



Research Article

<https://doi.org/10.53803/turvehab.1339346>

**A New Rupicolous Species from West of Türkiye: *Stachys cuhacioglui*
(Lamiaceae)**

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Received: 08.08.2023

Accepted: 21.09.2023

Published Online: 15.12.2023

Abstract

Stachys is one of the most diverse genera of the family Lamiaceae and currently consists of 360 species. Here, we describe *Stachys cuhacioglui* (Lamiaceae) as a new species based on morphological and micromorphological data. The new species was discovered in İzmir province in west of Türkiye. *Stachys cuhacioglui* differs from *S. annua* complex by its perennial, chasmophyte habitus, cordate basal leaves, shorter campanulate calyx with recurved teeth, and shorter corolla. The description, etymology, phenology, geographical distribution, IUCN threat category and ecology of the new species are given.

Keywords: Anatolia, İzmir, Labiatae, new species, *Stachys*, Türkiye

**Türkiye'nin Batısından Yeni Bir Rupikol Tür: *Stachys cuhacioglui*
(Lamiaceae)**

Özet

Stachys, Lamiaceae ailesinin en zengin cinslerinden biridir ve hâlihazırda 360 tür içerir. Burada, *Stachys cuhacioglui* (Lamiaceae) morfolojik ve mikromorfolojik verilere dayanarak yeni bir tür olarak tanımlanmaktadır. Yeni tür, Türkiye'nin batısından İzmir ilinden keşfedilmiştir. *Stachys cuhacioglui*, *S. annua* kompleksine ait türlerden, çok yıllık oluşu, kazmofit görünümü, kalpsi taban yaprakları, kıvrık dişli ve çan şeklindeki kaliksi ve daha kısa korollası ile kolaylıkla ayrılır. Bu çalışmada yeni türün tanımı, etimolojisi, fenolojisi, coğrafi dağılımı, IUCN tehdit kategorisi ve ekolojisi verilmiştir.

Anahtar kelimeler: Anadolu, İzmir, Labiatae, *Stachys*, Türkiye, yeni tür

INTRODUCTION

Stachys L., is the largest genus of the subfamily Lamioideae Harley (Harley et al. 2004) and it is one of the largest genera in the family Lamiaceae Martinov (Scheen et al. 2010). The genus *Stachys* is mainly distributed in the Mediterranean region and also in southwestern Asia and North and South America (Bhattacharjee 1980). However, it is not distributed in Australia and New Zealand. The genus comprises 362 species (435 taxa) (POWO 2022). Most of its species grow in forests on rocky places, on limestones, and banks of streams (Bhattacharjee 1980). In addition, endemic taxa are mostly intensified in the warm temperate regions of the Mediterranean Basin (Bhattacharjee 1982).

Bhattacharjee (1980), the most comprehensive revision of *Stachys* to date, revised the Old World species and categorized them into two subgenera *Betonica* L. and *Stachys*. Then, based on

Suggested Citation:

Güner, Ö., Özdöl, T. & Yıldırım, H. (2023). A New Rupicolous Species from West of Türkiye: *Stachys cuhacioglui* (Lamiaceae). *Türler ve Habitatlar* 4(2): 98–109.

the current molecular phylogeny, as Lindqvist & Albert (2002) suggested, Scheen et al. (2010) clearly corroborate the need to reestablish the genus *Betonica*. Recent phylogenetic analyses of chloroplast DNA (cpDNA) and nuclear ribosomal showed that the genus *Stachys* is subdivided into two distinct clades (Scheen et al. 2010; Roy et al. 2013). The first clade forms the center of diversity in the eastern part of the Mediterranean region then its distribution expanded over time to Western Asia, Western Europe and Macaronesia, and sub-Saharan Africa. Whereas the second clade includes the Hawaiian mints, *Suzukia* Kudô, all New-World *Stachys* species and some Old-World species. Phylogenetic findings of studies over the last decade reveal that *Stachys* is polyphyletic (Scheen et al. 2010; Roy et al. 2013).

Stachys is composed of 96 species (123 taxa) and 67 of these taxa are endemic to Türkiye (Güner 2022a; 2022b; Fırat & Güner 2022). *Stachys* species exhibit considerable diversity in floral, nutlet, and habit features. For example, *Stachys annua* L., with three subspecies, of which one is endemic to Türkiye (Figure 1), and *S. iberica* M.Bieb., with 4 infraspecific taxa (of which one is endemic to Türkiye), are distributed throughout the country and display a remarkable diversity in floral, leaves and calyx shape features (Akçiçek 2020). *Stachys* species are mainly identified using indumentum, calyx and corolla length, tooth-to-calyx ratio and verticillaster arrangement (Bhattacharjee 1982; Güner et al. 2021). Based on the morphological characters, some new *Stachys* species have recently been identified (González-Gallegos 2015; Akçiçek et al. 2016; Doğu & Bağcı 2021; Fırat 2021; Akçiçek & Güner 2022) and revision studies (Akçiçek 2020) on *Stachys* sections have been carried out. Furthermore, phylogenetic studies based on nuclear ribosomal and plastid DNA data have supported the morphological distinction between *Stachys* species (Dündar et al. 2013; Bendiksby et al. 2014; Berumen-Cornejo et al. 2017).

In 2012, during fieldwork in İzmir, the third author and Cem Çuhacıoğlu, an amateur botanist and nature lover, collected some interesting *Stachys* specimens on volcanic rocks (Figures 1 and 2). As a result of our detailed macro- and micromorphological studies, we have concluded that those specimens collected in İzmir province differ from other *Stachys* species and after consulting the relevant literature, we concluded the specimens represent a new species.

MATERIAL AND METHOD

The specimens of the new *Stachys* species were compared with other *Stachys* specimens deposited in various herbaria such as ANK, HUB, E, EGE, G, GAZI, ISTE, ISTF, ISTO, K and W (Thiers 2022). In addition, the available relevant literature (Dumortier 1827; Ball 1972; Bhattacharjee 1982; Davis et al. 1988; Strid & Tan 1991; Akçiçek 2020) was reviewed. The gross morphology of the new species was examined under a stereo-binocular microscope and measurements of these specimens were performed with a millimetric ruler. A total of 30 specimens of the new species were examined. At least 50 pollen grains and 30 mature seeds were measured using a light microscope and a scanning electron microscope (SEM). For SEM observations, seed and pollen grains were placed on aluminium stubs with double-sided adhesive tape, sputter coated with gold using a Emiteck K550 and then examined using an FEI Quanta 250 FEG SEM. During field studies, photographs of living material of the new species and its related taxa were taken with a Nikon D300 digital camera. The conservation status of the new species was evaluated based on field observations in accordance with the IUCN (2022) guidelines.

RESULTS AND DISCUSSION

Stachys cuhacioglu Yıldırım & Ö.Güner, **sp. nov.** (Figures 2 and 3)

Type. Türkiye. **İzmir:** Menderes-Gümüldür road, across of Tahtalı Dam, on volcanic rock cracks, 156 m a.s.l., 24.05.2012, *H.Yıldırım 2334* & *C.Çuhacıoğlu* (**holotype:** EGE 43772!, **isotype:** EGE 43773!, NGBB!).

Paratype. Türkiye. **İzmir:** Menderes-Gümüldür road, 1 km to Şaşal, 143 m a.s.l., 04.05.2018, *T.Özdöl 982* & *H.Yıldırım* (EGE 43774!); Menderes, Tahtalı Dam road, before to Şaşal, right of the road, valley road, 231 m a.s.l., 05.08.2018, *T.Özdöl 1260* (EGE 43775!); *ibid.*, 09.05.2019, *T.Özdöl 1612* (EGE 43776!); Menderes, between Deliömerli and Şaşal, 494 m a.s.l., 26.07.2019, *T.Özdöl 2253* & *H.Yıldırım* (EGE 43777!).

Diagnosis. *Stachys cuhacioglu* is morphologically similar to *S. annua*, *sensu lato*, but differs from it by the perennial habitus, cordate basal leaves, campanulate calyx, recurved calyx teeth, and shorter calyx with 6–7 mm long and corolla with 8–9 mm long.

Description. Suffrutescent, caespitose perennial with basal sterile rosettes. Flowering stems 15–45 cm long, erect, simple or branched, densely to sparsely retrorsely pilose at base or throughout and sometimes retrorsely pubescent, upper parts with sessile glands. Leaves sparsely adpressed pilose with sessile glands. Basal leaves, 1.3–3 × 0.9–2.3 cm, crenate at margin, cordate at base; petiole 1.2–3.4 cm long. Cauline leaves 1.3–4 × 0.5–1.4 cm, ovate to ovate-lanceolate, crenate-dentate at margin, attenuate at base; petiole to 2 cm long. Floral leaves broadly lanceolate to linear-lanceolate, margin entire, longer than lower verticillasters and gradually shorter than upper verticillasters, obtuse to acute at apex, sessile. Verticillasters usually remote, 2–4-flowered, 0.3–3.5 cm distant. Bracteoles few, linear, 1–2.5 mm long. Pedicels c. 1 mm long. Calyx regular, campanulate, 6–7 mm long, densely pilose with sessile glands, ± gibbous at base in fruit; teeth ± equal, triangular, 1.5–3 mm long, slightly recurved, with aristate tips; aristae c. 1 mm long, glabrous. Corolla white, lips streaked and spotted with pink inside, 8–9 mm long, densely short pilose hairy with sessile glands outside; tube 6–7 mm long, shortly exerted from calyx, exannulate; limb bilabiate, upper lip c. 3 mm long, retuse; the lower lip 3-lobed, middle lobe longer than 2 lateral lobes, 4 mm long, emarginate. Style c. 7 mm long, not exceeding the upper lip, glabrous, apex equally bifid; stigmas subulate. Stamens 4, within corolla tube; anthers dithecous, thecae divaricate; filaments flattened and with short swollen hairs near point of attachment to corolla tube. Nutlets 2.5–3 × 1.7–2 mm, oblong–obovoid to oblong–discoid, faintly trigonous, winged near base, blackish brown.

Phenology. Flowering in May and fruiting in mid–May and June.

Eponym. This new species was named in honor of the amateur botanist “Cem Çuhacıoğlu” who first discovered the new species together with the third author. The Turkish name of this species is suggested as “efeçayı” according to the guidelines of Menemen et al. (2016).

Habitat and ecology. *Stachys cuhacioglu* is currently known to be locally endemic to İzmir Province, West Anatolia. It is an element belonging to the Mediterranean floristic region. The new species grows in the maquis vegetation and opening of *Pinus brutia* Ten. forests in volcanic rock cracks, between 143 and 494 m a.s.l. in the triangle of Seferihisar, Menderes, and Gümüldür Districts in İzmir (Figure 1). It’s an obligate rupicolous plant (Figure 2). It is never seen on soil. Species growing in the near vicinity include *Arbutus unedo* L., *Asparagus acutifolius* L., *Ceratonia siliqua* L., *Lavandula stoechas* L. subsp. *stoechas*, *Lonicera caprifolium* L., *Origanum onites* L.,

Osyris alba L., *Peucedanum guvenianum* Yıldırım & H.Duman, *Phillyrea latifolia* L., *Pistacia lentiscus* L., *Satureja thymbra* L., and *Verbascum rupicola* (Hayek & Siehe) Hub.-Mor.

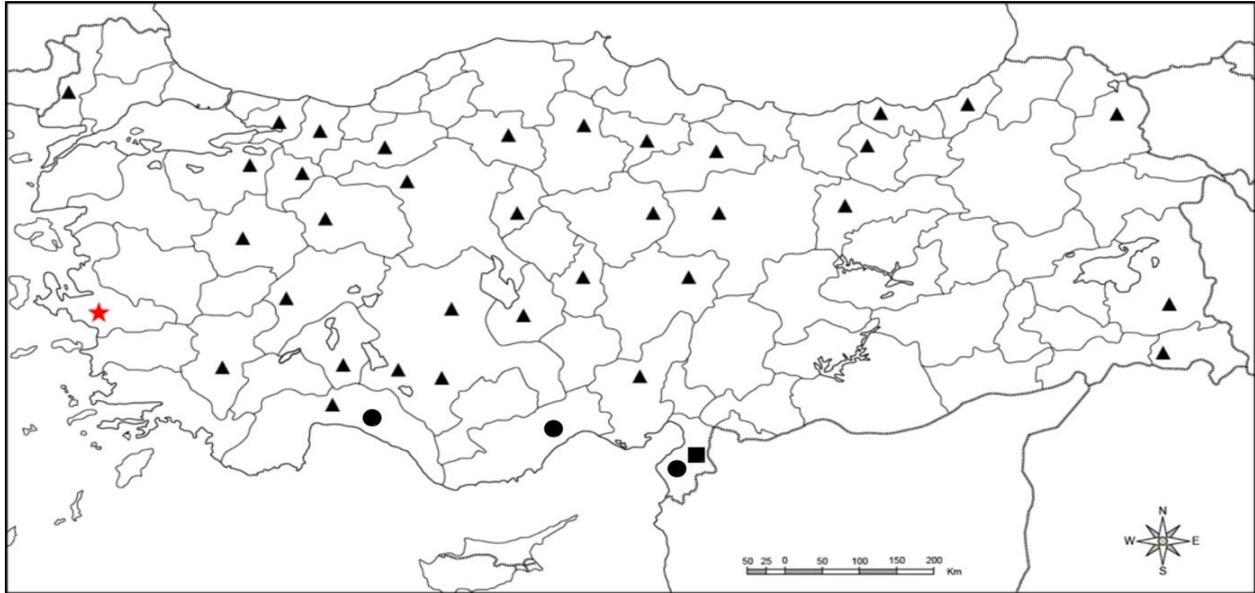


Figure 1. Distribution of *Stachys cuhacioglu* (★), *S. annua* subsp. *annua* (▲), *S. annua* subsp. *ammophila* (●) and *S. annua* subsp. *cilicica* (■) (data of subsp. *annua*, subsp. *ammophila* and subsp. *cilicica* from Akçiçek 2020; map obtained from CoğrafyaHarita 2022).

Taxonomical notes

Stachys cuhacioglu belongs to section *Olisia* Spach subsection *Annuae* Bhattacharjee. This subsection includes some closely related but remarkably variable species (notably *S. annua*), which could be interpreted as a species complex (Bhattacharjee 1982). *Stachys* subsect. *Annuae* is represented by only two species (*S. maritima* Gouan and *S. annua*) in Türkiye. *Stachys maritima* is closely related to *S. annua* but differs from it in having shorter calyx teeth and congested spicate inflorescence. While *S. maritima* is well adapted to live in the maritime sands of the Black Sea shore, *S. annua* prefers to grow in more variable habitats, such as the edges of cultivated and fallow fields, stream sides, forests, and limestone slopes in several regions of Türkiye (Bhattacharjee 1982). Moreover, *Stachys annua*, with its three recognized subspecies, is a widely distributed and morphologically variable taxon with a wide distribution from Europe to Siberia and Iran (POWO 2022). Much confusion has arisen regarding the taxonomic circumscription of the widely distributed and variable *S. annua*. Individuals of this species could be perennial, biennial, or annual with or without basal sterile rosettes (Bhattacharjee 1982; Akçiçek 2020).

Stachys annua contains the following infraspecific taxa: subsp. *annua*, subsp. *ammophila* (Boiss. & Blanche) Sam and subsp. *cilicica* (Boiss.) R.Bhattacharjee. While subsp. *annua* grows in various habitats and is widely distributed almost throughout Türkiye, subsp. *ammophila* and subsp. *cilicica* are locally found in South Anatolia. Moreover, subsp. *ammophila* is endemic to Türkiye (Bhattacharjee 1982; Akçiçek 2020). Although there is no problem among the subspecies of *Stachys annua* based on available data, these subspecies need to be re-evaluated in the light of molecular data. Our studies on the section *Olisia* continue at levels of molecular and micromorphological as well as morphological (Akçiçek 2020; Güner 2022b).

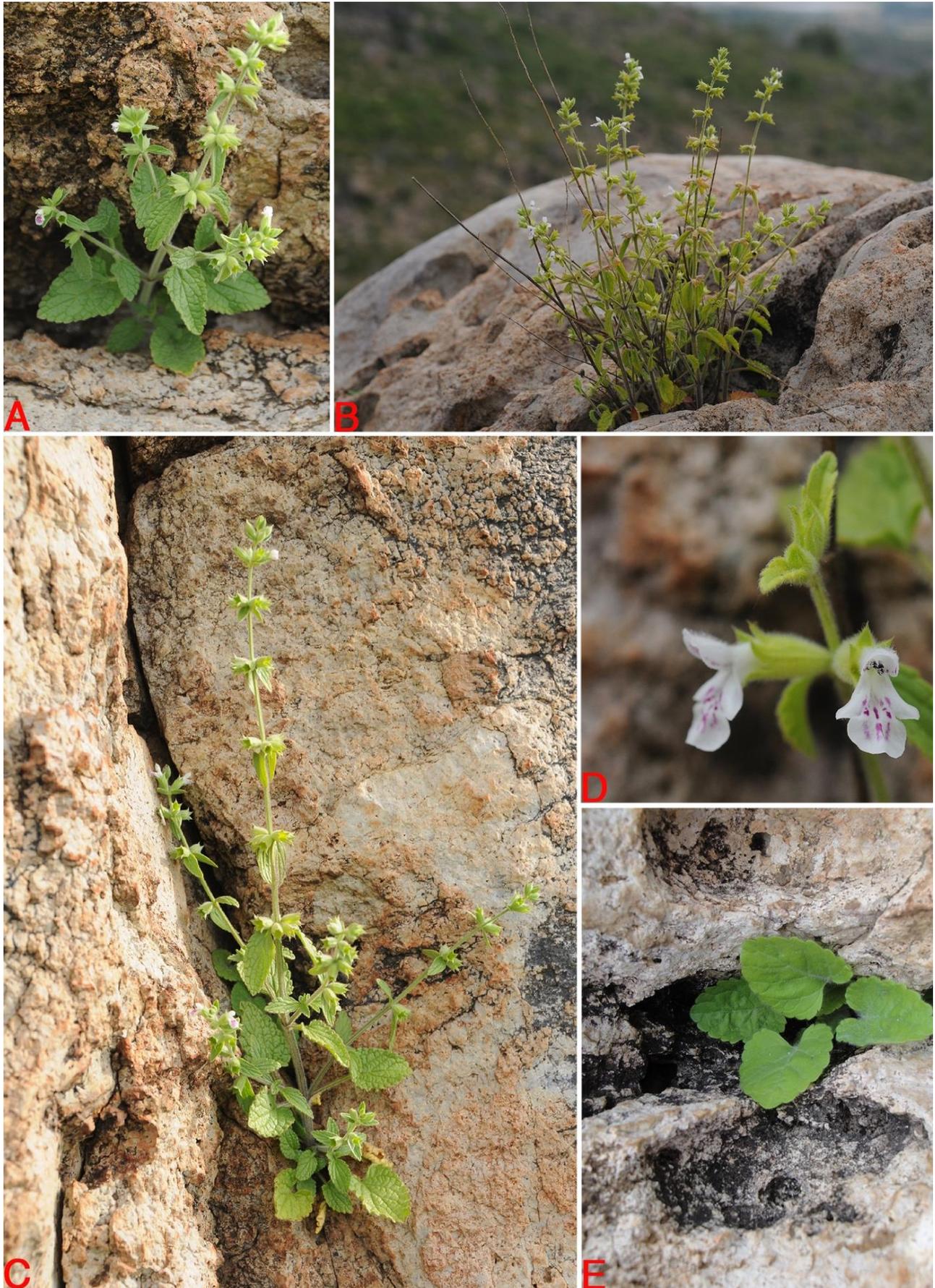


Figure 2. *Stachys cuhacioglu*. A, B and C: Habitus and habitat, D: Flowers, E: Leaf rosette.

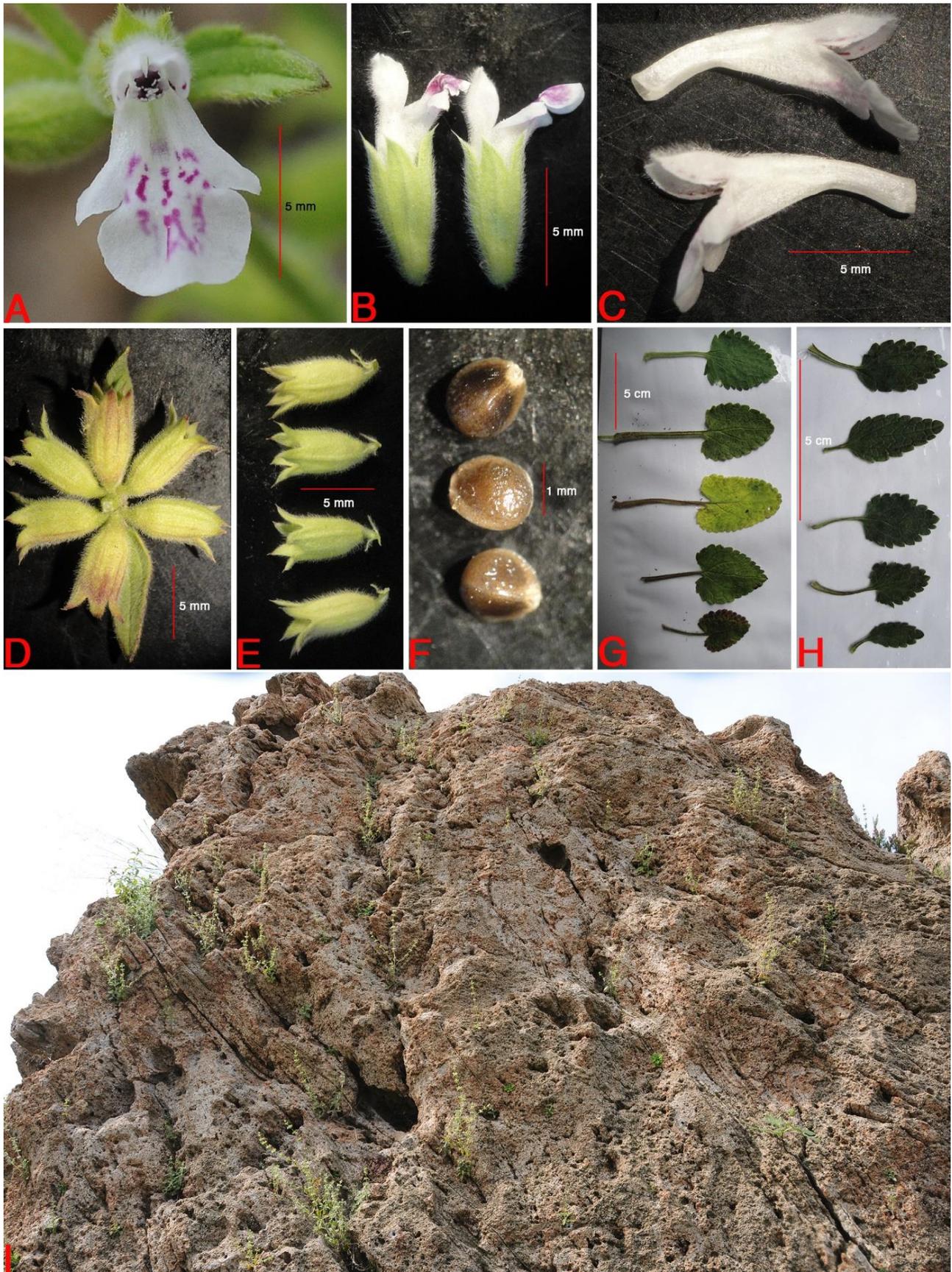


Figure 3. *Stachys cuhacioglu*. A and B: Flowers, C: Corolla, D and E: Calyx, F: Nutlets, G: Basal leaves, H: Cauline leaves, I: Habitat.

Stachys cuhacioglu only grows in volcanic rock crevices at elevations between 143 to 494 m in southwestern Türkiye. One of the most important differences of the new species from *S. annua* is that it lives in rocky habitats. It is an obligate rupicolous plant. Although our detailed research on the type locality of the new species, we could not see it in the soil or in any other habitat. On the other hand, according to previous studies (Bhattacharjee 1982; Akçiçek 2020) and observations, there are no specimens of *S. annua* complex living on rocks.

Stachys cuhacioglu is characterized by having cordate basal leaves, inflorescences with fewer verticillasters and shorter calyx. The new species is similar to *S. annua* (Figure 5) but can be clearly distinguished by some morphological characters (Table 1). These two species have especially significant differences in terms of calyx which is an important character in the discrimination of *Stachys* species (Güner et al. 2021). The new species has regular and campanulate calyx 6–7 mm long and recurved calyx teeth, while *S. annua* has sub-bilabiate and tubular to subcampanulate calyx 13–17 mm long and slightly recurved calyx teeth. Moreover, the new species has shorter corolla with white and 8–9 mm long, and tube subexserted. Based on morphological and micromorphological characters, the new species differs from all other members of the *S. annua* complex.

Table 1. Morphological comparison of *Stachys cuhacioglu* and *S. annua* subsp. *annua*.

Characters	<i>Stachys cuhacioglu</i>	<i>Stachys annua</i> subsp. <i>annua</i>
Life Form	perennial	annual
Habitat and altitude (a.s.l.)	on volcanic crevices, at altitudes of 143–494 m	dry igneous shady slopes, mixed forest, fallow fields; at altitudes of 90–2200 m
Basal leaves	cordate	ovate-oblong to ovate-lanceolate
Cauline leaves	ovate to ovate-lanceolate	ovate-rhomboid, broadly lanceolate to oblanceolate
Verticillasters	usually remote, 0.3–3.5 cm distant, 2–4(–6) flowered	usually remote, 1–4 cm distant, only the uppermost \pm approximate, 4–8 flowered
Bracteoles	linear, 1–2.5 mm long	linear to setaceous, 0.3–4.5 mm long
Calyx	regular, campanulate, 6–7 mm long, densely pilose with sessile glands, teeth \pm equal, triangular, 1.5–3 mm long, slightly recurved	sub-bilabiate, tubular to subcampanulate, 13–17 mm, patently villous or pilose with few sessile glands, teeth subequal, triangular-subulate to lanceolate, 2–5 mm, subpatent or recurved in fruit
Corolla	white, 8–9 mm long, tube shortly subexserted calyx	white or creamy-yellow, 10–17 mm, tube subexserted
Nutlets	obovoid, winged near base, 2.5–3 \times 1.7–2 mm	oblong-obovoid to obovoid, rarely subglobose, 1.5–2.2 \times 0.8–1.6 mm

Micromorphological Results. Pollen grains of the *S. cuhacioglu* are single, isopolar and tricolpate. The mean of a polar axis (P) and equatorial axis (E) is 41.16 $\mu\text{m} \pm 2.21 \mu\text{m}$ and 22.34 $\mu\text{m} \pm 2.55 \mu\text{m}$. The shape of pollen grains is prolate (Figure 4). The outline is elliptic in the

equatorial view. The sculpturing of the exine in *S. cuhacioglu* is micro-reticulate with perforations. Nutlets of *S. cuhacioglu* are oblong-obovoid to oblong-discoid, $1.7\text{--}2.1 \times 1.5\text{--}1.9$ mm, glabrous, reticulate on surface (Figure 4).

The pollen grains of *S. cuhacioglu* and *S. annua* subsp. *annua* are very similar. On the other hand, the seed morphology of the two species is different. Although the seeds of *S. cuhacioglu* are oblong-obovoid to oblong-discoid with reticulate surface, the seeds of *S. annua* L. subsp. *annua* are oblong to oblong-obovoid with reticulate-favolate surface.

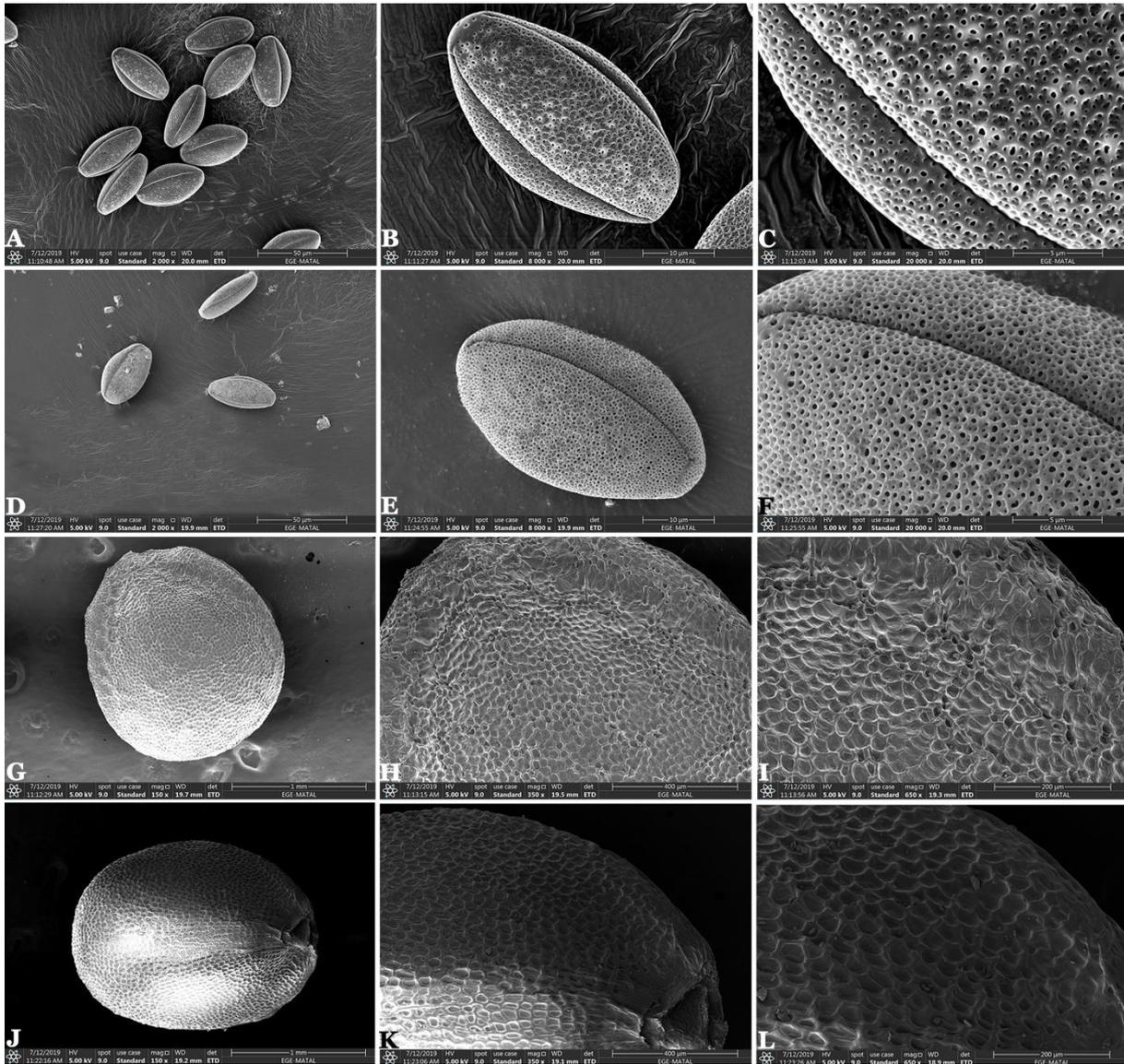


Figure 4. SEM photos of pollen grains. A, B and C: *Stachys cuhacioglu*, D, E and F: *S. annua* subsp. *annua*. SEM photos of nutlet. G, H and I: *S. cuhacioglu*, J, K and L: *S. annua* subsp. *annua*.

Distribution and Conservation status

The occupancy area (AOO) of *Stachys cuhacioglu* was calculated as 8 km^2 , in which about 700 individuals were estimated to occur. Forest fires occur frequently in the area. This situation affects the population of the new species more or less negatively. On the other hand, reforestation works and road works after forest fires have a very negative effect on *S. cuhacioglu*. Thus, according to

the criteria established by the IUCN (2022), *S. cuhacioglu* is hereby assessed as ‘Critically Endangered’ (CR) B2ab (iii,v), on account of its restricted distribution and anthropogenic effects on the population.



Figure 5. *Stachys annua*. A and B: subsp. *annua*, C and D: subsp. *ammophila*, E and F: subsp. *cilicica*.

Specimens Examined

***Stachys annua* subsp. *annua*.** Türkiye. **Hakkari:** Cilo Mountain, 11 km from Kırıkdağ to Cehennemdere, Dizderesi, 1760 m a.s.l., 09.06.2013, *Akçiçek 5561*, *Dirmenci & Ö.Güner* (Hb. Akçiçek!); **Van:** 110 km from Van to Başkale, streamsides, 2150 m a.s.l., 07.06.2013, *Akçiçek 5559*, *Dirmenci & Ö.Güner* (Hb. Akçiçek!); 60 km from Başkale to Yüksekova, stream sides, 1735 m a.s.l., 08.06.2013, *Akçiçek 5553*, *Dirmenci & Ö.Güner* (Hb. Akçiçek!).

***Stachys annua* subsp. *ammophila*.** Türkiye. **Hatay:** Dört Yol, Rabat, serpentine gravel, c. 100 m a.s.l., 25.04.2014, *Akçiçek 5611 & Ö.Güner* (Hb. Akçiçek!); **Antalya:** Aksu to Serik, moist fallow fields, 5 m a.s.l., 06.04.1956, *P.H. Davis 25672 & O.Polunin* (E!, K!).

***Stachys annua* subsp. *cilicica*.** Türkiye. **Hatay:** Antakya, St. Pierre church, rocky slopes, 120 m a.s.l., 27.04.2014, *Akçiçek 5619 & Ö.Güner* (Hb. Akçiçek!).

ACKNOWLEDGEMENTS

The authors are grateful to the curators of ANK, BEI, E, EGE, G, ISTE, ISTO, K, KNYA, SAW and W for access to *Stachys* materials for this study. This work was funded by Ege University Scientific Research Projects Coordination Unit (project no. FYL-2018-20184).

AUTHOR CONTRIBUTION STATEMENT

In this study; study idea and design, data collection, analysis and interpretation of results, writing the article draft was done jointly by the authors.

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