

## Flora of St Katherine Protectorate: key to families and genera

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### ABSTRACT

An illustrated key to families and genera of the flora of the St Katherine Protectorate is provided to facilitate the identification of the unique flora of the area, based on five years of collecting mainly in the mountains and wadis surrounding the town of St Katherine. The key includes 43 families and 141 genera, the families represented by the largest numbers of genera in the Protectorate are: Compositae (15 genera), Gramineae (11), Labiatae (11), Leguminosae (10) and Boraginaceae (9).

**KEYWORDS:** plants, diversity, Sinai, Egypt

### INTRODUCTION

The Sinai Peninsula is one of Egypt's most floristically diverse and phytogeographically interesting regions. Many of the plants growing the desert in Sinai and the Negev are utilized by Bedouin for pasture, medicine (for animals and themselves), food and other miscellaneous uses (Bailey & Danin 1981). The botanical exploration of Sinai has been intensive, and historically can be classified into successive periods (Batanouny 1985): expeditions in the eighteenth century; exploration from 1800 until the work of Fresenius (1834) on the flora of Sinai; exploration from 1835 until the work of Boissier (1867-88); a decade of intensive exploration (1861-1871); an era of extensive floristic studies (1871-1929) culminating with the publication of the Flora of Egypt (1956); a period of taxonomic updating; and an era of phytoecological studies. Botanical studies during the Israeli occupation of Sinai were fragmentary and the studies undertaken since that time have been carried out by scientists visiting Sinai for short periods. In the last three decades, hundreds of books have been written about Sinai, but almost all offer no scientific contributions except some good photographs. The unsettled situation has hampered scientific activities, and Sinai needs intense, continuous and meticulous botanical and phyto-ecological studies (Batanouny 1985).

During the period of updating, the number of species recorded from Sinai was subjected to many changes by various authors, as follows: El-Hadidi (1969) recorded two species new to Egypt, 30 new to Sinai, and one new to science, making a total of 298 species belonging to 53 families; Abdallah *et al.* (1984) stated that the flora of the Sinai region preserved in the CAIM herbarium represented 88 families, 404 genera, 732 species, 16 subspecies and 70 varieties of the native flora of Egypt; A total of 886 species were recorded from Sinai by Danin *et al.* (1985), composed of a few common and widespread semi-shrub and shrub species and many rare species which have restricted distributions in time and space; forty species were recorded for the first time from Sinai in this publication; Danin (1986) stated that there were 28 endemic species in Sinai, of which 25 occurred in the mountainous districts; El-Hadidi (1989) suggested that Sinai has 984 plant species belonging to 465 genera of vascular Cryptogams and flowering plants; he counted 108 species belonging to the Rosales families, with five species new to Sinai: *Medicago lupulina*, *Lotus halophilus*, *Tephrosia purpurea* and *Astragalus asterias* (Leguminosae). Gamal El-Din (1993) collected a total of 114 species of seed plants from Gebel El-Halal in northern Sinai during one season, of which 12 were new records; In his synthesis of the Egyptian flora, Boulos (1995) noted that

1285 taxa had been recorded from Sinai, of which 23 are doubtful records, leaving 1262 including infraspecific taxa. There were 33 taxa endemic to Sinai and another 4 endemic to Sinai and other mainland regions of Egypt; Moustafa & Kamel (1995) listed the species growing in the St Katherine mountains, identifying 221 plant species during their 3-year study period (1992-1994); Abdou (1997) identified 107 species belonging to 31 families from South Sinai; 12% were considered to be endemic; Aayed et al. (2000) suggested that Sinai contains approximately 1285 species, with South Sinai supporting 800, including 34 endemics; 62% were estimated as being rare or very rare; Gazara et al. (2000) recorded 154 species from Sinai representing 32 families, with 48 rare, four endemic and 13 medicinal species contributing about 8.4% of the total recorded from Gebel El-Halal.

The period of phytoecological studies is represented by a number of studies. Ramadan (1988) recognised 36 community types belonging to six groups from Wadi Feiran. These communities are: *Zygophyllum coccineum*, *Haloxylon salicornicum* (4 community types); *Panicum turgidum*, *Asphodelus tenuifolius* (4 community types); *Artemisia judaica*, *Zilla spinosa* (8 community types); *Gymnocarpos decandrus*, *Fagonia mollis* (8 community types); *Artemisia inculta*, *Achillea fragrantissima* (12 community types); *Capparis sinaica*, *Moringa peregrina* (2 community types). Moustafa (1990) identified 228 community types and plant associations which he classified into 12 main and 13 other clusters based on the floristic composition and the similarity of species composition. In South Sinai, Abd El-Wahab (1995) classified communities into six types: *Crataegus sinaica* - *Phlomis aurea* communities are common in elevated and rugged wadis in the St Katherine area; *Lycium shawii* is common in wadi bed and sloping rocky habitats, again in St Katherine and the surrounding wadis; *Raetama raetam* occurs in wadi El-Sheikh and its tributaries; and in addition there are the *Acacia raddiana*, *Nitraria retusa*, and *Salvadora persica* communities.

Many factors regulate the abundance and distribution of plants in Sinai, such as elevation, the nature of the rocks at the soil surface, the degree of exposure, available nutrients and soil moisture content (Abdou 1997). However, urban expansion, agriculture, over-grazing and over-cutting threaten to reduce the present biodiversity, with at least 61 of the rare species of southern Sinai estimated to be already endangered as a result. Further investigation and management of the flora in the St Katherine Protectorate requires some means of promoting the accurate identification of species, since the existing aids are very out-of-date and not particularly helpful.

Despite the richness of the flora of St. Katherine and the comprehensive floristic studies on Sinai in general, but there is no specific key dealing with the flora of the area, therefore this study was designed with the aim to enumerate a key of the dominant or common families and genera of the protectorate. This study will be followed by a comprehensive illustrated key to the common species within these families and genera.

## **MATERIALS AND METHODS**

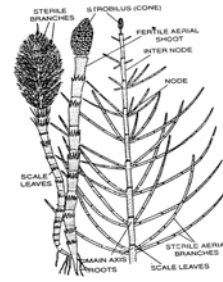
The flora of St. Katherine Protectorate has been surveyed intensively during the last five years through the regular expeditions of the Suez Canal University team in the Wadis and the mountains of the area (expeditions of Prof. Zalat and his group). The collected specimens have been examined, identified and deposited in the herbariums at Suez Canal University (Ismailia) and Environmental Research Center (St. Katherine). Plant names and identification were followed in most cases the publications of the flora of Palastine and Egypt (Zohary 1966, 1972; Täckholm 1974; Feinbrun 1978, 1986; Boulos 1995, 1999, 2000; El-Hadidi 2000). For the arrangement of families, we followed the system of Engler published by Melchior (1964). Most drawings have been quoted from Zohary (1966, 1972) to facilitate the identification and ease the use of the key.

**RESULTS**

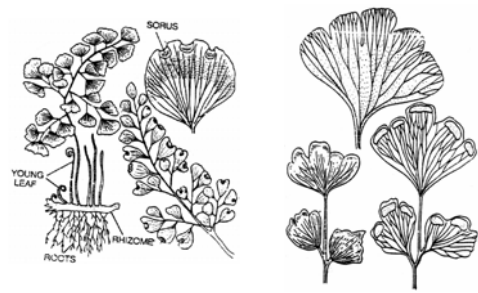
**Division : Pteridophyta**

**Key to families and genera**

1 Plant with tall rhizome (sometimes 1 m high);  
 leaves whorled, scale-like; sporangia borne in  
 terminal spike ..... **Equisetaceae**  
 ..... *Equisetum*



- Plant with short rhizome (less than 30 cm);  
 frond pinnate, herbaceous; sporangia borne  
 on lower surface of the pinna margin  
 ..... **Adiantaceae:**  
 ..... *Adiantum*



**Division: Gymnospermae**

- Leafless or almost leafless shrubs, seeds  
 surrounded by fleshy or membranous bracts  
 ..... **Ephedraceae**  
 ..... *Ephedra*



**Division : Angiospermae**

**Class 1: Dicotyledoneae**

**Key to families**

1 Perianth of a single or two whorls of segments,  
 not differentiated into calyx and corolla,  
 stamens free from perianth ..... **2**

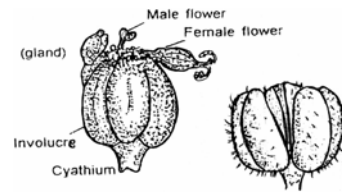
- Calyx and corolla both present, stamens free or  
 united with perianth ..... **6**

2 Leaves usually with stipules united into a  
 sheath (ochrea); perianth sepaloid or petaloid,  
 3-6 segments ..... **Polygonaceae**



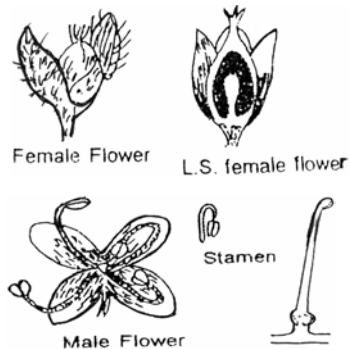
- Leaves exstipulate or stipules not as above;  
perianth sepaloid; 4-5 segments ..... **3**

3 Plant with latex; inflorescence a cyathium, fruit  
schizocarpic..... **Euphorbiaceae**



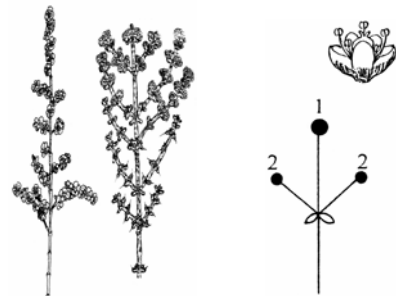
- Combination of characters not as above (fruit  
nut or drupe) ..... **4**

4 Flowers unisexual, plant with rough or stinging  
hairs..... **Urticaceae**

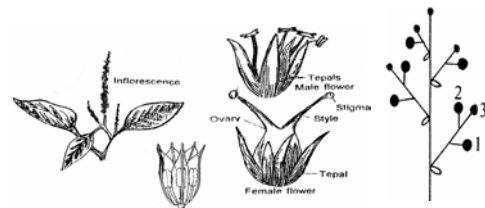


- Flower bisexual, stinging hairs absent .... **5**

5 Inflorescence, dichasial cyme, perianth green  
or membranous; styles 2-5, usually free  
..... **Chenopodiaceae**



- Inflorescence often racemose, condensed,  
perianth hyaline or papery; styles 1, 2, 3 .....  
..... **Amaranthaceae**



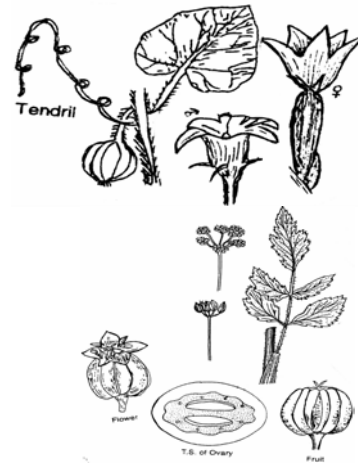
6 Petals free, stamens not united with petals..... **7**

- Petals united into tube, at least below; stamens  
mostly united with petals ..... **25**

7 Ovary inferior ..... **8**

- Ovary superior ..... **9**

8 Climbing herbs with tendrils, flowers unisexual, ovary with 3 carpels; numerous ovules; fruit berry-like..... **Cucurbitaceae**



- Plant not climbing; flower bisexual; ovary with 2 carpels, ovules 1 per cell; schizocarp.....  
..... **Umbelliferae**



9 Carpel 1, placentation marginal; fruit a legume  
..... **Leguminosae**

- Combination of characters not as above..... **10**

10 Calyx with 2 sepals; fruit usually capsule ...**11**

- Calyx usually more than 2 sepals; fruit various ..... **12**

11 Leaf fleshy, placentation free, central; stipule hair like; sap watery..... **Protulaceae**



- Leaf herbaceous, placentation parietal; sap milky or coloured ..... **Paveraceae**



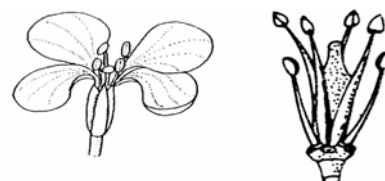
12 Sepals and petals 4 ..... **13**



- Sepals and petals five or more .....**18**

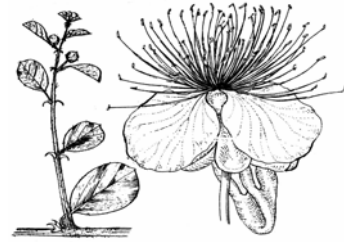


13 Sepals 4 in two decussate pairs, stamens 6, tetradynamous ..... **Cruciferae**



- Combination of characters not as above.... 14

14 Spiny stipules, stamens borne on a long androphore, ovary borne on a gynophore ..... **Capparaceae**



- Glandular stipules or absent, androphore and gynophore short or absent ..... 15

15 Leaves compound (3-7 foliate) rarely simple, fruit a siliqua ..... **Cleomaceae**



- Leaves simple, lobed, small or scales, fruit a capsule ..... 16

16 Flower zygomorphic, stamens 3-40, making an irregular disc; posterior filament of stamens shorter than other filaments; some or all of the petals fringed ..... **Resedaceae**



- Flower actinomorphic, stamens 5 or more or less; petals not fringed ..... 17

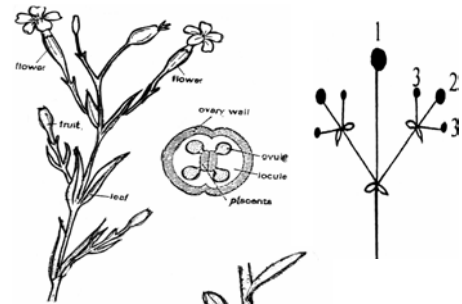
17 Leaves mostly opposite, usually evergreen, stipulate; style single ..... **Cistaceae**



- Leaves alternate, scale-like, exstipulate, styles 5 ..... **Tamaricaceae**



18 Leaves opposite, decussate; stem nodes swollen, stipules translucent and papery or rarely absent, inflorescence dichasial; placentation free, central .....  
 ..... **Caryophyllaceae**



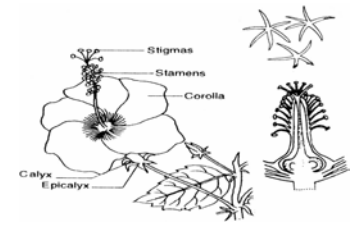
- Leaves alternate; the combination of characters not as above ..... **19**

19 Stamens numerous, carpels numerous free or united; epicalyx mostly present ..... **20**



- Stamens 5-10, carpels 2-5, united, epicalyx absent ..... **21**

20 Leaves simple or divided, with stellate hairs, stamens united at the base to staminal tube, pollen grains with echinate exine .....  
 ..... **Malvaceae**



- Leaves lobed or compound, hairs not stellate, stamens with free filaments, pollen grains not as above ..... **Rosaceae**



21 Flower zygomorphic, subtended by a bract and 2 bracteoles, corolla reduced to 3 petals with the lowest petal often saucer-shaped and sometimes with fringes ..... **Polygalaceae**



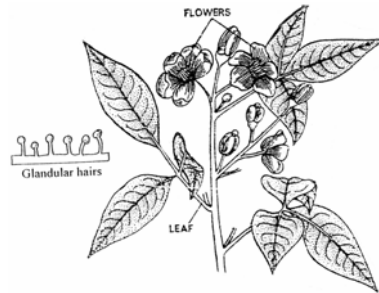
- Flower regular, the combination of characters not as above ..... **22**

22 Leaves 3-5 nerved; stamens 4-5, antepetalous; placentation axile or basal; ovules 1 (rarely 2) per locule ..... **Rhamnaceae**



- Leaves not 3-5 nerved; stamens 10 or more; parietal or axile placentation; ovules 1 or more per cell ..... **23**

- 23 Leaves dotted with glands; aromatic; exstipulate; inflorescence consists of terminal corymbs or various ..... **Rutaceae**



- Leaves not dotted with glands, not aromatic, stipulate or exstipulate; flower solitary, paired or in cymose inflorescences ..... **24**

- 24 Leaves fleshy or leathery; stamens all fertile; filaments free, fruit a capsule, sometimes splitting into 5 portions ..... **Zygophyllaceae**



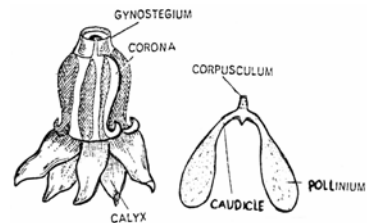
- Leaves herbaceous, stamens all fertile or with some staminodes, filament fused at the base; fruit schizocarpic (rarely capsule).....  
..... **Geraniaceae**



- 25 Climbers with tendrils, flowers unisexual  
..... **Cucurbitaceae**

- Tendrils absent; flowers bisexual ..... **26**

- 26 Pollen usually in coherent masses (pollinia), milky sap present; corona present .....  
..... **Asclepiadaceae**



- Combination of characters not as above  
..... **27**



27 Leaves scale-like, never green, root parasites  
 ..... **Orobanchaceae**

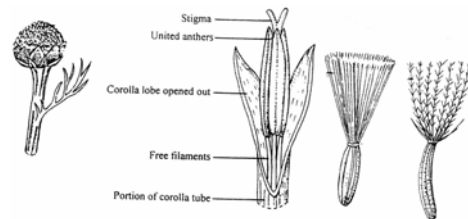


- Leaves green, expanded, free living plants  
 ..... **28**

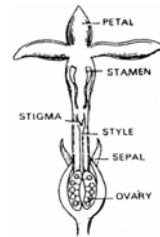
28 Ovary inferior ..... **29**

- Ovary superior ..... **30**

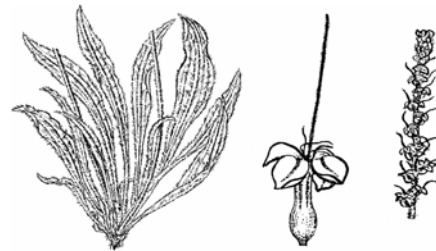
29 Inflorescence an involucre head, rarely 1-flowered, anthers united into a tube, ovule 1, cypsela, usually with pappus, basal placentation ..... **Compositae**



- Inflorescence various, anthers free, ovules 1-n per cell, capsule, berry or schizocarp, pappus absent, axile placentation ..... **Rubiaceae**



30 Corolla papery, translucent, 4-lobed, stamens 4; leaves with parallel veins, often basal; inflorescences in dense axillary spike or head  
 ..... **Plantaginaceae**



- Combination of characters not as above ... **31**

31 Flowers usually actinomorphic, stamens usually 5, corolla rarely 2-lipped ..... **32**



- Flowers usually zygomorphic, stamens 2 or 4, corolla usually 2-lipped ..... **34**

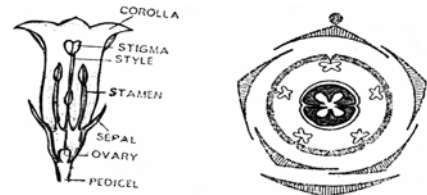


32 Flowers in spirally coiled cymes (scorpioid or helicoids), roughly hairy plants.....  
 ..... **Boraginaceae**

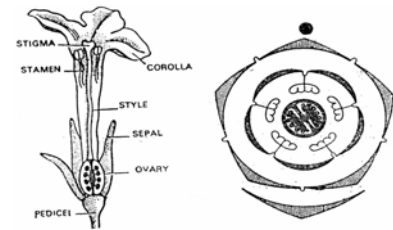


- Flowers cymose or solitary, plants not roughly hairy ..... **33**

33 Sepals free, ovary with 2 ovules per locule, septum of ovary in the horizontal plane .....  
 ..... **Convolvulaceae**



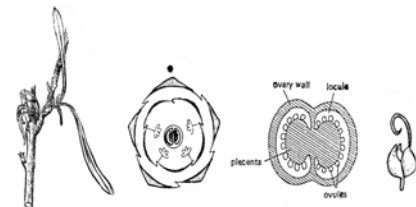
- Sepals partly fused, ovary with numerous ovules, septum of ovary oblique .....  
 ..... **Solanaceae**



34 Stems often square in cross-section; plant aromatic, ovules 1 per cell, fruit 4 nutlets .....  
 ..... **Labiatae**



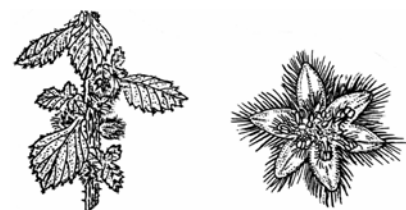
- Stems circular in cross-section, plant not aromatic, ovules 1 or more per cell, fruit capsule .....  
 ..... **Scrophulariaceae**



**Key to genera**

**Family: Urticaceae** (*Forsskalea*, *Parietaria*).

1 Perennial with appressed wool; hispid herb or shrublet, leaves with upper surface green, hispid, lower surface white-woolly, margin dentate ..... ***Forsskalea***



- Annual, pilose-hairy, leaves greenish, leaves margin entire..... ***Parietaria***



**Family: Polygonaceae** (*Atraphaxis*, *Polygonum*, *Rumex*).

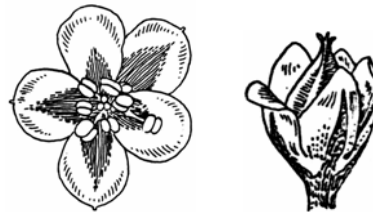
1 Shrub, spiny at apex, stem bark grayish-white to brownish, ochrea membranous, bifid at apex ..... *Atraphaxis*



- Annual, biennial or perennial herbs, stem not as above, ochrea tubular or lacerate, fringed or ciliate ..... 2



2 Perianth 4-5 lobed, stamens 8 (rarely fewer), fruiting perianth not winged or dentate ..... *Polygonum*



- Perianth 6-lobed (rarely 4), stamens 6, fruiting perianth winged or dentate ..... *Rumex*



**Family: Caryophyllaceae** (*Dianthus*, *Gymnocarpos*, *Gypsophila*, *Paronychia*, *Pteranthus*, *Silene*, *Spergula*)

1 Sepals or tepals connate at least to about half their length ..... 2



- Sepals or tepals free or connate at their lower part only ..... 5



2 Leaves stipulate, stem woody, grayish-white bark, stamens mostly 5; fruit indehiscent ..... *Gymnocarpos*



- Leaves exstipulate, stem herbaceous or woody, not grayish-white bark, stamens (5-) 10, fruit dehiscent ... 3

3 Calyx subtended by an epicalyx of 1 to many pairs of scales, styles 2, leaves grass-like .....  
 ..... ***Dianthus***



- Calyx not as above, styles 2-3, leaves not grass-like ..... 4

4 Petals with coronal scales between limb and claw, calyx mostly with 10 but sometimes with 20-30 nerves, capsule dehiscing by 6(-10) teeth .....  
 ..... ***Silene***



- Petals without coronal scales; calyx 5-nerved, capsule dehiscing by 4(-6) valves .....  
 ..... ***Gypsophila***



5 Flowers 4-merous, peduncle leaf-like .....  
 ..... ***Pteranthus***



- Flowers 5-merous, peduncle not leaf-like ..... 6



6 Leaves whorled, bract green or membranous, stamens (5-) 10, styles 3, seed with hyaline wing .....  
 ..... ***Spergula***



- Leaves opposite, bract silvery, stamens 5 sometimes fewer, styles 2, seed without hyaline wing .....  
 ..... ***Paronychia***



**Family: Chenopodiaceae**

(*Agathophora, Anabasis, Atriplex, Chenopodium, Cornulaca, Haloxylon*)

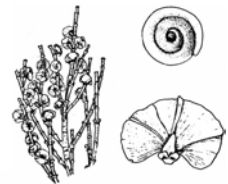
1 Stems jointed or articulate; leaves opposite, subulate or reduced to scale; flower all bisexual or a proportion of them female ..... 2



- Stems not jointed or not articulate; leaves alternate, flat, triangular or semi cylindrical; flowers bisexual or unisexual ..... 3



2 Wings of fruiting perianth 3 or 5; seeds vertical ..... *Anabasis*



- Wings of fruiting perianth 5; seeds horizontal ..... *Haloxylon*



3 Leaves flat, petiolate or sessile, not terminating in a stiff bristle ..... 4



- Leaves semi-cylindrical or triangular, sessile, mostly terminating in a stiff bristle ..... 5



4 Plant glabrous or mealy; flowers all bisexual or some female only, flowers bractless ..... *Chenopodium*



- Plant mealy-white, flowers unisexual, male flowers without bracteoles, female flowers with 2 bracteoles ..... *Atriplex*



5 Leaves rigid, triangular or needle-like, flowers with leaf-like bract and 2 bracteoles, fruiting perianth not winged ..... *Cornulaca*

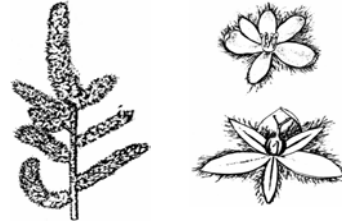


- Leaves fleshy, semi-cylindrical, middle flowers bractless, the lateral with 2-3 bracteoles (bracteoles ovate-triangular), fruiting perianth with wings ..... **Agathophora**



**Family: Amaranthaceae** (*Aerva*, *Amaranthus*).

- 1 Plant densely woolly, herbs or shrubs; tepals fleecy; anthers 2-celled, style short with 2 minute stigmas ..... **Aerva**



- Plant glabrous or pubescent but not woolly; tepals glabrous; anthers 4-celled; no style, stigmas 2-4 ..... **Amaranthus**



**Family: Papaveraceae** (*Glaucium*, *Papaver*, *Roemeria*).

- 1 Plant glabrous; capsule obovoid or clavate, glabrous, opening by pores ..... **Papaver**



- Plant pubescent or pilose; capsule linear-cylindrical, glabrescent to hairy, opening by valves ..... **2**



- 2 Flowers red or violet, ovary 3-valved; stigma 2-4 lobed ..... **Roemeria**



- Flowers yellow or orange, ovary 2-valved, stigma 2-horned ..... **Glaucium**



**Family: Cruciferae** (*Diplotaxis*, *Farsetia*, *Lepidium*, *Malcolmia*, *Matthiola*, *Moricandia*, *Schouwia*, *Sisymbrium*, *Zilla*)

- 1 Fruit a siliqua (at least 2 times as long as broad) ..... 2
- Fruit a silicula (less than 3 times as long as broad) ..... 8
- 2 Seeds in 2 parallel rows in each locule ..... 3
- Seeds in 1 row in each locule ..... 5
- 3 Plant hispid with simple hairs, leaves usually lyrate-pinnatifid ..... *Diplotaxis*
- Plant glabrous or canescent with forked hairs; leaves undivided ..... 4
- 4 Plant glabrous, lower leaves sessile, upper amplexicaulous, flower with short pedicels ..... *Moricandia*
- Plant canescent with appressed forked hairs, leaves subsessile or tapering at base, flower pedicellate ..... *Farsetia*
- 5 Fruit beakless, flower conspicuous or minute (about 4mm long) ..... *Sisymbrium*
- Fruit beaked, flower larger than above (more than 5mm long) ..... 6
- 6 Plant glabrous, leaves undivided, upper amplexicaulous, often entire ..... *Moricandia*



- Plant canescent or tomentose, leaves not as above, rarely entire ..... 7

7 Leaves linear to lanceolate, flower sessile, seeds mostly narrowly winged ..... **Matthiola**



- Leaves oblong or oblong-obovate, flower pedicellate, seeds wingless ..... **Malcolmia**

8 Spiny shrub, almost leafless plant; with spiny beak ..... **Zilla**

- Plant not as above ..... 9

9 Perennial herbs or half shrub, canescent with forked, stiff appressed hairs, flower large (1.5-2 cm) ..... **Farsetia**

- Annual or perennial herb, glabrous or with simple hairs, flower smaller (less than 1.2 cm) ..... 10

10 Leaves fleshy, fruit many seeded, silicula dehiscent, lower segment winged .....

..... **Schouwia**



- Leaves not fleshy, fruit 1-seed (rarely 2 in each cell), silicula cordate, indehiscent, valves reticulate ..... **Lepidium**

**Family: Resedaceae** (*Caylusea, Ochradenus, Reseda*).





1 Dioecious or polygamous shrub; leaves linear, soon deciduous, petals absent or linear, fruit a berry ..... ***Ochradenus***

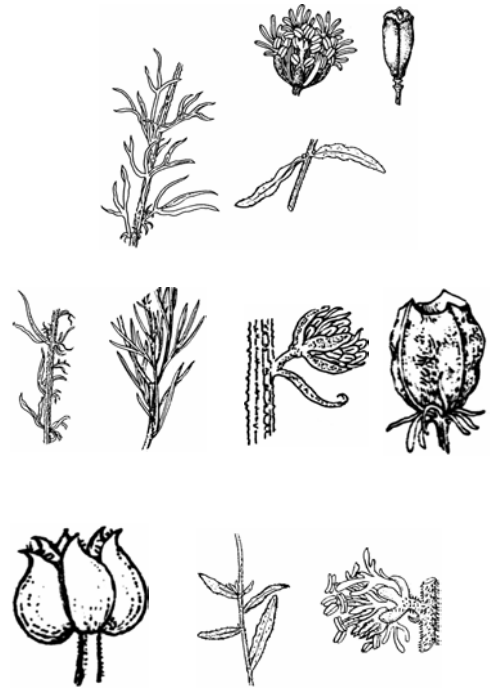
- Bisexual annual or perennial herb or semi-shrubs, leaves pinnate or dissected, linear lanceolate or oblanceolate, persistent, petals 4-8, fruit a capsule ..... **2**

2 Leaves entire or divided; sepals and petals 4-8; gynophore much shorter than calyx; ovary with united carpels, many seeds ..... ***Reseda***

- Leaves simple, entire; sepals and petals 5; gynophore longer than calyx; ovary with separate carpels, 1(-2) seeds per carpel ..... ***Caylusea***

1 Leaves imparipinnate, stipules adnate to petiole, carpels numerous, free ..... ***Rosa***

- Leaves pinnatilobed or partite, stipules caducous, carpels 1-2, rarely 3-5; united ..... ***Crataegus***



**Family: Rosaceae** (*Crataegus, Rosa*).

**Family: Leguminosae**

**Subfamily: Papilionoideae:** Flower papilionaceous, with standard keel and wings.

(*Astragalus, Crotalaria, Lotononis, Medicago, Melilotus, Retama, Trigonella*).

1 Plant with simple leaf, early deciduous, exstipulate ..... **2**

- Plant with 3-foliolate or imparipinnate or paripinnate leaf, stipules present ..... **3**

2 Flower white; pod mostly indehiscent, obovoid-ellipsoid, seed spherical ..... ***Retama***



- Flower yellow with reddish stripes; pod dehiscent or not, oblong-ellipsoid, seed ovoid ..... ***Crotalaria***



- 3 Leaves pinnate ..... ***Astragalus***



- Leaves usually 3-foliolate ..... **4**



- 4 Leaflets entire; stamens monadelphous ..... ***Lotononis***



- Leaflets dentate or serrate; stamens diadelphous ..... **5**



- 5 Pod spirally coiled, usually spiny ..... ***Medicago***



- Pod not spirally coiled or twisted, not spiny ..... **6**

- 6 Pod 6-8 mm long, globular or ovoid; 1 or rarely 2-3 seeds; flowers in axillary raceme, not umbellate ..... ***Melilotus***



- Pod much longer, linear or cylindrical, 1 to many seeds, flowers in umbellate raceme ..... ***Trigonella***



**Subfamily: Caesalpinioideae** (*Ceratonia*, *Senna*).

- 1 Dioecious trees; pod thick, fleshy; petals absent ..... ***Ceratonia***



- Herbs, shrubs or trees; pod leathery; petals present ..... ***Senna***



**Family: Zygophyllaceae** (*Fagonia*, *Peganum*, *Tribulus*, *Zygophyllum*).

- 1 Leaves paripinnate; fruit winged, prickly or tuberculate ..... ***Tribulus***



- Leaves simple, dissected or 2-3 foliate; fruit not as above ..... **2**



- 2** Stipules spiny ..... ***Fagonia***

- Stipules not spiny ..... 3

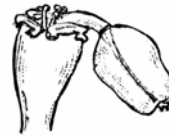
3 Leaves irregularly dissected, not succulent, stamens (8-) 12-15 ..... **Peganum**

- Leaves simple or 2-foliolate, leaves mostly fleshy or succulent; stamens 5-10 .....  
..... **Zygophyllum**



**Family: Euphorbiaceae** (*Andrachne, Chrozophora, Euphorbia*).

1 Flowers arranged in cyathia; each cyathium containing numerous staminate flowers (each of 1 stamen) around a single female flower; latex present ..... **Euphorbia**



- Flowers not as above; latex absent ..... 2

2 Leaves 0.4-1 cm long; stamens 5-6, free or connate at base, capsule with 2 seeds in each cell ..... **Andrachne**



- Leaves 2-10 cm long; stamens 5-15, in 1-3 whorls, filaments connate into a central column, capsule with 1-seed in each cell ..... **Chrozophora**



**Family: Malvaceae** (*Althaea, Malva*).

1 Epicalyx of 3 (rarely 2) free segments .....  
..... **Malva**



- Epicalyx of 6-12 segments, connate below ...  
..... **Althaea**



**Family: Tamaricaceae** (*Reaumuria, Tamarix*).

1 Dwarf shrub; leaves leathery or fleshy, flat or cylindrical-linear; flowers subtended by 5-10 bracts; stamens numerous ..... **Reaumuria**



- Shrubs or trees; leaves scale-like, amplexicaul or sheathing; flowers subtended by 1 bract; stamens 4-5 (-12) ..... **Tamarix**



**Family: Cucurbitaceae (*Citrullus*, *Cucumis*)**

- 1 Leaves triangular-ovate in outline, acute, deeply 5-7 lobed, lobes obtuse, sinuate-undulate, lobes lobate; fruit globose or ellipsoid, glabrous at maturity ..... ***Citrullus***
- Leaves nearly orbicular in outline, undulate, palmately 3-5 lobed, sinuate-toothed; fruit ellipsoid, with fleshy spines, bristly or prickly-tuberculate, rarely smooth ..... ***Cucumis***



**Family: Umbelliferae (*Deverra*, *Ferula*).**

- 1 Plant almost leafless at time of flowering, leaves basal, undivided or subdivided; flower with greenish-white petal; fruit laterally compressed, ovoid or globular ..... ***Deverra***
- Plant often very large, finely 2-5 pinnately or ternately dissected, with narrowly lobed leaf; flower yellow, whitish or yellowish-green; fruit dorsally compressed, flat, ovate or elliptical ..... ***Ferula***



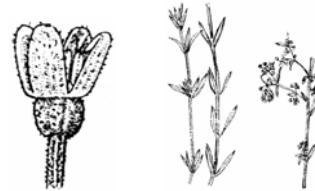
**Family: Asclepiadaceae (*Asclepias*, *Calotropis*, *Leptadenia*, *Solenostemma*)**

- 1 Shrub or small tree 2-4 m high; leaves 10-20 cm broad, ovate, elliptic or obovate, auriculate at base; follicles subglobose, obliquely ellipsoid or ovoid ..... ***Calotropis***
- Herbs or shrub, leaves and follicles not as above ..... **2**
- 2 Leafless plant; follicles 10-13 cm long, fusiform, sparingly pubescent ..... ***Leptadenia***
- Leafy plant; follicles 4-6.5 cm long, oblong or ovoid ..... **3**
- 3 Corolla 15-25 cm in diameter, yellowish; follicles oblong, tapering to beak, tomentose with reddish soft prickles or bristles ..... ***Asclepias***
- Corolla 7-8 mm in diameter, white; follicles ovoid beaked smooth ..... ***Solenostemma***



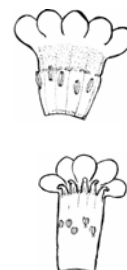
**Family: Rubiaceae** (*Crucianella*, *Galium*).

- 1 Leaves in whorls of 6, linear; flowers in a spike, subtended by bract and 2 stiff bracteoles; corolla salver-shaped; mericarps oblong rarely hemispherical ..... ***Crucianella***
- Leaves opposite or in whorls 4-8, oblong-lanceolate to linear or filiform; flowers in cyme or few flowered, bract and bracteoles membranous or inconspicuous; corolla rotate; mericarps globose, hemispherical, ovoid or ellipsoid ..... ***Galium***



**Family: Boraginaceae** (*Alkanna*, *Anchusa*, *Arnebia*, *Heliotropium*, *Lappula*, *Microparacaryum*, *Myosotis*, *Paracaryum*, *Trichodesma*)

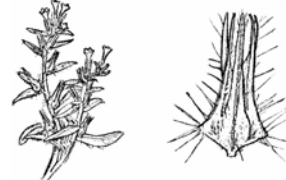
- 1 Stamen with a long appendage, exerted above the corolla; appendages twisted together ..... ***Trichodesma***
- Stamens included ..... 2
- 2 Inflorescences ebracteate ..... 3
- Inflorescences bracteate ..... 5
- 3 Each nutlet surrounded by introflexed rugose or denticulate margin concealing part of the median, nutlets concave urn-shaped ..... 4
- Nutlet not as above, convex ..... 5
- 4 Perennial, corolla dark-violet to brownish purple, nutlets 4-5 mm broad; fruiting pedicels spreading, erect ..... ***Paracaryum***
- Delicate annuals, corolla blue; nutlets 1.5-2.5 mm broad; fruiting pedicels recurved ..... ***Microparacaryum***
- 5 Flower sessile, yellow or white ..... ***Heliotropium***
- Flower pedicellate, blue ..... ***Myosotis***
- 6 Throat of corolla with a ring of hairs and sometimes with small invaginations; annulus of separate lobes or rim-like, glabrous or ciliate; root with red dye ..... 7
- 65 Throat of corolla with scales; root without red dye ..... 8



7 Plant with viscid glandular hairs; calyx divided to the base or to its lower third; nutlets subreniform or obliquely ovoid, strongly curved, beak straight, curved or deflexed .....  
 ..... ***Alkanna***



- Plant not viscid; hispid; calyx deeply divided; nutlets subglobose or ovoid-pyramidal, beak acute .....  
 ..... ***Arnebia***



8 Pedicels as long as calyx or longer; nutlets oblong or obliquely ovoid, reticulate ribbed and sometimes finely tuberculate or granulate between ribs .....  
 ..... ***Anchusa***



- Pedicels short or absent; nutlets pyriform, ovoid or trigonous, tuberculate or glochidiate; glochidia if present in 1-2 rows along margin .....  
 ..... ***Lappula***



**Family: Labiatae** (*Ballota, Lavandula, Mentha, Nepeta, Origanum, Phlomis, Salvia, Stachys, Teucrium, Thymus, Ziziphora*)

1 Stamens 2, only the 2 anterior stamens fertile, 2 posterior either reduced to small staminodes or lacking ..... **2**

- Stamens 4, all fertile ..... **3**

2 Perennial or annual herbs; calyx ovoid or tubular, more or less distinctly 2-labiate, staminodes absent ..... ***Salvia***



- Annual herbs or low chamaephytes; calyx narrowly tubular, slightly 2-labiate, elongate; staminodes present in addition to 2 fertile stamens .....  
 ..... ***Ziziphora***



3 Corolla with 4-5 lobes or with only a single lip ..... **4**

- Corolla distinctly 2-labiate ..... **5**



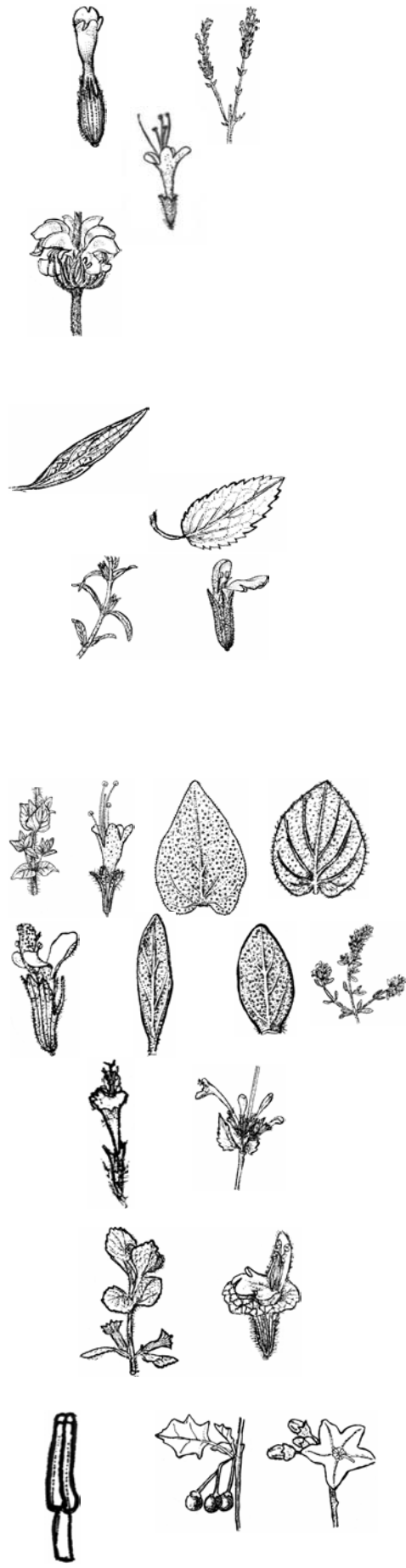
4 With a minty scent; corolla infundibular, limb 4-lobed ..... ***Mentha***



- Without a minty scent; corolla 1-labiate, 5-lobed, deciduous .....  
 ..... ***Teucrium***



5	Stamens usually included in corolla tube ..... ..... <b>Lavandula</b>
-	Stamens usually exserted in corolla tube ..... <b>6</b>
6	Plant often woolly or felty; flower length 2 cm or more, usually yellow ..... <b>Phlomis</b>
-	Plant not as above; flowers not more than 1.5 cm long, not yellow ..... <b>7</b>
7	Leaves entire or slightly cuneate-crenate .... <b>8</b>
-	Leaves serrate or dentate ..... <b>10</b>
8	Plant white to gray, densely stellate-tomentose; leaves oblong or oblong-lanceolate; calyx with 5-10 veins ..... <b>Stachys</b>
-	Plant with densely yellow or reddish sessile gland; leaves not as above; calyx with 10-13 veins ..... <b>9</b>
9	Calyx teeth more or less equal; leaves broadly ovate to orbicular, cordate or rounded at base ..... <b>Origanum</b>
-	Calyx 2-labiate; leaves leathery lanceolate .... ..... <b>Thymus</b>
10	Calyx 15-veined; corolla not hairy-ringed inside; posterior pair of stamens longer than anterior pair ..... <b>Nepeta</b>
-	Calyx 10-veined; corolla hairy-ringed inside, anterior pair of stamens longer than posterior pair ..... <b>Ballota</b>



**Family: Solanaceae** (*Hyoscyamus, Lycium, Solanum*).

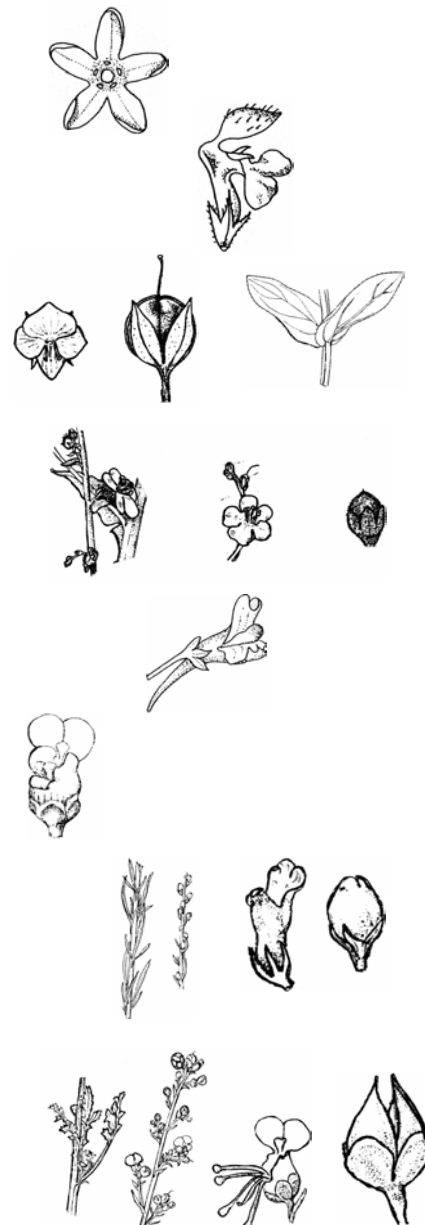
1	Calyx and corolla rotate, actinomorphic, stamen with filament very much shorter than anther ..... <b>Solanum</b>
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-	Calyx and corolla cupuliform or campanulate, mostly zygomorphic, stamen with filament longer than anther ..... <b>2</b>
2	Spiny shrub, flowers solitary or in cyme clusters, fruit a berry ..... <b><i>Lycium</i></b>
-	Annual or perennial herbs, flowers in raceme or spikes, fruit a capsule ..... <b><i>Hyoscyamus</i></b>



**Family: Scrophulariaceae** (*Anarrhinum, Kickxia, Scrophularia, Verbascum, Veronica*).

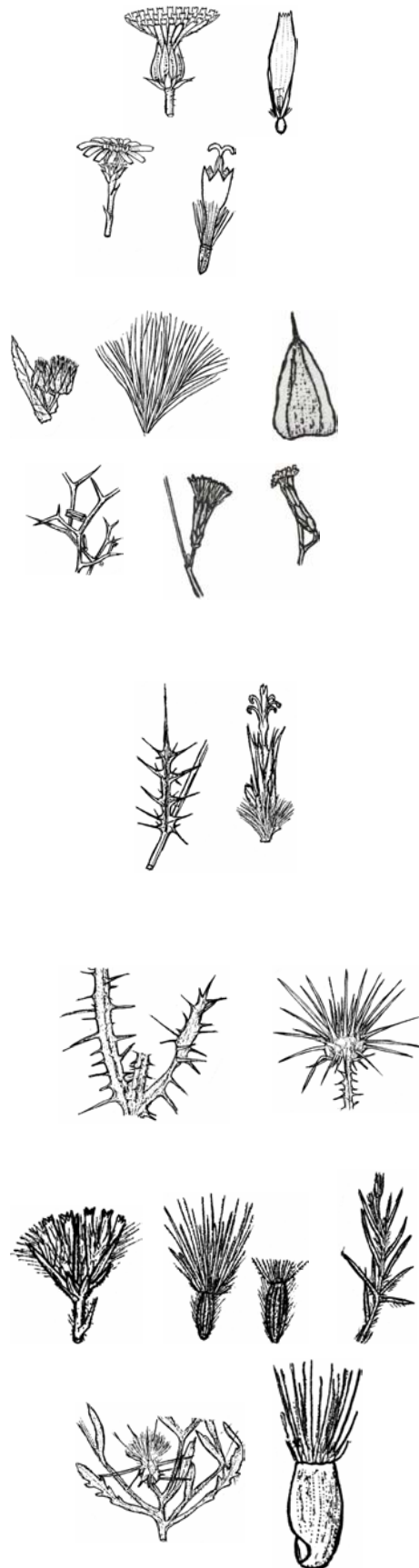
1	Corolla rotate ..... <b>2</b>
-	Corolla bilabiate ..... <b>3</b>
2	Corolla 4(-5) lobed, mostly blue, more rarely white, pink or lilac, lobes unequal; calyx deeply divided into 4(-5) lobes, lobes often unequal; stamens 2 ..... <b><i>Veronica</i></b>
-	Corolla 5-lobed, yellow; calyx deeply 5-lobed, equal; stamens 5 or 4 ..... <b><i>Verbascum</i></b>
3	Corolla spurred ..... <b><i>Kickxia</i></b>
-	Corolla not spurred ..... <b>4</b>
4	Corolla white; stamens 4, without staminodes; capsule dehiscing by an apical oblong valved pore ..... <b><i>Anarrhinum</i></b>
-	Corolla purple, brick red, yellowish or greenish; staminode present; capsule septicial, with 2 entire or bifid valves ..... <b><i>Scrophularia</i></b>



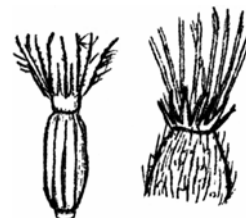
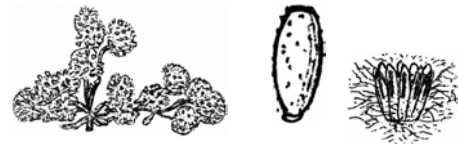


**Family: Compositae** (*Achillea*, *Artemisia*, *Centaurea*, *Conyza*, *Echinops*, *Ifloga*, *Iphiona*, *Lasiopogon*, *Launaea*, *Onopordum*, *Phagnalon*, *Pulicaria*, *Reichardia*, *Tanacetum*, *Varthemia*)

1	All florets ligulate, ligules 5-dentate ..... <b>2</b>
-	All or at least the central florets tubular; ligulate florets if present, with 3-dentate ligules ..... <b>3</b>
2	Outer involucre bracts with broad hyaline margins; peduncles thickened below the head, pappus connate at the base into a ring and deciduous at maturity in one piece ..... <b>Reichardia</b>
-	Outer involucre bracts membranous or hyaline margined, peduncles and pappus not as above; pappus mostly persistent ..... <b>Launaea</b>
3	Leaves or bracts or both spiny ..... <b>4</b>
-	Neither leaves nor bracts spiny ..... <b>7</b>
4	Each headlet or floret with its own involucre (partial involucre), corolla white or cream coloured ..... <b>Echinops</b>
-	Headlet or floret without involucre, corolla not white or cream coloured ..... <b>5</b>
5	Stems and branches with spiny shallowly lobed wings; receptacle fleshy; lower leaves broadly elliptic 5-8 cm broad, shallow-lobed ..... <b>Onopordum</b>
-	All the combination characters not as above ..... <b>6</b>
6	Heads homogenous; leaves subulate; achenes hirsute, cylindrical, 8-10 ribbed ..... <b>Iphiona</b>
-	Heads heterogeneous; leaves oblong or oblong-lanceolate in outline, achenes smooth, glabrous or soft hairy, somewhat compressed ..... <b>Centaurea</b>



7	Dwarf annuals, plant woolly to canescent; head minute (1.5-5 mm long), aggregated into glomerules ..... <b>8</b>
-	All the combination of characters not as above ..... <b>9</b>
8	Plant white lanate or dense-tomentose; involucre bracts in 1-2 rows, herbaceous, broadly hyaline-margined, oblong; stem prostrate; receptacle flat; achenes obovoid ..... <b><i>Lasiopogon</i></b>
-	Plant not as above; involucre bracts in many rows, scarious to membranous, broadly ovate to ovate-lanceolate; stem erect; receptacle cylindrical; achenes ovate ..... <b><i>Ifloga</i></b>
9	Pappus absent ..... <b>10</b>
-	Pappus present ..... <b>11</b>
10	Leaves undivided, serrulate, linear in outline; involucre bract oblong-ovoid, canescent; achenes strongly compressed, narrow at base, truncate at tip ..... <b><i>Achillea</i></b>
-	Leaves ovate to round in outline, pinnatisect or partite; involucre orbicular or oblong, with hyaline margine, achenes obovoid or cylindrical ..... <b><i>Artemisia</i></b>
11	Head homogamous, discoid, tubular, 5-dentate, receptacle alveolate; leaves entire, flowering stems yellowish from yellow glands ..... <b><i>Varthemia</i></b>
-	Head heterogamous; combination of characters not as above ..... <b>12</b>
12	Pappus in 2 rows, outer row short, inner row of much longer fragile scabrous bristles ..... <b><i>Pulicaria</i></b>
-	Pappus not as above ..... <b>13</b>



13	Heads usually solitary, long pedunculate; achenes nearly cylindrical; involucre bracts leathery to scarious, spreading after dispersal of achenes ..... <b><i>Phagnalon</i></b>
-	Heads numerous; achenes oblong or prismatic-cylindrical with ribs, involucre bracts herbaceous to scarious reflexed after flowering ..... <b>14</b>
14	Leaves cuneate below, obovate-spathulate above; achenes 1 mm; outer florets in many rows; filiform ..... <b><i>Conyza</i></b>
-	Leaves oblong in outline, pinnatisect into linear-oblong segments; achenes 2.5-3 mm; outer florets in 1-row, 3-dentate ..... <b><i>Tanacetum</i></b>



**Division: Angiospermae**  
**Class 2: Monocotyledoneae**  
**Keys to the families and genera**

1	Dioecious trees or shrubs; stem unbranched; leaves pinnatisect; flowers sessile in branched spadix enclosed in a spathe ..... <b><i>Palmae; Phoenix</i></b>
-	Combination of characters not as above ..... <b>2</b>
2	Perianth represented by thin membranous structures, either hyaline or reduced to bristles, hairs, narrow scales or absent ..... <b>3</b>
-	Perianth well-represented by petal-like segments (tepals) ..... <b><i>Liliaceae; Asphodelus</i></b>
3	Inflorescence in 2 superposed, dense, unisexual, elongate, brownish terminal spikes ..... <b><i>Typhaceae; Typha</i></b>



-	Inflorescence not superposed, bisexual; spikelets terminal, lateral simple or compound cymes ..... <b>4</b>
4	Flowers surrounded by 2 bracts (glumes), aggregated in spikes or spikelets; ovary with one ovule; fruit a caryopsis or a nut ..... <b>5</b>
-	Flowers not surrounded by 2 bracts, aggregated in few cymose heads; ovary with 3 to many ovulate, fruit a capsule ..... <b>Juncaceae</b> -Capsule ellipsoid to ovoid, as long as or slightly longer than perianth ..... <b>Juncus</b>
5	Leaves 3-ranked, with closed sheath; stem with solid triangular internodes; each flower subtended by only a glume; fruit is a nut ..... ..... <b>Cyperaceae; Cyperus</b> - Stem and leaves rigid; spikelets 8-16 flowered, straw coloured.
-	Leaves 2-ranked, with open sheath; stem with hollow cylindrical internodes; each flower subtended by 2-glumes; fruit a caryopsis ..... ..... <b>Gramineae</b>



**Family: Gramineae** (*Avena, Bromus, Cynodon, Hordeum, Oryzopsis, Panicum, Pennisetum, Poa, Schismus, Stipa, Stipagrostis*)

1	Inflorescence a spike, several spikes of spikelets or a spike-like cylindrical panicle .. ..... <b>2</b>
-	Inflorescence effuse, or a contracted panicle or a dense raceme-like panicle ..... <b>4</b>
2	Spikelets awned, in triplets at each node ..... <b>Hordeum</b>
-	Spikelets awnless, not in triplets at each node ..... <b>3</b>



3	Inflorescence with several spikes, branches digitate; spikelets laterally compressed; caryopsis oblong; very common .....	<i>Cynodon</i>
-	Inflorescence a spike-like cylindrical panicle; spikelets dorsally compressed; caryopsis obovoid or globose .....	<i>Pennisetum</i>
4	Spikelets awned .....	5



-	Spikelets awnless .....	9
5	Spikelets 1-flowered; glumes mostly 3-veined .....	6
-	Spikelets several- to many-flowered; glumes 1-9 veined .....	8

6	Ligule membranous; awn of lemma not branched .....	7
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-	Ligule a dense fringe of short hairs; awn of lemma divided into 3 branches; all, or median branches only, leathery .....	<i>Stipagrostis</i>
7	cle contracted, lemma hairy, palea hyaline .....	<i>Stipa</i>
-	Panicle lax (or effuse), lemma glabrous, palea coriaceous .....	<i>Oryzopsis</i>



8	Glumes equal or subequal; awn arising at middle lemma; caryopsis cylindrical grooved on ventral side .....	<i>Avena</i>
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-	Glumes unequal; awn arising in sinus between apical teeth or lobes of lemma; caryopsis flattened at back, oblong, with a hairy apical appendage ..... <b><i>Bromus</i></b>
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9	Plant annual; ligule reduced to a fringe of long hairs; spikelets 5-10 flowered ..... <b><i>Schismus</i></b>
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-	Plant perennial, ligule membranous, with or without rim with a row of dense hairs or with cilia at margin; spikelets 1,2 or 2-10 flowered ..... <b>10</b>
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10	Glumes and lemma keeled; spikelets 2-10 flowered, plant with bulbous base ..... <b><i>Poa</i></b>
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-	Glumes and lemma not keeled; spikelets (-)2 flowered, plant without bulbous base ..... <b>11</b>
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11	Inflorescence an effuse or more rarely a contracted panicle; spikelets not subtended by bristles or spines, spikelets pedicelled; caryopsis elliptic ..... <b><i>Panicum</i></b>
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-	Inflorescence a spike-like cylindrical panicle; spikelets subtended by bristles or spines; spikelets sessile; caryopsis obovoid or globose ..... <b><i>Pennisetum</i></b>
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