

Nutlet morphology and its taxonomic implication in some taxa of Lamiaceae in Egypt

Wafaa M. Kamel

Botany Department, Faculty of Science, Suez Canal University, Ismailia-Egypt

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Nutlet morphology of 28 taxa belonging to 15 genera of Lamiaceae were examined using light and scanning electron microscopy. The taxa included representatives of the three subfamilies Ajugoideae, Lamioideae and Nepetoideae which all collected especially from Sinai, Egypt. Morphological characters, including nutlet shape, color, size; hilum (shape, length x width and position); epidermal cell shape; anticlinal walls (level, undulation, thickness and secondary sculpture); outer periclinal cell walls (level and secondary sculpture) are presented. The reticulate type was the most common among the studied taxa. Four types of basic anticlinal cell wall boundaries were recognized and many different shapes of the outer periclinal cell wall were described. Nutlet ornamentation, shape, size, colour and particularly hilum characters proved to be good taxonomic characters for the Egyptian Lamiaceae taxa. A key for the identification of the investigated taxa based on nutlet characters is provided.

Key words: Lamiaceae, nutlet morphology, SEM, Egypt.

Introduction

Lamiaceae (Labiatae) is one of the largest angiospermic families, includes 236 genera and about 7173 species. They are almost cosmopolitan but absent from the coldest regions of high altitude or latitude, including many well-known plants, herbs, shrubs and trees of horticultural, economic and medicinal significance (Harley *et al.* 2004). Hedge (1992) recognized six regions of high Labiatae diversity. The Mediterranean and SW Central

Asiatic regions represent one of the greatest centers of diversity of many genera.

In the flora of Egypt, Lamiaceae is the tenth largest plant family, represented by 23 genera and 55 species, four of which are endemic in Egypt (Boulos 2002, 2009). Täckholm (1974) reported 22 genera and 56 species. El-Husseini (1986) in her Ph.D. Thesis recorded also 22 genera and only 54 species, whereas El-Hadidi and Fayed (1995) reported only 20 genera and 51 species. Based on the most recent classification of Harley *et al.* (2004) and Bendiksby *et al.* (2011), Lamiaceae is divided into seven subfamilies. In this study all Egyptian Lamiaceae taxa are classified under the three subfamilies Ajugoideae, Lamioideae and Nepetoideae (Harley *et al.* 2004 and Bendiksby *et al.* 2011).

Heywood (1971) drew attention to the importance and impact of scanning electron microscopy (SEM) in the study of the systematic problems, as very valuable information has been provided by using this technique.

Nutlet morphology and micromorphology in Lamiaceae has proved useful to varying degrees at different levels of the taxonomic hierarchy, depending on the characters chosen and variation present. Studies on nutlet morphology and pericarp structure in Lamiaceae are increasing (Cantino 1990 and 1992; Husain *et al.* 1990; Demissew and Harley 1992; Ryding 1993, 1994 and 1998; Marin *et al.* 1994 and Oran 1996). In recent years, the importance of scanning electron microscopy (SEM) in the study of nutlets surface and its taxonomic value has been ascertained for various genera of Lamiaceae (Stace 1989; Husain *et al.* 1990; Stuessy 1990; Ryding 1993; Marin *et al.* 1994, 1996; Oran 1996; Guerin 2005, Salmaki *et al.* 2008; Hassan *et al.* 2012; Mousavi *et al.* 2013 and Tarimcilar *et al.* 2013). These studies showed that nutlet characters are potentially useful within the Lamiaceae at the level of section, genus and species.

Ryding (1993, 1994) studied nutlet characters in *Leucas* and related genera of subfamily Lamioideae and pericarp structure and phylogeny of subfamily Podostemonoideae of Lamiaceae using SEM. He found that nutlet surfaces were typically smooth, while sub-surface characters were used to distinguish taxa. Marin *et al.* (1994) characterized nutlets of *Teucrium* L. using the presence and density of oil glands. Oran (1996) found that gross nutlet morphology and surface sculpturing in species of *Salvia* L. was variable and taxonomically useful. He developed descriptive categories

for shape, surface sculpturing pattern and cellular deposits. Husain *et al.* (1990) studied the micromorphology in the tribe Saturejeae and found that sculpturing patterns (most commonly reticulate) were the most useful characters. Demissew and Harley (1992) studied the seed epidermis and stated that surface types correlated with the three infrageneric groups of *Stachys* in tropical Africa. The surface types recognized were coarsely reticulate, finely reticulate, and reticulate-spinulose. Guerin (2005) studied nutlets of *Hemigenia* and *Microcorys*. Significant variation, mainly useful at the infrageneric level, was found in nutlet shape, nature of the attachment scar, nature of surface sculpturing, exocarp cell shape and sculpturing, and nature of the indumentums. Salmaki *et al.* (2008) studied nutlets micromorphology and its systematic implication in 31 taxa of *Stachys*, representing nine sections and one species of a closely genus distributed in Iran. However, the type of sculpturing is more useful for separating species within the section, rather than correlating the related ones to each other. Hassan *et al.* (2012) studied nutlets micromorphology of thirteen species of *Nepeta*. Two main patterns, reticulate and indistinct reticulate were described. Mousavi *et al.* (2013), studied micromorphology features of ten *Salvia* nutlets growing in NE Iran. They divided these species into three and four groups based on the shape and ornamentation of nutlets respectively. The variation in color, size and ornamentation of mericarp helped to identify species. Tarimcilar *et al.* (2013) investigated nutlet morphology of 11 taxa of *Mentha* distributed throughout Turkey using SEM. In their study, they divided *Mentha* into three groups, based on nutlet sculpturing type such as distinctly bireticulate, inconspicuously bireticulate and reticulate.

Husain *et al.* (1990) concluded that features of nutlets were useful in providing evidence for phylogenetic reconstruction. Cantino (1992) and Ryding (1998) used nutlet characters, including ultrastructure, surface morphology and shape, in cladistic analyses within Lamiaceae, but they did not elaborate on the nature or selection of the characters.

Although there are many studies on the nutlet characters of family Lamiaceae as shown above, only few Egyptian species have been treated e.g. *Teucrium polium* (Marin *et al.* 1994); *Salvia sclarea* (Marin *et al.* 1996 and Mousavi *et al.* 2013); *Salvia palaestina* (Kahraman and Dogan 2010) and *Mentha longifolia* (Tarimcilar *et al.* 2013). Therefore the present investigations deal with morphological characters of nutlet (mericarp) of 28 taxa belonging to 15 genera of Lamiaceae in Egypt, especially in Sinai, to

find good nutlet characters for comparison and delimitation of genera and species in the family.

Materials and Methods

This study is based on mature nutlets of 28 species of Lamiaceae. Sample of each taxon were taken from field collections and herbarium specimens (Table 1). Voucher specimens are deposited in the Herbarium of the Suez Canal University, Faculty of Science, Ismailia, Egypt (SCU-I, proposed acronym of the herbarium). The collected specimens were identified according to Täckholm (1974) and Boulos (2002 , 2009).

The external macromorphological aspects of the nutlets of the studied taxa were examined by light stereomicroscope. At least 10-15 mature nutlets for each taxon were taken to cover the range of variations. For scanning electron microscopy (SEM) investigation, the nutlets were dried and fixed to specimens stubs with an adhesive material and placed on the revolving discs of Joel fine coat ion sputter (Joel, JFC 1100E). Each nutlet was uniformly coated with a thin layer of gold, then scanned and photographed using JEOL JSM 5300 SEM with an accelerating voltage of 15 kv at Electron Microscopic Unit, Faculty of Science, Assiut University (Egypt). Actually, nutlets were studied from different views, but when the sculpturing patterns varied at different views, the dorsal surfaces were chosen for description. Nutlet surface sculpturing terminology follows Barthlott (1981) and Stearn (1983). Selected SEM micrographs of nutlets are presented in Figs. (1-33).

The main features of the investigated nutlets are summarized in Table (2, 3 &4). The shape of nutlets showed types of variation among the investigated taxa (Figs. 1-33).

Result and Discussion

The main features of the investigated nutlets are summarized in Table (2, 3 &4). The shape of nutlets showed types of variation among the investigated taxa (Figs. 1-33).

Nutlet shape varies from obovoid (e.g. *Ajuga iva* and *Stachys aegyptiaca*), ellipsoid (*Teucrium leuclidum*), ellipsoid-obovoid (*Teucrium decaisnei*), obovoid-trigonous (*Phlomis aurea*), oblong (*Marrubium alysson* and *Lavandula coronopifolia*), oblanceoloid-ellipsoid

(*Salvia deserti*), subglobose (*Mentha longifolia* subsp. *typhoides*), globose (*Salvia palaestina* and *S. spinosa*) to ovoid-oblong (*Thymus decussatus*).

Nutlet size ranged between 0.6-5.5 mm in length and 0.2-2.5 mm in width. Among the examined taxa *Phlomis aurea* has the largest nutlets (4.3-5.5 x 1.9-2.5 mm) followed by *Salvia palaestina* (3.2-3.7 x 2.5-3 mm), while species like *Mentha longifolia* subsp. *typhoides* (0.6-0.7 x 0.4-0.5mm) and *Micromeria sinaica* possessed small (0.7-1 x 0.2-0.3mm) nutlets (Table 2). Most of the studied taxa showed glabrous nutlets (23 taxa), but the remaining five species covered by sparsely or dense sessile glandular hairs e.g. *Ballota undulata*, *Marrubium alysson*, *M. vulgare*, *Lavandula coronopifolia* and *L. pubescens*.

Nutlet colour were ranging from pale brown or brown (*Lavandula pubescens*), brown (*Marrubium vulgare*, *Thymus bovei* and *T. decussatus*), dark brown (*Teucrium decaisnei* and *T. polium*), yellowish brown (*Micromeria sinaica*), orange brown (*Origanum syriacum* subsp. *sinaicum*), greyish to black (*Ajuga iva*), dark brown-black (*Stachys aegyptiaca* and *Nepeta septemcrenata*) and black (*Salvia aegyptiaca*, *S. deserti* and *S. lanigera*); except for *Lamium amplexicaule* dark brown with irregular whitish spots; and *Salvia multicaulis*, *S. palaestina*, *S. sclarea* and *S. spinosa* have pale or dark brown with darker net veins. **Luster of nutlets** surface varies from matte in 14 taxa, semi matte in 12 taxa and glossy in *Salvia palaestina* and *S. spinosa* (Table 2).

Dorsal surface of nutlets showed three types of variation among the investigated taxa. Most nutlets were convex (24 taxa); more or less convex in *Otostegia fruticosa* and *Micromeria nervosa* and convex-trigonous in *Lavandula coronopifolia* and *L. pubescens*. The ventral mid rib of the nutlet was indistinct in 20 taxa; distinct in the three species *Lamium amplexicaule*, *Otostegia fruticosa* and *Phlomis aurea*. Moreover four taxa have distinct midrib toward the base e.g. *Marrubium alysson*, *M. vulgare*, *Stachys aegyptiaca* and *Mentha longifolia* subsp. *typhoides*. *Ballota undulata* was the only species having a more or less distinct mid rib. The majority of the nutlets apex were rounded (23 taxa). The apex was rounded with more or less mucronate tip in one taxon (*Stachys aegyptiaca*); truncate in 3 species, *Lamium amplexicaule*, *Otostegia fruticosa* and *Phlomis aurea* and obtuse in *Micromeria sinaica* (Table 2).

Base of nutlet was rounded in 10 taxa and obtuse in 7 taxa. *Lamium amplexicaule* was characterized by having a nutlet with an elongated, light

coloured elaiosome cells at the truncate base. This result agrees with that given by Strasburger (1978), Wojciechowska(1972), and Packham(1983). Base was truncate in *Ajuga chamaepitys* subsp. *tridactylites* and *Salvia sclarea*; rounded with more or less pointed tip in *Marrubium vulgare*; obtuse with more or less small beak in *Thymus decussates*; shortly attenuate in *Otostegia fruticosa* and shortly attenuate-obtuse in the remaining 5 taxa.

Shape of hilum showed either obovoid (e.g. *Ajuga chamaepitys* subsp. *tridactylites* , *A.iva*, *Thymus bovei* and *T. decussatus*), triangular (*Lamium amplexicaule* and *Marrubium alysson*), subglobose-globose (*Teucrium polium*, *T. leuclidum*), globose (*Teucrium decaisnei*), rhomboidal-globose (*Salvia lanigera*), discoid (*Salvia multicaulis*), bilobed (*Nepta septemcrenata*), ovoid (*Micromeria nervosa*), ellipsoid (*Micromeria sinaica*) or obcordate-rounded (*Lavandula coronopifolia* and *L. pubescens*). In some taxa hilum was present at lateral position others have basal and subbasal position, mostly without rim (22 taxa). **Hilum size** ranged from 0.06 -1.9 mm in length and 0.05- 1.3 mm in width. Among the examined taxa *Ajuga chamaepitys* subsp. *tridactylites* and *A.iva* showed the largest hilum (1.3-1.4 X 0.6- 0.7mm & 1.8-1.9 X 1.2-1.3 mm), while *Micromeria nervosa* and *M.sinaica* possessed small (0.06-0.1 x 0.05-0.1mm & 0.08-0.1 x 0.05- 0.07 mm) hilum. The two genera, *Ajuga* and *Teucrium*, showed significant length of the hilum (often over half length of nutlet). This result agree with that given by Guerin (2005) and Özkan *et al.* (2009). Since the shape, position and size of hilum varies within the species, so it was useful character for delimitation of the taxa (Table 4).

Homogeneity of testa cell size of the studied taxa were variable from regular, more or less regular and irregular. It was regular in *Teucrium decaisnei*, *T. leuclidum*, *Otostegia fruticosa*, *Mentha longifolia* subsp.*typhoides* , *Micromeria nervosa*, *M. sinaica*, *Thymus bovei* and *T. decussatus* (figs. 3c,4c,10c,15c,16c,17c,27c,28c). *Marrubium alysson* is more or less regular, (fig.8c). The remaining taxa (19 taxa) had irregular testa cell size. Epidermal cell shape varies from tetra-penta-hexagonal to elongated or rounded.

Surface ornamentation: Regarding the nutlet surface ornamentation, four main types can be distinguished: I. reticulate (the most common type) , II. rugose, III. ruminant, and IV. smooth slightly tuberculate. Within these types, variants were recognized (Table 3).

Type I: Reticulate: be divided into 8 subtypes. These are:

Subtype 1: Reticulate, this sculpture pattern is recorded in *Ajuga iva*, *Ballota undulata*, *Lamium amplexicaule*, *Stachys aegyptiaca*, *Lavandula pubescens*, *L. coronopifolia*, *Mentha longifolia* subsp. *typhoides*, *Micromeria nervosa*, *Salvia aegyptiaca*, *S. deserti* and *Thymus bovei* (figs. 2c, 6c, 7c, 12c, 13c, 14c, 15c, 16c, 20c, 21c, 27c).

Subtype 2: reticulate to reticulate-colliculate in *Teucrium decaisnei*, *T. leuclidum*, *T. polium* (figs. 3c, 4c, 5c).

Subtype 3: upper portion reticulate (1/3 length) and remaining portion transversely rugose (2/3 length) in *Ajuga chamaepitys* subsp. *tridactylites* (fig. 1c).

Subtype 4: reticulate-verrucate in *Marrubium vulgare* *M. alysson*, *Salvia lanigera* (figs. 8c, 9c, 22c).

Subtype 5: reticulate-ruminate in *Otostegia fruticosa* (fig. 10c).

Subtype 6: reticulate-tuberculate in *Nepeta septemcrenata* (fig. 18c).

Subtype 7: reticulate-foveate in *Salvia multicaulis* and *S. spinosa* (figs. 23c, 26c).

Subtype 8: indistinct reticulate in *Thymus decussatus* (fig. 28c).

Type II: rugose: this type is divided into 3 subtypes as follows:

Subtype 1: irregular rugose- scrobiculate in *Phlomis aurea* (fig. 11c).

Subtype 3: longitudinal coarse rugose in *Micromeria sinaica* (fig. 17c).

Subtype 4: scleariform-rugose in *Salvia sclarea* (fig. 25c). This result agree with those given by Mousavi *et al.* 2013 and do not agree to Marin *et al.* 1996.

Type III: ruminant: in *Origanum syriacum* subsp. *sinaicum* (fig. 19c).

Type IV: smooth, slightly tuberculate in *Salvia palaestina* (fig. 24c). This result is similar to that given by Kahraman and Dogan 2010.

Anticlinal cell wall boundaries were generally well developed (Table 3). These were four types:

1. channelled in 5 taxa: *Marrubium alysson*, *Stachys aegyptiaca*, *Micromeria nervosa*, *Thymus bovei* and *T. decussatus* (figs. 8c, 12c, 16c, 27c, 28c).
2. slightly raised in 7 taxa: *Teucrium decaisnei*, *T. leuclidum*, *Lavandula pubescens*, *Mentha longifolia* subsp. *typhoides*, *Salvia palaestina*, *S. sclarea* and *S. spinosa* (figs. 3c, 4c, 14c, 15c, 24c, 25c, 26c).
3. more or less raised in *Phlomis aurea* (fig. 11c).

4. raised in the remaining 15 taxa (figs. 1c, 2c, 5c, 6c, 7c, 9c, 10c, 13c, 17c, 18c, 19c, 20c, 21c, 22c, 23c). Undulation of the anticlinal walls were straight in most of the studied taxa (21); more or less straight in *Ajuga chamaepitys* subsp. *tridactylites*, *Lamium amplexicaule* and *Salvia lanigera* (figs. 1c, 7c, 22c); undulate in *Ajuga iva*, *Origanum syriacum* subsp. *sinaicum*, *Salvia sclarea* and *Thymus decussatus* (figs. 2c, 19c, 25c, 28c). The anticlinal walls were distinct thick in *Ajuga iva* and *Mentha longifolia* subsp. *typhoides* (figs. 2c, 15c); thick in 7 taxa *Otostegia fruticosa*, *Marrubium vulgare*, *Micromeria sinaica*, *Origanum syriacum* subsp. *sinaicum*, *Salvia palaestina*, *S. sclarea* and *S. spinosa* (figs. 10c, 13c, 17c, 19c, 24c, 25c, 26c); more or less thick in *Ballota undulata*, *Phlomis aurea* and *Salvia lanigera* (figs. 6c, 11c, 22c); and thin in the remaining taxa (16). The patterns of the secondary sculpture in anticlinal walls varies from greatly smooth in *Salvia spinosa* (fig. 26c); undulate in *Ajuga iva*, *Lamium amplexicaule* and *Origanum syriacum* subsp. *sinaicum* (figs. 2c, 7c, 19c); ribbed in *Micromeria sinaica* and *Salvia sclarea* (figs. 17c, 25c) and striate in the 22 remaining taxa.

Periclinal walls were distinctly flat in *Phlomis aurea*, *Mentha longifolia* subsp. *typhoides* and *Micromeria nervosa* (figs. 11c, 15c, 16c); flat to slightly convex in *Thymus decussatus* (fig. 28c); flat to slightly concave in *Marrubium alysson*, *Stachys aegyptiaca*, *Lavandula pubescens*, *Salvia sclarea* and *Thymus bovei* (figs. 8c, 12c, 14c, 25c, 27c); concave with sunken center in *Otostegia fruticosa* and *Lavandula coronopifolia* (figs. 10c, 13c); slightly concave in *Teucrium decaisnei*, *Origanum syriacum* subsp. *sinaicum*, *Salvia palaestina* and *S. spinosa* (figs. 3c, 19c, 24c, 26c) and concave in the remaining 13 taxa.

Secondary sculpture (fine relief of cell wall) in periclinal cell walls showed also great variations. It varies from striate-favulariate e.g. *Ajuga chamaepitys* subsp. *tridactylites*, *Teucrium decaisnei*, *Marrubium vulgare* (Figs. 1c, 3c, 9c); smooth in *Ajuga iva*, *Phlomis aurea*, *Micromeria sinaica*, *Origanum syriacum* subsp. *sinaicum* and *Salvia palaestina* (Figs. 2c, 11c, 17c, 19c, 24c); favulariate in *Teucrium leucocladum* and *Salvia lanigera* (Figs. 4c, 22c); striate to micro-crimped papillae in *Teucrium polium* (Fig. 5c); striate with mostly globular central papillae in *Mentha longifolia* (Fig. 15c); striate to micro-reticulate in *Ballota undulata*, *Thymus bovei* and *T. decussatus* (Figs. 6c, 27c, 28c); ruminant to micro-reticulate in *Lamium*

amplexicaule (Fig. 7c); smooth outer-striate in center in *Marrubium alysson*(Fig. 8c); striate-foveate in *Otostegia fruticosa* (Fig. 10c); striate-rugose in *Stachys aegyptiaca* (Figs. 12c); striate in *Lavandula coronopifolia*; *L. pubescens*, *Nepta septemcrenata*, *Salvia aegyptiaca*, *S. deserti* and *S. multiculais* (Figs. 13c, 14c, 18c, 20c, 21c, 23c); ruminant in *Salvia sclarea* (Fig. 25c); foveate-smooth in *Salvia spinosa* (Fig. 26c) and circular striate in *Micromeria nervosa* (Fig. 16c).

Key to the studied taxa based on Nutlet characters

- 1a. Nutlets with distinct large hilum, more than half its length 2
 b. Nutlets with small hilum, less than fourth its length 6
 2a. Nutlets obovoid or narrowly obovoid, length 2.3-3 mm 3
 b. Nutlets ellipsoid or nearly ellipsoid, length 1.2-2.2 mm 4
 3a. Nutlets 0.6-0.8 mm wide; sculpture reticulate above (1/3 L.), transversely rugose in remaining its length. (2/3L.); anticlinal boundaries thin
 *Ajuga chamaepitys* subsp. *tridactylites*
 b. Nutlets 1.3-1.6 mm wide; sculpture reticulate; anticlinal boundaries very thick *Ajuga iva*
 4a. Hilum 0.8-0.82x0.77-0.81 mm; nutlets 1.2-1.5x0.7-1 mm; dark brown to black..... *Teucrium leucocladum*
 b. Hilum 1-1.2x0.98-1.1 mm; nutlets 1.6-2.2x1-1.4 mm; dark brown 5
 5a. Nutlets ellipsoid-obovoid; periclinal cell wall sculpture striate-favulariate; anticlinal boundaries slightly raised ... *Teucrium decaisnei*
 b. Nutlets ellipsoid-oblong; periclinal cell wall cell sculpture striate-to microcrimped papilla; anticlinal boundaries raised ... *Teucrium polium*
 6a. Nutlets sculpture distinct reticulate or nearly reticulate 7
 b. Nutlets sculpture not reticulate 24
 7a. Anticlinal boundaries channelled 8
 b. Anticlinal boundaries raised or slightly raised 12
 8a. Nutlets 0.8-1x0.4-0.6 mm; with base obtuse; hilum 0.05-0.1 mm wide . 9
 b. Nutlets 1.8-2.8x1-2.4 mm; with base rounded or shortly attenuate-obtuse; hilum 0.13-0.35 mm wide 10
 9a. Sculpture of periclinal cell wall circular striate; anticlinal boundaries straight; hilum ovoid, 0.06-0.1mm long *Micromeria nervosa*
 b. Sculpture of periclinal cell wall striate to micro-reticulate; anticlinal boundaries undulate; hilum obovoid, 0.12-0.15 mm long
 *Thymus decussatus*

- 10a. Nutlets oblong, with glandular hairs at apex *Marrubium alysson*
 b. Nutlets obovoid or ellipsoid- obovoid, not hairy at apex **11**
- 11a. Nutlet dark brown to black; hilum 0.3-0.35x0.35-0.4mm; sculpture of periclinal wall striate-rugose *Stachys aegyptiaca*
 b. Nutlet brown; hilum 0.15-0.18x0.13-0.15mm; sculpture of periclinal wall striate-to micro-reticulate *Thymus bovei*
- 12a. Nutlet surface with darker net veins; sculpture reticulate-foveate **13**
 b. Nutlet surface without darker net veins; sculpture not as above **14**
- 13a. Nutlets 1.8-2.2mm long; semi-matte; anticlinal boundaries raised, thin, striate *Salvia multicaulis*
 b. Nutlets 1.2-1.5mm long; glossy; anticlinal boundaries slightly raised, thick, not striate (smooth) *Salvia spinosa*
- 14a. Nutlet apex truncate; ventral surface with distinct mid rib **15**
 b. Nutlet apex rounded ; ventral surface with mostly distinct mid rib toward base **16**
- 15a. Nutlet dark brown with irregular whitish spots; base truncate with an elongated light coloured elaiosome cells ; sculpture of periclinal cell wall ruminant to micro-reticulate, concave *Lamium amplexicaule*
 b. Nutlets brown; shortly attenuate towards base, sculpture of periclinal cell wall striate-foveate ,concave with sunken center
 *Otostegia fruticosa*
- 16a. Hilum bilobed or broad obcordate-rounded, 0.3-0.6 mm wide **17**
 b. Hilum not bilobed, 0.05-0.2 8mm wide **20**
- 17a. Nutlets with glandular hairs; dorsal surface convex-trigonous **18**
 b. Nutlets glabrous; dorsal surface convex **19**
 18a. Nutlets 1.2-1.4x0.6-0.7mm; anticlinal boundaries thick; periclinal cell wall slightly concave with sunken center *Lavandula coronopifolia*
 b. Nutlets 1.5-1.8x0.8-1 mm; anticlinal boundaries thin; periclinal cell wall flat- slightly concave *Lavandula pubescens*
- 19a. Nutlets oblong-ellipsoid or obovoid, 1.6-2x0.9-1.1mm; sculpture reticulate-tuberculate; anticlinal boundaries thin *Nepta septemcrenata*
 b. Nutlets subglobose, 0.6 -0.7x0.4-0.5 mm; sculpture reticulate; anticlinal boundaries thick *Mentha longifolia* subsp. *Typhoides*
- 20a. Nutlets brown or dark brown; ventral surface hairy at apex **21**
 b. Nutlets black; ventral surface glabrous **22**
- 21a. Nutlet sculpture reticulate; sculpture of periclinal cell wall striate-to micro-reticulate; anticlinal boundaries thick *Ballota undulata*

- b. Nutlets sculpture reticulate-verrucate ; sculpture of periclinal wall striate-favulariate; anticlinal boundaries thin *Marrubium vulgare*
- 22a. Nutlets 1.2-1.4mm long; sculpture reticulate -verrucate; anticlinal boundaries \pm thick; sculpture of periclinal cell wall favulariate
..... *Salvia lanigera*
- b. Nutlets 1.8-2.2 mm long; sculpture reticulate; anticlinal boundaries thin; sculpture of periclinal cell wall striate **23**
- 23a. Nutlets semi-matte, oblong or oblong-ellipsoid, 0.8-0.9 mm wide; hilum obovoid *Salvia aegyptiaca*
- b. Nutlets matte, oblanceoloid-ellipsoid, 1.1-1.2 mm wide; hilum ellipsoid *Salvia deserti*
- 24a. Nutlets 0.7-1x0.2-0.7mm; yellowish or orange brown **25**
- b. Nutlets 2.5-5.5x2-3mm; pale to dark brown **26**
- 25a. Nutlets narrow oblong, sculpture longitudinal coarse rugose
..... *Micromeria sinaica*
- b. Nutlets subglobose to broadly ovoid, sculpture ruminant
..... *Origanum syriacum*
- 26a. Nutlets obovoid- trigonous; apex truncate with small beak; surface of nutlets without vines *Phlomis aurea*
- b. Nutlets globose, subglobose-ellipsoid, apex rounded; surface of nutlets with darker net viens **27**
- 27a. Sculpture smooth-slightly tuberculate; nutlets 3.2-3.7mm long
..... *Salvia palaestina*
- b. Sculpture sclariform-rugose; nutlets 2.4-2.6mm long ... *Salvia sclarea*

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Table 1. Nutlet specimens examined; their sub familial classification (according to Harley 2004) and collection details.

Taxa	Collection Data
Subfamily: Ajugoideae kostel. (1843)	
1- <i>Ajuga chamaepitys</i> (L.) Schreb. subsp. <i>tridactylites</i> (Benth.) P.H.Davis	S. Sinai, E' slopes of Jebel Katherine, 1900 - 2250m, 33° 58' E, 28°31' N, 28.4.1991, E.Gamal Eldin, s.n.SCU-I.
2- <i>Ajuga iva</i> (L.) Schreb.	Mersa- Matruh, the road of Sallum, 16.4.2010, A.El Banhawy, s.n.SCU-I.
3- <i>Teucrium decaisnei</i> C.Presl	S. Sinai, Wadi El-Deir, 31.8.2001, W. Kamel, s.n.SCU-I.
4- <i>Teucrium leucocladum</i> Boiss.	S. Sinai, Wadi Teffaha, 33° 55' E, 28 ° 34' N, 30.8.2001, W. Kamel, s.n.SCU-I.
5- <i>Teucrium polium</i> L.	S. Sinai, Wadi Gebal, 13.7.2002, M. Soliman, s.n.SCU-I.
Subfamily: Lamioideae Harley (2003)	
6- <i>Ballota undulata</i> (Fresen.) Benth.	S. Sinai, Kahf El-Ghola, 21.6.1999, W. Kamel, s.n.SCU-I.
7- <i>Lamium amplexicaule</i> L.	S. Sinai, Wadi El-Arbaeen, El-Deir garden, 33° 57' E, 28°33' N, 3.5.2004, W. Kamel, s.n.SCU-I.
8- <i>Marrubium alysson</i> L.	Alexandria - Matruh road Kilo 45, 31.8.1984, W. Kamel s.n.SCU-I.
9- <i>Marrubium vulgare</i> L.	Sallum road , toward W. Mersa- Matruh, 15.4.2010, A.El Banhawy, s.n.SCU-I.
10- <i>Otostegia fruticosa</i> (Forssk.) Penz.	S. Sinai, Wadi Isla , 1.10.1990, E.Gamal Eldin, s.n.SCU-I.
11- <i>Phlomis aurea</i> Decne.	S. Sinai, Wadi El-Arbaeen, 33° 57' E, 28°32' N, 2.11.2009, W. Kamel, s.n.SCU-I.
12- <i>Stachys aegyptiaca</i> Pers.	S. Sinai, Wadi El-Arbaeen, 5.11.2009, W. Kamel, s.n.SCU-I.
Subfamily: Nepetoideae (Dumort.) Luerss.(1882)	
13- <i>Lavandula coronopifolia</i> Poir.	S. Sinai, Wadi Gharba, 2.6.2001, M. Zaghoul, s.n.SCU-I.
14- <i>Lavandula pubescens</i> Decne.	S. Sinai, Wadi Tala'a , 24.4.2009, W. Kamel, s.n.SCU-I.
15- <i>Mentha longifolia</i> (L.) Huds.subsp. <i>typhoides</i> (Briq) Harley	S. Sinai, Wadi Isla , 1.10.1990, E.Gamal Eldin, s.n.SCU-I.
16- <i>Micromeria nervosa</i> (Desf.) Benth.	N. Sinai, Ain El-Gedeirat , 3.5.1988, W. Kamel, s.n.SCU-I.
17- <i>Micromeria sinaica</i> Benth.	S. Sinai, Wadi El-Deir, 30.5.1991, E.Gamal Eldin, s.n.SCU-I.
18- <i>Nepeta septemcrenata</i> Benth.	S. Sinai, Kahf El-Ghola, 3.12.1993, W. Kamel, s.n.SCU-I.

Table 1 (Continued)

19- <i>Origanum syriacum</i> L. subsp. <i>sinaicum</i> (Boiss.) Greuter&Burdet	S. Sinai, Wadi Abu Tuweita, 9.5.2009, A.El Banhawy, s.n.SCU-I.
20- <i>Salvia aegyptiaca</i> L.	N. Sinai, before Nakhl by 3 Km , 3.4.1996, W. Kamel, s.n.SCU-I.
21- <i>Salvia deserti</i> Decne.	S. Sinai, Wadi El- Rahaa, 1480-1500 m, 33° 56' E, 28°35' N, 23.4.12009 W. Kamel, s.n.SCU-I.
22- <i>Salvia lanigera</i> Poir.	N. Sinai, El-Qusaima, H.Soliman garden, 2.4.2009. W. Kamel, s.n.SCU-I.
23- <i>Salvia multicaulis</i> Vahl	S. Sinai, Wadi Abu Tuweita, 9.5.2009, A.El Banhawy, s.n.SCU-I.
24- <i>Salvia palaestina</i> Benth.	S. Sinai, Wadi Tobouq, 1775 m, 33° 56' E, 28°32' N, 8.5.2009, A.El Banhawy, s.n.SCU-I.
25- <i>Salvia sclarea</i> L.	S. Sinai, Wadi Gebal, 10.5.2009, A.El Banhawy, s.n.SCU-I.
26- <i>Salvia spinosa</i> L.	S. Sinai, Scientific station in St. Katherine city , 33° 57' E, 28°33' N, 3.5.2004, W. Kamel, s.n.SCU-I.
27- <i>Thymus bovei</i> Benth.	S. Sinai, Wadi Gebal, 3.12.2011, M. Soliman, s.n.SCU-I.
28- <i>Thymus decussatus</i> Benth.	S. Sinai, Wadi El Fara'a, 4.5.2004, W. Kamel, s.n.SCU-I.

Table 2. Nutlet macromorpholog of studied taxa.

Taxa	Characters								
	Shape	L X W (mm)	Colour	Luster	Dorsal surface	Ventral midrib	Apex	Base	Presence of glands
Subfamily: Ajugoideae 1- <i>Ajuga chamaepitys</i> (L.) Schreb. subsp. tridactylites (Benth.) P.H.Davis	Narrowly obovoid	2.3 -2.8 X 0.6-0.8	Brown or dark brown	Matte	Convex	Indistinct	Rounded	Truncate	-
2- <i>Ajuga iva</i> (L.) Schreb.	Obovoid	2.5 -3 X 1.3 -1.6	Black or greyish	Matte	Convex	Indistinct	Rounded	Rounded	-
3- <i>Teucrium decaisnei</i> C.Presl	Ellipsoid -obovoid	1.6-2 X 1-1.3	Dark brown	Matte	Convex	Indistinct	Rounded	Rounded	-
4- <i>Teucrium leucocladum</i> Boiss.	Ellipsoid	1.2-1.5 X 0.7-1	Dark brown to black	Matte	Convex	Indistinct	Rounded	Rounded	-
5- <i>Teucrium polium</i> L.	Ellipsoid -oblong	1.8-2.2 X 1.1-1.4	Dark brown	Matte	Convex	Indistinct	Rounded	Rounded	-
Subfamily: Lamioideae 6- <i>Ballota undulata</i> (Fresen.) Benth.	Obovoid	1.8-2.2 X 1-1.3	Dark brown	Matte	Convex	± Distinct	Rounded	Obtuse	±
7- <i>Lamium amplexicaule</i> L.	Prolonged obovoid	2-2.4 X 1.2-1.3	Dark brown with irregular whitish spots	Matte	Convex	Distinct	Oblique truncate	Truncate with elongated cells base	-
8- <i>Marrubium alysson</i> L.	Oblong	1.8-2 X 1-1.2	Dark brown	Matte	Convex	Distinct toward base	Rounded	Rounded	+ at apex
9- <i>Marrubium vulgare</i> L.	obovoid- ellipsoid	2- 2.2 X 1.1 - 1.3	Brown	Semi-matte	Convex	Distinct toward base	Rounded	Rounded ± pointed tip	+ at apex of ventral surface
10- <i>Otostegia fruticosa</i> (Forssk.) Penz.	Widely obovoid-trigonus	1.3-1.5 X 1.1- 1.3	Brown	Matte	± Convex	Distinct	Truncate	Shortly attenuate	-
11- <i>Phlomis aurea</i> Decne.	Obovoid-trigonus	4.3-5.5 X 1.9-2.5	Brown to dark brown	Matte	Convex	Distinct	Truncate with small beak	Very shortly attenuate - obtuse	-
12- <i>Stachys aegyptiaca</i> Pers.	Obovoid	2.2-2.5 X 1.2-1.4	Dark brown to black	Matte	Convex	Distinct toward base	Rounded or ± mucronate	Rounded	-
Subfamily: Nepetoideae 13- <i>Lavandula coronopifolia</i> Poir.	Oblong	1.2-1.4 X 0.6-0.7	Brown	Semi-matte	Convex-trigonus	Indistinct	Rounded	Rounded	+
14- <i>Lavandula pubescens</i> Decne.	Oblong or oblong-ellipsoid	1.5-1.8 X 0.8 -1	Pale brown or brown	Matte	Convex-trigonus	Indistinct	Rounded	Rounded	+

Table 2 (Continued)

15- <i>Mentha longifolia</i> (L.). Huds.subsp <i>typhoides</i> (Briq.)Harley	Subglobose	0.6-0.7 X 0.4-0.5	Brown to dark brown	Semi- matte	Convex	Distinct toward base	Rounded	Obtuse	-
16- <i>Micromeria nervosa</i> (Desf.) Benth.	Oblong	0.8-0.9 X 0.4-0.5	Brown	Semi- matte	± Convex	Indistinct	Rounded	Obtuse	-
17- <i>Micromeria sinaica</i> Benth.	Narrowly oblong	0.7-1 X 0.2 -0.3	Yellowish brown	Semi- matte	Convex	Indistinct	Obtuse	Obtuse	-
18- <i>Nepeta septemcrenata</i> Benth.	Oblong - ellipsoid or obovoid	1.6-2 X 0.9-1.1	Dark brown or black	Matte	Convex	Indistinct	Rounded	Rounded	-
19- <i>Origanum syriacum</i> L. subsp. <i>sinaicum</i> (Boiss.) Greuter&Burdet	Subglobose to broadly ovoid	0.7-0.9 X 0.5-0.7	Orange brown	Semi- matte	Convex	Indistinct	Rounded	Obtuse	-
20- <i>Salvia aegyptiaca</i> L.	Oblong or oblong- Ellipsoid	1.8-2 X 0.8-0.9	black	Semi- matte	Convex	Indistinct	Rounded	shortly attenuate - obtuse	-
21- <i>Salvia deserti</i> Decne.	Oblanceoloid- ellipsoid	1.8-2.2 X 1.1-1.2	black	Matte	Convex	Indistinct	Rounded	shortly attenuate - obtuse	-
22- <i>Salvia lanigera</i> Poir.	Obovoid- ellipsoid	1.2-1.4 X 0.6-0.7	black	Semi- matte	Convex	Indistinct	Rounded	shortly attenuate - obtuse	-
23- <i>Salvia multicaulis</i> Vahl	Subglobose- obovoid	1.8-2.2 X 1.2-1.4	dark brown with fine longitudinal net veins	Semi- matte	Convex	Indistinct	Rounded	Rounded	-
24- <i>Salvia palaestina</i> Benth.	Globose- subglobose	3.2-3.7 X 2.5-3	Pale brown with darker net veins	Glossy	Convex	Indistinct	Rounded	Obtuse	-
25- <i>Salvia sclarea</i> L.	Subglobose- ellipsoid	2.4 -2.6 X 2-2.4	Brown with darker net veins	Semi- matte	Convex	Indistinct	Rounded	Truncate	-
26- <i>Salvia spinosa</i> L.	Subglobose- globose	1.2-1.5 X 1-1.4	Brown with darker net veins	Glossy	Convex	Indistinct	Rounded	Obtuse	-
27- <i>Thymus bovei</i> Benth.	Ellipsoid- obovoid or obovoid	2.5 -2.8 X 2.2-2.4	Brown	Semi- matte	Convex	Indistinct	Rounded	shortly attenuate - obtuse	-
28- <i>Thymus decussatus</i> Benth.	Ovoid- oblong	0.9-1 X 0.5-0.6	Brown	Semi- matte	Convex	Indistinct	Rounded	Obtuse with ± small beak	-

Table 3. Nutlet micromorphology of studied taxa.

Taxa	Testa appearance			Anticlinal wall				Periclinal wall	
	Multicellular Sculpture	Homogeneity of cell size	Shape of epidermal cell	Level	Undulation	Thickness	Sculpture	Level	Sculpture
Subfamily: Ajugoideae 1- <i>Ajuga chamaepitys</i> (L.) Schreb. subsp. tridactylites (Benth.) P.H.Davis	Upper portion (1/3L.) reticulate, transversely rugose (2/3L.)	Irregular	Penta-, hexagonal	Raised	± Straight	Thin	Striate	Concave	Striate-favulariate
2- <i>Ajuga iva</i> (L.) Schreb.	Reticulate	Irregular	Penta-, hexagonal elongated, rounded	Raised	Undulate	Very thick	Undulate	Concave	Smooth
3- <i>Teucrium decaisnei</i> C.Presl	Reticulate or reticulate-colliculate	Regular	Penta-, hexagonal	Slightly raised	Straight	Thin	Striate	Slightly concave	Striate - favulariate
4- <i>Teucrium leuocladum</i> Boiss.	Reticulate or reticulate-colliculate	Regular	Rounded, Pentagonal	Slightly raised	Straight	Thin	Striate	Concave	Favulariate
5- <i>Teucrium polium</i> L.	Reticulate or reticulate-colliculate	Irregular	Penta-, hexagonal	Raised	Straight	Thin	Striate	Concave	Striate to micro-crimped papilla
Subfamily: Lamioideae 6- <i>Ballota undulata</i> (Fresen.) Benth.	Reticulate	Irregular	Hexagonal, rounded	Raised	Straight	± Thick	Striate	Concave	Striate to micro-reticulate
7- <i>Lamium amplexicaule</i> L.	Reticulate	Irregular	Tetra, penta-, hexagonal	Raised	± Straight	Thin	Undulate	Concave	Ruminate to micro-reticulate
8- <i>Marrubium alysson</i> L.	Reticulate-verrucate	± Regular	Penta-, hexagonal	Channelled	Straight	Thin	Striate	Flat- slightly concave	Smooth outer-striate in center
9- <i>Marrubium vulgare</i> L.	Reticulate-verrucate	Irregular	Penta-, hexagonal	Raised	Straight	Thin	Striate	Concave	Striate-favulariate
10- <i>Otostegia fruticosa</i> (Forssk.) Penz.	Reticulate-ruminate-	Regular	Penta-, hexagonal	Raised	Straight	Thick	Striate	Concave with sunken center	Striate-foveate
11- <i>Phlomis aurea</i> Decne.	Irregular rugose-scrobiculate	Irregular	Irregular, elongated	± Raised	Straight	± Thick	Striate	Flat	Smooth

Table 3 (Continued)

12- <i>Stachys aegyptiaca</i> Pers.	Reticulate	Irregular	Penta-, hexagonal	Channelled	Straight	Thin	Striate	Flat - slightly concave	Striate- rugose
Subfamily: Nepetoideae	Reticulate	Irregular	Penta-, hexagonal	Raised	Straight	Thick	Striate	Concave with sunken center	Striate
13- <i>Lavandula coronopifolia</i> Poir.									
14- <i>Lavandula pubescens</i> Decne.	Reticulate	Irregular	Penta, hexagonal, elongated	Slightly Raised	Straight	Thin	Striate	Flat - slightly concave	Striate
15- <i>Mentha longifolia</i> (L.) Huds subsp <i>typhoides</i> (Briq.)Harley -.	Reticulate	Regular	Penta-, hexagonal, rounded	Slightly raised	Straight	Very thick	Striate	Flat	Striate with mostly globular central papilla
16- <i>Micromeria nervosa</i> (Desf.) Benth.	Reticulate	Regular	Tetra-, penta-, hexagonal, elongated	Channelled	Straight	Thin	Striate	Flat	Circular striated
17- <i>Micromeria sinaica</i> Benth.	Longitudinal coarse rugose	Regular	Elongated	Raised	Straight	Thick	Ribbed	Concave	Smooth
18- <i>Nepeta septemcrenata</i> Benth.	Reticulate-tuberculate	Irregular	Penta-, hexagonal	Raised	Straight	Thin	Striate	Concave	Striate
19- <i>Origanum syriacum</i> L. subsp. <i>sinaicum</i> (Boiss.) Greuter&Burdet	Ruminant	Irregular	Irregular	Raised	Undulate	Thick	Undulate	Slightly concave	Smooth
20- <i>Salvia aegyptiaca</i> L.	Reticulate	Irregular	Penta-, hexagonal	Raised	Straight	Thin	Striate	Concave	Striate
21- <i>Salvia deserti</i> Decne.	Reticulate	Irregular	Penta-, hexagonal	Raised	Straight	Thin	Striate	Concave	Striate
22- <i>Salvia lanigera</i> Poir.	Reticulate-verrucate	Irregular	Penta-, hexagonal	Raised	± Straight	±Thick	Striate	Concave	Favulariate
23- <i>Salvia multicaulis</i> Vahl	Reticulate-foveate	Irregular	Penta-, hexagonal	Raised	Straight	Thin	Striate	Concave	Striate
24- <i>Salvia palaestina</i> Benth.	Smooth-slightly tuberculate	Irregular	Penta-, hexagonal, elongated	Slightly raised	Straight	Thick	Striate	Slightly concave	Smooth
25- <i>Salvia sclarea</i> L.	Scalariform-rugose	Irregular	Penta-, hexagonal, elongated	Slightly raised	Undulate	Thick	Ribbed	Flat - slightly concave	Ruminant
26- <i>Salvia spinosa</i> L.	Finely reticulate-foveate	Irregular	Penta-, hexagonal	Slightly raised	Straight	Thick	Smooth	Slightly concave	Foveate-smooth
27- <i>Thymus bovei</i> Benth.	Reticulate	Regular	Tetra-, penta-, hexagonal	Channelled	Straight	Thin	Striate	Flat -slightly concave	Striate to micro-reticulate
28- <i>Thymus decussatus</i> Benth.	Indistinct Reticulate	Regular	Tetra-, penta-, hexagonal	Channelled	Undulate	Thin	Striate	Flat -slightly convex	Striate to micro-reticulate

Table 4. Hilum features of studied taxa.

Taxa	Hilum Character			
	Shape	L X W (mm)	Position	Rim
Subfamily: Ajugoideae				
1- <i>Ajuga chamaepitys</i> (L.) Schreb. subsp. <i>tridactylites</i> (Benth.) P.H.Davis	Obovoid	1.3 - 1.4 X 0.6 -0.7	Baso-lateral	+
2- <i>Ajuga iva</i> (L.) Schreb.	Obovoid	1.8 - 1.9 X 1.2 - 1.3	Sub baso-lateral	+
3- <i>Teucrium decaisnei</i> C.Presl	Globose	1.1-1.2 X 1-1.1	Sub baso-lateral	+
4- <i>Teucrium leucocladum</i> Boiss.	Subglobose- globose	0.78-0.82 X 0.77 -0.81	Sub baso-lateral	+
5- <i>Teucrium polium</i> L.	Subglobose- globose	1-1.04 X 0.98 -1.0	Sub baso- lateral	+
Subfamily: Lamioideae				
6- <i>Ballota undulata</i> (Fresen.) Benth.	Ovoid- globose or ovoid	0.2 -0.3 X 0.2 -0.28	Basal	-
7- <i>Lamium amplexicaule</i> L.	Triangular	0.15- 0.2 X 0.3 -0.4	Basal – sub basal	-
8- <i>Marrubium alysson</i> L.	Triangular	0.3 -0.4 X0.3	Basal	-
9- <i>Marrubium vulgare</i> L.	Obovoid	0.2-0.3 X 0.15-2	Basal	-
10- <i>Otostegia fruticosa</i> (Forssk.) Penz.	Triangular	0.17-0.2 X 0.35-0.4	Basal	-
11- <i>Phlomis aurea</i> Decne.	Ovoid- triangular	0.3-0.4 X 0.6-0.7	Basal	-
12- <i>Stachys aegyptiaca</i> Pers.	Quadrangular, broad triangular	0.3-0.35 X 0.35-0.4	Basal	-
Subfamily: Nepetoideae				
13- <i>Lavandula coronopifolia</i> Poir.	Broad obcordate- rounded	0.4 -0.5 X0.5 -0.6	Basal, white	-
14- <i>Lavandula pubescens</i> Decne.	Broad obcordate- rounded	0.5 -0.6 X0.4 -0.6	Basal, white	-
15- <i>Mentha longifolia</i> (L.) Huds.subsp. <i>typhoides</i> (Briq.)Harley	Bilobed	0.12-0.2 X 0.3-0.4	Basal, white	-
16- <i>Micromeria nervosa</i> (Desf.) Benth.	Ovoid	0.06-0.1 X 0.05-0.1	Basal, whitish in colour	-
17- <i>Micromeria sinaica</i> Benth.	Ellipsoid	0.08-0.1X 0.05-0.07	Basal, whitish in colour	-
18- <i>Nepeta septemcrenata</i> Benth.	Bilobed	0.25-0.3X 0.6-0.8	Sub basal, whitish in colour	-
19- <i>Origanum syriacum</i> L. subsp. <i>sinaicum</i> (Boiss.) Greuter&Burdet	± Globose	0.15-0.2 X 0.2-0.25	Sub basal, whitish in colour	-
20- <i>Salvia aegyptiaca</i> L.	Ellipsoid -obovoid	0.1-0.2 X 0.05-0.1	Sub basal	-
21- <i>Salvia deserti</i> Decne.	Ellipsoid-obovoid	0.15-0.23 X 0.1 -0.13	Sub basal	-
22- <i>Salvia lanigera</i> Poir.	Rhomboidal- globose	0.25-0.35 X 0.2 -0. 3	Sub basal, whitish in colour	+
23- <i>Salvia multicaulis</i> Vahl	Discoïd	0.35-0.4 X 0.6 -0. 7	Basal	-
24- <i>Salvia palaestina</i> Benth.	± Globose	0.13-0.16 X 0.13 -0. 16	Basal	-
25- <i>Salvia sclarea</i> L.	Discoïd	0.12-0.15 X 0.2 -0. 3	Basal	-
26- <i>Salvia spinosa</i> L.	Ovoid – oblong	0.1-0.2 X 0.2 -0. 25	Basal, marginal, white	-
27- <i>Thymus bovei</i> Benth.	Obovoid	0.15-0.18 X 0.13-0.15	Basal, whitish in colour	-
28- <i>Thymus decussatus</i> Benth.	Obovoid	0.12-0.15 X 0.08-0.1	Basal, whitish in colour	-

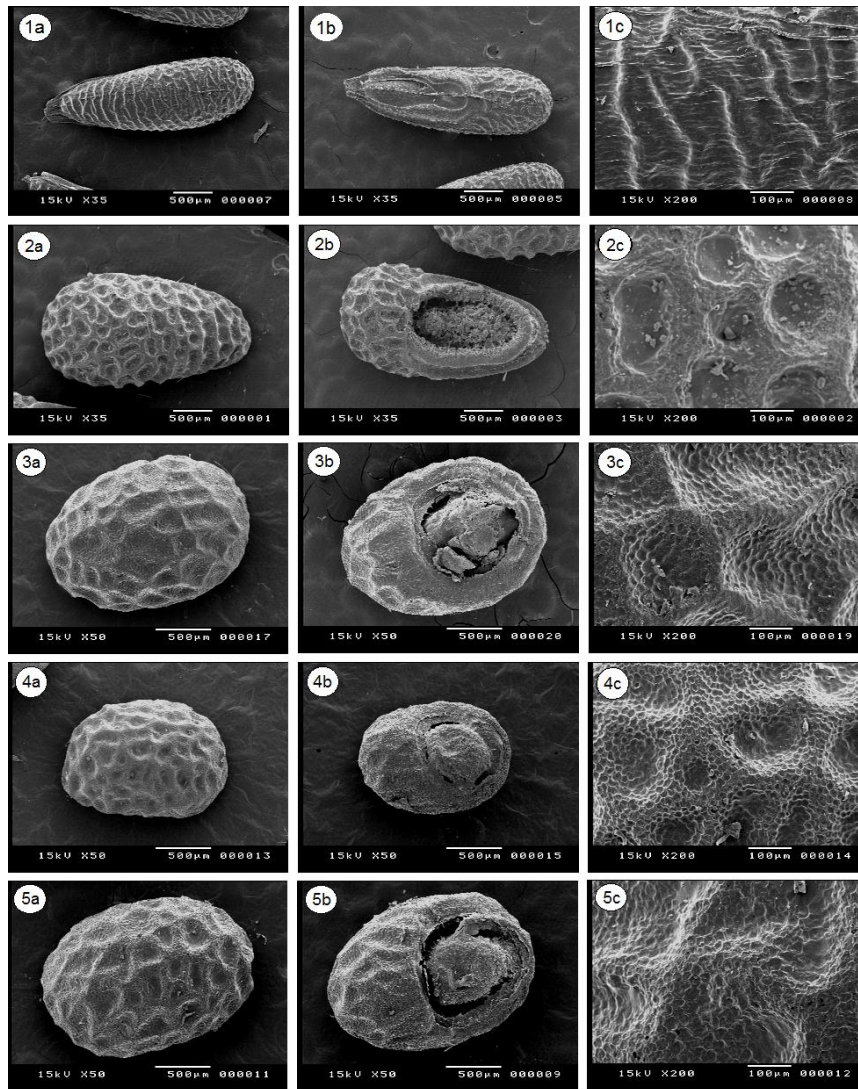


Fig. 1-5. Scanning electron micrographs of nutlets. a. dorsal view, b. ventral view, c. surface sculpture. 1. *Ajuga chamaepitys* subsp. *tridactylites*; 2. *A. iva*; 3. *Teucrium decaisnei*; 4. *T. leucocladum*; 5. *T. polium*.