TAXONOMIC REVISION AND NUMERICAL ANALYSIS OF HIBISCUS L. IN EGYPT

Amany Mostafa1*, Elsa2 S.S., Mohamed1 A.A. and El-Shamey2 I.

1- Flora and Phytotaxonomy Researches Dept., Horticulture Res. Institute, Agric. Res. Center, Giza, Egypt
2- Agric. Botany Dept., Fac. of Agric., Ain Shams Univ., P.O. Box 68, Hadayek Shoubra 11241, Cairo, Egypt

*Corresponding author: amanymostafa_2020@yahoo.com

Received 17 December, 2019            Accepted 19 February, 2020

ABSTRACT

The present study undertakes a survey, taxonomic revision and numerical analysis of the genus Hibiscus L. in Egypt including wild and cultivated species. The taxonomic treatment based on collecting of fresh material from the studied species, in addition to the investigation of the herbarium specimens as well as information from the literature. Eleven species of Hibiscus were recorded, of which five wild species (H. diversifolius Jacq., H. micranthus L. f., H. vitifolius L., H. sabdariffa L. and H. trionum L.) and six cultivated species (H. cannabinus L., H. mutabilis L., H. rosa-sinensis L., H. schizopetalus (Dyer) Hook. f., H. syriacus L. and H. tiliaceus L.). An identification key to the species of Hibiscus is constructed. For each species, valid name, synonyms, morphological descriptions based on the examination of herbarium specimens and fresh materials as well as distribution, type specimen, habitat, selected specimens and economic importance are provided. The numerical analysis based on thirty six morphological characters including vegetative, flowers and fruits parts of the studied species. SPSS Statistics version 22 used to get morphometric analysis. The numerical analysis revealed two main clusters. The first cluster included 3 species, viz. H. micranthus L. f., H. vitifolius L. and H. trionum L. The second cluster included two groups: group (a) viz. H. diversifolius Jacq., H. syriacus L., and H. tiliaceus L., and group (b) viz. Hibiscus cannabinus L., H. mutabilis L., H. rosa-sinensis L., H. sabdariffa L. and H. schizopetalus (Dyer) Hook. f.

Keywords: Egypt; Flora; Hibiscus; Malvaceae; Taxonomy.

1. INTRODUCTION

The Genus Hibiscus L. belongs to the family Malvaceae Juss. which considered as one of the important families consists of about 111 genera and about 1800 species of herbs, shrubs and/or trees, distributed all over the world especially in warm temperate and tropical regions (Mabberley, 1997). Hibiscus is a polymorphic and a large genus in Malvaceae. It contains about 300 species of annual or perennial herbs, shrubs or trees distributed in tropical and subtropical regions (Mabberley, 1997). It occurs in various habitats, from grasslands to savannas, forests, and marshes (Wilson, 1999). The name Hibiscus L. was validated by Linnaeus in “Species Plantarum” (1753). Hibiscus is derived from the Greek name ibiskos, said to be derived from the sacred ibis, to which bird one species of the genus was consecrated in ancient Egypt. The genus was monographed by Hochreutiner (1900), who recognized 197 species, and divided the genus into 12 sections. Since 1900, there had no revision for all the genus, except some taxonomic studies which treated with a certain sections as Bombicella (Fryxell, 1980) and Furcaria (Wilson, 1994, 1999). Since that time few genera separated from Hibiscus as Abelmoschus, Alyogyne, Radyera, and Wercklea (Fryxell, 1997). In addition some species accepted as new Hibiscus species or some genera were emerged in it. Hibiscus species have been widely used in several formulae in traditional medicine (Ling et al 2009), and also the species are widely
cultivated as ornamental plants for their showy flowers (H. rosa-sinensis L. and H. schizopetalus (Dyer) Hook. f.), or cultivated for its fibers (H. cannabinus L. “kenaf”) or for its fleshy calyx (H. sabbdariffa L. “rosella”).

In general, Hibiscus has been the subject of many taxonomical investigations focusing on the general morphological descriptions (Masters, 1868; Andrews, 1952; Hutchinson and Dalziel, 1958; Hutchinson, 1967; Täckholm, 1974; Abedin, 1979; Townsend, 1980; Zohary, 1987; Boulos, 2000), in addition to its anatomical, micro-morphological or palynological studies (Hosni and Arafia, 1999; El-Naggar, 2004; El-Naggar and Sawady, 2008). The investigation, survey and documentation of the flora of Egypt have been studied extensively in several earlier works which included the wild species of Hibiscus (Forskål, 1775; Delile, 1813; Boissier, 1867; Ascherson and Schweinfurth, 1887; Muschler, 1912; Montasir and Hassib, 1956, 1957; El-Hadidi et al 1999; Boulos, 2000; Shamso and Khattab, 2016). Muschler (1912) recorded three species of Hibiscus in Egypt viz. H. trionum L., H. sabdariffa L. and H. cannabinus L. while Täckholm (1974), El-Hadidi and Fayed (1994/95), El-Hadidi et al (1999) and Boulos (2000, 2009) recorded four species of Hibiscus in the flora of Egypt viz. H. trionum L., H. sabdariffa L., H. micranthus L.f. and H. vitifolius L. Montasir and Hassib (1956) said that H. cannabinus L. is cultivated species in Nile region and escaped from cultivation. Badry et al (2015) recorded H. diversifolius Jacq as a new addition to the flora of Egypt.

Numerical taxonomic studies are important for documenting and discovering the significance of morphological characters in determining the relationships in different groups of plants. Many studies have been made for understanding taxonomic relationships in different groups of plants (Kahraman 2010; Abdel Khalik 2012; Heenan 2017; Fayed et al 2019).

Certainly, no previous studies were reported concerning the cultivated species of Hibiscus in Egypt. This work aims to survey available species of Hibiscus (wild and cultivated) in Egypt, in respect to their taxonomic treatment, distribution in their phytogeographical regions and their uses for local communities, and the relationships among the species in numerical analysis.

2. MATERIALS AND METHODS

2.1. Taxonomic treatments

The present study based upon the morphological investigation of about 110 herbarium specimens in the major herbaria in Egypt (CAIM: Herbarium of Flora & Phyto taxonomy researches department, CAI: Cairo University Herbarium). In addition to fresh specimens collected during the field trips. About 35 herbarium specimens were prepared and deposited in CAIM. The dimensions and characters of leaves, flowers parts (including pedicel, epicalyx, calyx, corolla and staminal column), fruits and seeds were measured. The identification of the collected specimens was performed by using the appropriate florals of Egypt and adjacent florals (Masters, 1868; Bailey, 1947, 1949; Andrews, 1956; Cullen, 1967; Webb, 1968; Täckholm, 1974; Abedin, 1979; Townsend, 1980; Zohary, 1987; Boulos, 2000) and other books about cultivated plants. In addition they compared with previously determined herbarium sheets and scientific illustrations. Nomenclature of studied species and their synonyms was updated according to the online sources (www.Tropicos.org; www.theplantlist.org). Identification key was constructed to differentiate between the studied species. Accepted scientific names with their citations, synonyms, descriptions, distributions, type specimens and habitats are provided for all species.

From the herbarium specimens examined, 1 to 3 selected specimens are chosen to represent each species. Economic importance includes uses in Egypt and other countries. The phytogeographical regions for the wild species in Egypt, according to Boulos (2009) (Fig. 1).

2.2. Numerical analysis

For the numerical analysis, thirty six morphological characters were used (Table 1). The characters were converted into binary states and multi-states (interval) code. Morphometric analysis of quantitative data related to the characters were done using SPSS Statistics version 22. The data matrix was subjected to cluster analysis using UPGMA (Unweighted pair group method with arithmetic mean) and a dendrogram was constructed to show the relationship among the species.
Fig. 1. Map indicates the phytogeographical regions in Egypt according to Bolous (2009). Abbreviations: \textbf{N} = the Nile region; \textbf{O} = the oases region; \textbf{M} = Mediterranean region; \textbf{R} = Red sea region; \textbf{GE} = Gebel Elba region; \textbf{De} = Eastern desert; \textbf{Dw} = western desert; \textbf{S} = Sinai region.
Table 1. Morphological characters used in the numerical analysis of *Hibiscus* species in Egypt

| No. | Characters | Characters differentiation/code |
|-----|------------|---------------------------------|
|     | **Habit**  |                                  |
| 1   | Habit growth | Tree (1) shrub (2) herb (3)    |
| 2   | Stem armed  | unarmed (1) armed (2)           |
| 3   | Stem texture | Almost glabrous (1) stellate hairy (2) pubescent or tomentose (3) villose (4) crisped and strigose hairs (5) |
|     | **Stipules** |                                 |
| 4   | Stipules shape | Filiform (1) linear (2) linear-lanceolate (3) subulate (4) oblong ovate (5) |
| 5   | Stipules length | 2-10 mm long (1) 11-30 mm long (2) |
|     | **Petiole**  |                                  |
| 6   | Petiole texture | Glabrous (1) pubescent (2) crisped hairs and stigose (3) stigose (4) villose (5) |
|     | **Leaves**   |                                  |
| 7   | Leaves outline | elliptic (1) ovate (2) ovate-cordate (3) |
| 8   | Adaxial surface texture | Glabrous (1) pubescent (2) hairy (3) stigose (4) strigose and pubescent (5) |
| 9   | Abaxial surface texture | Glabrous (1) pubescent (2) hairy (3) stigose (4) strigose and pubescent (5) |
| 10  | Upper leaves division | Entire (1) lobed (2) digitate (3) |
| 11  | Lower leaves division | Entire (1) lobed (2) digitate (3) |
| 12  | Leaves margin | Entire (1) dentate to serrate (2) |
| 13  | Leaves base | Cordate (1) cordate-truncate (2) cuneate (3) rounded (4) |
| 14  | Leaves apex | Acute (1) acuminate (2) |
| 15  | Leaves length | Less than or equal 3 cm (1) more than 3 cm (2) |
|     | **Pedicel**  |                                  |
| 16  | Pedicel texture | Glabrous (1) villose (2) pubescent or tomentose (3) stigose (4) |
|     | **Epicalyx** |                                 |
| 17  | Epicalyx segments | Filiform (1) linear (2) linear-lanceolate (3) subulate (4) triangular (5) |
| 18  | Epicalyx texture | Stellate hairy (1) hispid (2) stigose (3) setose (4) pubescent (5) glabrous (6) |
| 19  | Epicalyx length | Less than 5 mm (1) more than or equal 5 mm (2) |
|     | **Calyx**    |                                  |
| 20  | Calyx lobes | Lanceolate (1) triangular (2) triangular-lanceolate (3) ovate (4) elliptic (5) |
| 21  | Calyx texture | Glabrous (1) pubescent or tomentose (2) stigose (3) setose (4) |
| 22  | Calyx apex | Acute (1) acuminate (2) long acuminate (3) |
| 23  | Calyx length | Less than 0.5 cm long (1) equal or more than 0.5 cm long (2) |
|     | **Corolla**  |                                  |
| 24  | Corolla diameter | Less than 3 cm across (1) more than 3 cm across (2) |
|     | **Petal**    |                                  |
| 25  | Petal shape | Obovate (1) rounded-ovate (2) |
| 26  | Petal apex | Entire (1) laciniate (2) |
| 27  | Petal length | Less than 1 cm (1) from 1.5 to 2.5 cm (2) more than 3 cm (3) |
|     | **Staminal column** | Exerted out of corolla (1) included in corolla (2) anthers near the column apex (1) anthers throughout the column (2) |
|     | **Fruit**    |                                  |
| 30  | Fruit shape | Ovoid (1) oblong (2) globose to subglobose (3) |
| 31  | Fruit apex | Acuminate (1) acute (2) |
| 32  | Fruit margin | Winged (1) wingless (2) |
| 33  | Fruit texture | Almost glabrous (1) long simple hairs (2) stellate hairs (3) stigose (4) pubescent (5) hispid (6) |
| 34  | No. of valves | 10-valved (1) 5-valved (2) |
|     | **Seeds**    |                                  |
| 35  | Seed shape | Reniform (1) ovoid-reniform (2) triangular-reniform (3) |
| 36  | Seed texture | Glabrous (1) stellate hairy (2) long simple hairs (3) cottony hairs (4) silky hairs (5) |
3. RESULTS

The present revision recorded five wild and six cultivated species, belonging to six sections of *Hibiscus* in Egypt (Table 2).

3.1. Taxonomic treatments

*Hibiscus* L. Sp. Pl. ed. 1: 693 (1753); Masters 1868, p. 194; Bailey 1947, p. 1483; Andrews 1952, p. 20; Hutchinson & Dalziel 1958, p. 343; Hutchinson 1967, p. 544; Täckholm 1974, p. 355; Abedin 1979, p. 7; Townsend 1980, p. 264; Zohary 1987, p. 312; Boulos 2000, p. 107.

Annual or perennial herbs, woody shrubs or small trees usually stellate-hairy. Leaves undivided, shallowly or deeply palmately lobed or digitately parted; stipules caducous or somewhat persistent. Flowers bisexual, large and showy, red, white or yellow, usually solitary and axillary, or in terminal racemes by suppression of upper leaves, sometimes in fascicles. Epicalyx usually of 5 or more segments, free or shortly connate at base, rarely fused to above halfway. Calyx 5- dentate or 5- partite, sometimes spathe-like and deeply cleft, persistent in fruit. Corolla 5 free petals, usually campanulate, adnate at base to the staminal column. Staminal column sometimes very long, divided into numerous filaments above, truncate at the tip. Ovary 5 locules, with 1-several ovules in each locule; Stylar column 5-branched above; Stigmas capitate or subcapitate. Fruit a loculicidally dehiscent 5-valved capsule, sometimes 10 (by false septa), membranous or leathery. Seeds reniform or globose, angular, glabrous, hairy, or woolly.

**Type species:** *Hibiscus syriacus* L.

| Sections  | Species |
|-----------|---------|
| Azanza    | *H. tiliaceus* |
| Bombycella| *H. syriacus*, *H. micranthus* |
| Furcaria  | *H. cannabinus*, *H. sabdariffa* and *H. diversifolius* |
| Lilibiscus| *H. schizopetalus* and *H. rosa-sinensis* |
| Trionum   | *H. mutabilis* and *H. trionum* |
| Pterocarpus| *H. vitifolius* |

**Table 2. Hibiscus species recorded in Egypt within their sections according to Hochreutiner (1900)**

Key to the studied species of *Hibiscus*:

1. Shrubs or small tree .......................... 2
2. Annual or short lived perennial herbs ........ 8
3. Stipules foliaceous, oblong-ovate, 1-3 cm long; ovary 10 locules due to false septa. .......................... 1. *H. tiliaceus*  
4. Stipules filiform, linear, linear-lanceolate, 0.2-1 cm long; ovary 5 locules .......................... 3
5. Plants densely hairy, tomentose ............... 4
6. Plants glabrous or almost ............... 6
7. Leaves unlobed; corolla less than 2 cm across; seeds covered by long cottony hairs .......................... 2. *H. micranthus*  
8. Leaves lobed; corolla more than 2 cm across; seeds hairy but not cottony hairs .......................... 5
9. Calyx lobes ovate, acuminate; corolla white turning to pink .......................... 3. *H. mutabilis*  
10. Calyx lobes triangular-lanceolate, acute; corolla yellow with a marron center .......................... 4. *H. vitifolius*  
11. Staminal column included, antheriferous throughout the column .......................... 5. *H. syriacus*  
12. Pedicel 4-8 cm long; petals apex entire .... 6. *H. rosa-sinensis*  
13. Pedicel 8-12 cm long; petals apex laciniate .......................... 7. *H. schizopetalus*  
14. Stem, branches and petioles hairy or glabrous; leaves digitate .......................... 9
15. Stem, branches and petioles with hard conical prickles; leaves angular or 3-5 lobed .......................... 8. *H. diversifolius*  
16. Leaves covered with long hairs; leaves segments irregularly pinnatifid .......................... 9. *H. trionum*  
17. Leaves glabrous or almost; leaves 3-7 narrowly segments .......................... 10
18. Leaves segments sharply serrate; calyx lobes triangular, apex long acuminate; Petals 4-8 cm long .......................... 10. *H. cannabinus*  
19. Leaves segments crenate-serrate; calyx lobes lanceolate, apex acuminate, enlarged and fleshy in fruit; Petals 3.5-4.5 cm long .......................... 11. *H. sabdariffa*
1. *Hibiscus tiliae*ceus L., Sp. Pl. ed.1: 494 (1753); Masters 1868, p. 207; Bailey 1947, p. 1487; Bailey 1949, p.665; Hutchinson & Dalziel 1958, p. 345; Abedin 1979, p.9.

A small evergreen tree, 4-10 m tall, with purplish branches, marked with the annular scars made by the deciduous stipules. Leaves 3-20(-30) cm long, 2-20 (-30) cm broad, orbicular to ovate, coriaceous at base, usually entire or undulate to crenate, acute to acuminate, almost glabrous above, hairy below, lower surface at base with linear glands on 1-5 nerves, coriaceous. Petioles shorter than the blades, 3-8 cm long. Stipules large, foliaceous, clasping the stem, 1-3 cm long, 0.5-1 cm broad, oblong-ovate, deciduous. Flowers solitary, clustered at the end of branches. Pedicel 1-2 cm long, in fruit up to 2 cm, stellate pubescent. Epicalyx cup-shaped, 5-10 mm long, 7-12-toothed; teeth deltoid or triangular, 2-3 mm long. Calyx ½ to ⅓ fused, 1.5-3 cm long; lobes lanceolate, about 1 cm broad, each with linear gland on the central nerve. Corolla 5-8 cm across yellow with or without a purple center in the morning and become red towards evening. Petals obovate, 4.5-7 cm long, 4-5 cm broad, claw slightly hairy on margin. Staminal column about 3 cm long, included, anthers almost throughout its length. Ovary oblong, pubescent, 5 mm long. Capsule 2-3 cm long, oblong, apex acuminate, beaked, margin wingless, densely stellate hairy, 10 locules. Seeds many, dark brown 4-5 mm long, reniform, stellate hairy.

**Type**: Herb. Hermann vol. 3: fol. 51 Linn. n. 258 (BM).

**Distribution**: The species is distributed in tropics and subtropics of both hemispheres. It is recorded in Egypt as cultivated ornamental tree.

**Habitat**: Cultivated in the gardens.

**Specimens selected**: Aswan botanic garden, 28.12.2013, Hafiz Rofaeeel, 29893 (CAIM).

**Economic importance**: The species can be used as ornamental plant.

**Arabic name**: Khassia Rashid.

2. *Hibiscus micranthus* L. f., Suppl. Pl. 308, 310 (1782); Masters 1868, p. 205; Täckholm 1974, p. 356; Abedin 1979, p. 15; Zohary 1987, p. 312; Boulos 2000, p.108.

**Synonyms**: *Hibiscus ovalifolius* (Forssk.) Vahl, Symb. Bot. 1: 50 (1790).

*Hibiscus gossypinus* DC., Prodr. 1: 453 (1824).

*Bombix micranthus* (L.F.) I. Riedl., in Fl. Iran. 120: 34 (1976).

Low stellate-hairy shrub 0.5-1.2 m tall. Stems stiff, branched, erect or ascending. Leaves 1-3.5 cm long, 1-3 cm broad, scabrous, broadly ovate to lanceolate, undivided, serrate-dentate, the base rounded or truncate, the apex acute. Petiole 0.2-1.2 cm, stigrose. Stipule 2-4 mm long, filiform. Flowers axillary, solitary. Pedicel 0.3-4 cm long, jointed or not, accrescent in fruit, stigrose. Epicalyx 6-8 segments, 2-4 mm long, filiform, stiff. Calyx 3-4 mm long, 5 lobed; lobes lanceolate or triangular, acute. Corolla 1.2-1.5 cm across, white or pink. Petals 5, obovate, apex entire, 5-6 mm long, reflexed, stellate hairy outside. Staminal column included, up to 5 mm long, anthers near the column apex. Capsule globose, 5 valves, 7-9 mm across, apex acute, margin wingless, almost glabrous. Seeds numerous, 2 mm long, 1 mm broad, reniform, densely covered by long cottony hairs.

**Type**: Herb. Linn. n. 875. 2 (LINN).

**Distribution**: Tropical Africa, South Africa, Palestine, Arabia, Pakistan and India. In Egypt, the species was recorded as wild in Sinai, Red Sea and Gebel Elba.

**Habitat**: Stony wadis, rocky ground and hillsides.

**Specimens selected**: (S): Barrag El-Samara (Sinaï), 4.5.1927, Alfred Kaiser, s.n. (CAIM). (GE): Gebel sheilal, S. E. Desert, 10.9.1936, M. Drar, s.n. (CAIM); Gebel Ideib, Gebel Elba, 7.3.1938, Shabetai, 5192 (CAIM). (R): Gebel Hamatâ, 7.2.1961; V.Täckholm et al. s.n. (CAI)

**Economic importance**: The species can be used as an ornamental plant.

**Arabic name**: Khassia Rashid.

3. *Hibiscus mutabilis* L., Sp. Pl. ed.1: 694 (1753); Bailey 1949, p.666; Abedin 1979, p. 10; Townsend 1980, P. 270

**Synonyms**: *Abelmoschus mutabilis* (L.) Wall. ex Hassk., Cat. Hort. Bot. Bogor. 198 (1844).

*Hibiscus sinensis* Mill., Gard. Dict. ed. 8 2 (1768).

*Ketmia mutabilis* (L.) Moench, Methodus 617 (1794).

Shrub or small tree, 2-5 m tall, all parts densely stellate pubescent and mixed with simple, glandular yellowish or purplish hairs. Petiole 3-10 cm long. Leaves 5-15 cm long, usually broader than long, shallowly coriaceate-truncate at base, coarsely serrate obscurely-distinctly 3-7 lobed, lobes acute. Stipules small, linear-lanceolate. Flowers axillary, solitary, large, single or double. Pedicel longer than petiole, articulate near the top. Epicalyx 8-12 segments,
free, 0.7-2 cm long, linear to linear-lanceolate. Calyx free below or to the middle, 2.5-3 cm long, accrescent in fruit up to 4.5 cm, lobes ovate, acuminate. Corolla 5-8 mm across, white to pink, changing in color to more or less red by late evening, but not so in single flowers. Petals 4-6 cm long, obovate, pubescent outside, claw with ciliate margin. Staminal column included, bearing filaments almost throughout its length. Capsule 2-2.5 cm, subglobose, apex acute, margin wingless with long white simple hairs outside, glabrescent inside, claw ciliate margined. Staminal column 3 cm long, included, filaments almost throughout its length. Capsule 1.2 cm long, stellate pubescent. Epicalyx 6 mm long, linear. Petiole 0.5 cm long, shortly ovoid, densely furnished with spreading, the apex acute, unlobed or obscurely to deeply 3-lobed. Stipules 3-5 mm, filiform, caduceus. Flowers axillary, solitary. Pedicel 0.2-2 cm long, stellate pubescent. Epicalyx 6-8 segments, linear, stellate-hairy, 6-15 mm long. Calyx 1.2-2 cm long, free to the middle, densely stellate-tomentose, lobes lanceolate, acute. Corolla campanulate, 4-5 cm across, single or double, white, red, purple or bluish. Petals obovate, 3-5 cm long, stellate hairy outside, glabrescent inside, claw ciliate margined. Staminal column 3 cm long, included, filaments almost throughout its length. Capsule 1.2 cm across, 1.5-2 cm long, shortly ovoid, densely furnished with a yellowish stellate pubescent, apex acuminate, beaked, margin wingless, 5-valves. Seeds 2-4 mm long, reniform, brownish-purple, with a dense fringe of yellowish silky hairs on the dorsal side.

**Type:** H.U. Linn. Herb. n. 875. 24 (LINN).

**Synonyms:**
- Althaea frutex Hort. ex Mill., Gard. Dict., ed. 8. (1768).
- Hibiscus rhombifolius Cav., Diss. 3: 156. t. 69. f. 3. (1787).
- Ketmia syriaca (L.) Scop., Fl. Carniol., ed. 2. 2: 45. (1772).

Glabrous shrub or small tree, mostly 1-3 m tall. Leaves 2.5-9 cm long, 1.5-5 cm broad, elliptic-rhomboid, irregularly dentate, the base cuneate, the apex acute, unlobed or obscurely to deeply 3-lobed. Stipules 4-6 mm long, linear. Petiole 0.5-2 cm long, pubescent. Flowers axillary, solitary. Pedicel 0.2-2 cm long, stellate pubescent. Epicalyx 6-8 segments, linear, stellate-hairy, 6-15 mm long. Calyx 1.2-2 cm long, free to the middle, densely stellate-tomentose, lobes lanceolate, acute. Corolla campanulate, 4-5 cm across, single or double, white, red, purple or bluish. Petals obovate, 3-5 cm long, stellate hairy outside, glabrescent inside, claw ciliate margined. Staminal column 3 cm long, included, filaments almost throughout its length. Capsule 1.2 cm across, 1.5-2 cm long, shortly ovoid, densely furnished with a yellowish stellate pubescent, apex acuminate, beaked, margin wingless, 5-valves. Seeds 2-4 mm long, reniform, brownish-purple, with a dense fringe of yellowish silky hairs on the dorsal side.

**Type:** H.U. Linn. Herb. n. 875. 24 (LINN).
Distribution: Native of temperate and subtropical Eastern Asia cultivated and naturalized in Southern Europe. In Egypt, it is cultivated as an ornamental shrub in many gardens.

Habitat: Cultivated.

Specimens selected: Agricultural Museum Garden, 4.10.1952, Mahdi & M. Abdallah, S.N. (CAIM).

Economic importance: The species is an ornamental shrub cultivated as a hedge.

Arabic name: Ward Al Majal, Khatmiyah.

6. *Hibiscus rosa-sinensis* L., Sp. Pl. 694 (1753); Bailey 1949, p. 665; Abedin 1979, p. 12; Townsend 1980, p. 269.

Synonyms: *Hibiscus festalis* Salisb., Prodr. Stirp. Chap. Allerton 383 (1796).

*Hibiscus boryanus* DC., Prodr. 1: 446 (1824).

*Hibiscus storkii* Seem., Fl. Vit. 17 (1865).

Shrub or small tree, 1-4 (-5) m tall, glabrous or almost so in its vegetative parts. Leaves broadly ovate, 4-12 (-15) cm long, at the base cuneate to truncate, entire, coarsely but bluntly serrate above, the apex subacute to shortly acuminate. Petioles 0.5-3 cm long. Stipules 5-10 mm long, linear. Flowers axillary, solitary, erect or subpendulous. Pedicel 1-8 cm long, glabrous, articulate near the top. Epicalyx 6-8 segments, linear-lanceolate, glabrous, 6-15 mm long. Calyx 1.5-3 cm long, tubular-campanulate, lobes 5-15 mm long, deltoid-lanceolate. Corolla 4-9 cm across, usually double, usually in various shades of red or white, more rarely yellow or orange, petals obovate or oblong-obovate, 5-9 cm long, obtuse or irregularly lobed at apex. Staminal column very long, 5-10 cm, exerted, anthers near the column apex. Capsule 3-4 cm long, 1 cm across, oblong, cylindrical, apex acute, margin wingless, glabrous, 5-valves. Seeds about 5 mm long, reniform, blackish, moderately stellate-hairy.

Type: Herb. Hermann 3:4; n. 260 (BM).

Distribution: Native to China and East Asia. It is cultivated throughout the tropics and sub-tropics. In Egypt, it is widespread cultivated as an ornamental hedge shrub in gardens.

Habitat: Cultivated.

Specimens selected: Agricultural Museum Garden, Dokki, 30.6.1987, Badia & Abdallah Hassan, s.n. (CAIM); Aswan Botanical Garden, 26.5.1995, Hafiz Rofaeel, s.n. (CAIM).

Economic importance: Widely spreading as cultivated ornamental shrub. It has been used as male parent in the crosses with *Hibiscus rosa-sinensis* L. and its varieties (Abedin 1979; Mabberley 1997).

Arabic name: Hibiscus Nagava.

7. *Hibiscus schizopetalus* (Dyer) Hook. f., Bot. Mag. 106: t.6524 (1880); Bailey 1947, p. 1487; Bailey 1949, p. 665; Abedin 1979, p. 12.

Synonym: *Hibiscus rosa-sinensis* var. *schizopetalus* Dyer, Gard. Chron., 12: 372, 568 (1879).

Shrub, 2-4 m tall, with spreading or usually drooping branches, glabrous. Leaves 2-7 cm long, 1-5 cm broad, elliptic, toothed, the base rounded, the apex acute or acuminate, glabrous. Petiole short, 0.5-2 cm long, glabrous. Stipules 3 mm long, subulate. Flowers axillary, solitary, pendulous. Pedicle 8-15 cm long, articulate nearly in the middle, glabrous. Epicalyx 5-8 segments, 1-2 mm long, triangular, glabrous. Calyx tubular, 1-5 cm long, irregularly 2-5 lobed, glabrous, lobes elliptic, acute. Corolla 7-9 cm across, red with pinkish streaks. Petals 5, 4-6 cm long, 2-3 cm broad, laciniate, recurved. Staminal column 8-10 cm long, exerted, anthers near the column apex. Capsule 3-4 cm long, 1 cm across, oblong, cylindrical, apex acute, margin wingless, glabrous, 5-valves. Seeds smooth, glabrous.

Type: Kenya. Wanika hills, behind Mombasa, s.d., Kirk, s.n. (K). Lectotype.

Distribution: Native of East Tropical Africa. In Egypt, it is recorded as a cultivated ornamental shrub in many gardens.

Habitat: Cultivated.

Specimens selected: Agricultural Museum Garden, Dokki, 17.4.1987, Badia, s.n. (CAIM); Aswan Botanical Garden, 1.11.1996, Hafiz Rofaeel, s.n. (CAIM).

Economic importance: Widely spreading as cultivated ornamental shrub. It has been used as male parent in the crosses with *Hibiscus rosa-sinensis* L. and its varieties (Abedin 1979; Mabberley 1997).

Arabic name: Hibiscus Nagava.

8. *Hibiscus diversifolius* Jacq., Collectanea, 2: 307 (1788); Masters 1868, p. 198; Andrews 1952, p. 24; Badry et al. 2015.

Synonyms: *FURCARIA DIVERSIFOLIA* ULBR., VEG. ERDE 9 (III 2): 402 (1921).

*Hibiscus paludosus* Merr., Philipp. J. Sci. 3: 151 (1908).

*Hibiscus scaber* Lam., Encycl. 3: 350 (1792).

A tall perennial herb or undershrub up to 3.5 m high; branches as well as petioles and nerves of leaves armed with hard conical prickles. Leaves blade 3.5-9.5 cm, long, 0.7-10.6 cm broad, heteroblastic. Lower leaves cordate at the base, roundish, angular or 3-5 lobed, irregularly toothed; upper
leaves elliptic or lanceolate, the apex acute to obtuse. Stipules 3.5-6 mm, linear, pubescent. Petiole 0.8-10 cm long. Flowers in a terminal cluster, subsessile. Pedicel 3-15 mm long. Epicalyx 8-10 segments, subulate, often appendiculate, shorter than the densely bristly, pointed calyx-lobes, caducous, 7-12 mm long, slightly connate at the base, hispid. Calyx 16-22 mm long, 5-8.5 mm broad, covered with long stiff bristles, lobes narrowly triangular to lanceolate, apex acute. Corolla 3-4 times the length of the calyx, 2.3-4.6 cm long, 1.9-3 cm broad, shortly connate at the base, obovate, yellow with a red-purple centre, hairy on the abaxial surface. Staminal column 1.7-2.2 cm long, included, bearing filaments almost throughout its length, dark red-purple. Ovary 5-loculed. Ovules 2- more per locule. Capsule 1.7-2.3 cm long, ovoid, acuminate, pointed, margin wingless, covered with dense, long stiff appressed hairs. Seeds ovoid-reniform, about 1.4 mm, brown to black, smooth.

**Type:** Australia, 5. 1819, Cunningham, A. 38 (K).

**Distribution:** Native to tropical and subtropical Africa and naturalized with cosmopolitan distribution elsewhere in Asia, Australia, South and North America. In Egypt, it is recorded as wild species in Nile region (Qena Governorate).

**Habitat:** Nile banks and moist lands.

**Specimens selected:** (N): Ezbet Donkol, Nag Hammadi, 23.11.1993, A. Abd El-Mogali (CAIM).

**Economic importance:** The leaves and flowers are prepared as a side dish. The bark fibers are used as string to make mats (Ruffo et al. 2002).

**Arabic name:** Unknown.

9. *Hibiscus trionum* L., Sp. Pl. ed.1: 697 (1753); Masters 1868, p. 196; Andrews 1952, p. 22; Abedin 1979, p. 11; Townsend 1980, p. 265; Zohary 1987, p. 312; Boulos 2000, p. 108.

**Synonyms:** *Hibiscus ternatus* Cav., Diss. 172 (1787).

*Hibiscus africanus* Mill., Gard. Dict. ed. 8, Hib. (1768).

*Hibiscus trionum* var. *cordifolius* DC., Prodr. 1: 453 (1824).

Annual herb, 15-75 cm tall, stem erect and branched in the lower half or with decumbent branches from the base, stem and branches with vertical lines of long crisped hairs and scattered simple or stellate strigose hairs, frequently with pellucid lines or blotches. Leaves deltoid or roundish in outline, 3-7 cm long, 3-6 cm broad, 3- or imperfectly 5-palmatisect, the segments further irregularly pinnatifid with broad blunt lobes, the upper surface subglabrous, the lower with scattered strigose hairs. Petioles to 3 cm long, with a line of crisped hairs above and scattered strigose hairs. Stipules subulate, 3-4 mm long, strigose-ciliate, more or less persistent. Flowers 3-4 cm across, solitary, axillary, creamy or yellow, each petal with a dark purplish basal blotch. Peduncles 2.5-5 cm long, stellate-toomentose and with scattered strigose hairs. Epicalyx 9-12 segments, quite free, linear, strigose. Calyx membranous, about 1.2 cm long, inflated and very accrescent about 2 cm in fruit, strigose with large, usually geminate, tuberculate-based, strigose hairs along the conspicuous green to purplish veins, teeth deltoid, acute. Petals broadly rounded-ovoblate, 1.5-2.5 cm long, about twice as long as the calyx teeth. Staminal column about 4mm, included, with clavate hairs, bearing filaments almost throughout its length. Ovary 5-loculed with about 8-10-ovulate. Capsule subglobose, concealed within the bladdery calyx, apex acute, margin wingless, covered with long shining unicellular hairs and shorter white papillate hairs. Seeds triangular-reniform, 2.75 mm long, dark brown, minutely pitted, white-pustulose.

**Type:** Herb. Linn. n. 875.39 (LINN).

**Distribution:** Tropical and subtropical regions of the old world, naturalized in America and Australia. In Egypt, the species is recorded as a weed in Nile Valley, Oases and Mediterranean.

**Habitat:** Weed in summer crops, irrigation canal banks.

**Specimens selected:** (N): El-Zarabi, Abu Tig, 20.11.1993, A. Abd El-Mogali, 1561 (CAIM); El-Zagazig, Sharkiya, 11.6.2007, Mona Fikry, s.n (CAIM). (O): Baharia Oasis, 16.7.1933, M. Drar, s.n (CAIM). (M): Rosetta, Alexandria, 21.8.1937, Shabetai, 6098 (CAIM).

**Economic importance:** The leaves are used to prepare diaphoretic syrup. The seeds contain about 23-24% oil. It is also sometimes cultivated as an ornamental summer plant.

**Arabic name:** Thil Shaytani, Shebbet.

10. *Hibiscus cannabinus* L., Syst. Nat. ed. 10, 2: 1149 (1759); Masters 1868, p. 204; Bailey 1949, p. 665; Andrews 1952, p. 28; Webb 1968, p. 256; Townsend 1980, p. 267.

**Synonyms:** *Hibiscus malangensis* Baker F., J. Bot. 77: 22 (1939).

*Furcaria cannabina* Ulbr., Veg. Erde 9 (III 2): 400 (1921).

Erect annual herb, about 0.7-2 (-4) m, simple or much branched, glabrous or almost so in its vegetative parts but the stem, branches, petioles and peduncles with scattered upwardly directed curved spines. Leaves roundish- acuminate in outline, the
lowest entire or obscurely trilobed, the upper digitate to the petiole into 3-7 narrowly elliptic to linear-lanceolate segments, all sharply serrate, glabrous or sparsely strigose. Flowers solitary and axillary, sometimes pseudo-racemose. Epicalyx 7-10 segments, linear to linear-lanceolate, about 2 cm, setose-marginated and sometimes finely hairy below. Calyx accrescent about 2.5 cm in fruit, the lobes long-acuminate from a triangular base, rigid and subspinoso in the acumen, setose especially along the margins, each lobe with prominent median and lateral nerves bearing a woolly tomentum at least below, the median nerve bearing a swollen gland at about the middle. Petals 4-8 cm long, yellow, each with purplish spot at the base. Staminal column short, included, bearing filaments almost throughout its length. Capsule subglobose, apex acuminate, margin wingless, about 2 cm long, with long simple silky hairs above a shorter indumentums. Seeds about 5 mm, deltoid-reniform, minutely pitted, with scattered simple and stellate hairs.

**Type:** A specimen cultivated at Uppsala, probably of Indian origin.

**Distribution:** Native of tropical Africa and Asia. Cultivated in parts of S. E. Europe, S. W. Asia and other tropical and subtropical parts of the world. In Egypt, the species is cultivated as a fiber crop.

**Habitat:** Cultivated.

**Specimens selected:** Botanical section, Giza, 28.9.1931, Khattab, 971 (CAIM); Giza, 19.10.1954, Khattab, 915 (CAIM); Botanical section, Giza, 24.9.1962, Khattab, s.n. (CAIM).

**Economic importance:** It is cultivated for its fiber which suitable for making string, binder twine, fishing net wrapping cloth. The leaves are edible and sometimes used as spinach. The leaves are eaten in salads, the fleshy calyx and capsules made into jam or other forms of preserve. The fibers of the stems are fairly tough and used for cord, binder twine, sackcloth. The medicinal value of the plant is recognized as diuretic, antiscorbutic and as a remedy for gastric complaints and hypertension (AboZid and Mohamed, 2011), the flowers, fruits and seeds all being used for this purpose.

**Arabic name:** Tīl, Teel.

11. *Hibiscus sabdariffa* L., Sp. Pl. ed.1: 695 (1753); Masters 1868, p. 204; Bailey 1949, p. 664; Andrews 1952, p. 28; Abedin 1979, p. 9; Townsend 1980, p. 268; Boulos 2000, p. 108.

**Synonyms:** *Abelmoschus cruentus* (Bertol.) Walp., Repert. Bot. Syst. 1: 310 (1842).

*Furcaria sabdariffa* Ulbr., Veg. Erde 9 (III 2): 402 (1921).

*Hibiscus cruentus* Bertol., Fl. Guatimal. 28 (1840).

Annual or short-lived perennial herb, erect, about 0.7-2 m tall. Stems simple or much branched, reddish, glabrous to stellate-hairy. Leaves roundish to elliptic in outline, the uppermost digitate, 3-7 lobed or reduced to a single lobe, lobes elliptic to elliptic-lanceolate, more or less regularly crenate-serrate, acute, glabrous or almost so. Petiole to 20 cm long. Stipules 6-8 mm long, subulate. Flowers 3-4 cm across, solitary, axillary, sometimes pseudo-racemose by suppression of the upper leaves. Epicalyx 8-10 segments, lanceolate-acuminate to oblong, about 1.5 cm long, setose, crimson-red. Calyx 1.5-2 cm long, 0.5 cm broad, accrescent in fruit, the lobes lanceolate-acuminate, becoming enlarged and fleshy in fruit, crimson-red, each with prominent median and lateral nerves, the former with a stoma-shaped gland at about the middle. Petals 3.5-4.5 cm long, yellow with a deep purplish spot at the base. Staminal column short, included, bearing filaments almost throughout its length. Capsule ovoid, apex acuminate, margin wingless, about 2-2.5 cm, glabrous or pressed pubescent, 5-valves. Seeds many, 4 mm, reniform, minutely pitted, with lines and tufts of stellate hairs.

**Type:** From Ceylon.

**Distribution:** Native of tropical and subtropical regions of the world. The species is widely cultivated in southern Egypt and the Oases, and escape from cultivation.

**Habitat:** cultivated and escaped in irrigated alluvial soil.

**Specimens selected:** Kharga Oasis, 20.11.1965, Khattab, 914 (CAIM); El-Zarabi, Abu Tig (N), 26.11.1933, A. Abd El-Mogali, 1570 (CAIM); Aswan Botanic Garden, 27.10.1995, Haliez Rofaeel, 29096 (CAIM).

**Economic importance:** The leaves are eaten in salads, the fleshy calyx and capsules made into jam and are used in the preparation of a refreshing drink or other forms of preserve. The fibers of the stems are fairly tough and used for cord, binder twine, sackcloth. The medicinal value of the plant is recognized as diuretic, antiscorbutic and as a remedy for gastric complaints and hypertension (AboZid and Mohamed, 2011), the flowers, fruits and seeds all being used for this purpose.

**Arabic name:** Karkadeh.

### 3.2. Numerical analysis

The UPGMA dendrogram of the genus *Hibiscus* (Figure 2) clearly discriminated 11 species producing two main clusters at the level 25 of average taxonomic distance. The first cluster (I) comprises 3 species viz. *H. micranthus, H. vitifolius* and *H. trionum*. The second cluster (II) comprises 8 species which divided into two groups (Iia & Iib) at the distance level 16. The first group (Iia) comprises 3 species viz. *H. syriacus, H. diversifolius* and *H. tilaceus*. The second group (Iib) comprises 5 species viz. *H. cannabinus, H. mutabilis, H. rosasinensis, H. sabdariffa* and *H. schizopetalus*.
**Figure 2.** The UPGMA dendrogram showing the relationships between studied species of *Hibiscus* in Egypt.

**Table 3.** Morphological variations among 11 studied species based on absolute similarity matrix

| Species             | Absolute Correlation between Vectors of Values |
|---------------------|-----------------------------------------------|
|                     | *H. tiliaceus* | *H. micranthus* | *H. mutabilis* | *H. vitifolius* | *H. syriacus* | *H. rosa-sinensis* | *H. schizopetalus* | *H. diversifolius* | *H. trionum* | *H. cannabinus* | *H. sabdariffa* |
| *H. tiliaceus*      | 1.000          |                  |                |                |              |                  |                  |                  |               |                |              |
| *H. micranthus*     | 0.027          | 1.000            |                |                |              |                  |                  |                  |               |                |              |
| *H. mutabilis*      | 0.397          | 0.390            | 1.000          |                |              |                  |                  |                  |               |                |              |
| *H. vitifolius*     | 0.222          | 0.398            | 0.231          | 1.000          |              |                  |                  |                  |               |                |              |
| *H. syriacus*       | 0.289          | 0.163            | 0.144          | 0.070          | 1.000        |                  |                  |                  |               |                |              |
| *H. rosa-sinensis*  | 0.286          | 0.086            | 0.664          | 0.164          | 0.058        | 1.000          |                  |                  |               |                |              |
| *H. schizopetalus*  | 0.368          | 0.071            | 0.624          | 0.090          | 0.038        | 0.835          | 1.000            |                  |               |                |              |
| *H. diversifolius*  | 0.424          | 0.185            | 0.195          | 0.232          | 0.508        | 0.116          | 0.193            | 1.000            |               |                |              |
| *H. trionum*        | 0.075          | 0.278            | 0.381          | 0.381          | 0.115        | 0.028          | 0.141            | 0.154            | 1.000        |                |              |
| *H. cannabinus*     | 0.118          | 0.025            | 0.242          | 0.171          | 0.096        | 0.493          | 0.369            | 0.390            | 0.086        | 1.000          |              |
| *H. sabdariffa*     | 0.431          | 0.200            | 0.342          | 0.147          | 0.437        | 0.519          | 0.442            | 0.513            | 0.167        | 0.572          | 1.000        |
4. DISCUSSION

4.1. Taxonomic treatments

Egypt is predominantly arid desert, with little effective rainfall, at most 200 mm y\(^{-1}\) and unequally distributed and on limited areas. Nile River is the main source for cultivation. Aridity and water shortage are the main constraint and major limiting factors facing growing and spreading the desert flora in Egypt. \(H.\) \textit{micranthus} and \(H.\) \textit{vitifolius} grow on desertic habitat (rocky hillsides and stony wadis), while other wild species grow in mesic habitat (moist lands and canal banks). \(H.\) \textit{vitifolius} and \(H.\) \textit{diversifolius} are mono-regional species which grow in GE and N phytogeographical region respectively. While other wild species found in more than one phytogeographical region. The cultivated species widely spreading in Egypt as ornamental plants specially \(H.\) \textit{rosa-sinensis} and its cultivars. They grow in well drained clay, silt, yellow soil and also in reclaimed soil. Anthropogenic activities have influenced the natural flora and vegetation of Egypt from several decades, weather impacted on the natural vegetation or the cultivated species escaped and naturalized. \(H.\) \textit{cannabis} and \(H.\) \textit{sabdari} are cultivated in Egypt for its fiber and fleshy calyx respectively, also they are considered as escaped from cultivation.

4.2. Numerical analysis

The dendrogram of the genus \textit{Hibiscus} (Fig. 2) clearly discriminated 11 species producing two main clusters at the level 25 of average taxonomic distance. Cluster (I) comprises 3 species viz. \(H.\) \textit{micranthus}, \(H.\) \textit{vitifolius} and \(H.\) \textit{trionum} was separating by owning different characters: stem and petioles covered with stellate, villose, strigose hairs respectively; adaxial and abaxial leaf surface strigose, pubescent, and hairy. \(H.\) \textit{micranthus} splitting from others by having leaves 1- 3.5 cm long; epicalyx filiform; calyx less than 3-4 mm long; corolla less than 3 cm diameter; petals 5-6 mm long; seeds covered by long cottony hairs. The second cluster (II) divided into two groups. The first group (IIa) comprises 3 species viz. \(H.\) \textit{syriacus}, \(H.\) \textit{diversifolius} and \(H.\) \textit{tiliae}us which splitting from other species in cluster II by stipules shape, epicalyx segments shape and texture, and fruit texture. But \(H.\) \textit{tiliae}us separating at level distance 12 by its specialist characters: tree; stipules foliaceous, oblong ovate, 11–30 mm long; leaves margin entire; Capsule densely stellate hairy, 10 locules.

The second group (IIb) comprises 5 species \(H.\) \textit{cannabis}, \(H.\) \textit{mutabilis}, \(H.\) \textit{rosa-sinensis}, \(H.\) \textit{sabdari} and \(H.\) \textit{schizopetalus}. Absolute similarity values of all 11 species ranged from 0.02 to 0.83 (Table 3). \textit{Hibiscus schizopetalus} was found to be closely related to \textit{Hibiscus rosa-sinensis} in dendrogram tree, which showed the maximum similarity value (0.83). \(H.\) \textit{sabdari} and \(H.\) \textit{cannabis} showed similarity value (0.57), therefore, it was found to be closely related in dendrogram tree, which further supports the monograph of Hochreutiner (1900) and Wilson (1994). Fei et al (2002) based on chloroplast DNA sequences, sections Furcaria, Azanza, Liliscus are monophyletic groups while others are not. That is agree with our species in cluster II except of \(H.\) \textit{syriacus} (sect. Bombycella) and \(H.\) \textit{mutabilis} (sect. Trionum). The minimum similarity value (0.02) was observed between \(H.\) \textit{cannabis} and \(H.\) \textit{micranthus}, \(H.\) \textit{tiliae}us and \(H.\) \textit{micranthus}, and \(H.\) \textit{rosa-sinensis} and \(H.\) \textit{trionum}.

Conclusion: Morphological characters and identification keys as classical taxonomy are still important, in addition numerical analysis required to clarify the taxonomic relationships between studied species.

5. REFERENCES

Abdel Khalik K.N. 2012. A numerical taxonomic study of the family Zygophyllaceae from Egypt. Acta Bot. Bras. 26(1), 165-180.

Abedin S. 1979. Malvaceae. In: Nasir, E, Ali S.I. (eds.), Flora of West Pakistan, No 130, Dept. Bot. Univ. Karachi, pp. 1-107.

AboZid S.F. 1994. \\textit{Hibiscus} \textit{cannabinus} and \textit{H.} \textit{micranthus} in cultivated and escaped. The Stand (126), 37-47.

Andrews F.W. 1952. The Flowering Plants of the Anglo-Egyptian Sudan, Vol. 2, T. Buncle and Co., Arbroath, Scotland, pp. 20-32.

Ascherson P. 1887. Illustration de la Flore d’Egypte. Mem. Inst., Egypt.

Badry M.O., Tate J.A., Sheded M.G., El-Naggar S.M. and Hamed S.T. 2015. Macro- and Micro-Morphological Characters of \textit{Hibiscus diversifolius} Jacq. subsp. \textit{diversifolius} (Malvaceae): A New Record for the Flora of Egypt. \\textit{Feddes Repertorium}, (126), 37-47.

Bailey L.H. 1947. The Standard Cyclopedia of Horticulture, the Macmillan Company, New York, USA pp. 1483-1488.
Taxonomic Revision and Numerical Analysis of *Hibiscus* L. in Egypt

**Bailey L.H.** 1949. Manual of Cultivated Plants, the Macmillan Company, New York, USA, pp. 663-666.

**Boissier E.** 1867. *Flora Orientalis*, Genève, Bâle, Lyon, Vol. 1, 839-840.

**Boulos L.** 2000. *Flora of Egypt* (Geraniaceae-Bo- raboraginaceae), Al-Hadara Publishing, Cairo, Egypt, vol. II, 107-109.

**Boulos L.** 2009. *Flora of Egypt*, Check List, Al-Hadara Publishing, Cairo, Egypt, 7 p.

**Cullen J.** 1967. *Malvaceae*, In: Davis, P.H., Cullen, J., Coode, M.J.E. (eds.), *Flora of Turkey and the East Aegean Islands*, Univ., Press. Edinburgh, Vol. 2, 402.

**Delile A.F.** 1813. Explication des planches in description de la' Egypte, Paris, Vol. 4.

**El-Hadidi M.N.** and **Fayed A.A.** 1994/95. Materials for Excursion Flora of Egypt (EFE). *Taechholmia*. 15, 1-233.

**El-Hadidi M.N.**, **Hosni H.A.**, **El-Hadidy A.M.H.** and **Arafha S.** 1999. *Malvaceae* in the Flora of Egypt. 1. Systematic Revision of the Indigenous Taxa. *Taechholmia*. 19(2), 127-146.

**El-Naggar S.M.** 2004. Pollen Morphology of Egyptian Malvaceae: An Assessment of Taxonomic Value. *Turk. J. Bot.* 28, 227-240.

**El-Naggar S.M.** and **Sawady N.** 2008. Pollen Morphology of Malvaceae and its Taxonomic Significance in Yemen. *Flora Mediterranea*. 18, 431-439.

**Eman M.S.** and **Khattab A.A.** 2016. Phenetic relationship between Malvaceae S.S. and its related families. *Taechholmia*. 36, 115-135.

**Fayed A.A.**, **El-Hadidy A.M.H.** and **Olwey A.O.** 2019. Taxonomic implications of multivariate analyses of Egyptian *Ononis L.* (Fabaceae) based on morphological traits. *Korean J. Pl. Taxon.* 49(1), 13-27.

**Forskål A.** 1775. *Flora Aegyptiaco-Arabica*, Kopenhagen.

**Fryxell P.A.** 1980. *A Revision of the American Species of Hibiscus Section Bombicella*. *Techn. Bull. U.S. Dep. Agric.* 1624, 1-53.

**Fryxell P.A.** 1997. The American Genera of Malvaceae- II. *Brittonia*. 49 (2), 204-269.

**Heenan P.B.** 2017. A taxonomic revision of *Cardamine L.* (Brassicaceae) in New Zealand. *Phyto-taxa.* 330(1), 1-154.

**Hochreutiner B.P.G.** 1900. *Revision du genre Hibiscus*. Annuaire Conservatoire du Jardin Botanique, Genève, 4, 23-191.

**Hosni A.H.** and **Arafha S.** 1999. *Malvaceae* in the Flora of Egypt. 2. Pollen Morphology and its Taxonomic Significance. *Taechholmia*. 19(2), 147-156.

**Hutchinson J.** 1967. *The Genera of Flowering Plants (Angiospermae)*, Dicotyledones the Clarendon Press, Oxford, *Vol. 2*, 544.

**Hutchinson J.** and **Dalziel J.M.** 1958. *Flora of West Tropical Africa*, Crown Agents for Overseas Governments and Administrations. Milbank, London, *Vol. 1* , part 2, 343-348.

**Kahraman A., Celep F., Dogan M.** and **Bagherpour S.** 2010. *A taxonomic revision of Salvia euphratica sensu lato and its closely related species (sect. Hymenosphace, Lamiaceae)* using multivariate analysis. *Turk. J. Bot.* 34, 261-276.

**Ling K.H., Kian C.T.** and **Hoon T.C.** 2009. A Guide to Medicinal Plants, World Scientific Publishing Co. Pte. Ltd., Singapore, 67-72.

**Linnaeus C.** 1753. *Species Plantarum*, Holmiae.

**Mabberley D.J.** 1997. *The Plant-Book*. 2nd ed., Cambridge Univ., Press, Cambridge.

**Masters M.T.** 1868. *Malvaceae*, In: *Oliver, D.* (ed.), *Flora of Tropical Africa*, L. Reeve and Co., Ltd., Ashford, Kent, *Vol. 1*, 193-208.

**Montasir A.H.** and **Hassib M.** 1956. Illustrated Manual Flora of Egypt, Imprimerie Misr, S.A.E., Egypt, 1st ed., *part 1*, 301-303.

**Muschler R.** 1912. A Manual Flora of Egypt, R. Frielander & Sohn, Berlin, *Vol. 1*, 633-636.

**Pfeil B.E., Brubaker C.L., Craven L.A.** and **Crisp M.D.** 2002. *Phylogeny of Hibiscus and the Tribe Hibisceae (Malvaceae) Using Chloroplast DNA Sequences of ndhF and the rpl16 Intron*. *Systematic Botany*. 27(2), 333-350.

**Ruffo C.K., Birnie A.** and **Tengnäs B.** 2002. Edible wild plants of Tanzania. Nairobi, Kenya: Regional Land Management Unit (RELMA), Swedish International Development Cooperation Agency (Sida), *Technical Handbook Series* 27, 364 p.

**Täckholm V.** 1956. Student’s Flora of Egypt, Anglo-Egyptian bookshop, Cairo, Egypt, 1st ed. *251-232.*

**Täckholm V.** 1974. Student’s Flora of Egypt, Cairo Univ., Cairo, Egypt, 2nd ed., *355-356.*

**Townsend C.C.** 1980. *Malvaceae*, In: *Townsend C.C.* and *Guset E.* (eds.), *Flora of Iraq*, Ministry of Agriculture and Agrarian Reform Republic of Iraq, *Baghdad*. *Vol. 4*, Part 1, 251-270.

**Webb D.A.** 1968. *Malvaceae*, In: *Tutin, T. G.* et al (eds.), *Flora Europaea*, Cambridge Univ. Press, Cambridge, *Vol. 2*, 255-256.

**Wilson F.D.** 1994. *The Genome Biogeography of Hibiscus L. Section Furcaria DC*. *Genetic Research and Crop Evolution* 41, 13-25.

**Wilson F.D.** 1999. *Revision of Hibiscus Section Furcaria (Malvaceae) in Africa and Asia*. *Bull. Nat. Hist. Mus. Lond. (Bot).* 29 (1), 47-79.

**Zohary M.** 1987. Flora Palaestina. *The Israel Academy of Sciences and Humanities, Jerusalem*, *Part II*, 312.

AUJASCI, Arab Univ. J. Agric. Sci., 28(1), 2020
تحكيم: أ.د. منير عبد الغني  
أ.د. إيمان شمسو  
أ.د. جيلان الشاذلي

مراجعة تصنيفية وتحليل عددى لجنس الهبسكس في مصر

أ.د. سيد عبد عيسى 1 - عبد الحليم عبد المجلى محمد 1
أ.د. إبراهيم الشامي 2

1- قسم بحوث الفلورة وتصنيف النباتات - معهد بحوث النباتات - مركز البحوث الزراعية - الجيزة - مصر
2- قسم النباتات الزراعية - كلية الزراعة - جامعة عين شمس - ص.ب 68 - حي دارا 11241 - القاهرة - مصر
*Corresponding author: amanymostafa_2020@yahoo.com

Received 17 December, 2019          Accepted 19 February, 2020

تم في هذه الدراسة حصر ومراجعة تصنيفية وتحليل عددى لجنس الهبسكس في مصر، سواء في ذلك الأنواع البرية أو المزروعة. أعدت الدراسة على جمع العينات النباتية الحية لبعض الأنواع التي شملتها الدراسة إلى جانب فحص العينات المعشبية المحفوزة بالعينات الرئيسية في مصر. تم تسجيل أحد عشر نوع من الهبسكس، منها خمسة أنواع برية: Hibiscus micranthus L., H. vitifolius L., H. trionum L., H. cannabinus L., H. mutabilis L. وستة أنواع مزروعة: H. syriacus L., H. rosa-sinensis L., H. schizopetalus (Dyer) Hook. f., H. tiliaceus L., H. sabdariffa L., H. rosa-sinensis L.

الكلمات المفتاحية: مصر، فلورة، هبسكس، الخبازية، التصنيف

تحكيم: أ.د. منير عبد الغني  
أ.د. إيمان شمسو  
أ.د. جيلان الشاذلي