Comparative botanical studies on four genera of family Convolvulaceae

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ABSTRACT

This study was conducted on 10 species representing 4 genera belonging to Convolvulaceae. These species were *Ipomoea batatas, I. cairica, I. carnea, I. pes-caprea, I. tricolor*, *Convolvulus arvensis, C. scammonia*, *Cuscuta chinensis, C. pedicellata* and *Cressa cretica*. The study was done on the morphological and anatomical characters of stems, leaves and flowers. The results were recorded in the form of a comparison among the examined taxa. All the examined species were chlorophyllous except only two taxa *Cuscuta chinensis* and *Cuscuta pedicellata* that were parasite. *Cressa cretica* is perennial, however *Cuscuta chinensis* and *Cuscuta pedicellata* were annual. The herb species were *Convolvulus arvensis, C. scammonia*, *Cuscuta chinensis, C. pedicellata* and *Cressa cretica*. The shrub species was *Ipomoea carnea*. All the investigated species have weak stems in various forms; either twining as *Convolvulus arvensis* or prostrate stem as *Ipomoea pes-caprea*, while *Ipomoea carnea* and *Cressa cretica* have erect stems. The leaves of the majority of taxa were simple as in *Ipomoea cairica* except *Cuscuta chinensis* and *Cuscuta pedicellata* were leafless. The leaves were unlobed as in *Convolvulus arvensis, C. scammonia, Cressa cretica, Ipomoea carnea* and *Ipomoea pes-caprea.* The lobed leaves were found in *Ipomoea cairica, I. batatas* and *I. tricolor*. The leaves were hastate in *Convolvulus arvensis*, cordate in *Ipomoea carnea*, palmately-lobed in *Ipomoea cairica* and orbicular in *Ipomoea pes-caprea*. The flowers present in an inflorescence in most taxa such as *Ipomoea tricolor* or in solitary status as in *Convolvulus arvensis*. The anatomical study shows that the stem center in the cross section was solid in all taxa, except *Ipomoea carnea that* was hollow. The leaves mesophyll consists of palisade and spongy tissue in most of the plants or palisade tissue only as in *Convolvulus scammonia* and *Ipomoea carnea*.

Key words: botany, morphology, anatomy, Convolvulaceae.

INTRODUCTION

Convolvulaceae contains around 55 genera and 1650 species (Lawrence, 1951). It is represented in Egypt by 9 genera (excluding *Cuscuta*) with forty-one species (Boulos, 2000). The most important food plants in this family are *Ipomoea batatas* (Sweet potato) Certain other species are source of drugs and some (*e.g., I. tricolor*) are climbers of horticultural merit (Hickey and King, 1988). Convolvulaceae, th perennial or annual herbs and shrubs, that are often with milky sap, represented in parasitic species, are mostly twining or climbing stems that rarely erect *e.g., Ipomoea carnea* (Wiley and Sons, 2013). Morphological features of stems and leaves were recorded by Täckholm (1974) and Mukherjee *et al.* (2019). Convolvulaceae flowers solitary axillary or in an inflorescence (Boulos, 2000). Corolla 5 united petals, funnel form, campanulate, salverform, or urceolate (John *et al.,* 2015). Androecium 5 free epipetalous stamens, equal or unequal in length (Mukherjee *et al.,* 2019). Pollen grains of Convolvulaceae tricolpate or polyporate (Abd El-Raouf *et al.,* 2020). Gynoecium consistes of two united carpels; the ovary of 2-locular with one or two ovules in each locule (Sunita *et al.,* 2011). Styles united or free, stigmas capitate or linear (Sahu and Gupta, 2014). Convolvulaceous plants had paracytic, anisocytic, tetracytic and abnormal stomata patterns (Tayade and Patil, 2011), Sabbour *et al.,* (2018) and Ashfaq *et al.* (2019)). Hairs unicellular, multicellular and glandular types (Kuster *et al.,* (2016) and Ashfaq *et al.,* (2019)). The stem cortex consists of parenchyma, collenchyma and surrounded by sclerenchyma cells with some crystals and resin ducts. on the other side, pith contains parenchyma cells only (Madani and Majbour, (2017) and Eid *et al.,* (2017)). Mesophyll of some Convolvulaceae species consists of spongy and palisade tissues, while in others it contains palisade tissue only. Vascular bundle bicollateral or collateral with parenchymatous sheath (Mukherjee *et al.,* 2019).

The present investigation aims to throw light upon the variation of the morphological and anatomical characters of stems, leaves, flowers and fruits of 10 species representing 4 genera of Convolvulaceae and to explain the taxonomic relationship between them.

MATERIALS AND METHODS

Trail Sites

This work was carried out in the Department of Agricultural Botany, Faculty

of Agriculture, Al-Azhar University, Nasr City, Cairo, Egypt. The plant samples were obtained from five different governorates; Alexandria, Cairo, Matrouh, Al Sharkia and Al Buhayrah (Table 1). Identification of the collected plants was achieved by comparing their morphological characters as those in different publishes (Bailey, (1951), Täckholm, (1974) and Boulos, (2000)).

Preparing samples for anatomical study

Specimens from tested plants were fixed in (F.A.A.) for at least 48 h then samples were taken from the plants to study the different aspects as follows:

Patterns of stomata and trichomes: Epidermal peels of foliage leaves, and petals are cleared in warm Lactic acid over slides for microscopic examination.

Shape of epidermal cells, and

Epidermal cell walls.

TO pripre sections stems (1 cm in length) and leaf lamina (1 cm^2) were washed and dehydrated in series solutions of ascending concentrations of ethyl alcohol varying from 50% to 100 %. The samples are embedded in paraffin wax (m.p 58-60), using xylol as solvent (Johansen, 1940). Using rotary microtome, sections were cut at the thickness of 15 microns and then mounted on slides with the aid of egg-albumin as an adhesive (Sass, 1958). Wax is dissolved in Xylol and the slides are passed through a series of ethyl alcohol solutions varying from 100% to 50 % in descending order. The sections on the slides are stained in safranin and Light green. Then the colored sections were kept as permanent preparations on the slides with Canada balsam as mounting medium. Sections in such cases are microscopically examined for making microphotographs which can be explored for the different tissues.

The flowers are dissected into their different parts under stereomicroscope, then spread and cleared by warming in Lactic acid over slides for microscopic examination. Pollen grains preparations were made according to the method of Franks and Watson (1963). All photomicrographs were prepared by Pentacon camera on Olympus microscope B H 2 and Stereomicroscope Carl zeiss Jena (Citoval 2).

Statistical analysis

The analysis was done by Multi Variate Statistical Package (MVSP) program (Sneath and Sokal (1973).

Results and Discussion

Morphological characters:

Macromorphological characters:

Habit: All the examined species were chlorophyllous as *Ipomoea cairica* (Fig.1a), except only two taxa *Cuscuta chinensis* and *Cuscuta pedicellata* (Fig.1b), they were parasite. The majority of the species were perennial as *Cressa cretica* (Fig.1c); however a few plants were annual as *Cuscuta chinensis* (Fig.1b). The species were shrubs as *Ipomoea carnea* (Fig.1d), and herbs such as *Cressa cretica* (Fig.1c). Latex yield was present in *Ipomoea carnea* (Fig.1e). These results were in agreement with those obtained by Hickey and King (1981) and Boulos (2000). They recorded that the species of Convolvulaceae were herbs or shrubs, annual or perennial, chlorophyllous or parasite and milky latex present.

Stems: The stems were herbaceous in most of the examined species as *Cressa cretica, Cuscuta pedicellata, C. chinensis, Convolvulus scammonia* and *C.arvensis* (Fig.1f), and some taxa have woody stems as in *Ipomoea carnea* (Fig.1d). All the investigated species have weak stems in various forms; twining as in *Convolvulus arvensis* (Fig.1f), prostrate as in *Ipomoea pes-caprea* (Fig.1g), and erect in two species only; *Cressa cretica* and *Ipomoea carnea* (Fig.1d). The stem surface was glabrous in most of the examined taxa as in *Ipomoea carnea* (Fig.1d), hairy in some taxa as in *Cressa cretica* (Fig.1h), and glabrous only in *Ipomoea cairica* (Fig.1i). Such results were strengthened by the findings of Bailey (1951) and John *et al.,* (2015). They reported that the plants of Convolvulaceae were herbaceous or woody, weak stems or erect, glabrous or hairy.

Leaves: All the investigated species have leafy plant as *Ipomoea cairica* (Fig.1a) except in *Cuscuta chinensis* and *Cuscuta pedicellata* were leafless (Fig.1b). The Leaves of the leafy plants were usually petiolated as in *Ipomoea cairica* (Fig.1i), except in *Cressa cretica* were sessile (Fig.1h). The leaves were glabrous in most of the leafy taxa as in *Ipomoea pes-caprea* (Fig.1j) and hairy in some taxa as in *Cressa cretica* (Fig.1h). The leaf venation was pinnate in most the taxa *e.g. Ipomoea pes-caprea* (Fig.1j), while palmate in some others as in *Ipomoea cairica* (Fig.1k). The leaves in many shapes: cordate in the most of taxa as *Ipomoea carnea* (Fig.1l), palmately-lobed in *Ipomoea cairica* (Fig.1k), hastate in *Convolvulus arvensis* (Fig.1m), ovate in *Cressa cretica* (Fig.1h) and orbicular in *Ipomoea pes-caprea* (Fig.1j). The lamina apex was acute in most taxa as in *Convolvulus arvensis*

(Fig.1m), caudate in *Ipomoea carnea* (Fig.1l) and emarginate in *Ipomoea pes-caprea* (Fig.1j). Cheng and Staples (1995), Boulos (2000) and Mukherjee *et al.,* (2019) confirmed these results, where they stated that the leaves of Convolvulaceae plants were simple, glabrous or hairy, unlobed or lobed, with pinnate or palmate venation.

Flowers: The flowers were present in inflorescence form in most of taxa as in *Ipomoea tricolor* (Fig.2a) or solitary as in *Convolvulus arvensis* (Fig.2b). The inflorescence was either cymes as in *Ipomoea tricolor* (Fig.2a) or raceme as in *Cressa cretica* (Fig.2c). Such results were reported by Cheng and Staples (1995) and Boulos (2000) who stated that the flowers of Convolvulaceae were aggregated in an inflorescences or solitary status.

Calyx: Sepals were equal in size as in *Ipomoea cairica* (Fig.2d) or unequal as in *Ipomoea pes-caprea* (Fig.2e). Aposepalous as in *Ipomoea batatas* (Fig.2f) and gamosepalous as in *Cuscuta pedicellata* (Fig.2g). Similar results were reported by Hickey and King (1988).

Corolla: The corolla consists of 5 united petals in all the examined samples. Corolla was funnel- form as in *Ipomoea batatas* (Fig.2h), campanulate as in *Cressa cretica* (Fig.2i), tubular-shape in *Cuscuta chinensis* (Fig.2j) and salver-form as in *Ipomoea cairica* (Fig.2k). Corolla was completely fusion in *Ipomoea batatas* (Fig.2h), deeply lobed such as *Cressa cretica* (Fig.2i) and shallow lobed in *Ipomoea carnea* (Fig.2l). Corolla white in color as in *Convolvulus arvensis* (Fig.2m), pink in *Ipomoea carnea* (Fig.2l) and violet in *Ipomoea cairica* (Fig.2k). These results were in agreement with Cheng and Staples (1995), who reported that the corolla of Convolvulaceae plants were sympetalous, funnel-form, campanulate, salver-form, or urceolate, limb subentire or deeply lobed. Cheng and Staples (1995) reported that the corolla of *Ipomoea batatas* was 5 petals and funnel shape.

Androecium: The androecium consists of 5 epitepalous stamens in all the examined samples. The filaments were equal in length in most taxa as in *Convolvulus arvensis* (Fig.2m) and unequal in length in *Ipomoea carnea* (Fig.2-n). The filament base was hairy in most taxa such as *Ipomoea carnea* (Fig.2o) or glabrous in *Cuscuta chinensis* (Fig.2-p). Filaments were base fixed with anther in most taxa as *Ipomoea carnea* (Fig.3a) and dorsa fixed in few taxa such as *Convolvulus arvensis* (Fig.3b). The anther shape was oblong in most taxa such as *Ipomoea tricolor* (Fig.3c), sagittate in some taxa as *Ipomoea cairica* (Fig.3d), globose in *Cuscuta pedicellata* (Fig.3e) and ovate in *Cuscuta chinensis* (Fig.2p). These results were in agreement with Govil and Lavanla (1980), who recorded that the androecium of Convolvulaceae plants consists of four or five epipetalous stamens inserted in the corolla tube. Boulos (2000) reported that the stamens of *Ipomoea* were unequal, inserted above the corolla base; filaments 6-10 mm long with trichomes on base, while Mukherjee *et al.,* (2019), stated that the androecium of *Ipomoea carnea* was 5 free epipetalous stamens which are unequal in length; hairy at the basal part of the filament Filament measures 1.6-2.1 cm long. Filament attachment to the base of anther.

Pollen grains: Pollen grains were usually monads in all investigated taxa. The pollen grains were polyporate as *Ipomoea batatas* (Fig. 4a) and tricolpate as *Convolvulus arvensis* (Fig. 4b). The exine sculpture was spinulose in most taxa as in *Ipomoea batatas* (Fig.4a) and smooth as in *Convolvulus arvensis* (Fig.4b). Similar results were reported by Abd El-Raouf *et al.,* (2020) who reported that the pollen grains of Convolvulaceae were smooth or spinulose, while John *et al.,* (2015) mentioned that the pollen grains of *Convolvulus arvensis* and *Convolvulus scammonia* were tricolpate, more or less spherical.

Gynoecium: The gynoecium consists of 2 united carpels in all examined samples. Two locular in most of the examined taxa as in *Cuscuta chinensis* (Fig.4c), four locular as in *Ipomoea carnea* (Fig.4d), four ovules in the ovary in most of the examined taxa as in *Cuscuta chinensis* (Fig.4c), eight as in *Ipomoea carnea* (Fig.4d), ovary smooth as in *Convolvulus arvensis* (Fig.4e) and hairy only in *Cressa cretica* (Fig.4f). The styles were united in all the examined plants as in *Ipomoea cairica* (Fig.4g) and free only in *Cuscuta species* (Fig.4h). Style was fully united in most of examined plants as in *Convolvulus arvensis* (Fig.4e) and partialiy united only in *Cressa cretica* (Fig. 4f). The stigmas were united in many examined taxa as in *Ipomoea cairica* (Fig.4g) and free in the ether taxa as in *Convolvulus arvensis* (Fig.4e). The stigma shape was capitate as in *Cressa cretica* (Fig. 4f), linear as in *Convolvulus arvensis* (Fig.4e) and filiform only in *Cuscuta pedicellata* (Fig.4i). The nectariferous have many shapes, annular as in *Ipomoea carnea* (Fig.4j), plate shaped as in *Ipomoea tricolor* (Fig.4k) and lobular as in *Convolvulus arvensis* (Fig.4e). These results were in agreement with results obtained by Hickey and King (1988) and

Simpson (2010), who reported that the ovary was 2-1oculed, glabrous, the stigma capitate - bilobed, Mukherjee *et al.,* (2019), who stated that the gynoecium consists of two carpels, and two locules that contain one or two ovules, stigma is divided into two lobes. Malik and Trapathi (2017) recorded that the nectaries of Convolvulaceae flowers were present, consisting of an annular disk around base of ovary.

Fruit and seed: The fruits were ovate, capsule and the cotyledonary embryo in all of the examined taxa except acotyledons embryo only in *Cuscuta species* (Table3). The seed was curly as in *Convolvulus arvensis* (Fig.4l), and hairy as in *Ipomoea carnea* (Fig.4m). Seed color was black as in *Convolvulus arvensis* (Fig.4l), brown as in *Cressa cretica* (Fig.4n) and gray as in *Ipomoea cairica* (Fig.4o). These results were in agreement with the results obtained by Yadav *et al.,* (2018). They reported that seeds of *Ipomoea* were ovoid, black to brown, glabrous. John *et al.,* (2015*)* stated that seeds of *Convolvulus arvensis* were dark brown to black, wedge-shaped, obovate to broadly obovate, glabrous. On the other hand, Malik and Trapathi (2017) reported that seeds of Convolvulaceae varied from oblong or ovoid to oblong-ovoid or pear-shaped to pyramidal and surface varies from glabrous to hairy.

Micromorphological characters:

Epidermal cell wall:

Leaf: The leaf cell walls in the upper and lower epidermis surfaces were undulate as in *Convolvulus arvensis* (Fig.5a) or straight as in *Ipomoea carnea* (Fig.5b). There was ornamentation on the cell walls in few examined taxa as in *Ipomoea batatas* (Fig.5c). The epidermal cells shape of the upper and lower surfaces was irregular in most plants as in *Convolvulus arvensis* (Fig.5a), sometimes polygonal as in *Ipomoea carnea* (Fig.5b). The epidermal cell walls of the corolla were thin in most plants as *Cressa cretica* and thick in few as in *Ipomoea tricolor*. The epidermal cells walls were undulate as in *Convolvulus arvensis*, straight as in *Cuscuta chinensis* (Table 3) and sinuous as in *Ipomoea cairica* (Fig.5d). Kuster *et al.,* (2016) and Ashfaq *et al.,* (2019) reported that the epidermal cell walls of Convolvulaceae were undulate or straight.

Hairs: Several forms of hairs were observed on the surface leaves and floral parts of the examined plants as follows:

Unicellular unbranched hairs on the leaves of few examined taxa as in *Ipomoea tricolor* (Fig. 6a) or on the floral parts as in *Cressa cretica*.

Unicellular branched hairs on the stem of *Cressa cretica* (Fig. 6b).

Multicellular unbranched hairs on the leaves of *Cressa cretica* (Fig. 6c).

Multiseriate glandular hair on the floral parts of some taxa as in *Ipomoea carnea* (Fig. 6d).

Sessile glandular hairs on the leaves of few taxa as in *Ipomoea pes-caprea* (Fig. 6e) and on the stem only of *Ipomoea batatas*.

Stellate hairs on the stem of *Ipomoea batatas* (Fig. 6f).

Ciliated hairs on the floral parts only of *Cuscuta chinensis* (Fig. 6g). These results were confirmed by the findings of Metcalfe and Chalk (1950), Kuster *et al.,* (2016) and Ashfaq *et al.,* (2019).

Stomata: Many types of stomata are observed on the surface of stem, leaf, and floral parts as follows:

Paracytic stomata were present on the leaves of *Ipomoea cairica* (Fig. 7a) and on floral parts of *Convolvulus arvensis*.

Hemi paracytic stomata on the stem of *Ipomoea cairica* (Fig. 7b).

Amphi hemi paracytic stomata on the leaves of *Convolvulus arvensis* (Fig7c).

Amphi paracytic stomata on the leaves of *Convolvulus arvensis* (Fig. 7d).

Anisocytic stomata on the leaves only of *Ipomoea batatas* (Fig. 7e).

Tricytic stomata on the leaves in *Ipomoea cairica* (Fig. 7f).

Anomocytic stomata in some leaves of *Cressa cretica* (Fig. 7g).

Desmocytic stomata on the leaves only of *Ipomoea batatas* (Fig. 7h).

Helicocytic stomata on the leaves of *Ipomoea pes-caprea* (Fig. 7i).

In addition of these types, associated stomata (parallel) on the stem and leaves in *Ipomoea batatas* (Fig. 7j), abnormal stomata (an arrested stoma) were observed on the leaves of *Ipomoea carnea* and *Convolvulus scammonia* (Fig. 7k). The abovementioned results were in harmony with the findings of Tayade and Patil (2011), Sabbour *et al.,* (2018), Yadav *et al.,* (2018) and Ashfaq *et al.,* (2019).

Anatomical characters

Stem anatomy:

The stem shapes were varied in the outline view. It was rounded as in *Cuscuta chinensis* (Fig.8a), oblong in few plants as in *Ipomoea tricolor* (Fig. 8b), tri-angled only in *Convolvulus arvensis* (Fig.8c) and tetra-angled in *Convolvulus scammonia* (Fig. 8d). Similar results confirmed by Eid *et al.,* (2017) and Madani and Majbour (2017).

Epidermis: The epidermal cells were often covered by cuticle layer. This layer was usually thin in most of the examined plants as in *Cuscuta chinensis* (Fig. 8e) as mentioned by Malik and Trapathi (2017) and Rani *et al.,* (2018), and rarely thick in some others as in *Ipomoea batatas* (Fig. 8f). The cuticle was smooth as in *Cuscuta chinensis* (Fig. 8e) and rough in few as in *Ipomoea cairica* (Fig. 8g). Secretory cells were observed in few plants as in *Ipomoea pes-caprea* (Fig. 8h), resin canals in *Cuscuta chinensis* (Fig. 8e) and amorphous inclusions in *Ipomoea pes-caprea* (Fig. 8i).

Cortex: Broad cortex was recorded in few taxa as in *Cuscuta chinensis* (Fig. 8a) and narrow in most as in *Convolvulus arvensis* (Fig. 8c). Palisade tissue was noticed in only two taxa; *Convolvulus arvensis* (Fig.8j). Collenchyma cell patterns were found in some examined taxa; angular as in *Convolvulus scammonia* (Fig.8k) and tubular in *Ipomoea cairica* (Fig.8l). Rosette crystals were in some taxa such as *Ipomoea carnea* (Fig.8m), bacilliform in *Ipomoea carnea* (Fig.8n). Resin canals were in some taxa as in *Ipomoea pes-caprea* (Fig.8o), laticifer tissue in *Ipomoea pes-caprea* (Fig. 8h), secretory cells in *Ipomoea pes-caprea* (Fig.8h), secretory cavities in *Convolvulus scammonia* (Fig.8k). amorphous inclusions in *Ipomoea pes-caprea* (Fig.8i). These results were confirmed by the findings of Porwal *et al.,* (2015), Quraishi (2016), Malik and Trapathi (2017), Madani and Majbour (2017) and Rani *et al.,* (2018).

Medullary rays: Anatomical observations of medullary ray revealed the presence of rosette crystals in few taxa as *Cressa cretica* (Fig.8p). These rays were uniseriate or biseriate in *Cressa cretica* (Fig.8p) (Kapadane *et al.,* (2019).

Vascular bundle: Vascular bundles in most taxa were bicollateral as in *Ipomoea carnea* (Fig.8q) as mentioned by Malik and Trapathi (2017), Shaikh (2017) and Kapadane *et al.,* (2019) or collateral as in *Cuscuta species* (Fig. 9a) either in complete ring as in *Convolvulus scammonia* (Fig.8d) or in group as in *Cuscuta chinensis* (Fig.9a). The vessels were found in chains as in *Ipomoea carnea* (Fig.8q) or in clusters as in *Cuscuta chinensis* (Fig. 9a).

Xylem: Tyloses were observed in some taxa such as *Cressa cretica* (Fig.9b). Protoxylem lacunas were in *Cuscuta chinensis* and *Cuscuta pedicellata* only (Fig. 9a) as mentioned by Eid *et al.,* (2017) and Rani *et al.,* (2018).

Phloem: Secretory cells were present in most of taxa as in *Ipomoea carnea* (Fig. 9c), and as reported by the finding of Malik and Trapathi (2017) and Rani *et al.,* (2018).

Pith: The stem center was solid in most of taxa as in *Convolvulus arvensis* (Fig.8c)it was only hollow in *Ipomoea carnea* (Fig. 9d). Laticifer tissues were observed in some taxa as in *Ipomoea carnea* (Fig. 9c). Rosette crystals were in most taxa such as *Ipomoea cairica* (Fig. 9e). These results were in harmony with the findings of Quraishi (2016) and Madani and Majbour (2017).

Leaf anatomy

Upper and lower epidermis**:** The cuticular layer on the upper epidermis is relatively thin in most taxa as in *Convolvulus arvensis* and thick in few as in *Ipomoea tricolor* (Table 3). The cuticular layer was usually smooth as in *Convolvulus arvensis* and rarely rough as in *Ipomoea cairica* and *Ipomoea carnea* only (Table 3). This result was in harmony with the findings of Malik and Trapathi (2017) and Madani and Majbour (2017).

Mesophylic tissue: The mesophylic tissue consists of spongy tissue and palisade in most taxa as in *Ipomoea cairica* (Fig. 10a) or palisade tissue only as in *Convolvulus scammonia* and *Ipomoea carnea* (Fig. 10b), as mentioned by (Suganthi *et al.,* (2007), Quraishi (2016), Eid *et al.,* (2017) and Mukherjee *et al.,* (2019)).

Palisade tissue**:** The palisade tissue was either monolateral in some taxa as in *Ipomoea cairica* (Fig.10a) or bilateral in most taxa as in *Ipomoea pes-caprea* (Fig.10c). Palisade tissue was present in midrib region of most taxa as in *Ipomoea pes-caprea* (Fig.10d) or absent in few as in *Convolvulus arvensis* (Fig.10e). Rosette crystals were observed in taxa such as *Ipomoea pes-caprea* (Fig.10f), as mentioned by Kuster *et al.,* (2016 & 2017), Rani *et al.,* (2018) and Mukherjee *et al.,* (2019).

Spongy tissue: Spongy tissue was noticed in most of the examined plants. Rosette crystals were observed in most taxa as in *Ipomoea pes-caprea* (Fig.10f), as reported by (Eid *et al.,* (2017) and Mukherjee *et al.,* (2019)) on the same taxon.

Midrib region: The upper epidermis was either convex in surface in most taxa as in *Ipomoea tricolor* (Fig.10g), or concave in some others as in *Convolvulus arvensis* (Fig.10e). The palisade tissue was separated in most taxa as in *Ipomoea tricolor* (Fig.10g), or continuous in some others as in *Ipomoea cairica* (Fig.10h). Collenchymatous cells were observed in most taxa as in *Ipomoea pes-caprea* (Fig.10d). These results was in harmony with the findings of Kuster *et al.,* (2016), Rani *et al.,* (2018) and Mukherjee *et al.,* (2019).

Vascular bundle**:** Vascular bundles were bicollateral in most taxa as in *Ipomoea carnea* (Fig.10i) or collateral in some others such as *Ipomoea tricolor* (Fig.10g). It could be one bundle in the midrib region in most taxa as in *Ipomoea cairica* (Fig.10h), or more than one in few as in *Ipomoea pes-caprea* (Fig.10d). Crescent vascular bundle shape was noticed in most taxa as in *Ipomoea cairica* (Fig.10h) and cuppa shape in few of them as in *Ipomoea pes-caprea* (Fig.10d). These results are confirmed by Metcalfe and Chalk (1950), Quraishi (2016), Eid *et al.,* (2017) and Mukherjee *et al*., (2019).

Xylem: Secretory cells were observed in some investigated taxa as in *Ipomoea tricolor* (Fig. 10j).

Phloem: Rosette crystals were observed in some investigated taxa as in *Ipomoea carnea* (Fig.10k). Resin canals were present in some taxa as in *Ipomoea carnea* (Fig.10k), or Ssecretory canals in some others as in *Ipomoea carnea* (Fig.10k).

The previous macro and micro-morphological characters in addition to anatomical data were transformed to qualitative characters and analyzed by Multi Variate Statistical Package Program (MVSP). This program represents the similarity or dissimilarity between the studied taxa in a form of dendrogram (Fig. 11 & Table 2).

From this dendrogram, it was obvious that the studied species (Table 3) were split into two clusters. The first cluster is divided into two sub-clusters. The first sub-cluster contains 4 species; they are No. 1, 2, 4 and 5 The minimum dissimilarity (12) was between species *Cuscuta chinensis* (No. 4) and *Cuscuta pedicellata* (No. 5), while the maximum dissimilarity (60) was between species *Convolvulus arvensis* (No. 1) and *Cuscuta chinensis* (No. 4). The second sub-cluster includes one plant only the *Cressa cretica* (No. 3), where the minimum dissimilarity (57) was between species *Cressa cretica* (No. 3) and *Convolvulus scammonia* (No. 2), while the maximum dissimilarity (65) was between species *Cressa cretica* (No. 3) and *Cuscuta pedicellata* (No. 5). The second cluster is divided into two sub-clusters. The first sub-cluster contains 2 species which are *Ipomoea cairica* (No. 7) and *Ipomoea tricolor* (No. 10), the dissimilarity (43) between them. The second sub-cluster includes 3 species; wich are No. 6, 8 and 9, where the minimum dissimilarity (37) was between species *Ipomoea batatas* (No. 6) and *Ipomoea pes-caprea* (No. 9), while the maximum dissimilarity (56) was between species *Ipomoea batatas* (No. 6) and *Ipomoea carnea* (No. 8).

A. Qualitative characters

***Macro morphological characters*:**

Plant life / not parasite (+) / parasite (-).

Plant chlorophyllous (+) / non-chlorophyllous (-).

Plant durations / perennial (+) / annual (-).

Plant habit / shrub (+) / herb (-).

Latex yield / present (+) absent (-).

Stem nature / herbaceous (+) / woody (-).

Stem weak (+) / erect (-).

weakness stem / twining (+) / prostrate (-).

Leaf / present (+) / absent (-).

Leaf surface/ glabrous (+) / hairy (-).

Leaf petiolate (+) / sessile / (-).

Leaf venation / pinnate (+) / palmate (-).

Flowers / in an inflorescence (+) /solitary (-).

Inflorescence type / cymes (+) / raceme (-).

Calyx sepals / equal (+) / unequal (-).

Calyx sepals / free (+) / gamosepalous (-).

Androecium

Filaments / equal in length (+) / unequal (-).

Filaments base / glabrous (+) hairy (-).

Filaments attachment to the anther / basifixed (+) dorsifixed (-).

Pollen grains

Apertures / polyporate (+) / tricolpate (-).

Exine sculpture / spinulose (+) smooth (-).

Gynoecium

Locular number / 2-locular (+)/ 4-locular (-).

Ovules number in the ovary / 4-ovulate (+) 8-ovulate (-).

Ovary / glabrous (+) / hairy (-).

Styles / united (+) / free (-).

Stigma / united (+) / free (-).

Seed

Embryo / cotyledons (+) / acotyledonous (-).

Seed surface / curly (+) / hairy (-).

Micromorphological characters

Leaf

upper and lower epidermis

epidermal cell walls / straight (+) / undulate (-).

ornamentation / present (+) / absent (-).

epidermis cell shape / irregular (+) / polygonal (-).

Corolla

epidermal cell walls / thick (+) / thin (-).

Anatomical characters

Stem anatomy

Epidermal Cuticul layer / thick (+) / thin (-).

Epidermal Cuticul layer / smooth (+) / rough (-).

Epidermal Secretory cells / present (+) / absent (-).

Resin canals / present (+) /absent (-).

Amorphous inclusions / present (+) / absent (-).

Cortex

Cortex / broad (+) / narrow (-).

Palisade tissue / present (+) / absent (-).

Collenchymal tissue / present (+) /absent (-).

Rosette crystals / present (+) / absent (-).

Bacilliform crystals / present (+) / absent (-).

Sandy crystals / present (+) / absent (-).

Resin canals / present (+) / absent (-).

Laticifer tissue / present (+) / absent (-).

Secretory cells / present (+) / absent (-).

Secretory cavities / present (+) / absent (-).

Amorphous inclusions / present (+) / absent (-).

Medullary rays rosette crystals / present (+) / absent (-).

" "/ uniseriate (+) / biseriate (-).

Vascular bundles / complete ring (+) / groups (-).

Bundl typ / bicollateral (+) / collateral (-).

Vessels / chains (+) / clusters (-).

Xylem tylosis/ present (+) / absent (-).

Protoxylem lacunas / present (+) / absent (-).

Phloem secretory cells / present (+) / absent (-).

Pith solid (+) / hollow (-).

Laticifer tissue / present (+) / absent (-).

Rosette crystals / present (+) / absent (-).

Leaf anatomy

Upper and Lower epidermis cuticul layer / thick (+) / thin (-).

Upper and Lower epidermis cuticul layer / smooth (+) / rough (-).

Upper and Lower epidermis resin canals / present (+) / absent (-).

mesoophylic consists of palisad and spongy (+) / palisad tissue only (-)

Palisade tissue /monolateral (+)/bilateral (-).

Palisade tissue in midrib region / present (+) / absent (-).

Palisade tissue Rosette crystals / present (+) / absent (-).

Spongy tissue rosette crystals / present (+) / absent (-).

Midrib region / convex (+) / concave (-).

Palisade tissue in Midrib region / continuous (+) / separated (-).

Vascular bundle type / bicollateral (+) / collateral (-).

Vascular bundle type / one bundle in midrib region (+) / more than one (-)

Vascular bundle type / crescent (+) / cuppa shape (-).

Xylem secretory cells/present (+)/ absent (-).

Phloem rosette crystals / present (+) / absent (-).

Phloem resin canals /present (+) / absent (-).

Phloem secretory canals / present (+) / absent (-).

Multistate characters

Macromorphological characters:

Stem

Stem surface (3 categories): glabrous, 1; hairy, 2 and granulose 3.

Leaf

Leaf shapes (5 categories): palmately-lobed,1; hastate, 2; cordate, 3; orbicular, 4 and ovate 5.

Leaf apex (3 categories): acute, 1; caudate, 2 and emarginate 3.

Flowers

Corolla shape (4 categories): funnel-shape,1; campanulate, 2; tubular shape, 3 and salverform 4.

Corolla (3 categories): complete,1; deeply lobed, 2 and shallow lobed 3.

Corolla colour (3 categories): white,1; pink, 2 and violet 3.

Androecium

Anther shape (4 categories): ovate, 1; globose, 2; sagittate, 3 and oblong 4.

Gynoecium

Stigma shape (3 categories): linear, 1; capitate, 2; and filiform 3.

Nectariferous shape (3 categories): annular, 1; plate shaped, 2; lobular, 3 and If absent *.

Seed Characters

Seed color (3 categories): black, 1; brown, 2 and gray 3.

Micromorphological characters

Flowers

Corolla epidermal cells wall (3categories): undulate, 1; straight, 2 and sinuous 3.

Hairs

Hairs types (7 categories): unicellular simple hair,1; unicellular branched hair, 2; multicellular unbranched hair, 3; multiseriate glandular hair, 4; sessile glandular hair, 5; stellate hairs, 6 and ciliated hair 7.

Stomata

Stomata (9 categories): paracytic,1; hemi paracytic, 2; amphi hemi paracytic, 3; amphi paracytic, 4; anisocytic stomata, 5; tricytic, 6; anomocytic, 7; desmocytic, 8; helicocytic 9.

Anatomical characters

Stem outline shapes / rounded, 1; oblong, 2; tri-angled, 3 and tetragonal 4.

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Table 1: Scientific names and sites of collection of (10) species representing (4) genera belonging to Convolvulaceae family.

No	Scientific Names	Sites of collection
1	*Convolvulus arvensis* L.	Sh
2	*C. scammonia* L.	Ma
3	*Cressa cretica* L.	Alex
4	*Cuscuta chinensis* Lam.	Ca
5	*C. pedicellata* Ledeb.	Bu
6	*Ipomoea batatas* Lam.	Bu
7	*I. cairica* L.	Bu
8	*I. carnea* Jacq.	Sh
9	*I. pes-caprea* L.	Bu
10	*I. tricolor* Cav.	Ca

Key: Alexandria (Alex), Cairo (Ca), Matrouh (Ma), Al Sharkia (Sh) and Al Buhayrah (Bu).

Table 2: Data matrix of the observed characters for the species of Convolvulaceae.

	10	9	8	7	6	5	4	3	2	1	
1										0.000	1
2									0.000	14.000	2
3								0.000	57.000	59.000	3
4							0.000	61.000	56.000	60.000	4
5						0.000	12.000	65.000	54.000	58.000	5
6					0.000	70.000	68.000	61.000	60.000	56.000	6
7				0.000	50.000	72.000	72.000	73.000	62.000	60.000	7
8			0.000	60.000	56.000	82.000	80.000	79.000	68.000	64.000	8
9		0.000	45.000	59.000	37.000	73.000	69.000	58.000	65.000	63.000	9
10	0.000	56.000	63.000	43.000	43.000	71.000	71.000	64.000	55.000	57.000	10
	10	9	8	7	6	5	4	3	2	1	

Table 3: List of (90) characters recorded comparatively for (10) species, representing (4) genera belonging to Convolvulaceae. The characters are distinguished in to (76) qualitative and (14) multistate characters respectively.

P / Ch	1	2	3	4	5	6	7	8	9	10
1	+	+	+	-	-	+	+	+	+	+
2	+	+	+	-	-	+	+	+	+	+
3	+	+	+	-	-	+	+	+	+	+
4	-	-	-	-	-	+	+	+	+	+
5	-	-	-	-	-	+	+	+	+	+
6	+	+	-	+	+	+	+	-	+	+
7	+	+	+	+	+	+	+	-	-	+
8	+	+	*	+	+	-	-	*	-	-
9	+	+	+	-	-	+	+	+	+	+
10	+	+	-	+	+	+	+	+	+	-
11	+	+	-	*	*	+	+	+	+	+
12	+	+	+	*	*	-	-	+	+	-
13	-	+	+	+	-	+	+	+	+	+
14	+	+	-	+	+	+	+	+	+	+
15	+	+	-	+	+	+	+	+	-	+
16	+	+	+	-	-	+	+	+	+	+
17	+	+	+	+	+	+	-	-	-	-
18	+	+	-	+	+	-	-	-	-	-
19	-	-	-	+	+	+	+	+	+	+
20	-	-	-	-	-	+	+	+	+	+
21	-	-	-	-	-	+	+	+	+	+
22	+	+	+	+	+	+	+	-	+	-
23	+	+	+	+	+	+	+	-	+	-
24	+	+	-	+	+	+	+	+	+	+
25	+	+	+	-	-	+	+	+	+	+
26	-	-	-	-	-	+	+	+	+	+
27	+	+	+	-	-	+	+	+	+	+
28	+	+	+	+	+	+	-	-	+	+
29	-	-	+	*	*	-	-	+	+	-
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43	-	-	-	-	-	-	-	+	-	-
44	-	-	-	-	+	+	-	+	+	-
45	-	-	-	-	-	+	-	+	+	-
46	-	-	-	-	-	-	-	-	+	-
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48	-	-	-	-	-	-	-	-	+	+
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58	-	-	-	-	-	+	+	+	+	-
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`60	-	-	+	*	*	-	-	-	-	+
61	+	+	+	*	*	+	-	-	+	+
62	-	-	-	*	*	-	-	-	-	+
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64	-	-	+	*	*	-	+	-	-	-
65	-	-	+	*	*	+	+	+	+	+
66	-	-	-	*	*	+	-	+	+	+
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68	-	-	+	*	*	+	+	+	-	+
69	-	-	-	*	*	-	+	-	-	-
70	+	-	+	*	*	+	+	+	+	-
71	+	+	+	*	*	+	+	-	-	+
72	+	+	+	*	*	+	+	-	-	+
73	-	-	-	*	*	-	-	-	-	+
74	-	-	-	*	*	-	-	+	+	-
75	+	-	-	*	*	-	-	+	-	-
76	-	-	-	*	*	-	-	+	+	-
77	1	1	2	1	1	1	3	1	1	2
78	2	2	5	*	*	1	1	3	4	1
79	1	1	1	*	*	1	1	2	3	1
80	1	1	2	3	3	1	4	1	1	1
81	3	3	2	2	2	1	1	3	3	1
82	1	1	1	1	1	2	3	2	2	3
83	4	4	4	1	2	4	3	4	4	4
84	1	1	2	2	3	2	2	2	2	2
85	3	3	*	1	1	*	1	1	*	2
86	1	1	2	2	2	2	3	1	2	1
87	1	1	1	2	2	1	3	1	1	2
88	**1**	1	1,2,3	7	*	5,6	4	1,4,5	4,5	1,4
89	1,3,4	1,11	7	1	*	1,2,3, 5,8	1,2,6	1,3,4,11	1,9	1
90	4	3	1	1	2	1	2	1	1	2

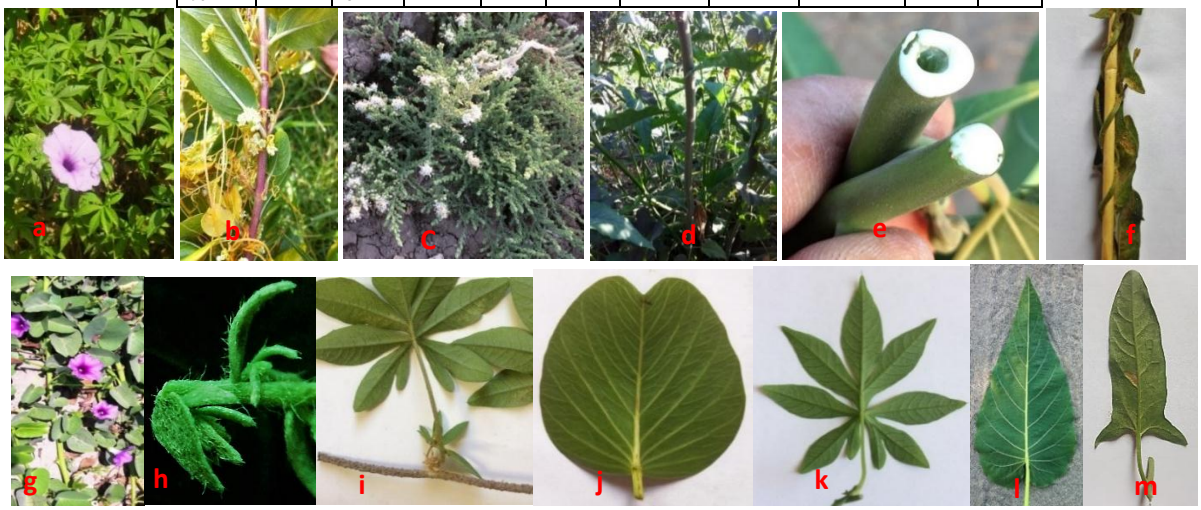


Figure 1: from (a-e) Show habit of Convolvulaceae plants: (a) not parasite in *Ipomoea cairica*, (b) parasite in *Cuscuta chinensis,* (c) perennial herbs in *Cressa cretica*, (d) shrubs and woody in *Ipomoea carnea* and (e) Latex yield in *Ipomoea carnea*, (f and g) show stem types: (f) twining in *Convolvulus*

arvensis and (g) prostrate in *Ipomoea pes-caprea,*and (h-m) show leaf shapes: (h) sessile in *Cressa cretica,* (i) petiolate in *Ipomoea cairica,* (j) orbicular in *Ipomoea pes-caprea* (k) palmately-lobed in *Ipomoea cairica,* (l) cordate in *Ipomoea carnea* and (m) hastate in *Convolvulus arvensis*.

Figure 2 :(a- c) show flowers status inflorescence: (a) cymes inflorescence in *Ipomoea tricolor,* b) solitary flowers in *Convolvulus arvensis* and (c) raceme inflorescence in *Cressa cretica,* (d-g) Show calyx types: (d) sepals equal in *Ipomoea cairica,* (e) unequal in *Ipomoea pes-caprea,* (f) aposepalous in *Ipomoea batatas* and (g) gamosepalous in *Cuscuta pedicellata* (h-m) show corolla shapes or color: (h) funnel form in *Ipomoea batatas,* (i) campanulate in *Cressa cretica,* (j) tubular-shape in *Cuscuta chinensis,* (k) salver form and violet color in *Ipomoea cairica,* (l) pink color in *Ipomoea carnea* and (m) white color and filaments equal in *Convolvulus arvensis*, (n -p) Show androecium status: (n) filaments unequal in *Ipomoea carnea,* (o) base hairy in *Ipomoea carnea,* (p) anther ovate in *Cuscuta chinensis.*

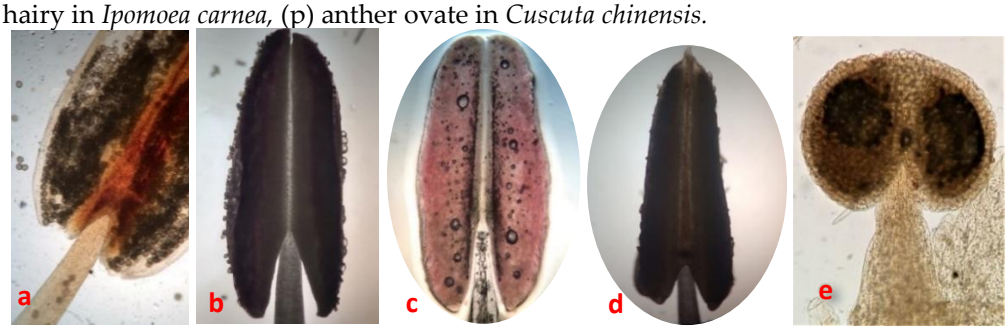
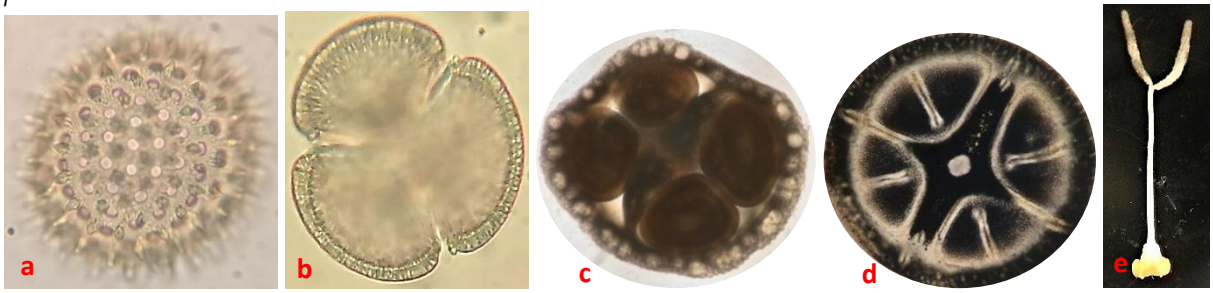


Figure 3: (a - e) show androecium status: (a) basifixed in *Ipomoea carnea,* (b) dorsifixed in *Convolvulus arvensis,* (c) oblong shape *Ipomoea tricolor,* (d) sagittate in *Ipomoea cairica* and (e) globose in *Cuscuta pedicellata*



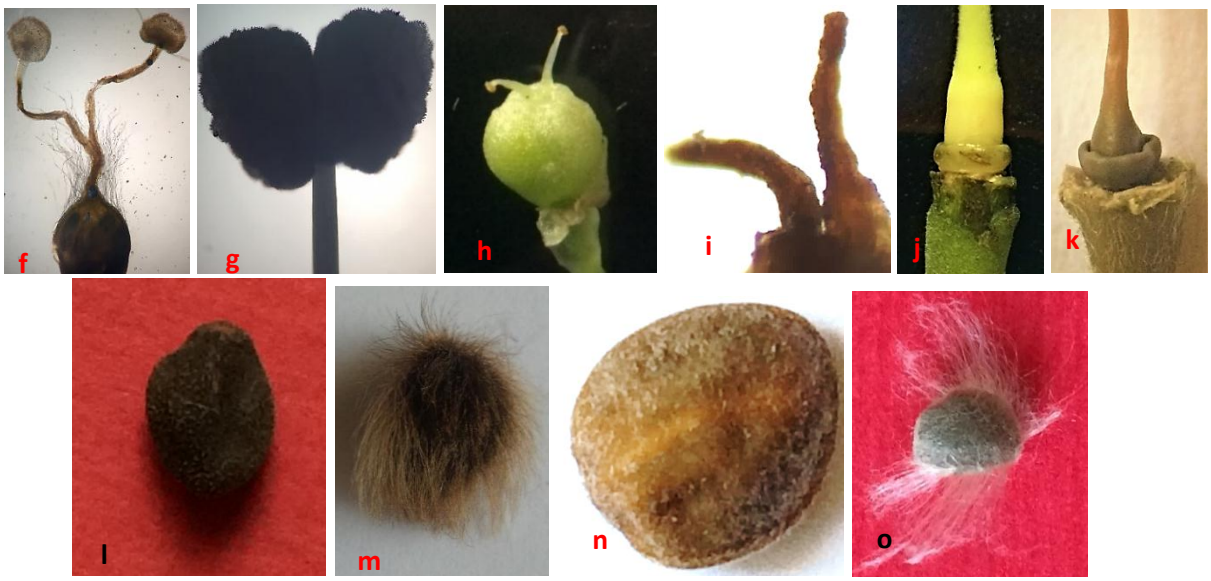


Figure 4: (a and b) show pollen grain shapes and the exine sculpture: (a) polyporate and spinulose in *Ipomoea batatas* And (b) tricolpate and smooth in *Convolvulus arvensis,* (c-k) Show gynoecium status: (c) locular two and four ovules in *Cuscuta chinensis,* (d) four locular and eight ovules in *Ipomoea carnea,* (e) ovary smooth and stigma free and linear in *Convolvulus arvensis,* (f) ovary hairy and stigma is capitate in *Cressa cretica,* (g) styles and stigma united in *Ipomoea cairica,* (h) styles free *Cuscuta chinensis,* (i) stigma is filiform in *Cuscuta pedicellata,* (j) necatariferous is annular in *Ipomoea carnea* and (k) necatariferous of plate shaped in *Ipomoea tricolor*, (L-O) Show seed shapes:(l) curly in *Convolvulus arvensis,* (m) hairy in *Ipomoea carnea,* (n) brown color in *Cressa cretica* and (o) gray in *Ipomoea cairic.*

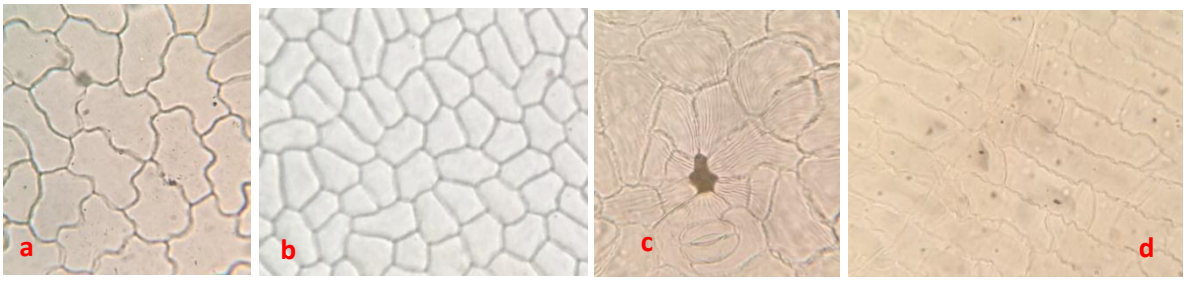


Figure 5: (a-d) Show types of epidermal cell: **(a)** undulate in *Convolvulus arvensis* **(b)** straight in *Ipomoea carnea*, **(c)** ornamentation in *Ipomoea batatas* and **(d)** sinuous in *Ipomoea cairica*.

Figure 6: (a-g) show Hair forms (x. 200): (a) unicellular unbranched in *Ipomoea tricolor,* (b) unicellular branched in *Cressa cretica,* (c) multicellular unbranched in *Cressa cretica,* (d) multiseriate glandular in *Ipomoea carnea,* (e) sessile Glandular in *Ipomoea pes-caprea,* (f) stellate in *Ipomoea batatas* and (g) ciliated in *Cuscuta chinensis*.

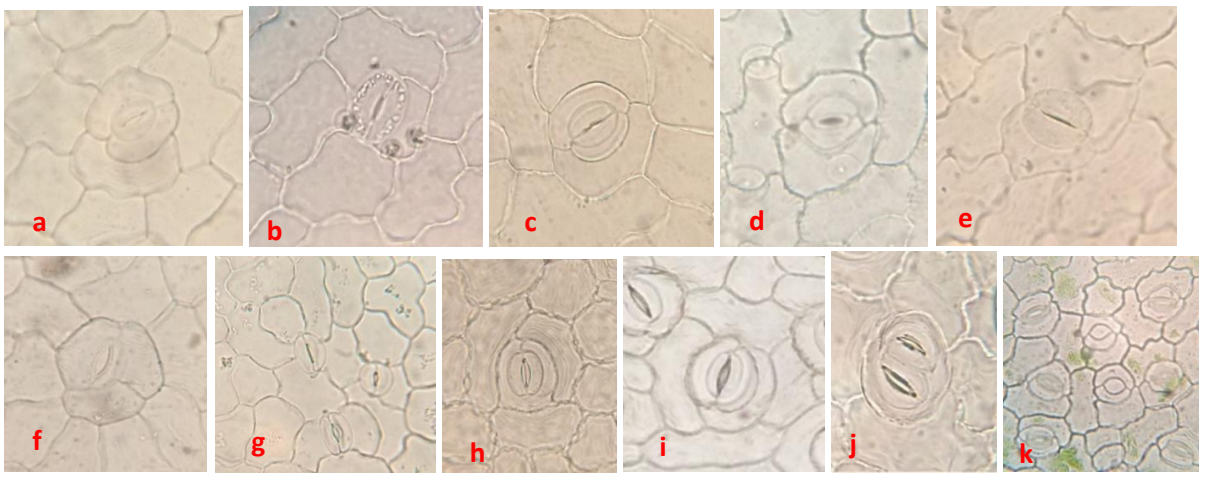


Figure 7: (a-k) show forms of stomata (x. 200): (a) paracytic in *Ipomoea cairica*, (b) hemi paracytic in *Ipomoea cairica*, (c) amphi hemi paracytic in *Convolvulus arvensis*, (d) amphi aracytic in *Convolvulus arvensis*, (e) anisocytic in *Ipomoea batatas*, (f) tricytic in *Ipomoea cairica*, (g) anomocytic in *Cressa cretica*, (h) desmocytic in *Ipomoea batatas*, (i) helicocytic in *Ipomoea pes-caprea*, (j) associated (parallel) in *Ipomoea batatas* and (k) Abnormal (an arrested stoma) in *Convolvulus scammonia*.

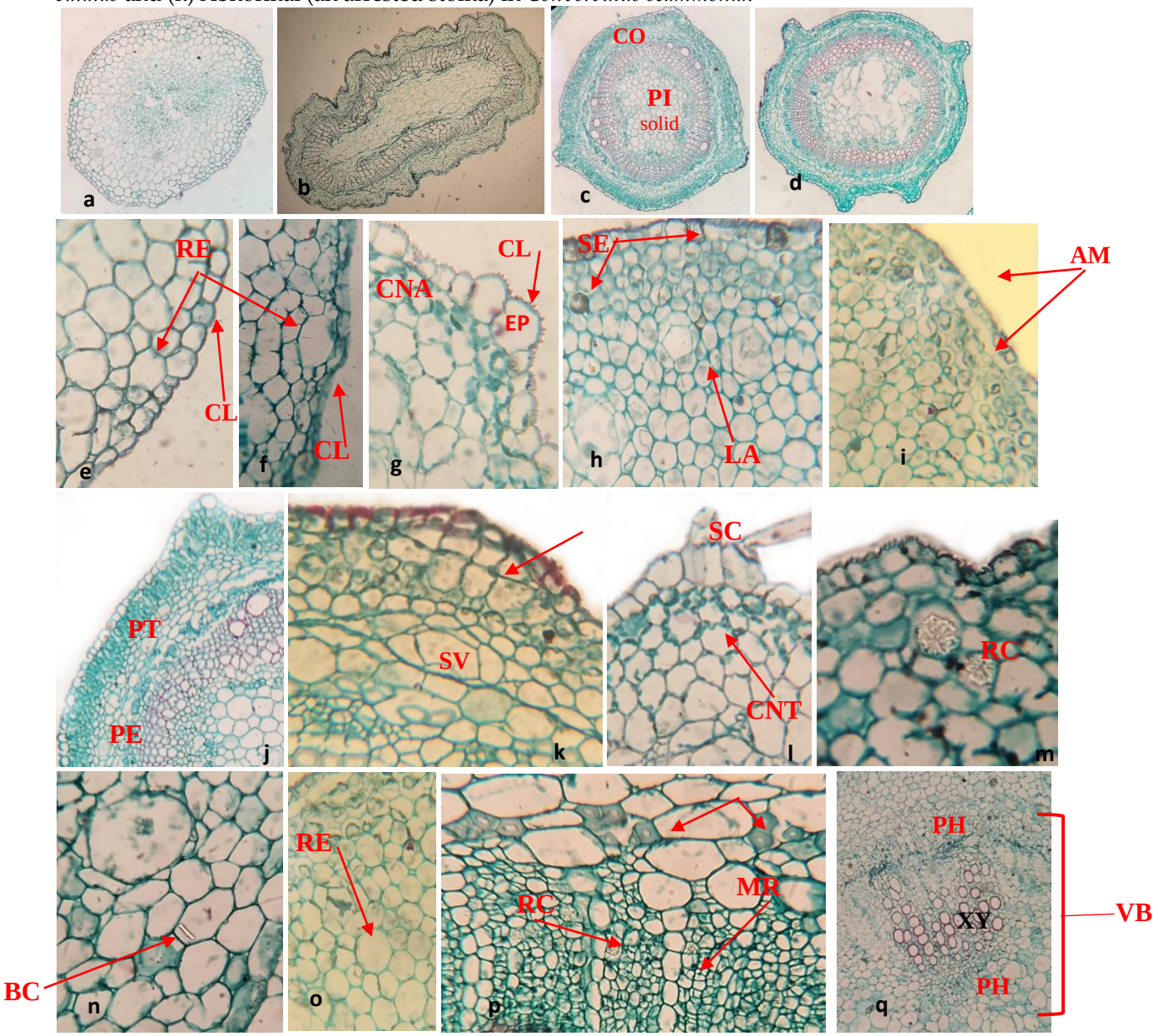


Figure 8: (a-q) Cross section in stems (x. 40) and (x. 100): (a) *Cuscuta chinensis,* (b) *Ipomoea tricolor* (c) *Convolvulus arvensis*, and (d) *Convolvulus scammonia* (e) *Cuscuta chinensis,* (f) *Ipomoea batatas*, (g) *Ipomoea cairica*, (h) *Ipomoea pes-caprea* (i) *Ipomoea pes-caprea,* (j) *Convolvulus arvensis*, (k) *Convolvulus scammonia*, (l) *Ipomoea cairica,* (m) *Ipomoea carnea,* (n) *Ipomoea carnea*, (o) *Ipomoea pes-caprea*, (p) *Cressa cretica* and (q) *Ipomoea carnea*.
Key : CL = Cuticular layer, EP = epidermis, AM = Amorphous inclusions, SV = Secretory cavities. PA= Parenchymatous cells, SC=Sclerenchyma tissue, CNA= Angular Collenchyma, CNT= Tubular Collenchyma, RE = Resin canals, RC= Rosette crystals, MR= Medullary rays, VB= Vascular bundles, XY= Xylem, PH= Phloem, LA= Laticifer tissue, SE= Secretory cells, PL= Protoxylem lacuns AM = Amorphous inclusions, PI= Pith, CO = Cortex, PE= Pericycle.

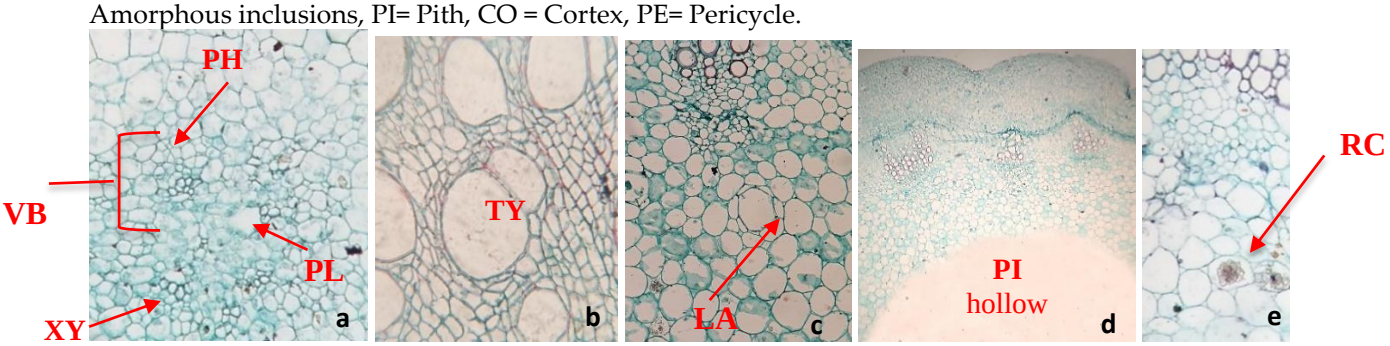


Figure 9: (a-e) Cross sections in stems (x. 100): (a) *Cuscuta chinensis,* (b) *Cressa cretica*, (c) *Ipomoea carnea*, (d) *Ipomoea carnea* and (e) *Ipomoea cairica.*

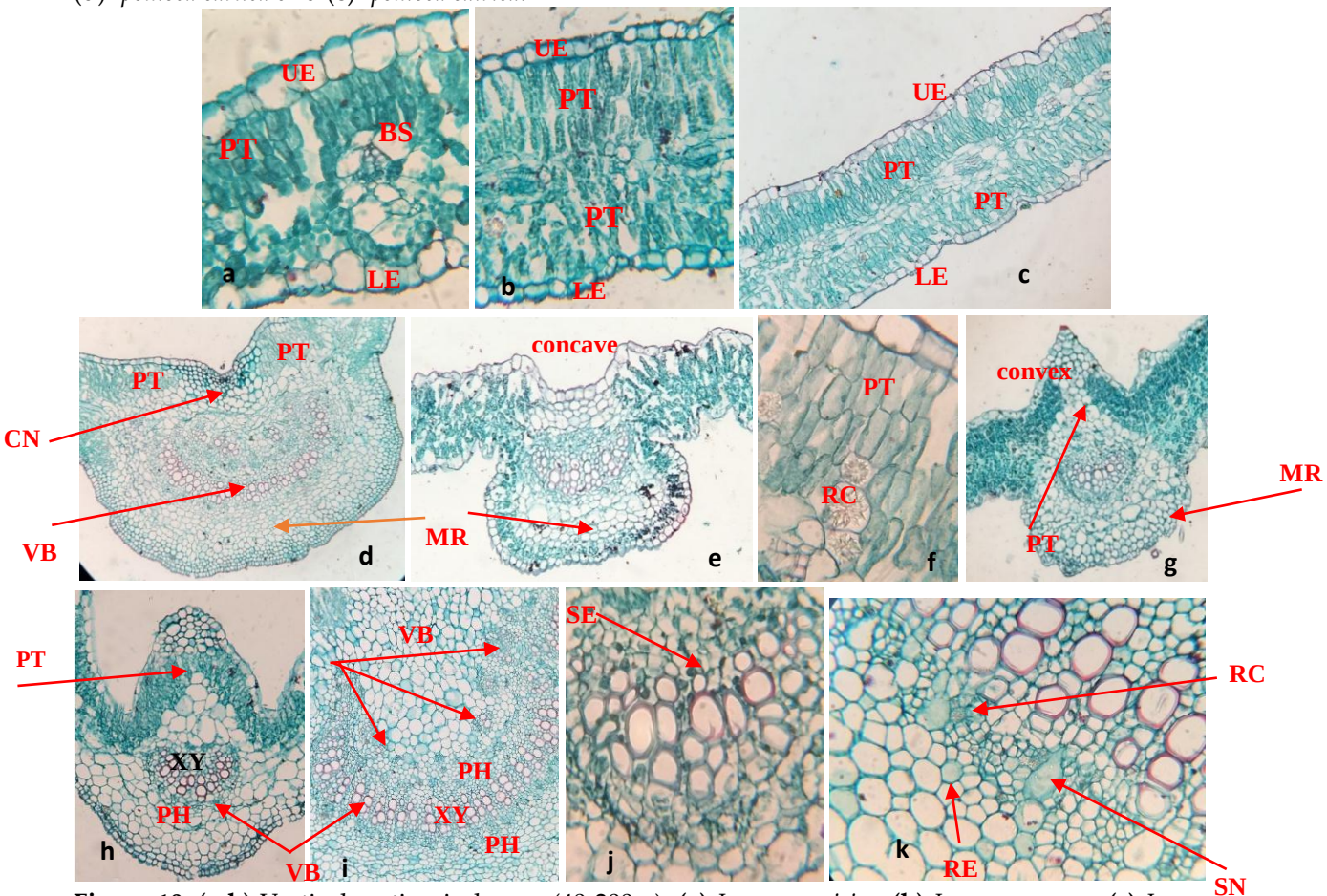


Figure 10: (a-k) Vertical section in leaves (40-200 x): **(a)** *Ipomoea cairica,* **(b)** *Ipomoea carnea,* **(c)** *Ipomoea pes-caprea,* **(d)** *Ipomoea pes-caprea,* **(e)** *Convolvulus arvensis,* **(f)** *Ipomoea pes-caprea,* **(g)** *Ipomoea tricolor,* **(h)** *Ipomoea cairica,* **(i)** *Ipomoea carnea,* **(j)** *Ipomoea tricolor* and **(k)** *Ipomoea carnea.*
Key: LE= Lower epidermis, **UE=** Upper epidermis, **PT=** Palisade tissue, **ST=** Spongy tissue, **RC=** Rosette crystals, **MR=** Midrib region, **SE =** Secretory cells, **CN=** Collenchymatous cells, **VB=** Vascular bundles, **XY=** Xylem, **PH** = Phloem, **BS=** Bundle sheath, **RE =** Resin canals, **SN=** Secretory canals.

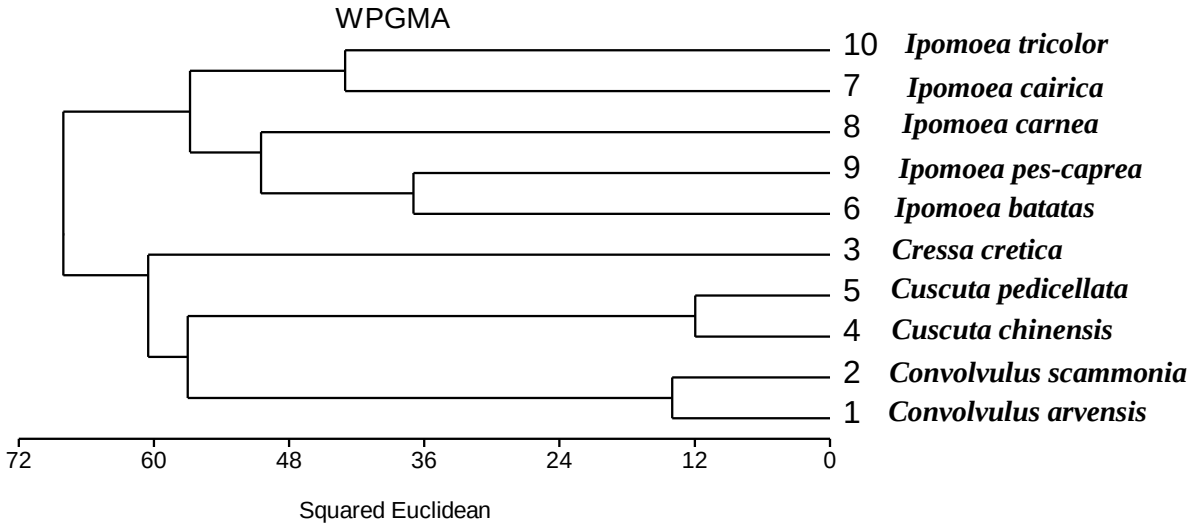


Figure 11: Dendrogram represent the relationships of similarity among 10 species of Convolvulaceae. Key: *Convolvulus arvensis* (No.1), *Convolvulus scammonia* (No.2), *Cressa cretica* (No.3), *Cuscuta chinensis* (No.4), *Cuscuta pedicellata* (No.5), *Ipomoea batatas* (No.6), *Ipomoea cairica* (No.7),*Ipomoea carnea* (No.8), *Ipomoea pes-caprea* (No.9) and *Ipomoea tricolor* (No.10).

دراسات نباتية مقارنة علي أربعة أجناس من الفصيلة العلاقية

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الملخص العـربي

أجريت هذه الدراسة علي 10 أنواع تمثل 4 أجناس من الفصيلة العلاقية. جمعت العينات النباتية من مناطق مختلفة بخمسة محافظات في جمهورية مصر العربية. أجريت الدراسة على الصفات المورفولوجية لكل من السيقان والأوراق والأزهار والنورات كما تم عمل سلخ في طبقة البشرة للسيقان والأوراق والغلاف الزهري لدراسة الثغور والشعيرات المختلفة الموجودة عليها، كما سجلت صفات حبوب اللقاح. دُرست الصفات التشريحية لكل من السوق والأوراق وأعناق الأوراق. وقد سجلت النتائج بطريقة مقارنة بين الأنواع محل الدراسة. أظهرت النتائج أن أغلب الأنواع محل الدراسة أعشاب قد تكون حولية كما في *Cuscuta chinensis* أو معمرة كما في *Cressa cretica* وقد تكون شجيرات كما في *Ipomoea carnea* . كما لوحظ أن كل سيقان الأنواع محل الدراسة كانت ضعيفة باستثناء نبات *Ipomoea carnea* ونبات *Cressa cretica*. وكانت الأوراق بسيطة فى كل الأنواع وتكون مفصصة راحية كما في النوع *Ipomoe cairica* أو تكون غير مفصصة وتأخذ عدة أشكال فقد تكون مزراقية كما فى *Convolvulus arvensis* وقلبية كما فى النوع *Ipomoea carenea* ومستديرة كما في *Ipomoea pes-caprea*.. وكانت الأزهار في أغلب الأنواع متجمعة في نورات كما فى *Ipomoea tricolor* وقد تكون مفردة كما في *Convolvulus arvensis* وشوكي كما في *Ipomoea carnea*. يتكون النسيج الوسطى للأوراق من نسيج عمادي ونسيج إسفنجي في معظم الأنواع محل الدراسة كما في *Ipomoea cairica* وقد يكون عمادي فقط كما في *Convolvulus scammonia*. بالإضافة إلى ظهور البلورات النجمية في عدد من الأنسجة المختلفة. وقد أظهر التحليل العنقودي للصفات المدروسة للأنواع المختلفة أن الأنواع انقسمت إلى مجموعتين كبيرتين كما هو موضح في الدندروجرام صورة رقم (10) وجدول رقم (2).

الكلمات الاسترشادية: النبات، الشكل الظاهري، تشريح، العلاقية.