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A new variety of the *Tripleurospermum* (Asteraceae) from Turkey

Mehmet Ufuk ÖZBEK [*1], Hilal ONAYLI [2]
ORCID: 0000-0002-2342-4143**;** 0000-0002-6291-7231

[1] Gazi University, Department of Biology, Faculty of Science, 06500, Teknikokullar, Ankara, Turkey
[2] Basınevleri District, 27. Street, Vadi Ankara Site, 5/14, Keçiören

Abstract

Tripleurospermum fissurale var. *radiata* (Asteraceae) was determined at Artvin Province in North-eastern Anatolia (Turkey) and was defined as a new variety for the scientific world. The description of the taxon, its distribution, ecology, detailed illustrations and achene morphology have been given in this study. It can be easily differentiated from the *T. fissurale* by its ligulate flowers.

Key words: Artvin, Asteraceae, new variety, *Tripleurospermum*, Turkey

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Türkiye'den yeni bir Tripleurospermum (Asteraceae) varyetesi

Özet

Tripleurospermum fissurale var. *radiata*, Kuzeydoğu Anadolu'da Artvin ilinde tespit edilmiş ve bilim dünyası için yeni bir varyete olarak tanımlanmıştır. Bu çalışmada taksonun betimi, yayılışı, ekolojisi, aken morfolojisi ve detaylı resmi verilmiştir. Dilsi çiçeklere sahip olması ile *T. fissurale* türünden kolayca ayırt edilir.

Anahtar kelimeler: Artvin, Asteraceae, yeni varyete,*Tripleurospermum*, Türkiye

1. Introduction

Within the Angiosperms, Asteraceae is a family which represents the greatest number species in the world. With approximately 1600-1700 genera and 24000-30000 species, they are distributed throughout the entire globe, excluding Antarctica. The number of species of the family constitutes approximately 10% of the flowering plants, which is estimated to be between 250000-350000 [1]; whereas, Anthemideae, which is one of the 43 tribes of the family, has a distribution of 111 genera and approximately 1800 species [2].

The Anthemideae tribe consists of 13 genera in the Flora of Turkey. These are the genera of *Anthemis* L., *Chamaemulum* Miller, *Anacyclus* L., *Leucocyclus* Boiss., *Achillea* L., *Santolina* L., *Otanthus* Hoffmans. & Link, *Chrysanthemum* L., *Leucanthemum* Mill, *Tanacetum* L., *Matricaria* L, *Tripleurospermum* Schultz Bip. and *Artemisia* L. [3].

In the differentiation of these genera and the taxa belonging to these genera, morphological characters, especially, are extremely important, such as the capitulum, involucrum, receptacle and achene. For example, while the capitulum is heterogamous and radiate in the *Anacyclus*, *Achillea*, *Chrysanthemum* and *Leucanthemum*, they are homogamous and discoid in the *Santolina* and *Otanthus*. The fact that the involucrum is oblong to depressed-globose (not hemispherical) in the tribe belonging to the *Artemisia* differentiates them from the other genera of the tribe. The receptaculum is with palea in the *Anthemis* and *Achillea*, whereas it is without palea in the *Tripleurospermum* and *Tanacetum*. While the achene is cylindrical, oblong or obpyramidal in the *Tripleurospermum* and generally with 2 glands, in the *Achillea*, it is compressed, oblong or obovate and without glands. However, in the *Anthemis*, it is

* *Corresponding author* / Haberleşmeden sorumlu yazar: Tel.: +905325168130; Fax.: +903122122279; E-mail: ufukozbek@gazi.edu.tr
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obconical, cylindrical or in the shape of a square on the cross-section of its breadth and sometimes it is compressed dorsiventrally and the gland is absent. There is no pappus in *Chrysanthemum*, *Otanthus* and *Santolina*, whereas it has been reduced to the shape of a corona in the other genera.

In recent years, numerous taxonomical, anatomical, karyological and palynological studies have been made on the genera, including the Anthemideae tribe [2,4,5,6,7,8,9,10,11,12,13]. Furthermore, research has been undertaken on the phylogenetic relationships amongst the genera, with the studies being made at a molecular level. At the conclusion of these studies, there have been changes made in the systematic position of some genera. For example, according to the Flora of Turkey, all the species located in the *Cota* (J.Gay) Rupr. section of the *Anthemis* have been transferred to the *Cota* J.Gay ex Guss. [14,15,16]. On the other hand, the *Chamaemelum mixtum* (L.) All., *Cladanthus mixtus* (L.) Oberpr. & Vogt, *Otanthus maritimus* (L.) Hoffmans. & Link, *Achillea maritima* (L.) Ehrend. & Y.P.Guo and the *Leucocyclus formosus* Boiss. have been accepted as a synonym of the *Achillea formosa* (Boiss.) Sch. Bip. [17,18,19]. In accordance with this information, the Anthemideae tribe is represented in the present-day with 12 genera in Turkey with the inclusion of the *Cota* and *Cladanthus* Cass.

Tripleurospermum is a genus that is distributed throughout the world with approximately 40 species in Europe, North Africa, temperate Asia and North America [20]. The first revision of the genus in Turkey was made in the work entitled *The Flora of Turkey and the East Aegean Islands* and 26 taxa were described. In subsequent years, 2 new records and 3 new species were added to Turkish Flora [6,20,21,22,23,24]. The addition of these taxa to the flora of Turkey has increased the number of *Tripleurospermum* taxa showing a distribution in Turkey to 32 (29 species, 3 varieties). Of these taxa, 16 are endemic.

When examining the specimens located at Ankara University, Faculty of Pharmacy Herbarium in 2018, two *Tripleurospermum* specimens were encountered which had not previously been identified. When the detailed morphological investigations of the specimens were made, one of these species was identified as *Tripleurospermum fissurale* (Sosn.) E. Hossain., whereas the other was a specimen of the same species having ligulate flowers. At the conclusion of the field studies which we made a year later in Yusufeli District of Artvin Province, both taxa displayed a distribution and we decided that the specimens that had a ligule were a new variety of the *Tripleurospermum fissurale*.

2. Materials and methods

The materials of the study were composed of specimens of *Tripleurospermum fissurale*, which was distributed in the environs of Dereiçi Village in Yusufeli District of Artvin Province in May 2019. There was an attempt to identify the specimens collected in a detailed manner from literature related to the subject [25,26,27,28,29]. Furthermore, the study materials were compared with specimens found in the AEF, ANK, GAZI and HUB herbaria. Photographs were taken of the specimens from the study area.

The achenes were first investigated using a Leica EZ4D stereomicroscope. In order to determine their average sizes, at least 20 mature fruits were measured for each species. For SEM analyses, the mature achenes were placed on stubs and covered with gold. They were investigated and photographed with a JEOL JSM 6060 Scanning Electron Microscope at the SEM laboratory of the Faculty of Science, Gazi University, Ankara. The terminology was adopted by Barthlott [30], İnceer et al. [9] and Özbek et al. [12].

3. Results

3.1. *Tripleurospermum fissurale* (Sosn.) E. Hossain, Notes Royal Botanical Garden Edinburgh 33: 435 (1975).

Type: [Turkey A8/9 Erzurum] prov. Kars: Olty prope p., Ukjam in rupium fissuris, 17 v 1912, *Sosnowsky* (photo E!).

= *Chamaemelum fissurale* Sosn. in Monit. Jard. Bot. Tiflis, Ann. 11: 15 (1915).

Description: Annual or biennial, 30–70 cm. Stem solitary or divided at base, arising from taproot. Leaves sessile, laciniae small, triangular-acute or linear-acute, mucronate, ± densely pubescent; lower leaves 3-pinnatisect; upper leaves 1-2 pinnatisect. Capitula heterogamous, radiate or homogamous, discoid. Involucre hemispherical, 7–18 mm broad. Peduncles long, 5–15 cm, glabrous. Phyllaries 4-seriate, glabrous; outer phyllaries 2–2.5 × 1–1.5 mm, ovate-lanceolate; inner phyllaries 4 × 1–1.5 mm, oblong-lanceolate, all with pale brownish membranous margins. Receptacle ovoid, epaleate. Ray flowers (if present) female, 15–20, white, elliptic, 8–10 × 3–4.5 mm, 3-lobed at apex. Disc flowers numerous, hermaphrodite, yellow, 5-lobed, lobes 0.2–0.4 mm, tube cylindirical, 2–2.2 mm, eglandular at tips. Anthers 5, coherent along most of their length and forming a tube around style, filaments ca. 0.4 mm, appendages conical, blunt at base; style of disc flowers ca. 2 mm, bifid, branches ca. 0.5 mm. Achenes 1.3–2.5 × 0.4–1 mm, oblong or obpyramidal, brown at maturity copiously mucilaginous, dorsal side smooth or faintly tuberculate, ventral side 3-ribbed; ribs thickened, white, fissures narrow; corona lobate, white, 0.25–0.8 mm.

Specimens examined: *Tripleurospermum fissurale* TURKEY. A8 Artvin: Yusufeli to İspir 2 km, rocky slopes, 40°47′59″E, 41°31′52″N, 25 May 2019, 605 m, *U.Özbek* 3119 (GAZI); Yusufeli-İspir road, around Kozakura district, on the rock, 17 May 2004, 590-620 m, *H. Duman* 9416 et al. (GAZI); Artvin: Yusufeli, Ahlat district, dry steep

slopes, 20 May 1983, 650 m, *A. Güner* 4821 & *M. Vural* (AEF), Artvin: From İspir to Yusufeli, 10 km to Yusufeli, roadsides, 31 May 2008, 653 m, *H.İnceer* 533 (photo E).

3.2. *Tripleurospermum fissurale* (Sosn.) E. Hossain var. *radiata* Özbek var. nova Figures 1-4.

Type: TURKEY. A8 Artvin. Yusufeli, 1.5 km from Dereiçi village, rocky slopes, 40°51′43″E, 41°31′30″N, 25 May 2019, 745 m, *U.Özbek* 3117 & *M. Ekici* (holotype GAZI, isotype AEF, ANK, NGBB).

Diagnosis: The new variety is similar to *Tripleurospermum fissurale*, but it clearly differs by the capitulum presence of ray flowers.

Paratypes: TURKEY. A8 Artvin: Yusufeli, Dereiçi village, rocky slopes, 20 May 1983, 720 m, *A. Güner* 4808 & *M. Vural* (AEF).

Ecology: *Tripleurospermum fissurale* var. *radiata*, which is endemic to Turkey, grows between 720 and 745 m. elevation on rocky slopes. The variety grows together with *Cleome ornithopodioides* L., *Chesneya elegans* Fomine, *Haplophyllum myrtifolium* Boiss., *Dianthus orientalis* Adams, *Veronica oltensis* Woronow ex Elenevsky, *Astragalus aduncus* Willd., *Astragalus xylobasis* Freyn & Bornm., *Tragopogon reticulatus* Boiss. & A.Huet and *Micromeria elliptica* K.Koch.

Phenology: The new variety was observed flowering from April to June and fruiting from May to July.

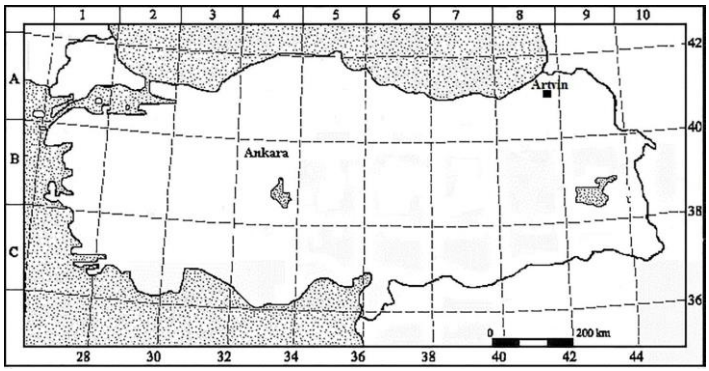

Figure 1. Distribution map of *Tripleurospermum fissurale* var. *fissurale* and *T. fissurale* var. *radiata* (black square)

3.3. Achene Morphology

The achenes of *Tripleurospermum fissurale* var. *radiata* are blackish-brown, obpyramidal or oblong, 2–2.5 × 0.7–1 mm, faintly tuberculate in anterior and 3-ribbed in posterior. Epidermal cells are rectangular with conspicuous, straight or rarely undulate anticlinal walls, showing a reticulate appearance and conspicuous, concave, rugose striped periclinal walls. These cells contain slime. The corona is lobate white and 0.5–0.8 mm in length. In *T. fissurale* var. *fissurale*, the achenes are blackish-brown, obpyramidal or oblong, 1.3–2 × 0.4–0.6 mm, tuberculate in anterior and 3-ribbed in posterior. Epidermal cells are rectangular with conspicuous, straight anticlinal walls, showing a reticulate appearance and conspicuous, concave, rugose striped periclinal walls. These cells contain slime. The corona is lobate, white and 0.25–0.5 mm in length. In *T. oreades*, the achenes are dark brown, obpyramidal or oblong, 1.5–2.2 × 0.6–1 mm, tuberculate in anterior and 3-ribbed in posterior. Epidermal cells are rectangular or polygonal with conspicuous or inconspicuous, straight anticlinal walls, showing a reticulate appearance and conspicuous, flat or concave, ruminated or striped periclinal walls. These cells contain slime. The corona is lobate, white and 0.5–1 mm in length (Fig. 4).

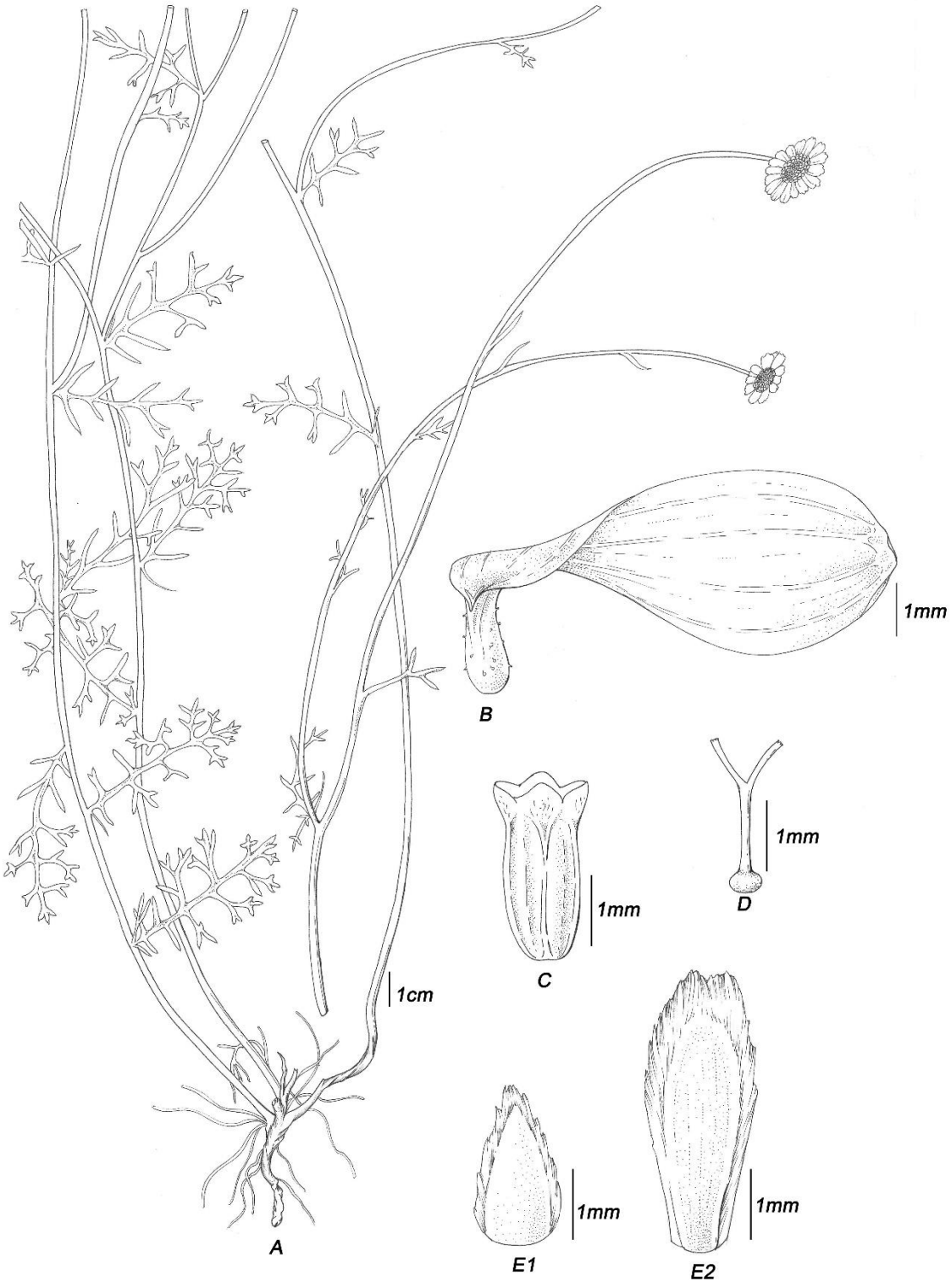

Figure 2. *Tripleurospermum fissurale* var. *radiata*, A- Habit; B- Ray flowers; C- Achene, D- Style; E1- Outer phyllaries; E2- Inner phyllaries

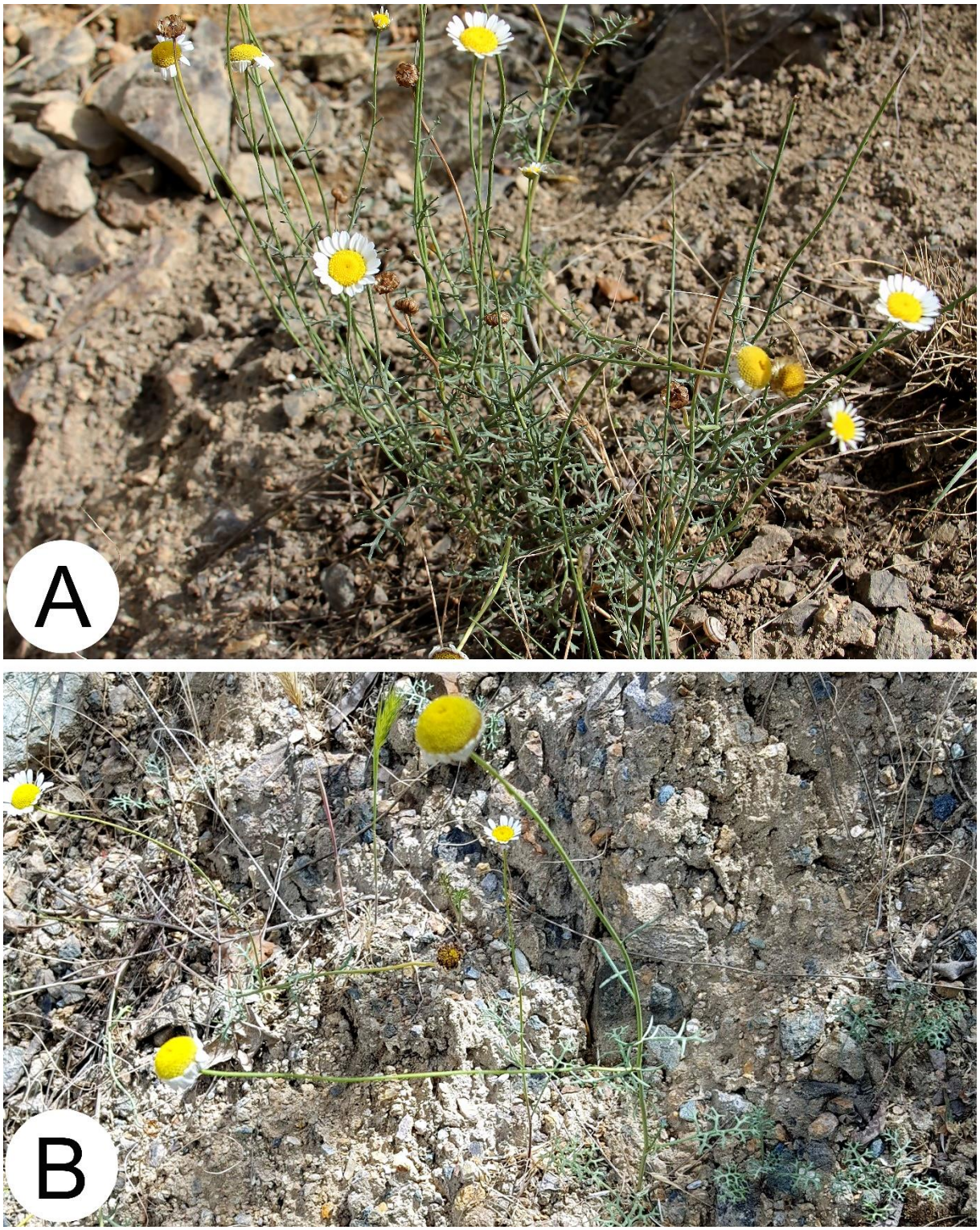

Figure 3. *Tripleurospermum fissurale* var. *radiata*, A-B. General views of habit

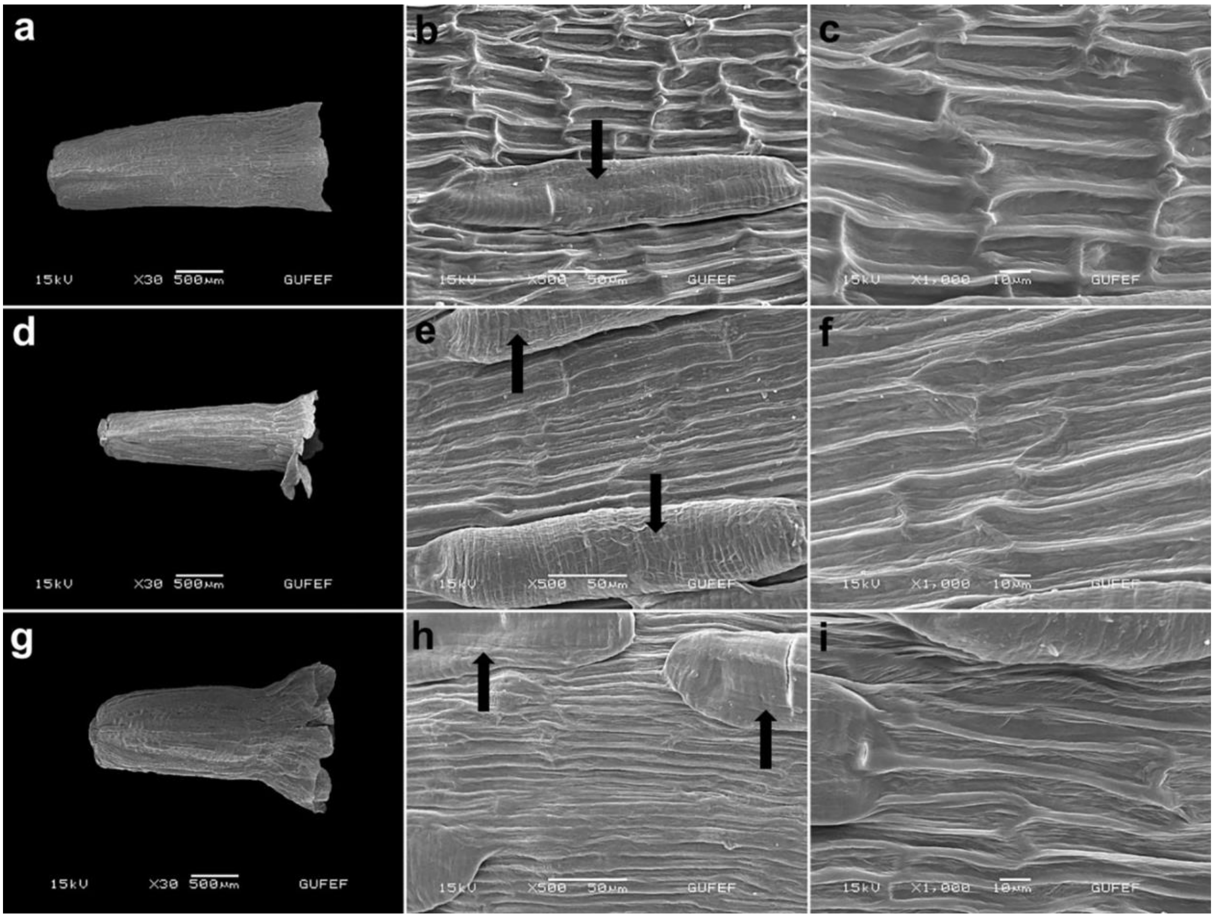

Figure 4. SEM micrographs of achenes of *Tripleurospermum fissurale* var. *radiata* (a-c), *T. fissurale* var. *fissurale* (d-f), *T. oreades* (g-i). a, d, g). General aspect; b, c, e, f, h, i). Surface ornamentation. Black arrows indicate slime cells.

4. Conclusions and discussion

Tripleurospermum fissurale is one of 4 species which is distributed in Turkey and which does not have ligulate flowers. The other species are *T. disciforme* (C.A. Meyer) Schultz Bip., *T. decipiens* (Fisch. & Mey.) Bornm. and *T. microcephalum* (Boiss.) Bornm. Amongst these, the only endemic species is *T. fissurale*. The leaves have very small laciniae, the flowers have a long peduncle, the corolla lobes are eglandular and the achenes are anteriorly smooth or faintly tuberculate, posteriorly 3-ribbed and include an abundant amount of mucilage and are differentiated from the other three species by having a long corona. However, the *T. fissurale* var. *radiata*, which is distributed in the same geographical area, is easily differentiated from *T. fissurale* by the existence of ligulate flowers. These types of variations are also observed in some genera within the tribe. For example, there are varieties of the *Anthemis aciphylla* Boiss. that have both radiate and discoid capitula and are endemic in these two taxa. A similar situation also occurs in the taxa belonging to the *Anthemis pectinata* (Bory & Chaub.) Boiss. & Reut., *Anthemis pauciloba* Boiss., *Anthemis calcarea* Sosn. and *Tanacetum balsamita* L.

Identification key to new variety with *T. fissurale* is given below:

1. Capitula discoid……..……………………..…………………….…..…………………………………...……..…var. ***fissurale***
1. Capitula radiate.……………………………………..……………………………………………………...…..…var. ***radiata***

T. fissurale var. *radiata* resembles the *T. oreades*, which has a distribution in the same region, since the new variety has ligulate flowers on the capitula and they are eglandular at the corolla tips. The fact that it is annual or biennial (not perennial), that the lower leaves are 3-pinnatisect (not 1-2-pinnatisect) and deep laciniae, triangular-acute or linear-acute (not linear-lanceolate or linear-filiform), the capitula 2-3 and 6-8 mm in width excluding the ligulate flowers (single and sometimes 2-9 and not a width of 1–1.8 mm excluding the ligulate flowers), that the outer phyllaries are ovate-lanceolate (not triangular-acute), that the inner phyllaries are oblong-lanceolate (not oblong), that the receptacles are ovoid (not ovoid-conical, ovoid or ± hemispherical), that the achenes are 2–2.5 × 0.7–1 mm (not 1.5–2.2 × 0.6–1 mm) and that the corona is 0.5–0.8 mm (not 0.5–1 mm), shows its difference (Table 1).

The achenes of the three investigated taxa are very similar to each other. In general, achenes are blackish-brown or dark brown, obpyramidal or oblong, (1.3-)1.5–2.5 × 0.4–1 mm, tuberculate in anterior and posteriorly 3-

ribbed. The surface ornamentation shows a little difference amongst the *T. fissurale* var. radiata, *T. fissurale* var. *fissurale* and *T. oreades*. The ornamentation on the achene surface is reticulate-rugose-striate in *T. fissurale* var. *radiata* and *T. fissurale* var. *fissurale*, whereas it is reticulate-ruminate-striate *in T. oreades*. All taxa have distinct slime cells on their achene surfaces. These results are in agreement with the data about *T. fissurale* of İnceer et al. (2012b). Enayet Hossain (1975) and also İnceer et al. (2012b) stated that the presence or absence of the slime has a diagnostic value for *Tripleurospermum* species.

Table 1. Morphological comparison of *Tripleurospermum fissurale* var. *radiata* and *T. oreades*

Characters	***T. fissurale* var. *radiata***	***T. oreades***
Habit	annual or biennial	perennial
Lower leaves	3-pinnatisect; triangular-acute or linear-acute	1–2-pinnatisect; linear-lanceolate or linear-filiform
Capitula	2-3; 6-8 mm width	2-9; 1-1.8 mm width
Outer phyllaries	ovate-lanceolate	triangular-acute
Inner phyllaries	oblong-lanceolate	oblong
Receptacle	ovoid	ovoid-conical, ovoid or hemispherical
Achenes	2–2.5 × 0.7–1 mm	1.5–2.2 × 0.6–1 mm
Corona	0.5–0.8 mm	0.5–1 mm

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