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Morphological and Anatomical Studies on *Cyclotrichium organifolium* (Labill.) Manden. & Scheng. (*Labiatae*)

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Abstract : Morphological and anatomical features of *Cyclotrichium organifolium* (Labill.) Manden. & Scheng. (*Labiatae*) collected from various localities in Turkey are described and discussed. Anatomical studies include transverse sections of stems and leaves with illustrations. Although some morphological variation was observed there was no anatomical variation in the wide range of specimens studied, from different areas of Turkey.

Key Words : *Labiatae*, *Cyclotrichium organifolium*, Morphology, Anatomy

Cyclotrichium organifolium (Labill.) Manden. & Scheng. (*Labiatae*) Üzerinde Morfolojik ve Anatmik Çalışmalar

Özet : Çeşitli lokalitelerden toplanan örnekler, morfolojik ve anatmik olarak incelenmiştir. Bitkinin yaprak, çiçek gibi organlarının morfolojik özellikleri ayrıntılı olarak verilmiştir. Anatmik çalışmalarda, bitkinin gövde ve yaprak kısımlarından alınan enine kesitler incelenmiş ve çizimlerle gösterilmiştir.

Anahtar Sözcükler : *Labiatae*, *Cyclotrichium organifolium*, Morfoloji, Anatomi

Introduction

The family *Labiatae* has an important role as a source of medicinal and aromatic plants of commercial importance. *Cyclotrichium* is represented by the following 5 species in the Flora of Turkey: *C. niveum* (Boiss.) Manden. & Scheng., *C. organifolium* (Labill.) Manden. & Scheng., *C. leucotrichum* (Staph ex Rech. fil) Leblebici, *C. stamineum* (Boiss. & Hohen.) Manden. & Scheng. and *C. glabrescens* (Boiss. & Kotschy ex Rech. fil) Leblebici (1). Later this number was increased to 6 with the discovery of a new species, *C. longiflorum* Leblebici (2,3). *C. niveum* and *C. glabrescens* are endemic and the percentage of endemism of this genus in Turkey is 33.3%. All the *Cyclotrichium* species are Irano-Turanian elements except for *C. organifolium* which is an East Mediterranean Mountain element growing at high altitudes (1300-2200 m) in SW Anatolia; it is also found in Lebanon (1). Local names are kızotu, köpeknanesi, karabaşotu, naneruhu and eşekkırdı (4).

Cyclotrichium is classified as moderately rich on the basis of essential oil content (5). The essential oil content of *C. organifolium* ranges between 0.4 and 1.4 % with cis-isopulegone (3.5-52.2%), pulegone (6.9-37.2%), isomenthone (2-30.7%) and isomenthol (0.3-11.2 %) as the main constituents (4).

In a previous study, we investigated the morphological and anatomical features of *C. niveum* (6). Here, we report on the morphology and anatomy of *C. organifolium*.

Materials and Methods

C. organifolium was collected in July and September from different localities (Afyon, Antalya, Hatay, İçel and Muğla). Voucher specimens are deposited in the Herbarium of the Faculty of Pharmacy of Anadolu University, in Eskişehir, Turkey (Acronym: ESSE).

Descriptions are based on living and herbarium specimens. All measurements were made directly on herbarium specimens. A Wild M5A stereomicroscope with a drawing tube and a Nikon Eclipse E 600 research microscope were used in the morphological and anatomical studies.

Results

Morphological Studies

Cyclotrichium origanifolium (Labill.) Manden. & Scheng. in Not. Syst. (Leningrad) 15:337 (1953).

Perennial 11-35 cm, suffruticose, much branched, strongly aromatic. Stem suberect, ascending or procumbent, eglandular-hirsute or pubescent with sessile or stalked glands. Leaves green, greyish-green (3-)6-18.5 x (2-)4-14 mm, ovate-orbicular, rarely elliptical, apex acute-obtuse to rounded, margin entire or slightly dentate towards apex, base obtuse, rounded, sometimes cuneate, both surfaces covered with trichomes, pale yellow-orange sessile or stalked glandular hairs. Bracts

(3.8-)6-16 x (2-)4-12 mm, short-petiolate, ovate, ovate-orbicular, apex obtuse, margin entire or with 1-2 teeth towards apex, base obtuse, rounded, sometimes cuneate, trichomes and glandular hairs as in leaves. Verticillasters 1-6 in the axils of bracts, densely flowered, remote with, 1.1-6.5 cm spaces. Bracteoles 2-8.5 x 0.2-2.5 mm, lanceolate-acuminate to subulate, as long as calyx tube or shorter (1/2-1 calyx tube). Calyx green or greenish-purple, slightly curved, 4-7(-8) mm, tubular, 13-veined, clearly bilabiate, upper lip 3-toothed, 0.4-1.5 mm, triangular-acuminate, curved upwards, lower lip 2-toothed, 0.8-2.5 mm, triangular, subulate, long or short ciliate, hirsute-pubescent, with sessile or stalked glands, orange or pale yellow, bearded in throat. Corolla purple on lips, white on tube, 6-10.5 mm, pubescent; upper lip emarginate; lower lip 3-lobed, middle lobe longer than laterals, corolla tube resupinate, annulate. Stamens 4, exerted, anthers white, 0.6-0.8(-1) mm; filaments purple, 5-9 mm. Style 8-14.5 mm; stigma branched, \pm unequal, subulate. Nutlets pale brown, (1.1-)1.3-1.5(-1.8) x 0.6-0.9 mm, oblong-ovoid, trigonous, apex obtuse-rounded, glabrous (Figures 1 and 2).

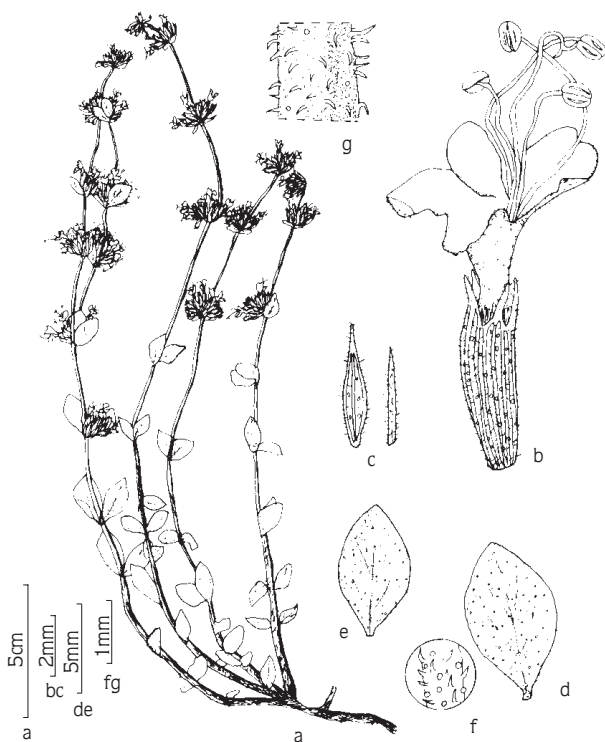


Figure 1. *Cyclotrichium origanifolium* (ESSE 11605), a) Plant b) Flower c) Bracteoles d) Leaf e) Bract f) Trichomes g) Indumentum.

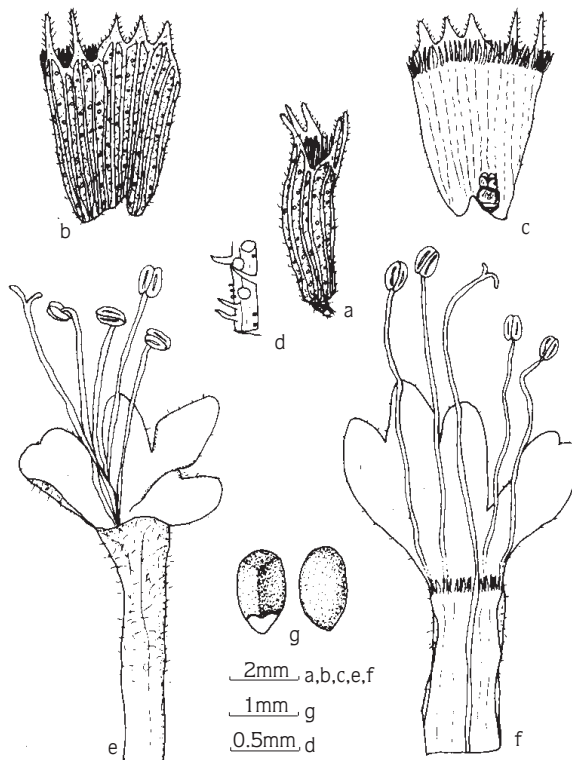


Figure 2. *Cyclotrichium origanifolium* (ESSE 11605), a-c) Calyx d) Trichomes of the calyx e-f) Corolla g) Nutlets.

B3 Afyon: Çay-Sultan Mountains, Çay Yalvaç mountain-road 10 km, 1400-1500 m, 12.8.1994, H.Duman ESSE 10728!; Isparta: Senirkent-Garip village, Cedrus forest, December 1993, G.Tümen, ESSE 10492!; Senirkent-Garip village, Cedrus forest, 10.11.1993, G.Tümen, ESSE 10962!; Senirkent-Garip village, Barla Mountain, Cedrus forest, rocky slopes 1900 m, L.Bekat, ESSE 10240! C2 Muğla: Fethiye-Akçay village, 10.8.1993, G.Tümen, ESSE 10088!; Fethiye, Babadağ, 10.8.1996, G.Tümen, ESSE 12728! C3 Antalya: Akseki-Kuyucak village, H.Malyer, ESSE 10338!; Isparta: Sütcüler Mountain, near Nato transmitter, September 1993, G.Tümen, ESSE 10115! C4 Antalya: Alanya-Köprübaşı area, Arpacık plateau, north area, 1600-2000 m, 10.8.1994, H.Duman, ESSE 10707!; Alanya, Mahmutlar-Hadim road, 1050 m, 17.7.1995, K.H.C.Başer, H.Duman, A.Altıntaş, ESSE 11518!; Alanya-Dürbanas, Eşek kırıldığı area, 11.8.1993, G.Tümen, ESSE 10073! C5 İçel: Bolkar Mountain, south valley, 1650 m, 7.3.1980, E.Tuzlacı, G.Sarıyar, A.Meriçli, ESSE 9471!; Gülek-Maden road, Kızılkırlık area, 22.7.1995, K.H.C.Başer, H.Duman, A.Altıntaş, ESSE 11605!; Gülek-Maden road, into the third stream, 1400-1500 m, 30.7.1995, G.Tümen, ESSE 1180!; Niğde: Çamardı, Demirkazık rocky, 3.8.1995, G.Tümen, ESSE 11479! C6 Hatay: Başkonuş plateau, near Hüseyin Oluk fountain, August 1994, G.Tümen, ESSE 10745!.

Anatomical Studies

Stem

Transverse sections taken from the middle part of the stem were observed as follows (Figures 3 and 4):

The epidermis is composed of a single layer of almost square, compactly arranged cells and bears stomata. The upper surface is covered with a thin cuticle and contains glandular and eglandular hairs. Covering trichomes are unicellular or multicellular (up to 6) and are also covered with a thin cuticle. Multicellular hairs are more frequent. Three types of glandular hairs are encountered (e.g., Fig. 5): 1) unicellular head and stalk; 2) unicellular head and bicellular stalk; 3) *Labiatae* type (8-celled), the last being rare. Eglandular hairs are more common than glandular hairs. The collenchyma tissue, which is located immediately under the epidermis, is 5-8-layered on the corners and 2-layered or sometimes single layered in between the corners. The shape of collenchyma cells is ovoid. Parenchyma tissue, which is 1-3-layered in the corners and 2-3-layered in between the corners, is composed of usually squashed, irregularly rectangular

cells. In thick stems, there is a 3-8-layered cork tissue above the endodermis with generally rectangular cells. The single-layered endodermis consists of compressed cells. The pericycle is either in groups of 1-3 elongated ovals forming a ring or is multi-layered in places interrupted by the phloem. The phloem is 2-5-layered and consists of irregular or rectangular cells. The cambium is not distinguishable. The xylem comprises trachea and tracheids. The tracheae are orbicular or ovoid while the tracheids are polyhedral. The rays are usually uniseriate, rarely biseriate. The pith consists of large orbicular or polyhedral parenchymatic cells. Those cells underlying the xylem are narrower and thick-walled.

Leaf

Transverse sections of the lamina and the midrib and surface preparations of both epidermises revealed the following elements (Figures 6 and 7).

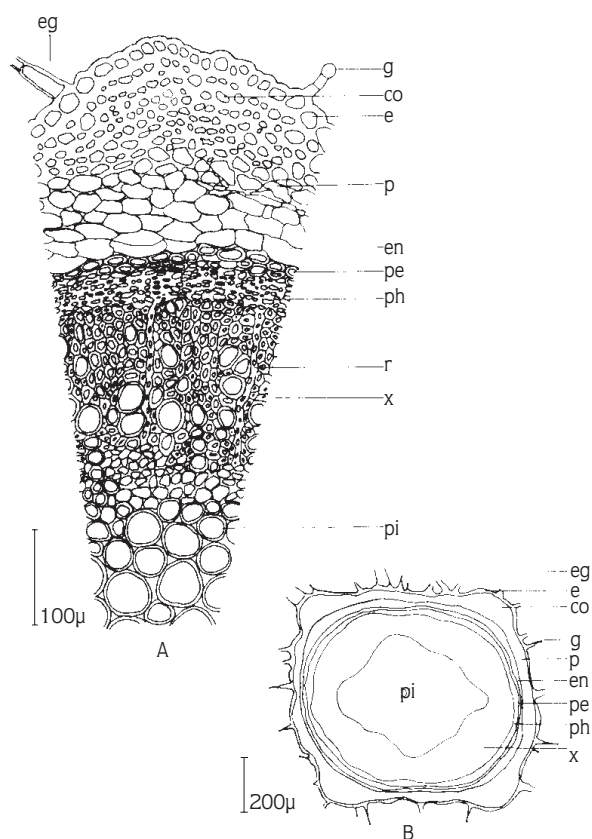


Figure 3. *Cyclothrichium origanifolium* (ESSE 11605). A-B Cross-section of stem. g) Glandular hair eg) Eglandular hair e) Epidermis co) Collenchyma p) Parenchyma en) Endodermis pe) Pericycle ph) Phloem r) Rays x) Xylem pi) Pith.



Figure 4. *Cyclotrichium origanifolium*. Cross-section of stem (2.5 x 20).

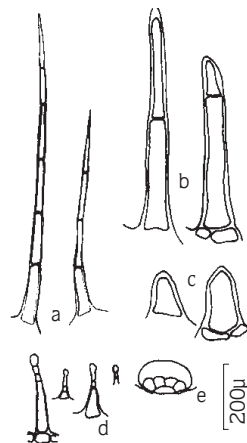


Figure 5. *Cyclotrichium origanifolium* (ESSE 11605). Hair types: Eglandular hairs; a,b,c) Trichomes are 1-7-cellular. Glandular hairs; d) Head unicellular, stalk 2-3-celled e) *Labiatae* type.

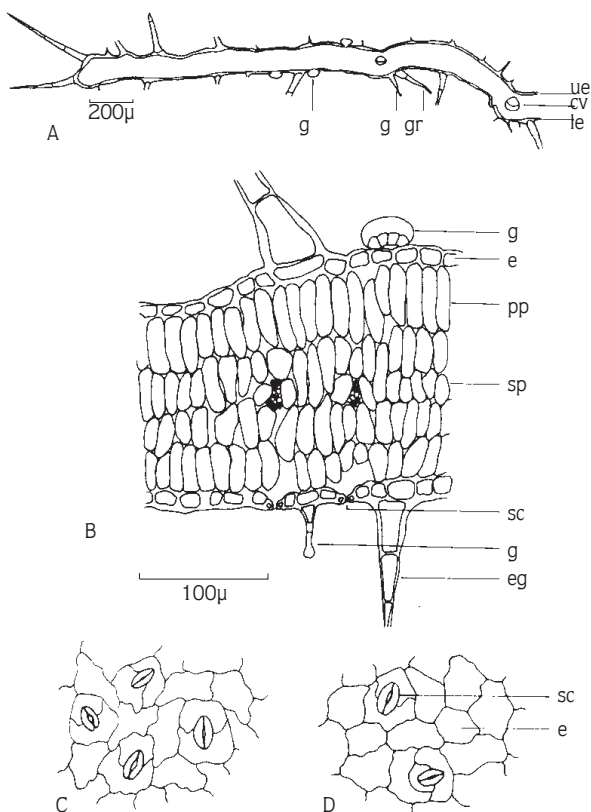


Figure 6. *Cyclotrichium origanifolium* (ESSE 11605). A-B) Cross-section of leaf. C) The stomata from upper epidermal peelings of leaf. D) The stomata from lower epidermal peelings of leaf; ue) Upper epidermis le) Lower epidermis cv) Central vessel g) Glandular hair eg) Eglandular hair e) Epidermis pp) Palisade parenchyma sp) Spongy parenchyma sc) Stoma cell.

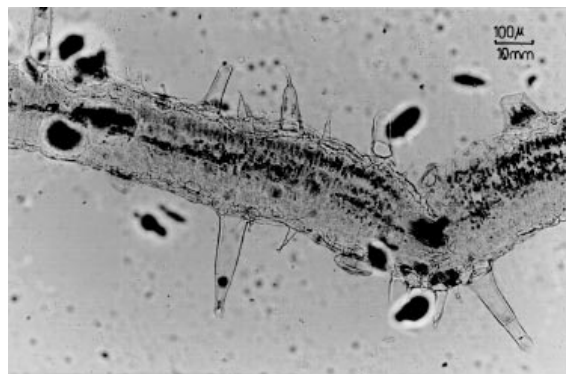


Figure 7. *Cyclotrichium origanifolium*. Cross-section of leaf (2.5 x 10).

In transverse section, the upper and lower epidermises comprise uniseriate oval, square and rectangular cells. The upper walls are thicker than the lower and lateral walls. Both epidermises are covered with a thin cuticle. Cells of the upper epidermises are larger than those of the lower epidermis. Covering trichomes are 1-7-cellular. Multicellular hairs are more abundant. There are 3 types of glandular hairs: 1) head bicellular, stalk unicellular; 2) head unicellular, stalk 2-3-celled; 3) *Labiatae* type (Figures 5 and 6). The last type is rare. Hairs with pear-shaped unicellular head and elongated 1-2-celled stalk are characteristic. The stomata type is diacytic and they occur on the surfaces of both

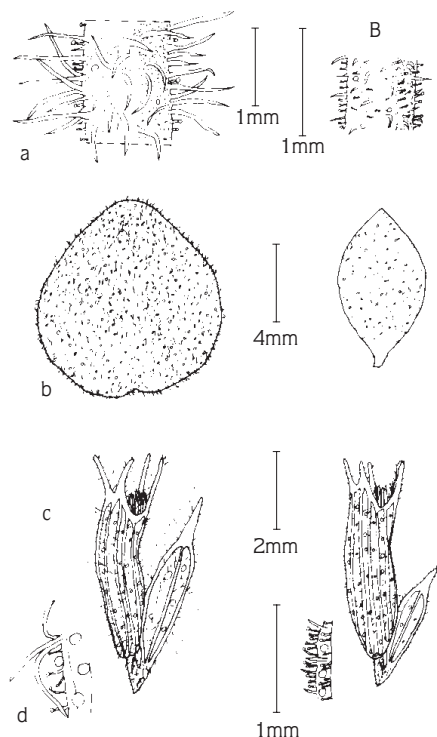


Figure 8. *Cyclotrichium origanifolium* A-Afyon (ESSE 10728). B-İçel (ESSE 9471). a) Stem b) Leaf c) Calyx and bracteole d) Trichomes of the calyx.

surfaces, being more abundant on the lower surface. They are located on the same level as epidermal cells or slightly higher. The leaf is monofacial. The mesophyll is differentiated into an elongated 1-2 seriate spongy parenchyma and 1-2-seriate palisade tissue. Vascular bundles occur in a narrow area. The central vessel is less developed. The xylem faces towards the upper surface while the phloem faces the lower epidermis. In the midrib region, there are collenchymatous cells under the upper and lower epidermises.

Results and Discussion

C. origanifolium samples collected from 12 different localities in the grid squares B3, C2-C6 were investigated and compared. Some morphological variations were observed in the indumentum, the number of verticillasters and bracteole length characteristics. The indumentum in Niğde, Isparta (ESSE 10240), Muğla

(ESSE 12728), Afyon and Antalya samples was denser with long hairs. Especially, the Niğde material resembled *C. niveum* because of the dense indumentums, but it was easily distinguished under the binocular microscope due to the presence of simple, not branched hairs (6). The leaves of Afyon and İçel (ESSE 11605) material were larger than those collected from other localities. İçel (ESSE 9471) material was characteristic in having abundant stalked glandular hairs most. While the number of verticillasters was generally 1-3, 4-6 verticillasters were encountered in Antalya (ESSE 10073, 11518), İçel (ESSE 11605) and Hatay material. The bracteoles in Afyon, Isparta, Muğla and Antalya (ESSE 10338, 11518) material were as long as the calyx tube while they were half the size of the calyx tube in material from the other localities. The calyx teeth were long-ciliate in Afyon, Isparta (Senirkent), Muğla, Antalya and Niğde material. The calyx was partially or wholly purple in İçel, Niğde, Antalya and Afyon materials.

Although our results generally agree with the description in the Flora of Turkey, a few differences were also determined. While the number of verticillasters was reported previously as 2-4, corolla length 8-12 mm, and the bracteoles as long as the calyx tube, we found that the number of verticillasters ranged between 1 and 6, the corolla length was 6-10.5 mm and the bracteoles were as long as the calyx tube or shorter. The plant size and nutlet dimensions are reported here for the first time (Figure 8).

No anatomical differences were observed in the material studied. The branched trichomes in *C. niveum* do not occur in *C. origanifolium* (6). Moreover, epidermal cells are smaller and elongated in *C. origanifolium* than those of *C. niveum*. In surface preparations, epidermal cell walls are more undulated in *C. origanifolium*. *Labiatae*-type glandular hairs are less abundant in *C. origanifolium* compared with *C. niveum* and these are replaced by 1-2-stalked glandular hairs with a unicellular pear-shaped head (7). The midrib is poorly differentiated and is surrounded by a parenchymatic bundle sheath. In contrast to *C. niveum*, the palisade parenchyma is uniseriate in some preparations.

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