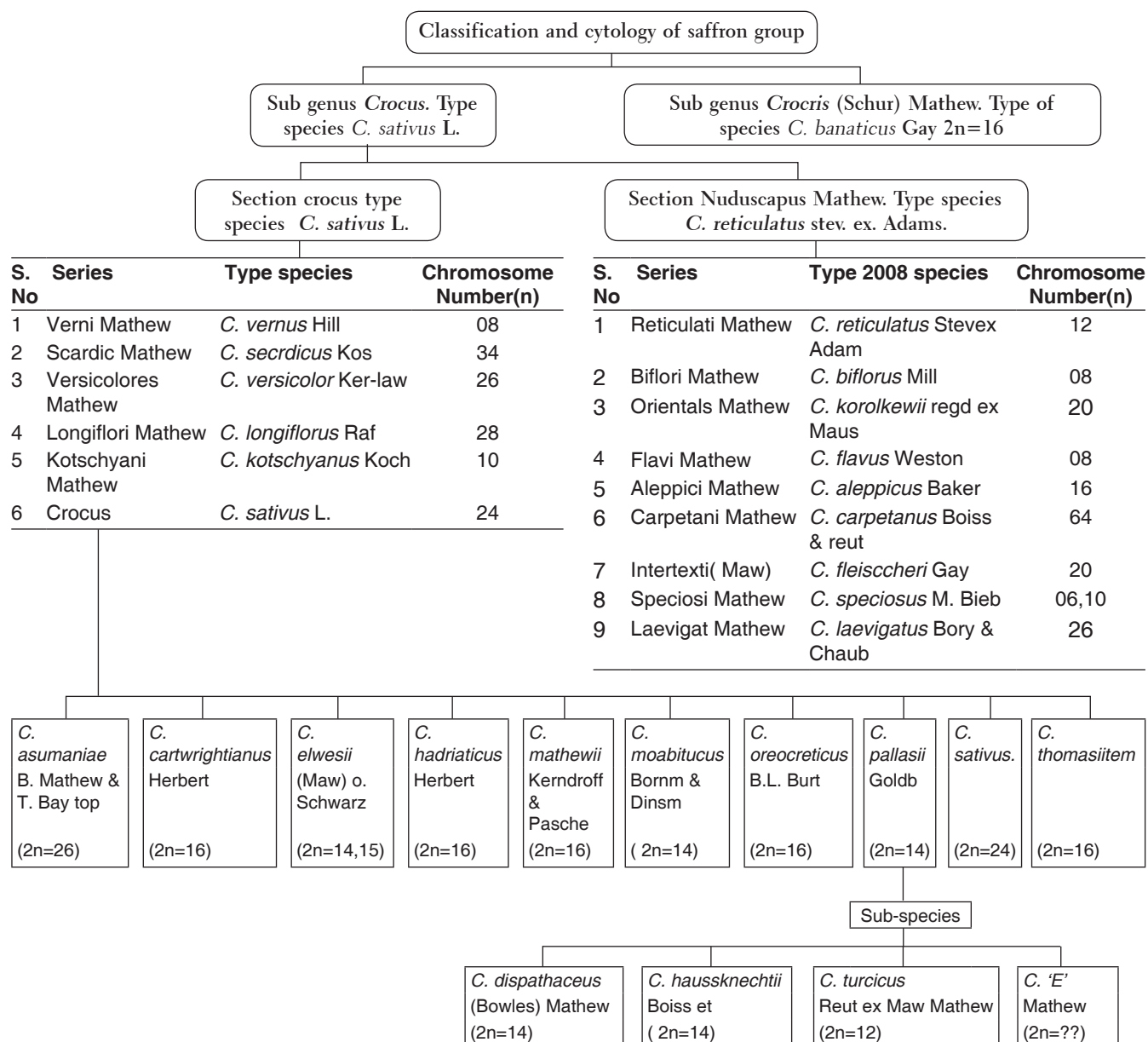


Figure 1: Classification and cytology of saffron group

References

- Mathew B. Botany, taxonomy and cytology of *crocus sativus* and its Allies. Amsterdam: Harwood Academic Publishers; 1999. p. 19-30.
- Brighton CA. Cytology of *crocus sativus* and its Allies (Iridaceae). PI Syst Evol, Austria: 1977; 128:137-57.
- Mathew B. The *crocus* – A revision of the Genus *crocus*, Batsford, London: BT Batsford ed. London; 1982.
- Saxena RB. A review on cultivation of saffron (*crocus sativus* L). Series Recent Progress in Medicinal Plants. Vol. 5. USA: SCI TECH Pub. 2002. p. 295-319.
- Mathew B, Beytop T. Some observations on Turkish *crocus*. Vol. 35. Notes from the Royal Botanic Gardens, Edinburgh: City of Edinburgh EH 3 5LR. United Kingdom; 1976. p. 61-7.
- Maw G.A. A synopsis of the Genus *crocus*. Gardene's chronicle London: 881. p.16.
- Maw G.A. monograph of the Genus *crocus*. London: Dulau and Co.; 1886.
- Feinbrun N. The genus *crocus* in Israel and neighbouring countries. Vol. 12. Royal Botanic Gardens, Kew green Kew, U.K.: Kew Bull. 1957. p. 269-85.
- Wulf EW. Flora Taurica I fasc. Journal Phyton published Argentina; 1929;2:69.
- Mouterde P. Contribution of Letude de la flore syrienne et libanaise(suite). Bull Soc Bot France 1954;101:420-8.
- Siehe W. *Crocus albanus* Siehe ap. n. Allg. Bot. Zeitschrift. Reimpression facsimile A. Asher & Co. Springer - Verlag; 1906;12:1.
- Burt BL. *Crocus oreocreticus*. Phyton 1948;1:224-5.
- Herbert W. History of the species of *crocus*. Vol. 2. London: Journal of the Horticultural Society; 1847. p. 249-93.
- Kerndroff H. Observations of *crocus* (Iridaceae) in Jordan with special reference to *crocus moabiticus*. Herberita 1988;44:33-53.
- Bornmuller J, Dinsmore JE. *Crocus moabiticus* Bornm. et. Dinsm, Fedde, Report. 10. 1912. p. 383.
- Goldbach KL. Monographiae Generis Croci Tantamen Mem. Soc Imp Net Moscou 1817;5:142-61.
- Bowles FA. A Handbook of *crocus* and colchicum London 1952. 2nd ed. London: Bodley Head, London; 1924.
- Boissier E. Flora Orientalis. Geneva; 1884. p. 5.
- Mathew B. *Crocus turcicus*. PI Syst Evol. Austria; 1977; 129:98.

हिन्दी सारांश

वनस्पति-विज्ञान, वर्गिकी-विज्ञान और कोशिका-विज्ञान के सन्दर्भ में क्रोकस सटायवस ग्रन्थमाला

आर. बी. सक्सेना

केशर (क्रोकस सटायवस एल परिवार-ईरीडेसी) सूखे वर्तिका द्वारा प्राप्त की जाती है। यह बाँझ ट्रिप्लोईड पौधा होने के कारण इसका जंगली पोधे होने का पता नहीं है। यह क्रोकस की उप-जाति क्रोकस ग्रन्थमाला कहलाती है इसमें दस विशिष्ट जाति (वर्ग) और चार उपजाति होती हैं। क्रोकस सटायवस ग्रन्थमाला विशिष्ट जाति (वर्ग) से ज्यादा मिलती है। इसको वर्गिकी-विज्ञान तथा जटिल कोशिका विज्ञान द्वारा अलग अलग करना कठिन है। वनस्पति-विज्ञान द्वारा क्रोकस सटायवस-ग्रन्थमाला का अध्ययन वर्गिकी-विज्ञान द्वारा उन विशिष्ट जाति और इन्फ्रास्पेसिफिक टाक्सा द्वारा किया गया। इसमें वर्गीकरण, परिस्थिति-विज्ञान तथा ऋतु-जैविका के अध्ययन के संग गुण-सूत्रों का नम्बर भी दिखाया गया जो सदृशीकरण की कुंजी हैं।