Morphological characteristics of two endemic subspecies of Clinopodium troodi (Post) Govaerts (Lamiaceae) growing in Turkey

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ABSTRACT
A group of Lamiaceae that has caused confusion over its generic boundaries are those species belonging to the complex surrounding the genera Satureja, Calamintha, Micromeria, Clinopodium and Acinos. In the current study, morphological and taxonomical characteristics of two endemic subspecies of Clinopodium troodi (Post) Govaerts subsp. vardaranum (Leblebici) Govaerts and Clinopodium troodi (Post) Govaerts subsp. grandiflorum (Hartvig and Å.Strid) Govaerts were studied for the first time using stereoscopic microscopy and detailed descriptions and illustrations of general appearance of plants and their leaf, bract, flower, calyx, corolla and fruit shapes were described and illustrated. At the same time, the variation borders of subspecies in Flora of Turkey was expanded and a identification key prepared. According to Flora of Turkey, status of a sample collecting from Denizli of C. troodi is doubtfull and here its real status was determined as subsp. grandiflorum.

Keywords: Clinopodium troodi, Lamiaceae, Morphology, Taxonomy

INTRODUCTION
Turkey is regarded as an important centre of biodiversity for the Lamiaceae. In Turkey, the family is represented by 45 genera, 546 species and a total of 731 taxa (1). The genus Clinopodium L. is also a member of Lamiaceae family. Recently some Satureja L., Micromeria Bentham, section Pseudomelissa Bentham species and all species of Calamintha Miller and Acinos Miller have been transferred to Clinopodium by Govaerts (2), Harley and Granda (3), Harley et al. (4), Brauchler et al. (5), Ryding (6-7) and Dirmenci et al. (8). Thus, the number of species belong to genus Clinopodium has reached about to 100. They are mostly distributed in the New World and temperate Eurasia, but a few in Africa, tropical Asia and Indo-Malaysia (4).

The genus Clinopodium had only 2 species in the first revision of Clinopodium was made by Davis and Leblebici (9) for the “Flora of Turkey”. Recently two considerable contributions on the taxonomy of Clinopodium have been made (10-11).
After the above mentioned taxonomic studies, the number of accepted taxa in Turkey has reached to 38.

All species of the genus Acinos including Acinos troodi (Post) Leblebici subsp. grandiflorus Hartvig and Strid and Acinos troodi (Post) Leblebici subsp. vardaranus Leblebici have been transferred into the genus Clinopodium and they have been included in the synonymy of Clinopodium by Harley et al. (4). After the last taxonomic rearrangement into Clinopodium, the accepted names in Turkey are as follows: C. troodi (Post) Govaerts subsp. grandiflorum (Hartvig and Å.Strid) Govaerts (Syn. Acinos troodi (Post) Leblebici subsp. grandiflorus Hartvig and Strid) and C. troodi (Post) Govaerts subsp. vardaranum (Leblebici) Govaerts (Syn. Acinos troodi (Post) Leblebici subsp. vardaranus Leblebici). These subspecies are endemic plants in Turkey and East Mediterranean elements (9, 12).

C. troodi subsp. grandiflorum is locally known as "sultan fesleğeni" and C. troodi subsp. vardaranum is locally known as "vardar fesleğeni" in the regions where they grow (13). Clinopodium species have used for medicinal purposes in the literatures. For example, the decoction of C. suaveolens (Sm.) Kuntze is used in Northern Greece as sedative and in others as an anti-inflammatory (14). Internally, C. acinos (L.) Kuntze is used in melancholy, for shortness of breath and for improving digestion. Externally, oil was once used to treat bruises, toothache, sciatica and neuralgia (15). C. alpinum (L.) Kuntze is employed in folk medicine having beneficial effects on coughs and gastrointestinal disorders in Spain (16). C. graveolens (M. Bieb.) Kuntze is used as herbal tea against to influenza in Denizli, Kütahya, Balıkesir of Turkey (17).

Morphological and anatomical studies are played an important role in systematics. In previous publications, the compositions of essential oils of these subspecies (18), leaf anatomic structures (19) and pollen features (20) were reported by us but morphological properties had not been studied yet.

In this study, distinguishing traits of two endemic subspecies of Clinopodium troodi have been investigated for the first time. A comparative study with different populations and herbarium materials constituted the basis of our observations. According to Flora of Turkey (9), status of a sample collecting from Denizli of C. troodi is doubtfull and more material is needed to settle its status. The aim of this paper is also to present morphological characters of the two subspecies, to discuss their taxonomic values and to determine real status of Denizli samples.

### MATERIAL AND METHODS

Clinopodium troodi subsp. vardaranum was collected from vary localities of Muğla province while subsp. grandiflorum was collected from different localities of Muğla and Denizli province. Some of them were brought as herbarium material and they are kept in the Herbarium of the faculty of Pharmacy of Anadolu (ESSE). Furthermore herbarium materials in ANK, EGE and İSTE were also examedinated.

Descriptions of species are based on living material. All measurements were made directly from herbarium specimens. Measurement were made a lot sample for description of each specimen. General views, stem, calyx, corolla, nutlet, leaves, bract and bracteol of subspecies had been drawn. Drawing of plant parts had made by illustration (drawing) tube of a wild M5 A stereomacrooscope.

### RESULTS

**Clinopodium troodi (Post) Govaerts subsp. vardaranum** (Leblebici) Govaerts (Figs. 1-2)

Perennial 2.5-16 cm. Stems decumbent, glandular and eglandular, 0.1 mm or shorter, puberulent, sparsely crispate-haired. Leaves green, seldom purple, from orbiculate to ovate-lanceolate, 2.8-5 x 2-9 mm, petiole to 1.5-7 mm, apex rotundate to acute-acuminate, margin entire or shallowly serrate towards to apex, base obtus rotundate, cuneate, rare truncate, veins prominent beneath, with 2-3 pairs of lateral veins, both of surface usually scabros or sparsely crispate-haired, dense glandular. **Floral leaves** ovate, lanceolate to elliptic, 3-7 x 1-6 mm, petiole to 0.5-7 mm, apex apiculate-acuminate, margin entire or shallowly serrate towards to apex, base cuneate, the venation like leaves, with 1-3 pairs of lateral veins, trichomes like leaves. **Bracteoles** subulate, 0.7-2 mm, ciliate. **Verticillasters** 1-4, forming a head in the axils of floral leaves, 2-10 flowered, distance between verticillasters up to 2 cm, flowers projecting beyond floral leaves, petiole 0.5-3.5 mm. **Calyx** green, seldom green-purple, 7-9.5 mm, 13-ribbed, sub-bilabiate, tube slightly curved and weakly gibbous at the base, throat bearded, five toothed, lower teeth two, 2.5-3.5 mm, subulate, upper teeth three, 1.5-2.5 mm, triangular-subulate, ciliate, glandular and eglandular, 0.1 mm or shorter puberulous-haired, densely glandular. **Corolla** yellowish-violet, but yellowish-white in calyx and purple spots on middle lobe and margin of lower lip, half of corolla in exserted of calyx, 12-20 mm, bilabiate, corolla tube like a narrow funnel, 1 mm wide toward to base, 4 mm wide in the upper, upper lip 2-lobed, 3.5-3 x 3-4.5 mm, lobes
obtus, lower lip 3-lobed, 3.5-4.5 x 5-6.8 mm, lobes rotundate, the middle lobe is longer than laterals, glandular and eglundular, indumentum dense and long in calyx outside, with parallel 2-row long-thick haired in lower lip, 2-row short-thin haired between stamens in upper lip. **Stamens** 4, didynamous, filaments white, 1.5-2.2 mm in upper pair, 3-6 mm in lower pair; anthers purple-white, 1-2 mm and 0.8-1.8 (-2) mm respectively. **Ovary** 0.4-0.5 mm, style white, purple in the apex, 12-20 mm, branched unequal, short lobe subulate, erect, 0.5 mm, long lobe large and recurved 0.8 mm. **Nutlets** brown, reticulate, 1.8-2 x 0.7-1 mm, obovoid-oblong, trigonous, apex obtus.

Flowering time: July-August  
Habitat: Rocky slopes on serpentine  
Altitude: 1700-2200 m.  
Distribution: South-West Anatolia  
Phytocography: East Medit. (mt.) element  
Climate: Mediterranean  
Red data category: EN (Endangered)  
**Endemic** (9, 21)

**Clinopodium troodi** (Post) Govaerts subsp. *grandiflorum* (Hartvig & Å.Strid) Govaerts (Figs. 3-4)  
Perennial 4-35 cm. **Stems** compact, decumbent, glandular and eglundular, 0.1-0.8 (-1) mm patent-haired. **Leaves** green, seldom purple, from orbiculate to ovate-lanceolate, 3-11 x 3-9 mm, petiole to 3-9 mm, ciliate, apex rotundate to acute-acuminate, margin entire or shallowly serrate towards to apex, base obtus-rotundate or cuneate, rare truncate, veins prominent beneath, with 2-3 pairs of lateral veins, both of surface short and long patent-haired and densely glandular. **Floral leaves** ovate-lanceolate to elliptic, 3.5-10 x 1.5-8 mm, petiole to 3-5 mm, ciliate, apex acute, acute-apiculate, margin entire, the venation like leaves, with 1-3 pairs of lateral veins, trichomes like leaves. **Bracteoles** subulate, 1-2 mm, ciliate. **Verticillasters** (1-) 2-4 (-6), forming a head in the axis of the floral leaves, 2-10 flowered, distance between verticillasters 2.5-58 mm, flowers exceded floral leaves, petiole 0.5-4 mm, **Calyx** green, seldom green-purple, 7-10.5 mm, 13-ribbed, sub-bilabiate, tube slightly curved and weakly gibbous at the...
base, throat bearded, five toothed, lower teeth two, 3-3.5 mm, subulate, upper teeth three, 1.8-2.5 mm, triangular-subulate, ciliate, glandular and eglandular, long patent-slightly crispatate haired at the base, shorter above, densely glandular. **Corolla** yellowish-violet, but yellowish-white in calyx and purple spots on the middle and margin of lower lip, half of corolla in exserted of calyx, 12-21 mm, bilabiatur, corolla tube like a narrow funnel, 1 mm wide toward to base, 4 mm wide in the upper, upper lip 2-lobed, 2.3-5 x 2.5-5 mm, lobes obtus, lower lip 3-lobed, 3.5-6 x 4.2-7.5 mm, lobes obtus-rotundate, the middle lobe is longer and widener than laterals, glandular and eglandular, indumentum dense and long in calyx outside, with parallel 2-row long-thick-haired in lower lip, 2-row short-thin haired between stamens in upper lip. **Stamens** 4, didynamous, filaments white, 2.2-5 mm in upper pair, 4-5.5 mm in lower pair; anthers purple-white, 1.5 mm and 1.5-1.8 mm respectively. **Ovary** 0.5 mm, style white, purple in the apex, 12-19 mm, branched unequal, short lobe subulate, erect, 0.5 mm, long lobe large and recurved 0.8 mm. **Nutlets** brown, reticulate, 1.8-2 x 0.7-1 mm, obovoid-oblong, trigonous, apex obtus.

**DISCUSSION**

*C. troodi* is an endemic species which grows on serpentine, limestone and rocky slopes at an altitude of 1700-2200 m. Plant is easily separated from the other *Clinopodium* species with decumbent or procumbent stem, slightly curved and weakly gibbous calyx tube and prominent veins on lower surface of leaves (9, 17). Results of the study show that there are some morphological variations in *C. troodi*, which is represented by two subspecies (subsp. *vardaranum* and subsp. *grandiflorum*) in Turkey. However, many characters are present in all of them.
Morphological and taxonomical properties of subspecies of *C. troodi* were summarized in Table according to our findings and the results were with Flora of Turkey compared. According to Table, the stem structure, hair length, hair structure and distance between verticillasters are significant diagnostic character to distinguish the subspecies. That is; in subsp. *vardaranum*, flowering stems are 2.5-16 cm, hairs to 0.1 mm, puberulent, sparsely crispate-haired and distance between verticillasters to 2 cm. In subsp. *grandiflorum*, flowering stems are 3.5-35 cm, hairs to 0.1-0.8 mm, patent-hair, and distance between verticillasters to 5.8 cm. This status is given in the separation key for the subspecies. In addition, measurements of plant, leaves, calyx and corolla lengths in subspecies were found higher than Flora of Turkey. According to result of this study, the variations borders of subspecies were expanded. Furthermore, the distance between verticillasters, properties and lengths of petiol, floral leaves, upper-lower teeth of calyx, upper-lower lip of corolla, stamen, pistil and nutlet are reported here in detail for the first time. The others features were in accordance with the published data. Some morphological variations were also determined in the length of trichomes, number of verticillasters and flower in investigated populations of subsp. *grandiflorum*. That is; the hairs in Muğla-Çağ mountain samples (0.8-1 mm) is longer than in Denizli-Bozdağ samples (0.5 mm) as the vertisil (1-6) and flower numbers (2-10) in Denizli-Bozdağ are more than in Muğla-Çağ mountain (1-4 vertisil, 2-6 flower). According to Flora of Turkey, status of a sample collecting from Denizli of *C. troodi* had determined to be doubtfull (9). We collected a lot samples from this locality and determined its real status as subsp. *grandiflorum*.

**Identification key for the subspecies**

Stem, leaves and calyx indumentum 0.1 mm or shorter, flowering stems 2.5-16 cm, vertisil distance to 2 cm .................

......................... *C. troodi* subsp. *vardaranum*

Stem, leaves and calyx indumentum 0.1-0.8 (-1) mm, flowering stems 4-35 cm, vertisil distance to 5.8 cm ..........

......................... *C. troodi* subsp. *grandiflorum*

**Acknowledgements**

I would like to thank the curators of ANK, EGE, ISTE for granting permission to examine their specimens, and F. Koca for her helping. This work was supported by the (TUBITAK) under Grant (number: TBAK-104T293-2009).

**Table** To compare of morphological features in subspecies of *C. troodi*

<table>
<thead>
<tr>
<th></th>
<th>subsp. <em>vardaranum</em></th>
<th>Flora of Turkey</th>
<th>subsp. <em>grandiflorum</em></th>
<th>Flora of Turkey</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stem</td>
<td>decumbent 2.5-16 cm</td>
<td>decumbent 3-10 cm</td>
<td>decumbent or procumbent 4-35 cm</td>
<td>procumbent to 30 cm</td>
</tr>
<tr>
<td>Indumentum</td>
<td>sparsely crispate haired or puberulent 0.1 mm or shorter</td>
<td>sparsely crispate haired, puberulent</td>
<td>patent 0.1-0.8 (-1) mm</td>
<td>Patent -</td>
</tr>
<tr>
<td>Leaves</td>
<td>2.8-5 x 2-9 mm</td>
<td>3-8 x 3-5 mm</td>
<td>3-11 x 3-9 mm</td>
<td>7-10 x 6.8-5mm</td>
</tr>
<tr>
<td>Petiol</td>
<td>1.5-7 mm</td>
<td>-</td>
<td>3.9 mm</td>
<td>-</td>
</tr>
<tr>
<td>Floral leaves</td>
<td>3-7 x 1-6 mm</td>
<td>-</td>
<td>3.5-10 x 1.5-8mm</td>
<td>-</td>
</tr>
<tr>
<td>Verticil number</td>
<td>1-4</td>
<td>1-3</td>
<td>(1-) 2-4 (-6)</td>
<td>2-3</td>
</tr>
<tr>
<td>Verticil distance</td>
<td>to 2 cm</td>
<td>-</td>
<td>0.25-5.8 cm</td>
<td>-</td>
</tr>
<tr>
<td>Calyx</td>
<td>7-9.5 mm</td>
<td>8-9.5 mm</td>
<td>7-10.5 mm</td>
<td>7.5-9.5 mm</td>
</tr>
<tr>
<td>C. upper teeth</td>
<td>1.5-2.5 mm</td>
<td>-</td>
<td>1.8-2.5 mm</td>
<td>-</td>
</tr>
<tr>
<td>C. lower teeth</td>
<td>2.5-3.5 mm</td>
<td>-</td>
<td>3-3.5 mm</td>
<td>-</td>
</tr>
<tr>
<td>Corolla</td>
<td>yellowish-violet</td>
<td>violet</td>
<td>yellowish-violet</td>
<td>pale bluish-violet</td>
</tr>
<tr>
<td>Corolla upper lip</td>
<td>12-20 mm</td>
<td>12-16 (-18) mm</td>
<td>12-21 mm</td>
<td>6-19 mm</td>
</tr>
<tr>
<td>Corolla lower lip</td>
<td>3-3.5 x 3-4.5 mm</td>
<td>-</td>
<td>2-3.5 x 2.5-5 mm</td>
<td>-</td>
</tr>
<tr>
<td>Nutlet</td>
<td>3.5-4.5 x 5-6.8 mm</td>
<td>-</td>
<td>3.5-6 x 4.2-7.5 mm</td>
<td>-</td>
</tr>
<tr>
<td>Nutlet upper lip</td>
<td>1.8-2 x 0.7-1 mm</td>
<td>-</td>
<td>1.8-2 x 0.7-1 mm</td>
<td>-</td>
</tr>
</tbody>
</table>
Türkiye’de yetişen Clinopodium troodi (Post) Govaerts (Lamiaceae) nin iki endemik alttürünün morfolojik özellikleri

ÖZ

Anahtar kelimeler: Clinopodium troodi, Lamiaceae, Morfoloji, Taksonomi

REFERENCES
Appendix

Examined specimens for *C. troodi* subsp. *vardaranum*: C2

Examined specimens for *C. troodi* subsp. *grandiflorum*: C2
DENİZLİ: Acıpayam, Bozdağ, 1750-1920 m, 14.7.1992, A. Kaya, İ. Kaya ESSE 10501!, Acıpayam, Bozdağ, 1900 m, 8.8.1993, A. Kaya, İ. Kaya, ESSE 10502!. 