

Acomparative Anatomical Study of The Genera *Clinopodium* L., *Hymenocrater* Fish.& Mey. and *Melissa* L. (Lamiaceae) in Kurdistan Region of Iraq.  
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## Acomparative Anatomical Study of The Genera *Clinopodium* L., *Hymenocrater* Fish.& Mey. and *Melissa* L. (Lamiaceae) in Kurdistan Region of Iraq.

Adel Mohan Adai AL-Zubaidy\* , Khulod Ibrahim Hassan\*\* and Basoz sadiq Jabbari \*\*\*

\*Sulaimani Polytechnic University, Agricultural Technical College

\*\*Sulaimani University , faculty of Agricultural sciences

\*\*\*Sulaimani Polytechnic University , Agricultural Technical College

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### Abstract

Nine taxa of Lamiaceae family including three of the genus *Clinopodium* (*C. vulgare* subsp. *vulgare* L., *C. vulgare* subsp. *arundanum* Boiss. , *C. umbrosum* (M. B.) C. Koch. and *C. congustum* Boiss. & Hausskn ex. Boiss., two of *Hymenocrater* Fish. & Mey. (*H. longiflorus* Benth. and *H. bituminosus* Fish & C. A. Mey ) and *Melissa officinalis* subsp. *fficialis* L. , *M. officinalis* subsp. *altissima* (SM.) and *M. officinalis* subsp. *inodora* (Bornm.) were studied the anatomy of stem, leaf, including petiole and trichomes for all taxa were investigated. Anatomy of stem showed valuable characteristics in the distribution of angular collenchyma, vascular bundles and the thickness of cuticle. Variations were recorded among petiole cross section, vascular strands, in their shapes and number. The anatomical study in cross sections of blade leaves showed that the epidermis were uniseriate, plane and consist of one row with shapes of tetra-angled, rectangle, ovate and irregular or polygonal. The mesophyll layers were distinguished in two layers in all studied genera. Detailed study was made for trichomes glandular and non-glandular hairs which showed variation in their types, position, dimension and basal cell number. These variations were important in classification of each species for the studied genera... This study was done for the first time on these taxa in Iraq.

**Key words:** Lamiaceae , *Clinopodium* L., *Hymenocrater* Fish.& Mey. and *Melissa* L., angular collenchymas , anatomical study.

### دراسة تشريحيه مقارنه *Clinopodium* L., *Hymenocrater* Fish.& Mey. and *Melissa* L. العائده للعائله الشفويه (Lamiaceae) للاجناس في اقليم كردستان العراق .

عادل موحد عداي الزبيدي\* , خلود ابراهيم حسن\*\* و به سوز صادق جباري\*\*\*

\* جامعة السليمانية التقنيه - الكليه التقنيه الزراعيه

\*\* جامعة السليمانية - فاكولتي العلوم الزراعيه

\*\*\* جامعة السليمانية التقنيه - الكليه التقنيه الزراعيه

### المخلص

تسعة مراتب تصنيفيه تعود للعائله الشفويه Lamiaceae هي :-

*Clinopodium* (*C. vulgare* subsp. *vulgare* L., *C. vulgare* subsp. *arundanum* Boiss. , *C. umbrosum* (M. B.) C. Koch. and *C. congustum* Boiss. & Hausskn ex. Boiss., two of *Hymenocrater* Fish. & Mey. (*H. longiflorus* Benth. and *H. bituminosus* Fish & C. A. Mey ) and *Melissa officinalis* subsp. *fficialis* L. , *M. officinalis* subsp. *altissima* (SM.) and *M. officinalis* subsp. *inodora* (Bornm.) .  
تمت دراسة التشريح

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الداخلي لسبقانها ، اوراقها ، بما في ذلك سويقاتها والشعيرات لجميع المراتب التصنيفيه اعلاه ، وأظهر تشريح الساق خصائص قيمة في توزيع الكولنكيما الزاويه والحزم الوعائية وسمك الكيوتكل . وسجلت الاختلافات في المقطع العرضي لسويقات الأوراق بما فيها اشكال وعدد الاشرطه الوعائيه وأظهرت الدراسة التشريحية في المقاطع العرضية لنصول الأوراق في ان بشرتها مكونه من صف واحد من الخلايا ذات اشكال متطاولة رباعية الزوايا ، بيضيه واخرى متعددة الاضلاع او غير منتظمه الشكل ، النسيج المتوسط متميز الى طبقتين في جميع الانواع المدروسه ، اظهرت الشعيرات تغيرا في انواعها ، مواقعها ، ابعادها وعدد الخلايا المكونه لقواعدها . اتضح ان التعايرت اعلاه ذات قيمه تصنيفيه لجميع انواع الاجناس المدروسه . تعتبر الدراسة الحاليه هي الاولى التي تناولت المراتب التصنيفيه هذه في العراق ، الكلمات المفتاحيه : العائله الشفويه ، الاجناس ، *Clinopodium* L. ، *Hymenocrater* Fish.& Mey ، *Melissa* L. ، الكولنكيما الزاويه ، دراسه تشريحيه .

### Introduction

Anatomy of plant is another classical source of data used in plant taxonomy (1). The anatomical characters have been developed recently, it is now generally realized that anatomical characters were valuable as morphological characters, and must not be neglected. Several specialists (2; 3; 4; 5) have assured the taxonomic value of anatomical characters. They provide additional features, which along with other characters were of great taxonomic value in the classification and identification of plants. Anatomical data were often extremely useful in solving problems of relationships because they can often suggest with greater confidence the homologies of morphological character status, and they can help in the interpretation of evolutionary directionality (6). The anatomy of some species of Lamiaceae family have been studied (7; 8). The most important features of Lamiaceae taxa are glandular hairs distributed in vegetative and reproductive organs (9). The aim of this study was provide a comprehensive description for three genera of Lamiaceae family including nine taxa grown in Kurdistan Region of Iraq using anatomical features as diagnostic characters focused on the shoot part like stem, leaf and petiole by using the paraffin way in preparing anatomical sectioning.

### Material and Methods

This study used fresh specimens of stems, leaves and petioles which were collected during scientific trips from different localities surveyed areas in Kurdistan Region of Iraq.

#### Killing and Fixation

Fresh materials (small part of stem, leaves and petiole) were fixed in FAA containing of (1:3:6 formalin, glacial acetic acid and alcohol %95) that prepared timely in field trips for 24 hours at room temperature then washed with Ethanol %70 twice and kept in the refrigerator till used.

#### Washing and Dehydration

The materials were washed several times with alcohol 70% before being passed through the following alcohol series for two hours, 80%, 90% and 95% and then in absolute alcohol overnight.

#### Clearing and Infiltration

This stage followed the methods of (Sass, 1958) as follows; this was carried out in sequence by passing the outcome of second step through the following series of absolute alcohol - xylene mixture (3:1, 1:1, 1:3) for half: two hours then washing twice in pure xylene.

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Small chopped pieces of paraffin (60 C° melting) were gradually added when the material was in the second pure xylene wash, and placed in oven at about (55-60 C°) for (36-48 hours), so that the wax could be melted. Material was then placed in an oven at 60 C° for (2-4) days to remove the remaining xylene.

### **Embedding and Mounting**

Melted pure wax containing the material (specimens) was poured into aluminum metal and specimen oriented with hot needles and labeled then left until the wax cooled thereafter placed in cold water to the solidified blocks were removed from the moulds, trimmed and fixed on carrier to be ready for sectioning by rotary microtome. A section of (8-12) μm in thickness, depending on organs, gave the best result. Obtained ribbons were laid on a clean slide smeared by a thin film of glycerin albumin, in order to spread ribbons evenly; slides were flushed with distilled water and then placed on a hot plate at 40 C° for (8-10 hours). This also removed wrinkles in the ribbon.

### **Removing of wax and Staining**

Slides were passed through the following:-

- a. Xylene (at 60 C°) twice for two hours. Xylene-absolute alcohol (1: 1) for five minutes.
- b. Alcohol series (95%, 80%, 70%, 50%, and 30%) five minutes for each concentration.
- c. Safranin (safranin 0.5% in alcohol 50%) for 12-24 hours.
- d. Progressive alcohol series (30%, 50%, 70%, 80%, 95%, and 100%) five minutes for each other.
- e. Fast green dye 1% (fast green 1gm in absolute alcohol 100ml) for 3-5 seconds.
- f. Absolute alcohol for five minutes.
- g. Xylene- cedar oil (1: 1) for five minutes.
- h. Pure xylene twice for three minutes.
- i. The back of the slides were cleaned with a paper towel and permanent mounting made with Canada balsam and covered with cover slide.
- j. The slides were placed on hot plate at (40-50 C°) to dry.

The sections were examined with compound microscope (Olympus) under magnification power (40xs × 10xs) and photographs taken with digital Camera Sony (10.3 mega pixels).

## **Results and Discussion**

### **Stem anatomy**

Tissues and cells of stems provide many helpful lines of taxonomist evidence (6). The stem consists of three tissues systems, dermal, fundamental and the vascular, as seen in cross section. The general outline of stem often quadrangular in section, cross sections of stems showed variation in all studied genera so that they have great taxonomical value in identification of taxa, these differences included types, sizes of all layer, epidermis, cortex, vascular bundle thickness and also showed a variety in pith cells and its diameter. The epidermis was composed of a single layer. The upper and lower walls of the epidermis are covered with a thick cuticle and they were thicker than the lateral walls. The outer layer was epidermis appeared in cross section as continuous layer forming rectangular cells with vertical rectum thick wall but sometime waved, while the cortex consist of two layers the first was cuticle having different thickness between studied genera, the second is medial tissues that consisted of two layers too, collenchyma and chlorenchyma with several layers.



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Vascular bundles consisted of phloem, xylem and between them was vascular cambium which formed continual cylindrical according xylem thickness, phloem fiber availability in all studied genera. The last part in stems is pith region with various diameter or area shown by studied genera (Table 1). The stem in genus *Clinopodium* was quadrant, winged and loment, and the thickness of cuticle was (6.25-22)  $\mu\text{m}$  and cortex layer ranged between (47.5-113)  $\mu\text{m}$  *arundanum* as a minimum and *C. vulgare* subsp. *vulgare* as a maximum, while the xylem thickness ranged between (67-162.5)  $\mu\text{m}$  in the species *C. vulgare* subsp. *vulgare* as a minimum and *C. congstum* as a maximum, the pith radius ranged between (335-522.5)  $\mu\text{m}$  in the *C. umbrosum* as a minimum and *C. congstum* as a maximum. In genus *Hymenocrater* the thickness of cuticle, cortex and pith radius ranged between (19.5-26)  $\mu\text{m}$ , (100-115)  $\mu\text{m}$  and (780-785)  $\mu\text{m}$  respectively in the species *H. longiflorus* as a minimum and the species *H. bituminosus* as a maximum, the xylem thickness (135-165)  $\mu\text{m}$  in the species *H. bituminosus* as a minimum and *H. longiflorus* as a maximum.  $\mu\text{m}$  in *C. vulgare* subsp. The thickness of cuticle, cortex and xylem in genus *Melissa* ranged between (10.5-11.5)  $\mu\text{m}$ , (145-155)  $\mu\text{m}$  and (100-120)  $\mu\text{m}$  respectively in *M. officinalis* subsp. *altissima* as a minimum and *M. officinalis* subsp. *officinalis* as a maximum, but the pith radius (430-600)  $\mu\text{m}$  in *M. officinalis* subsp. *officinalis* as a minimum and *M. officinalis* subsp. *inodora* as a maximum (Table1, Fig. 1).

### Leaf petiole

The petiole of dicotyledon leaves contains the same tissues as the stem, often in similar arrangement. Collenchyma or sclerenchyma occurs as supporting tissues; the number and arrangement of the vascular bundles in the petioles vary greatly (10). The structure of petiole showed variation between genera and species. Thus, useful petiole anatomic characters were determined in designated taxonomical structures of some species (11; 12; 13). Anatomical structures of the petiole were very important in family Lamiaceae (14). The epidermis in all studied genera was consisted of one layer with fabricated basal cells of trichomes, usually the epidermal cells of the petiole were irregular in shape and unequal in size, the largest volume was occupied by a thin-walled parenchyma with intercellular spaces; in the first genus *Clinopodium* the general outline of petioles is semi-triangular, bicorn and winged or deeply winged but the vascular arch formed lunette, semi-lunar and ovoid. In accordance to the number of vascular bundles (Fig. 2), the petioles of the studied genera can be divided into the following groups:

- a- Vascular bundles arranged in single ovoid shape which occupied the middle position of the petiole cross section found in *Clinopodium vulgare* subsp. *arundanum*.
- b- Vascular bundles arranged in single crescent shape which occupied the middle position of the petiole cross section found in *C. vulgare* subsp. *vulgare*.
- c- Vascular bundles arranged in three ovoid shape where the large one occupied the middle position of the petiole cross section and two small size occupied bi-laterals (middle both wings) in *C. umbrosum*, *Hymenocrater longiflorus* and *H. bituminosus*.
- d- Vascular bundles arranged in multi-crescent shape (seven) where the large one occupied the middle position of the petiole cross section and six small size occupied bi-laterals

(as long as both wings) such as *C. congstum*, *M. officinalis* subsp. *officinalis*, *M. officinalis* subsp. *altissima* and *M. officinalis* subsp. *inodora* .

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### Leaves

Leaves also provide many anatomical characters, most of these characters of taxonomic significance derive from the blade (6). This anatomical study in cross sections of leaves in all studied genera showed that the epidermis were uniseriate, consisted of one row with shapes of tetra-angled, rectangle, ovate and irregular or polygonal.

Mostly, the cells of the upper epidermis were larger than the cells of lower epidermis but mostly in midrib region were regularly arranged and equal in size compared with the other epidermis cells. The mesophyll layers were distinguished in two layers in all studied genera, the first layer is called palisade layer, located in the adaxial side, the palisade layers consisted of two layers, the upper layer was longer than the lower layer and the 2<sup>nd</sup> layer in mesophyll layers is called spongy layer. The leaves in all studied species were bifacial (palisade layer present in one side) except the species *Hymenocrater bituminosus* which is isobilateral (palisade layer present in both sides). The spongy layers consisted of one or more layers with different shapes of cells like semi-circular, oblong, polygonal and similar to the palisade layer with large or small air spaces. Starch crystals present in all subspecies of *Melissa*. The bundle sheath extensions, they were consisted of many parenchyma cells which connect the bundle sheath with upper and lower epidermis layers, also these extensions connected two adjacent or near bundle sheaths together in most of species. The vascular bundles of the midrib and lateral veins were of type collateral bundle, they have spherical, lunar and crescent shapes and the thickness ranged between (125-225)  $\mu\text{m}$  in genus *Clinopodium* which *C. vulgare* subsp. *vulgare* as a minimum and *C. congatum* as a maximum, while the bundle sheath thickness ranged between (190-230)  $\mu\text{m}$  in genus *Hymenocrater* in *H. longiflorus* as a minimum and *H. longiflorus* as a maximum, in genus *Melissa* the bundle sheath thickness ranged between (180-255)  $\mu\text{m}$  in *M. officinalis* subsp. *officinalis* as a minimum and *M. officinalis* subsp. *inodora*. The number of xylem arms were differed from the taxa which studied but the number of bundles in one arm can be grouped into three which are:

- 1- Three arms which consist all taxa of the genera *Hymenocrater* and *Melissa*.
- 2- Four arms which consist *C. vulgare* subsp. *vulgare* only.
- 3- Five arms which consist *C. vulgare* subsp. *arundanum*, *C. congatum* and *C. umbrosum*.

Xylem were consisted of tracheary elements arranged in rows from (3-23) arms, but the fiber element could not be distinguished. The protoxylem direction was toward adaxial surface while the metaxylem was toward abaxial surface. The phloem elements also presented as it have been seen clearly under the xylem toward abaxial surface, this agreed with (15). Leaf thickness was linked with the thickness of inside layers, which was between (125-165)  $\mu\text{m}$  in genus *Clinopodium* in the species *C. congatum* as a minimum and the species *C. umbrosum* as a maximum. Whereas the leaf thickness in genus *Hymenocrater* between (120-280)  $\mu\text{m}$  in the species *H. longiflorus* as a minimum and *H. bituminosus* as a maximum. The thickness of leaf in genus *Melissa* was between (75-135)  $\mu\text{m}$  with the species *M. officinalis* subsp. *inodora* as a minimum and *M. officinalis* subsp. *officinalis* as a maximum (Table 2, Fig 3).

### Trichomes

Trichomes were defined as unicellular or multicellular appendages, originating from epidermal cells only, and can be found on all parts of the plants: vegetative (leaves, stem and bracts) and reproductive (sepals, petals and fruits).

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Trichomes variables in their structure and function, could have taxonomical importance in certain plant groups, (16). The most important features of Lamiaceae taxa are glandular hairs distributed in vegetative and reproductive organs (9). These hairs are source of etheric oils and their structures have been examined anatomically and micromorphologically (17; 18; 16). The trichomes (hairs) cover the most aerial plant parts from the stem to fruits, in all examined species with differences in shape and density. The trichomes showed variation in their type, position, dimension and basal cell number. Therefore, they have taxonomic importance for distinguishing between genera and species. In this research we focused on stems and leaves (upper and lower surfaces), investigated were covered with various hairs in all studied genera. We defined two categories of these non glandular and glandular, according to the absence or presence of a secretory head on the trichomes. They could be divided into two main groups:-

### Glandular hairs

Which divided into two types :-

- a- Bicellular glandular hairs which consisted of basal and head cells.
- b- Multicellular glandular hairs which consisted of basal, neck and head cells.

### Non glandular (eglandular) hairs

Non glandular hairs was divided in three parts; the first part was unicellular eglandular hairs that consisted of one subulate cell, the second part was bicellular eglandular hairs which consisted of basal and subulate or oblong end cell, the last part was multicellular non glandular hairs which consisted of basal, neck and subulate end cells. The dimensions of non glandular and glandular hairs were different within the studied species. Neck lengths In *Clinopodium* species the was between (17-40)  $\mu\text{m}$  which was *C. vulgare* subsp. *arundanum* as a minimum and *C. congestum* as a maximum, and the head length ranged between (12-37)  $\mu\text{m}$  in *C. vulgare* subsp. *arundanum* as a minimum and *C. congestum* as a maximum, while base diameter was between (19-44)  $\mu\text{m}$  in *C. vulgare* subsp. *arundanum* as a minimum and *C. vulgare* subsp. *vulgare* as amaximum for glandular hairs, but for non glandular hairs the lengths ranged between (72-180)  $\mu\text{m}$  found in *C. umbrosum* as a minimum and *C. congestum* as a maximum, but base diameter ranged between (37-49)  $\mu\text{m}$  in *C. vulgare* subsp. *arundanum* as a minimum and *C. vulgare* subsp. *vulgare* as amaximum. The glandular hair in *Hymenocrater* species the neck, head length and base diameter ranged between (26-40), (28-29), (68-72)  $\mu\text{m}$  respectively with the species *H. longiflorus* as a minimum and *H. bituminosus* as a maximum, the length and base diameter for non glandular hair ranged between (155-190), (70-125)  $\mu\text{m}$  in the species *H. bituminosus* as a minimum and the species *H. longiflorus* as a maximum. The neck lengths for glandular hair in *Melissa* species ranged between (16-38)  $\mu\text{m}$  with *M. officinalis* subsp. *officinalis* as a minimum and *M. officinalis* subsp. *altissima* as a maximum, the head lengths ranged between (18-35)  $\mu\text{m}$  with *M. officinalis* subsp. *altissima* as a minimum and *M. officinalis* subsp. *officinalis* as a maximum and base diameter ranged between (21-27)  $\mu\text{m}$  in *M. officinalis* subsp. *officinalis* as a minimum and *M. officinalis* subsp. *inodora* as a maximum, while the lengths for non glandular hair ranged between (60-100)  $\mu\text{m}$  in *M. officinalis* subsp. *officinalis* as a minimum and *M. officinalis* subsp. *inodora* as a maximum and base diameter ranged between (29-33)  $\mu\text{m}$  with *M. officinalis* subsp. *altissima* as a minimum and *M. officinalis* subsp. *inodora* as a maximum. The types of glandular and non glandular hairs with their characters were show in (Table3& Fig. 4).



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### Conclusions.

The presence of anatomical study of stem, leaf, including petiole and trichomes of all selected taxa showed variation which were of great value in classification and identification of these taxa so the result of this study can be used for determining taxonomic relationship between taxa belonging to these genera.

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Table 1. Anatomical characters of stem cross section of all studied taxa.

Species	Shape	Cortex						Vascular cylinder		Pith diameter (µm)
		Cuticle thickness (µm)	Cortex thickness (µm)	Collenchyma		Chlorenchyma		Vascular bundles shape	Xylem thickness (µm)	
				Layer number	Appearance	Layer number	Cycling shape			
<i>Clinopodium vulgare</i> subsp. <i>vulgare</i>	Winged quadrant	(12.5-30)22	(90-125)113	11	Distinct-ovate	6	Continues	Non-continues	(38-88)67	(370-510)460
<i>C. vulgare</i> subsp. <i>arundanum</i>	Quadrant	(3.75-7.5)6.25	(30-55)47.5	6	Squeezed	3	Non-continues	Continues	(85-195)155	(360-450)420
<i>C. congestum</i>	waistly in all sides	(5-8.75)7	(37.5-62.5)52.5	6	Appearance	5	Continues	Non-continues	(75-195)162.5	(380-575)522.5
<i>C. umbrosum</i>	Quadrant, winged-waistly	(7.5-15)12.5	(70-105)97	6	Appearance, distinct	5	Continues, confused	Continues	(62.5-125)105	(280-360)335
<i>Hymenocrater longiflorus</i>	Quadrant	(13-25)19.5	(80-120)100	3	Distinct-ovate	5	Non-continues	Non-continues	(140-170)165	(650-900)780
<i>H. bituminosus</i>	Quadrant	(15-35)26	(90-125)115	1	Distinct	4	Non-continues	Non-continues	(90-145)135	(600-850)785
<i>Melissa officinalis</i> subsp. <i>officinalis</i>	Quadrant	(8-15)11.5	(85-180)155	2	Distinct-evident	4	Non-continues	Non-continues	(85-130)120	(350-520)430
<i>M. officinalis</i> subsp. <i>altissima</i>	Winged quadrant	(9-15)10.5	(75-160)145	2	Distinct	3	Continues	Continues	(70-110)100	(420-650)540
<i>M. officinalis</i> subsp. <i>inodora</i>	Quadrant, waistly in all sides	(8-15)11	(80-185)150	2	Distinct-evident	4	Continues	Non-continues	(75-120)115	(470-700)600

The numbers inside the brackets represent minimum and maximum and the number outside represent the average between (20-25) plants.



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**Table 2. Anatomical characters of leaf cross section of all studied taxa**

Species	Cuticle thickness (µm)	Lamina			Midrib			
		Lamina thickness (µm)	Mesophyll		Midrib vascular bundle		No. of xylem arms	No. of bundle in one arm
			No. of Palsied layer	Palisade thickness (µm)	Shape	Thickness (µm)		
<i>Clinopodium vulgare</i> subsp. <i>vulgare</i>	(5-10)8	(100-175)140	1, 2	(37.5-50)44	Lunar	(100-145)125	(7-12)11	(3-5)4
<i>C. vulgare</i> subsp. <i>arundanum</i>	(5-12.5)8.5	(120-162.5)145	1, 2	(25-62.5)50	Crispate	(155-220)195	(9-13)11	(3-6)5
<i>C. congstum</i>	(5-15)9	(105-150)125	2, 3	(62.5-87.5)75	Crispate	(160-315)225	(15-23)18	(3-6)5
<i>C. umbrosum</i>	(5-12.5)7.5	(155-225)165	2, 3	(60-90)82.5	Spherical	(137.5-187.5)170	(6-14)10	(4-6)5
<i>Hymenocrater longiflorus</i>	(2.5-10)8.5	(95-132.5)120	1, 2	(30-50)47	Lunar	(125-200)190	(3-9)8	(1-4)3
<i>H. bituminosus</i>	(2.5-12.5)9	(200-400)280	2, 3	(100-150)110	Crispate	(180-270)230	(10-17)13	(2-5)3
<i>Melissa officinalis</i> subsp. <i>officinalis</i>	(2.5-7.5)6	(112.5-175)135	1, 2	(37.5-55)45	Lunar	(135-195)180	(7-13)11	(3-5)3
<i>M. officinalis</i> subsp. <i>altissima</i>	(2.5-7.5)6.5	(130-195)130	1, 2	(55-75)60	Lunar	(200-300)245	(9-22)17	(2-5)3
<i>M. officinalis</i> subsp. <i>inodora</i>	(5-10)7	(50-87.5)75	1, 2	(25-45)40	Lunar	(185-295)255	(6-10)8	(3-5)3

The numbers inside the brackets represent minimum and maximum and the numbers outside represent the average between (20-25) plants.

**Table 3. Surface indumentums, (measurement in (µm) of all studied taxa.**

Species	Glandular trichomes				Non glandular trichomes		
	Base diameter	Neck length	Head length	Type	Base diameter	Length	Type
<i>Clinopodium vulgare</i> subsp. <i>vulgare</i>	(32-60)44	(15-75)39	(10-38)23	A,C,G	(40-55)49	(35-230)115	I,J,K
<i>C. vulgare</i> subsp. <i>arundanums</i>	(9-35)19	(8-35)17	(9-23)12	B,C,F,G	(18-50)37	(40-100)75	I,J,K
<i>C. congstum</i>	(18-38)27	(10-65)40	(20-75)37	A,C,D	(25-72)44	(115-255)180	I,J,K
<i>C. umbrosum</i>	(25-34)30	(10-35)22	(15-62)35	A,C,D,E	(25-50)42	(63-80)72	I,J,K
<i>Hymenocrater longiflorus</i>	(45-110)72	(10-35)26	(17-38)28	B,D,G,H	(50-200)125	(100-280)190	I,J,K
<i>H. bituminosus</i>	(40-100)68	(25-55)40	(20-40)29	B,F,G,H	(40-110)70	(92-287)155	I,J,K
<i>Melissa officinalis</i> subsp. <i>officinalis</i>	(15-32)21	(10-20)16	(8-80)35	A,C,E,F	(20-40)30	(30-75)60	I,J,K
<i>M. officinalis</i> subsp. <i>altissima</i>	(18-35)25	(25-45)38	(8-25)18	B,E,F,H	(15-40)29	(38-170)90	I,J,K
<i>M. officinalis</i> subsp. <i>inodora</i>	(13-38)27	(12-30)19	(8-30)20	E,F,G,H	(15-45)33	(52-180)100	I,J,K

The numbers inside the brackets represent minimum and maximum and the number outside represent the average between (20-25) plants.

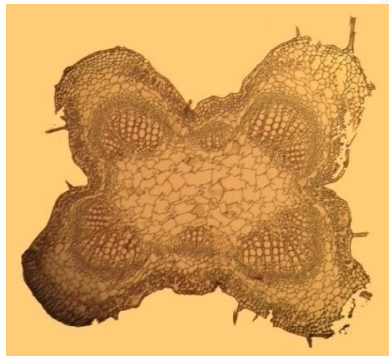
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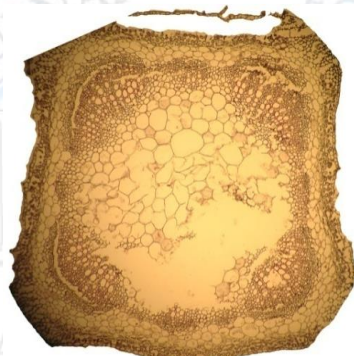
*Clinopodium vulgare* subsp. *vulgare*

*C. congestum*

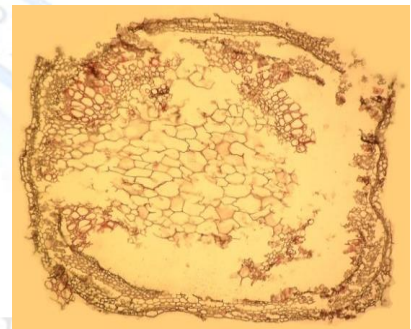
*C. vulgare* subsp. *arundanum*



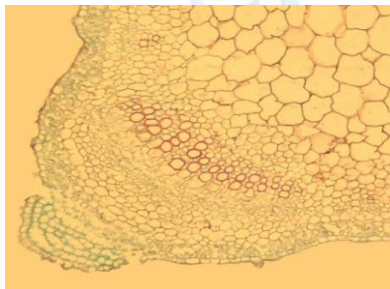
*C. umbrosum*



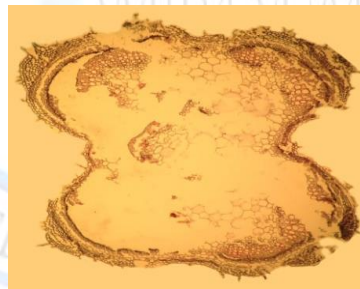
*C. umbrosum*



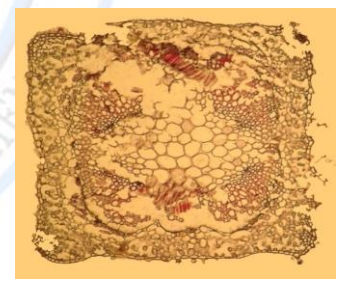
*Hymenocrater bituminosus*



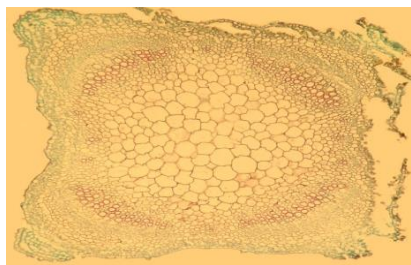
*Hymenocrater longiflorus*



*Melissa officinalis* subsp. *officinalis*



*M. officinalis* subsp. *altissima*

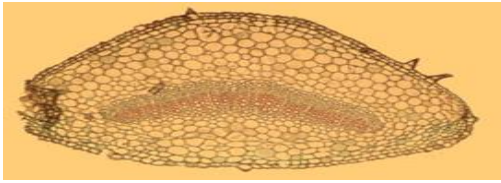


*M. officinalis* subsp. *inodora*

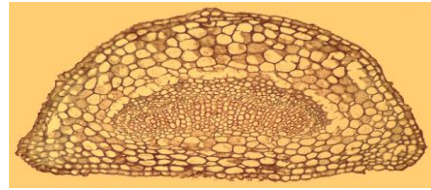
Figure 1. The cross section of Stems for all studied taxa. (40x×10x)



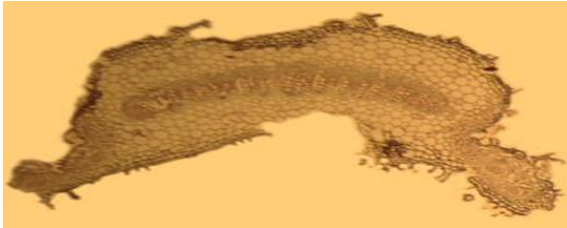
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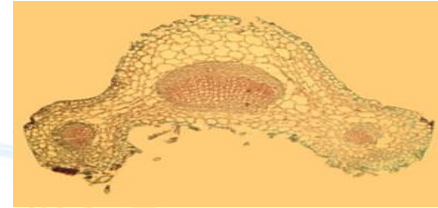
*Clinopodium vulgare* subsp. *vulgare*



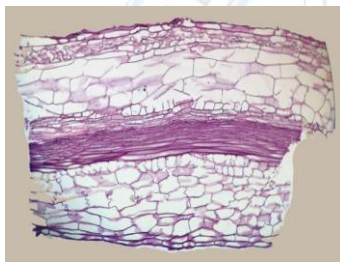
*Clinopodium vulgare* subsp. *arundanum*



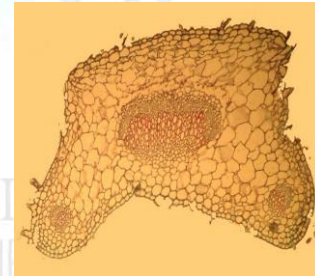
*Clinopodium congestum*



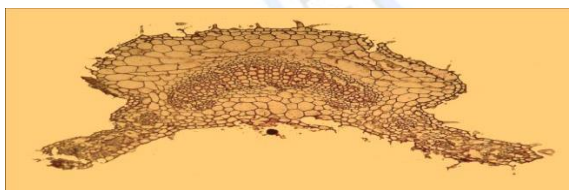
*Clinopodium umbrosum*



*Hymenocrater longeflorus*



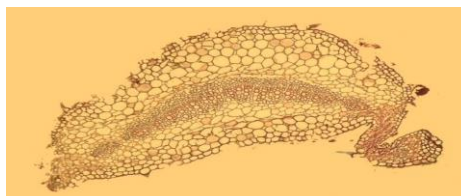
*Hymenocrater bituminosus*



*Melissa officinalis* subsp. *officinalis*



*Melissa officinalis* subsp. *inodora*

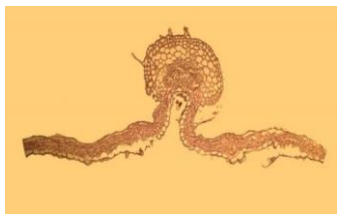


*Melissa officinalis* subsp. *altissima*

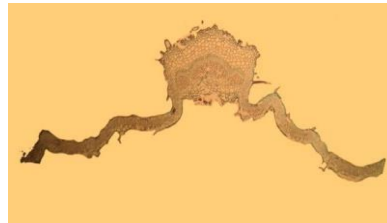
Figure 2. The cross section of Petiole of all studied taxa. (40x×10x)



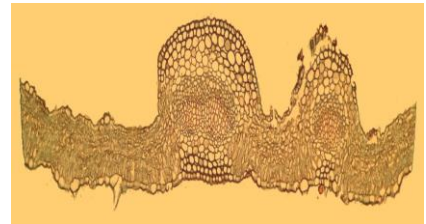
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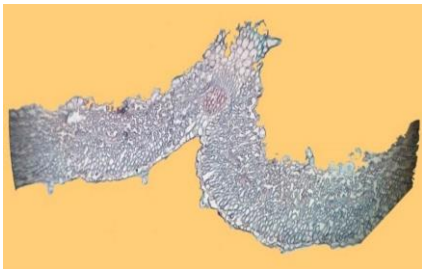
*Clinopodium vulgare* subsp. *vulgare*



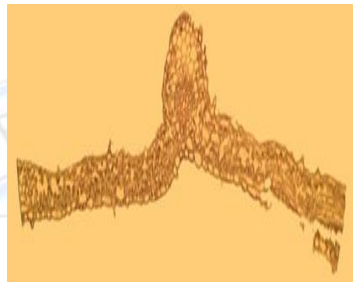
*Clinopodium congestum*



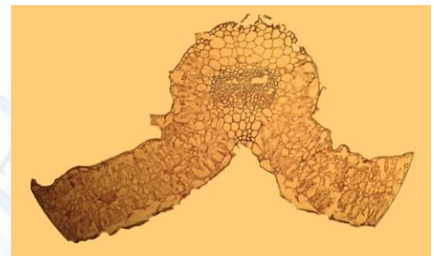
*Clinopodium vulgare* subsp. *arundanum*



*C.umbrosum*

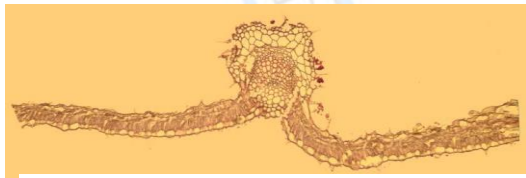


*bituminosus*

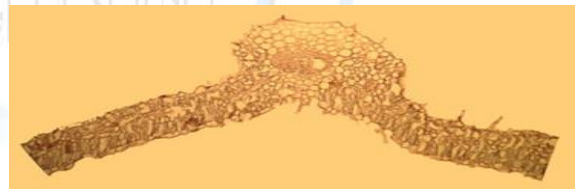


*Hymenocrater*

*Hymenocrater longeflorus*



*Melissa officinalis* subsp. *officinalis*  
*altissima*



*Melissa officinalis* subsp.



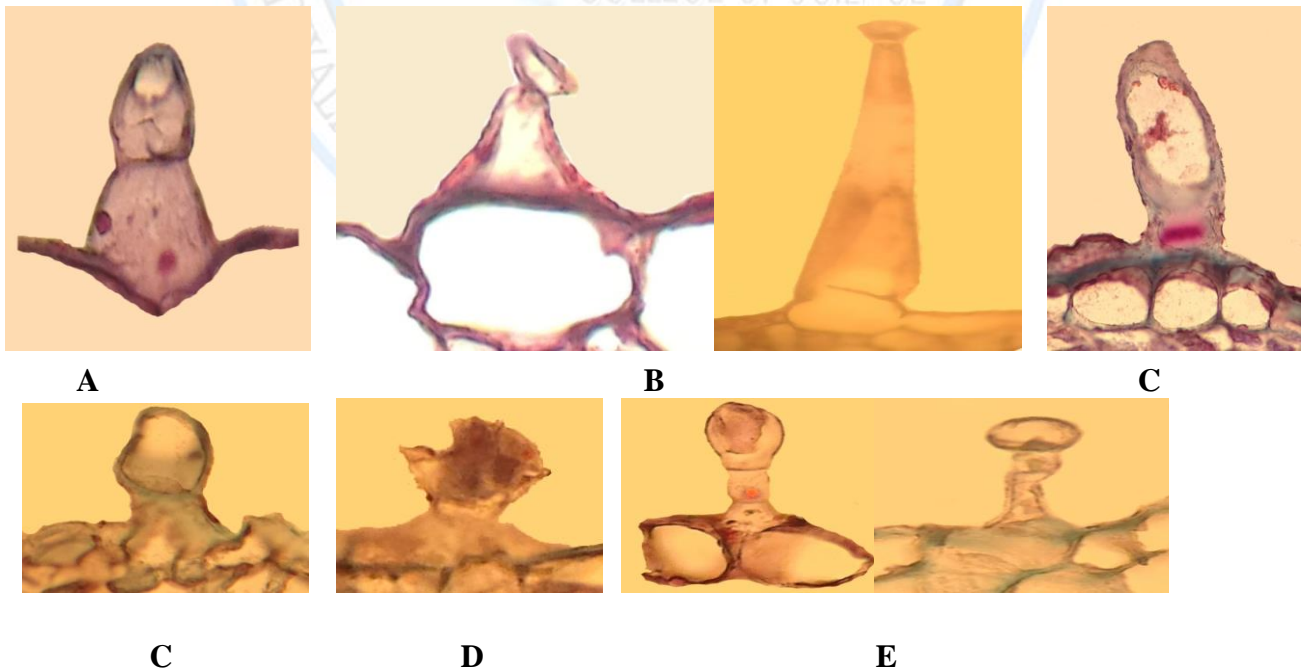
*Melissa officinalis* subsp. *inodora*

Figure 3. The cross section of leaf of all studied taxa (40x×10x)

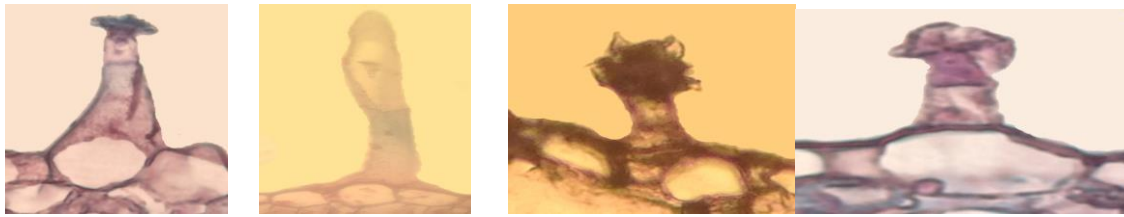
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The character key for (Table 3) with appurtenant trichomes of all studied taxa.

A	Bicellular glandular hairs which consisted of basal and circular head cells.
B	Bicellular glandular hairs which consisted of basal and resupinate triangle head cells.
C	Bicellular glandular hairs which consisted of basal and oblong head cells.
D	Bicellular glandular hairs which consisted of basal and starred head cells.
E	Multicellular glandular hairs which consisted of basal, neck and circular or semicircular head cells.
F	Multicellular glandular hairs which consisted of basal, neck and resupinate triangle head cells.
G	Multicellular glandular hairs which consisted of basal, neck and oblong head cells.
H	Multicellular glandular hairs which consisted of basal, neck and starred head cells.
I	Unicellular non glandular hairs that consisted of one subulate cell.
J	Bicellular non glandular hairs which consisted of basal and subulate or acute end cells.
K	Multicellular non glandular hairs which consisted of basal, neck and subulate end cells.



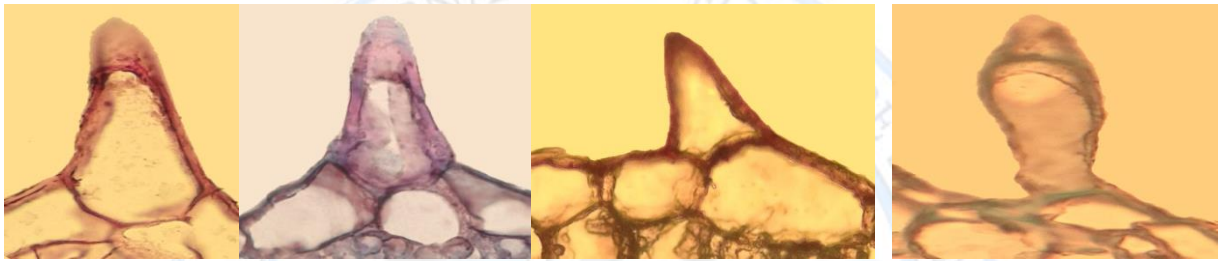
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F

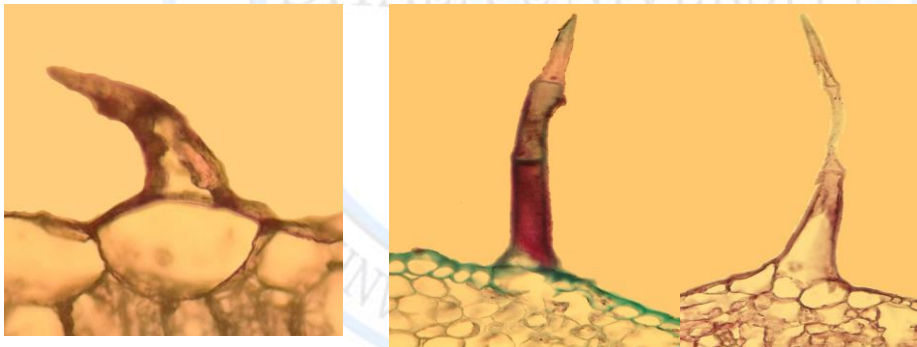
G

H



I

J



J

K

Figure 4. Trichomes types of all studied taxa.: a-Bicellular glandular hairs (circular head); b- Bicellular glandular hairs (resupinate triangle head); c-Bicellular glandular hairs (oblong head); d- Bicellular glandular hairs (starred head); e- Multicellular glandular hairs (circular or semicircular head); f- Multicellular glandular hairs (resupinate triangle head) : g- Multicellular glandular hairs (oblong head); h- Multicellular glandular hairs (starred head); i- Unicellular non glandular hairs (subulate end); j- Bicellular non glandular hairs (subulate or acute end) ; k- Multicellular nonglandular hairs (subulate end)