

Two new records of the genus *Orobanche* (Orobanchaceae) from Turkey

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Abstract: Two new records of *Orobanche* L. have been added to the 37 species of this genus previously reported from Turkey. *Orobanche owerini* (Beck) Beck is reported as a new record to flora of Turkey for the first time, and the existence of *O. reticulata* Wall. that was mentioned as a doubtful record for Turkey has been confirmed. Macro- and micromorphology of the taxa are discussed, geographical distributions in Turkey are mapped, and details of their habitat, ecology, and taxonomic remarks of the studied taxa are provided.

Key words: New record, *Orobanche*, Orobanchaceae, taxonomy, Turkey

1. Introduction

Orobanche L. s.l. (including *Phelipanche* Pomel) is the largest genus among the holoparasitic members of Orobanchaceae. It is mainly distributed throughout the subtropical and temperate regions of the northern hemisphere, and the Mediterranean region is one of the most important centres of its diversity (Plaza et al., 2004). Due to the changing of diagnostic characters on dried plant materials and lack of adequate field notes on herbarium sheets, taxonomy of the genus *Orobanche* has been difficult and it is more problematic than that of most other taxa. The distinct colours of the *Orobanche* species in the field turn into a uniform brown after pressing. Problematic identification keys in the floras and insufficient distribution data have led to a high number of misidentifications. Taxonomy and distribution of *Orobanche* s.l. in Turkey still rely on Gilli's treatment (1982), which is only based on herbarium materials and previous bibliographic references.

Based on the *Flora of Turkey* (Gilli, 1982; Davis et al., 1988), 37 species of *Orobanche* (including *Phelipanche* Pomel) grow naturally in Turkey. In order to update our knowledge about these, a revision of this genus (s.l.) is being undertaken, based on extensive field surveys as well as herbarium studies. During this revision morphology, seed and pollen micromorphology, anatomy, and molecular phylogeny of this genus have been studied (unpublished data). This paper presents some of our results on taxonomic matters and geographic distributions of the mentioned taxa.

2. Materials and methods

To study the taxonomy of *Orobanche* in Turkey, the authors have collected extensive samples of the genus from the field from 2008 to 2012. Voucher specimens are deposited at the herbarium of Hacettepe University (HUB). We have also studied local floras (Ocakverdi, 2001; Vural & Aytac, 2005) and the samples of major herbaria of Turkey (ANK, ISTE, ISTF, ISTO, GAZI, HUB). In addition, the investigated species were compared with type specimens and authentic materials in the following herbaria: BM, E, G, K, W, and WU. The descriptions of the taxa are given here in detail with pollen and seed micromorphology, and their distributions are given on a map (Figure 1). The pollen was examined with a LM Leica DM 4000B microscope and photographed with a DFC 320 camera. Polar axis (P), equatorial axis (E) lengths, and exine and intine thickness were measured using an eyepiece micrometer for 30 pollen grains. Data on the width and length of seeds are based on the measurement of 40 seeds per taxon, by means of direct observation under Leica Stereo Microscopes (Model MZ 16). Average and standard deviation were calculated in Excel and are given in species descriptions. For scanning electron microscopy (SEM), dry seeds and pollen grains were mounted directly on stubs and coated with gold in a sputter coater. SEM examination was carried out using a Zeiss EVO 50 EP microscope at Hacettepe University.

2.1. New records

Orobanche owerini (Beck) Beck, Feddes Repert. 18(1): 39 (1922).

Basionym: *Orobanche crenata* Forsk var. *owerini* Beck, Monogr. Orob. 227 (1890).

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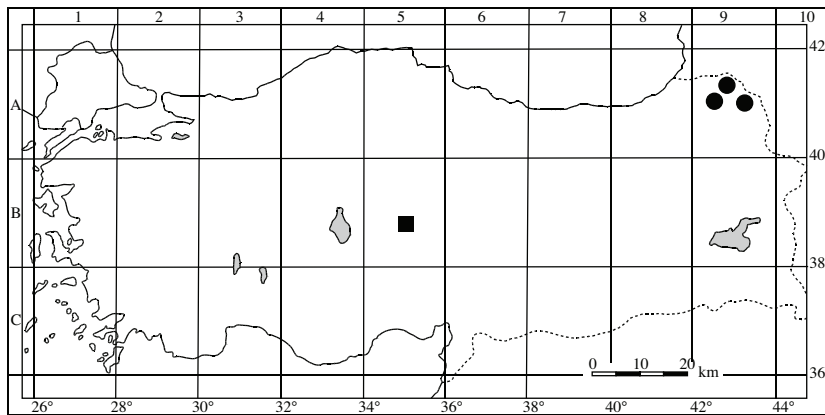


Figure 1. Distribution pattern of the species: *Orobancha owerini* (●), *O. reticulata* (■).

Type: LE, Georgian Republic.

Stem simple, 20–40 cm long, 3–8 mm thick at middle, hardly thickened at the base, reddish brown, densely glandular-pubescent. Scales lanceolate, 15–20 × 4–6 mm, dense, glandular hairy, pubescent. Inflorescence 4–10 × 3–4 cm, cylindrical or ovate, shorter or equal to the remaining part of stem, dense in lower part, lax in the middle and upper parts (18–22 flowers per inflorescence), flowers erect. Bracts 15–20 × 3–6 mm, lanceolate, glandular hairy, as long as or longer than corolla. Calyx 11–16 mm long, segments equal or unequal, 2-toothed, rarely entire, basally ovate, teeth long acuminate, densely long glandular hairs, shorter or longer than the corolla tube. Corolla 15–20 mm long, bell-shaped, violet-purple, base yellowish, densely, dark long violet glandular hairy, dorsal line curved, upper lip curved, often deeply bilobed, lobes large, broadly rounded; lower lip large, patent or almost deflexed, lobes rounded, with widely large folds between the lobes; all lobes irregularly denticulate at margin. Stamens inserted 2–3 mm above the base of corolla, filaments 8–10 mm long, glandular hairy; anthers 2 mm long, mucronate, brown, at suture sometimes hairy. Ovary ellipsoid, style with numerous glandular hairs; stigma yellow or sometime pink, dark and dry; capsule ellipsoid, 9–10 mm long. Seed $0.305 \pm 0.062 \times 0.184 \pm 0.037$ mm, shape ovoid to oblongoid, testa pattern isodiametric to irregular. Chromosome number: $2n = 38$ (Schneeweiss et al., 2004b).

Pollen type is inaperturate, exine ornamentation scabrate, 25.88 ± 3.25 μ m in diameter; intine thickness 1.00 ± 0.09 μ m; exine thickness 1.20 ± 0.33 μ m.

Hosts: Found by present authors on *Salvia sylvestris* L. and *Trifolium* sp. L.

Habitat: Subalpine meadows near a cultivated area.

Altitude: 1500–2000 m.

Flowering and fruiting time: July and August.

General distribution: Caucasus, Turkey, Georgia.

Examined specimens: A9 Ardahan: Posof, from Al village, 41°29.614'N, 42°45.962'E, 1523 m, G.Zare 477 & A.A.Dönmez (HUB). Ardahan: Çıldır Lake, Kars to Arpaçay, 8 km before Arpaçay, around cultivated area, 40°53.952'N, 43°16.247'E, 1976 m, 01.07.2009, G.Zare 466 & A.A.Dönmez (HUB). Artvin: between Artvin-Şavşat, around Küplüce village, 41°29.666'N, 42°25.462'E, 25.06.2010, H.Altınözül 5921 (HUB).

Beck von Mannagetta (1890) mentioned that *Orobancha owerini* is similar to *O. alba*, the latter differing from the former by mostly entire calyx segments, calyx teeth broader and very rarely filiform, stamens' insertion point of corolla tube (0–3 mm above corolla base), a reddish or purple stigma, and host. In our field study, we found 2 morphs, as well: individuals with pink corolla and red stigma and the other group with yellow corolla and yellow stigma in the same population (Figure 2). In *Flora of the USSR* (Novopokrovsky & Tzvelev, 1958), it was noted that *O. owerini* is a polymorphic species. However, Halamski (2011) stated that is phenotypic plasticity; in his research on *O. hederace* he identified 2 forms, euchrome (normal colour) and hypochromic (yellow), and described this phenomenon as phenotypic plasticity rather than a polymorphism.

Orobancha reticulata Wallr., Orob. Gen. 42 (1825).

Syn: *Orobancha polychrome* Beck, Pflanzenr. (Engler) Orobanchac., 155 (1930). *Orobancha elatior* Flügge ex Wallr., Orob. Gen., 42 (1825). *O. pallidiflora* Wimm. & Grab., Fl. Siles. 2(1): 233 (1829). *O. procera* W.D.J.Koch, Mert. & W.D.J.Koch, Deutschl. Fl. 4, ed. 3: 438 (1833). *O. antirrhina* Reut., Prodr. [A.P. de Candolle] 11: 21 (1847).

Type: Described from Toulouse, southern France, 1807, Flügge (LE), lectotype designed by Foley (2001).

Stem 12–28 (–70) cm long, 5–9 mm width at middle, slender, yellowish brown to red brown, densely glandular-pubescent, base slightly thickened. Scales 30–35 × 5–10 mm, triangular to lanceolate, glandular pubescent; stem

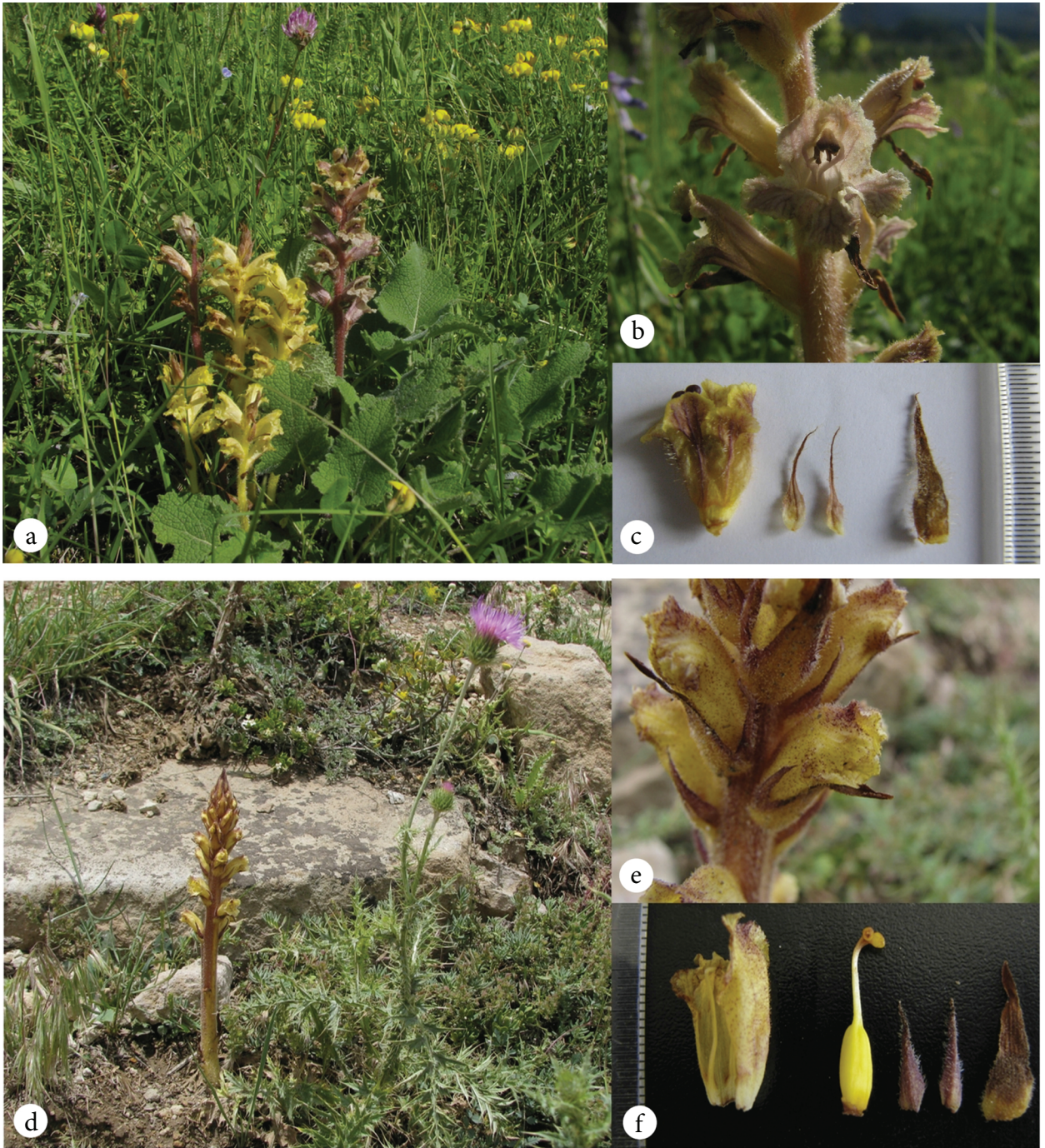


Figure 2. Floral morphology of *Orobanche owerini* and *O. reticulata*: a, b, and c- *O. owerini* (G.Zare 477); d, e, and f- *O. reticulata* (G.Zare 600).

densely scaled below, more sparsely above. Inflorescence 4–10 × 2.5–4 cm, cylindrical or ovate, equal or shorter than the remaining part of the stem, fairly dense (15–20 flowers per inflorescence); flowers erecto-patent at first and almost horizontal later. Bract 10–25 × 5–8 mm lanceolate, acute, red brown, glandular-pubescent, usually longer

than the corolla. Calyx 15–20 mm long, segments usually entire, rarely unequally bidentate, lanceolate, red brown, subulate, pubescent. Corolla 15–25 mm long, tubular or campanulate, slightly inflated above the insertion of stamens, with numerous, dense, dark violet glandular hairs, yellowish at the base, violet or purple violet in the

middle and near the upper lip (veins are dark violet), dorsal line of the corolla is evenly curved over its entire length; upper lip of corolla rounded; lower lip of corolla deflexed, middle lobe slightly less long or as long as lateral lobes, with rounded, crenate lobes and violet veins. Stamens are inserted 2–3 mm above base of corolla tube, with small nectary glands at base; filaments 10–12 mm long, sparsely pubescent; anthers cohering, glabrous, brown. Ovary 11–13 mm long in mature, ellipsoid, style sparsely glandular-pubescent or almost glabrous; stigma yellow, brown red, red violet (lighter in the upper part). Seed: $0.284 \pm 0.021 \times 0.163 \pm 0.013$ mm, shape narrowly ovoid to oblongoid; testa isodiametric to irregular. Chromosome number: $2n = 38$ (Hamblen, 1957).

Pollen type is inaperturate, exine ornamentation scabrate, diameter 31.31 ± 2.65 μ m; intine thickness 0.94 ± 0.15 μ m; exine thickness 0.97 ± 0.37 μ m.

Host: Found by the present authors on *Cirsium* Mill., these plants have also been reported as a host by Beck von Mannagetta (1930, p. 156) and Novopokrovsky and Tzvelev (1958, p. 95).

Habitat: Subalpine meadows, rubbly slopes and scrub in upper mountain belts with *Acanthus* L. and *Thymus* L. populations.

Altitude: 2000–2500 m.

Flowering and fruiting time: June to August.

General distribution: Central Europe, Mediterranean, Armenia, and Turkey.

Examined specimens: B5 Kayseri: Mountain Erciyes, from Hisarcık to Develi 15. km, $38^{\circ}30'42''$ N, $35^{\circ}29'58''$ E, 2100–2200 m, steppe, 14.07.2009, *G.Zare* 490, *G.Ekincioglu* & *F.Bozcuk* (HUB). Kayseri: Mountain Erciyes, 2 km southwards of Tekir Lake, steppe, $38^{\circ}29'52''$ N, $35^{\circ}30'59''$ E, 27.06.2010, *G.Zare* 600, *N.Bayrak* (HUB). Mountain Erciyes, Develi to Kayseri, 8 km before (southward) Tekir Lake, 27.06.2010, *G.Zare* 606 & *N.Bayrak* (HUB).

Orobanchе antirrhiна Reuter is synonym of *O. reticulata* Wallr. var. *procera* (W.D.Koch) Beck (Beck von Mannagetta, op. cit. 160, 1930). Based on Beck von Mannagetta (1930), flowers are longer than 20 mm and stigma colour is red or violet in type, but flowers shorter than 20 mm with different stigma colour are *O. reticulata* var. *procera*. This species has been recorded for the flora of Turkey from A2 Bursa: nr Bursa, Thirke (according to Tchihatcheff) by Gilli (1982). However, the presence of *O. reticulata* in Turkey is doubtful, according to Gilli (1982), but our results confirmed the existence of this species in Turkey. During field work in Kayseri (Mountain Erciyes), we found some different specimens mixed with *O. alba* population. Based on morphological characters, host, and habitat, these specimens have been identified as *O. reticulata*.

Orobanchе reticulata grows mainly in stony, alpine grassland; in grassy or thermophilous herbaceous

vegetation; in subalpine regions; and on alkaline and nutrient-rich, stony-loamy soil (Figure 2). It is frequent to sporadic in the higher altitude regions of the Alps and the alpine foothills of north-eastern Spain, through central and Eastern Europe and the Caucasus to the Himalayas (Kreutz, 1995). This species has a fairly wide range, but it is rare in nature (Rumsey & Jury, 1991; Kreutz, 1995).

3. Results and discussion

Until recently, *Orobanchе* s.l. has been treated under a single genus and comprises about 170 (Uhlich et al., 1995) species in the world, 30%–35% of which are present in Turkey. However, recent phylogenetic analyses have revealed 2 separate phylogenetic lineages at the generic level, which overlap the 2 morphologically distinct sections and support splitting the genus *Orobanchе* s.l. into 2 separate genera, as *Orobanchе* and *Phelipanche* (Schneeweiss et al., 2004a, 2004b; Weiss-Schneeweiss et al., 2006; Schneeweiss, 2007; Park et al., 2008). In *Flora of Turkey*, all broomrape have been treated under a single genus, *Orobanchе* L., of which 21 species belong to *Orobanchе* s.s. and 16 species belong to genus *Phelipanche*. Our 2 new records, *O. owerini* and *O. reticulata*, belong to genus *Orobanchе* s.s. and have increased the species number in Turkey to 23. Micromorphological results show that seeds of *Orobanchе* are less than 1 mm in size and their size is variable, both between and within individuals. Seed shape is also a variable character, ranging from oblongoid and ellipsoid to ovoid, and the ornamentation of the testa is alveolar in all taxa (Figures 3 and 4). Pollen shape in monads is spheroidal to oblate spheroidal (P/E: 0.88–1.00), and the equatorial axis is slightly longer than the polar axis. Based on our results and those of Abu Sbaïh and Jury (1994), the basic surface sculpture of pollen in *Orobanchе* is scabrate to rugulate (Figures 3 and 4). Our results show that seeds and pollen characters singly are not very useful for identification of all taxa (Abu Sbaïh et al., 1994; Abu Sbaïh & Jury, 1994; Plaza, 2004; Halamski, 2011) at the species level, but they can be helpful in addition to other morphological characters.

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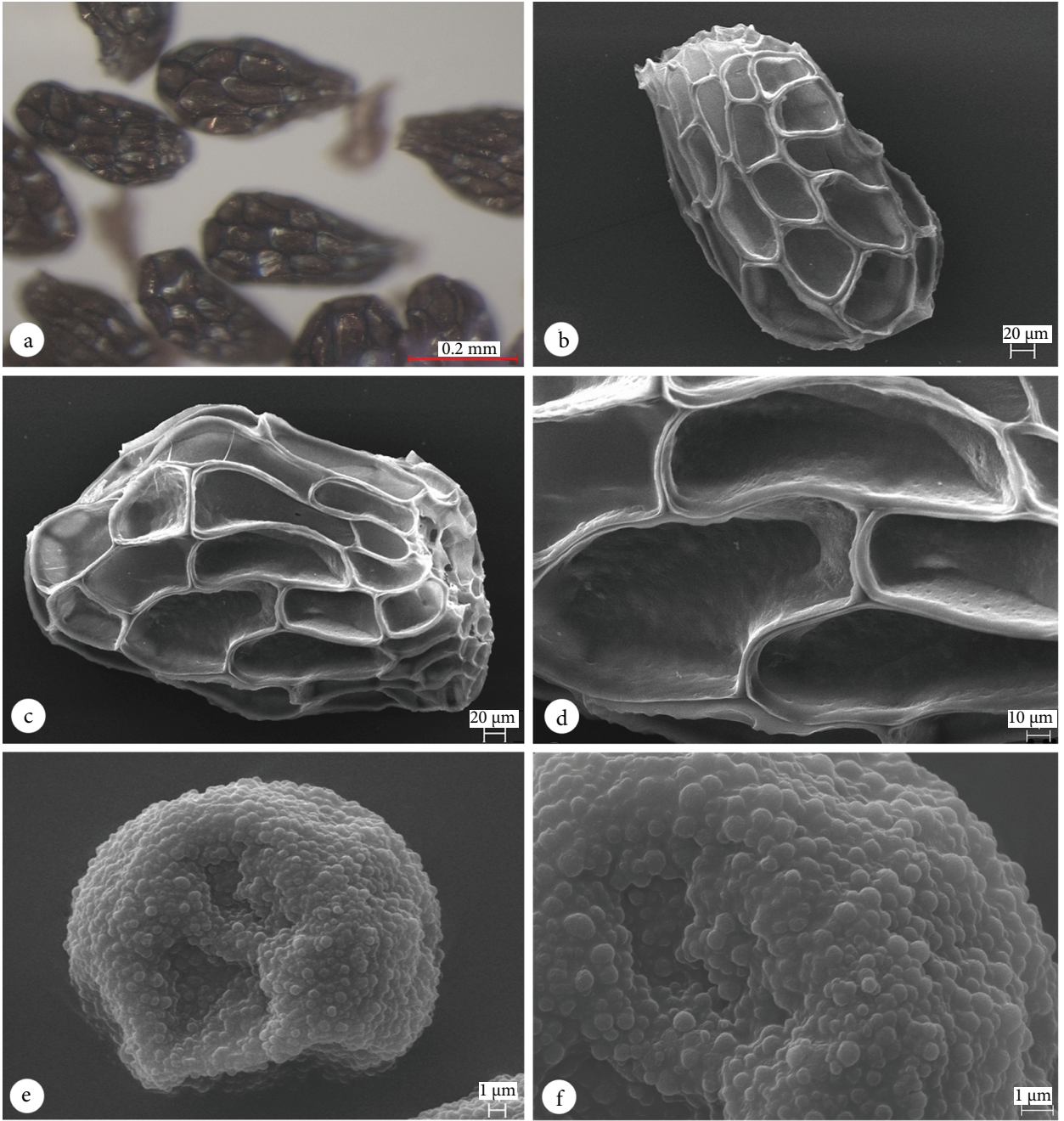


Figure 3. *Orobanche owerini*: a- seed shape by LM (H.Altınözlü 5922); b, c, and d- seed ornamentation; e and f- scabrate pollen ornamentation by SEM (G.Zare 477).

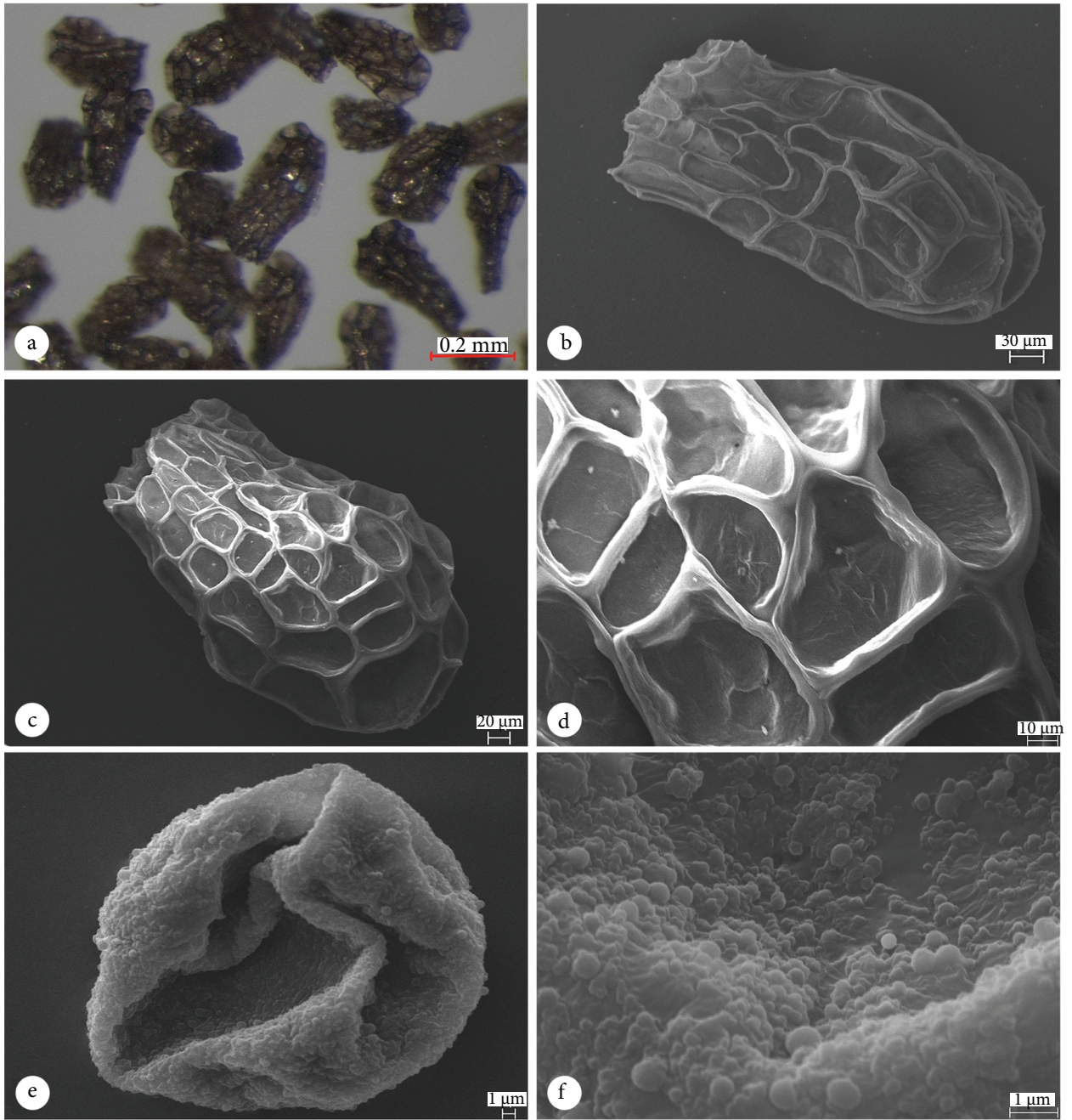


Figure 4. *Orobanche reticulata*: a- seed shape by LM (G.Zare 600); b, c, and d- seed ornamentation; e and f- scabrate pollen ornamentation by SEM (G.Zare 606).

References

- Abu Sbaih HA & Jury SL (1994). Seed micromorphology and taxonomy in *Orobanche* (Orobanchaceae). *Flora Mediterranea* 4: 41–48.
- Abu Sbaih HA, Keith-Lucas DM, Jury SL & Tubaileh AS (1994). Pollen morphology of genus *Orobanche* L. (Orobanchaceae). *Botanical Journal of the Linnean Society* 116: 305–313.
- Beck von Mannagetta G (1890). Monographie der Gattung *Orobanche*. *Bibliotheca Botanica* 19.
- Beck von Mannagetta G (1922). *Orobancheae novae*. *Feddes Repertorium* 30: 33–40.

- Beck von Mannagetta G (1930). Orobanchaceae. In: Engler A (ed.) *Das Pflanzenreich. regni vegetabilis conspectus*. Leipzig: W. Engelmann.
- Davis PH, Mill RR & Tan K (eds.) (1988). *Flora of Turkey and the East Aegean Islands* (Suppl. 1), Vol. 10, pp. 200–201, Edinburgh: Edinburgh University Press.
- Foley MJY (2001). *Orobanchaceae* in “Flora Iberica” area: new taxa, excluded taxa, and typification. *Anales de Jardín Botánico de Madrid* 58: 223–233.
- Gilli A (1982). *Orobanchaceae* L. In: Davis PH (ed.) *Flora of Turkey and the East Aegean Islands*, Vol. 7, pp. 1–23, Edinburgh: Edinburgh University Press.
- Halamski AT (2011). *Orobanche hederæ* Vaucher ex Duby (Orobanchaceae) phenotypic plasticity and seed micromorphology. *Bulletin mensuel de la Société linnéenne de Lyon* 80: 195–203.
- Hambler DJ (1957). Chromosome numbers in some members of the family Orobanchaceae. *Journal of the Linnean Society of London Botany* 55: 772–777.
- Kreutz CAJ (1995). *Orobanche: The European Broomrape Species: A Field Guide 1. Central and Northern Europe*. Limburg: Stichtung Natuurpublicaties.
- Mertens FK & Koch WDJ (1833). *Orobanche* Linn. In: Röhlings JC (ed.), *Deutschland Flora*, Vol. 4, p. 438, Frankfurt am Main.
- Novopokrovsky IV & Tzvelev NN (1958). Orobanchaceae Lindl. In: Komarov VL (ed.), *Flora SSSR*. Vol. 23, pp. 19–117. Moscow: Akademii Nauk SSSR.
- Ocakverdi H (2001). The flora of the mount Kısır (Kars and Ardahan) and nearest environs. *Turkish Journal of Botany* 25: 311–334.
- Park JM, Manen JF, Colwell AE & Schneeweiss GM (2008). A plastid gene phylogeny of the non-photosynthetic parasitic *Orobanche* (Orobanchaceae) and related genera. *Journal of Plant Research* 121: 365–376.
- Plaza L, Fernandez I, Juan R, Pastor J & Pujadas A (2004). Micromorphological studies on seeds of *Orobanche* species from the Iberian Peninsula and the Balearic Islands, and their systematic significance. *Annals of Botany* 94: 167–178.
- Reuter GF (1847). Orobanchaceae. In: Candolle AP (ed.) *Prodromus systematis naturalis. Regni vegetabilis sive enumeratio contracta ordinum, generum, specierumque plantarum*. Tomus 11: 1–45.
- Rumsey J & Jury SL (1991). An account on *Orobanche* L. in Britain and Ireland. *Watsonia* 18: 257–295.
- Schneeweiss GM (2007). Correlated evolution of life history and host range in the nonphotosynthetic parasitic flowering plants *Orobanche* and *Phelipanche* (Orobanchaceae). *Journal of Evolutionary Biology* 20: 471–478.
- Schneeweiss GM, Colwell A, Park JM, Jang CG & Stuessy TF (2004a). Phylogeny of holoparasitic *Orobanche* inferred from nuclear ITS sequences. *Molecular Phylogenetics and Evolution* 30: 465–478.
- Schneeweiss GM, Palomeque T, Colwell AE & Weiss-Schneeweiss H (2004b). Chromosome numbers and karyotype evolution in holoparasitic *Orobanche* (Orobanchaceae) and related genera. *American Journal of Botany* 91: 439–448.
- Uhlich H, Pusch J & Barthel KJ (1995). *Die Sommerwurzarten Europas*. Magdeburg: Westarp Wissenschaften.
- Vural C & Aytaç Z (2005). The flora of Erciyes Dağı (Kayseri, Turkey). *Turkish Journal of Botany* 29: 185–236.
- Wallroth FG (1825). *Orobanches Generis Diaskeue*. Frankfurt am Main: Verl. Fredericus Wilmans Francofurti ad Moenum.
- Weiss-Schneeweiss H, Greilhuber J & Schneeweiss GM (2006). Genome size evolution in holoparasitic *Orobanche* (Orobanchaceae) and related genera. *American Journal of Botany* 93: 148–156.
- Wimmer F & Grabowski H (1829). *Flora Silesiae, Pars Secunda*. Vol. 2, Vratislaviae: Korn.