

Short communication

Taxonomic notes on the genus *Chaenorhinum* (Plantaginaceae) in Turkey

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Abstract – *Chaenorhinum gerense* is an eastern Mediterranean species with rare distribution and a large variety in plant and seed morphology. In this study, the accuracy of the taxonomic status of this species, which was initially reported by P.H. Davis as *C. rubrifolium* from south eastern Turkey, is discussed and the typical representatives of *C. rubrifolium* were collected for the first time for Turkey from Muğla province, southwestern Anatolia. *C. gerense* is closely related to the *C. rubrifolium*, from which it differs by having a small and cream corolla with red blotch, capsule as long as or smaller 1/2-calyx teeth and triangular or rectangular blunt crest on seed. Detailed descriptions and identification keys for these two taxa are provided.

Key words: *Chaenorhinum rubrifolium*, *Chaenorhinum gerense*, Mediterranean Basin, Plantaginaceae, Turkey

Introduction

The genus *Chaenorhinum* (DC.) Rchb. (1828: 123) was described as a section of *Linaria* by De Candolle (1815: 410) and then raised by Reichenbach (1828) to the generic level. The taxonomy of the genus especially *C. rubrifolium* (Robill. & Castagne ex DC.) Fourr. species complex is rather problematic, because of considerable intraspecific variation, insufficient distribution data, confusing synonymies, incorrectly cited names, poorly described species and the distinction of numerous subspecies, varieties and forms (Fourreau 1869, Fernandes 1971, Speta 1980, Sutton 1988, Benedí-González 1991). The genus consists of ca. 20 species mainly distributed in southwest Europe, north Africa and south west Asia (Benedí and Güemes 2009). Davis (1978a) reported six species for the Flora of Turkey and then, *C. semispe-luncarum* Yıldırım, Kit Tan, Şenol & Pirhan and *C. yildir-imlii* Yıldırım, Kit Tan, Şenol & Pirhan have been described as new species (Yıldırım et al. 2010). Consequently, five (ca. 50%) of the eight *Chaenorhinum* species present in Turkey are endemics. Despite the high endemism ratio and species diversity, the genus is poorly known throughout the Mediterranean Basin, and especially in Turkey.

During field studies (March 2014 and June 2016) in a study on post-fire recovery of Mediterranean pine forests in Muğla province (Turkey), some *Chaenorhinum* materials

were collected. Comparisons with present materials in Turkish herbaria (ANK, GAZI, HUB and ISTE) and the Flora of Turkey (Davis 1978a) yielded no matching identification. Further herbarium studies and detailed micro-morphological investigations clearly showed that these materials belong to the common Mediterranean species *C. rubrifolium*, which was reported initially from the eastern part of Anatolia by Davis in his account (Davis 1978b). More detailed fieldwork and micro and macro-morphological investigations of the East Anatolian materials confirmed Sutton's decision (1988) to place these taxa belong in *C. gerense* (Stapf) Speta (1980: 27). Therefore, *C. rubrifolium* is introduced here as a new record for the Flora of Turkey.

Materials and methods

Fresh plant materials were collected from the field during excursions in 2014 and 2015. The specimens are deposited in Hacettepe University Herbarium (HUB). Herbarium specimens of *Chaenorhinum* in ANK, B, BC, E, GAZI, HUB, ISTE, MSB and W (acronyms according to Thiers 2016) were also examined. For scanning electron microscopy (SEM), dry seeds were mounted directly on stubs (Plaza et al. 2004) and coated with gold in a sputter coater prior to observation with a JEOL JSM-6490 LV scanning electron microscope.

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Results and discussion

Chaenorhinum gerense (Stapf) Speta in Stapfia 7: 27 (1980)

Basionym: *Linaria gerensis* Stapf, Bull. Misc. Inform. Kew (3): 75 (1906)

Type: Persia: In rupestribus prope pagum Gere inter Abuschir et Schiras, 23.3.1842, Th. Kotschy 92, holotype K; isotypes G, G-BOIS, JE, M, P, W!

Morphological description: Erect, slender, annual, 2.5–12(–25) cm, glandular-pubescent. Stem flexuous, simple or branched, adpressed to rocks. Basal rosette leaves elliptical to ovate, 8–12 × 3–4 mm, petiolate, green rarely purple below, glabrous, median cauline leaves elliptical to lanceolate, subsessile, glandular-pubescent. Raceme lax, flower patent. Pedicels ascending or patent in fruit, 5–10 mm, as long as or longer than leaf-like bracts. Calyx lobes 4–7 mm, linear to linear-spathulate, obtuse, usually patent or recurved. Corolla creamy, suffused with red or pink batch on the upper side, 5–7 (9) mm (included spur); spur tapering, 1.5–2 mm, subacute. Capsule spherical, 2–3 mm, 2–3× as short as calyx teeth. Seed ovoid-ellipsoid, small, 0.30–0.50 × 0.30–0.35 mm, dark brown, with prominent longitudinal crest, discontinuous, triangular or rectangular blunt and obtuse apex, testa of the intercostal spaces covered by papilla (Figs. 1,2).

Flowering and fruiting time: April-May.

Habitat: Crevices of limestone rocks and walls from 350 to 1200 m altitude.

General distribution: Eastern Mediterranean, Cyprus, Iran, Iraq, Pakistan, Turkey.

Examined specimens: Turkey: C8 Mardin: c. 11–13 km from Mardin to Savur, May 1957, Davis 28529 (E!), 4 km



Fig. 1. *Chaenorhinum gerense*: A) habitat; B) a general appearance; C) fruits and flowers (GZ1093).

E. of Mardin, 1200 m, 25 May 1957, Davis 28577 (E!), E of Mardin, Eskiakale village, limestone rocks, 1114 m, 37°18'29" N 40°45'53" E, 06 June 2015, G. Zare & G. Ergan, GZ1093 (HUB!), C9 Mardin: Cizre, 350 m, Walls of mosque, 09 May 1966, Davis 42705 (E!).

Chaenorhinum rubrifolium (Robill. & Castagne ex DC.) Fourr. in Ann. Soc. Linn. Lyon nov. ser. 17: 127 (1869)

Basionym: *Linaria rubrifolia* Robill. & Castagne ex DC., Fl. Fr. 5: 410 (1815)

Lectotype: Described from S. France, Cette plante croît sur les collines rocailleuses des environs de Marseille, notamment près le fort de N.-D.-de-la-Garde du côté de la mer [lectotype designated by C. Benedi in Collect. Bot. (Barcelona) 20: 72 (1991): G-DC]

Morphological description: Erect, slender, annual, 4–22 cm high, glandular-pubescent often tinged purple. Stem flexuous, simple or branched. Basal leaves broadly obovate or spatulate, 7–25 × 5–11 mm, dark green above, purple below, subglabrous; cauline leaves narrowly elliptical, subsessile, glabrous, elliptical to lanceolate. Flower in elongating lax raceme. Pedicels erect-patent, slender, 5–15 mm, as long as or longer than leaf-like bracts. Calyx lobes 5–9 mm, linear to linear-spathulate, obtuse, usually patents. Corolla white, suffused with violet on the upper lip, 8.5–10.5 mm; spur tapering, 2–3 mm, subacute. Capsule spherical, 4.5–6 mm long, shorter than calyx teeth. Seeds ovoid-ellipsoid, 0.65–0.70 × 0.45–0.50 mm, dark brown to black, with prominent longitudinal crest, discontinuous, clearly echinate, testa of the intercostal spaces covered by papilla (Figs. 2,3).

Flowering and fruiting time: May-June.

Habitat: Recently burned *Pinus brutia* forest from 100 to 200 m altitude.

Examined specimens: Turkey: C1 Muğla: Ören, between Çamlıca and Kumluca villages, recently burned *Pinus brutia* forest, 150 m, 37°03'28.50" N, 27°57'34.26" E, 09 May 2014, G. Zare & G. Ergan, GZ963 (HUB!)

Greece: Arkadhia, Ep. Mandinias, NW Artemisi, Acker, Krautflurent, 600 m, 37°41'04" N, 22°21'41" E, Jaunery 2007, FG 27, No 93.138 (B!)

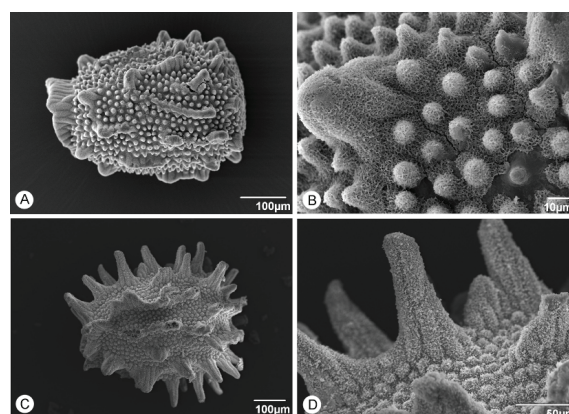


Fig. 2. Comparison of seed ornamentations by SEM. A, B) *Chaenorhinum gerense* (GZ1093); C, D) *C. rubrifolium* (GZ963).

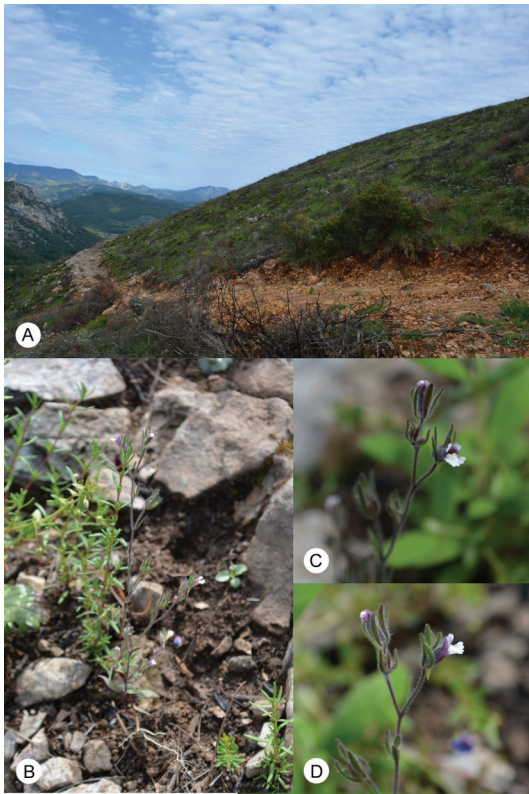


Fig. 3. *Chaenorhinum rubrifolium*: A) habitat; B) a general appearance; C, D) flowers (GZ963).

Cyprus: Aradippou, SW of village, eastern side of motorway S of Kalo Chorio/Aradippou exit open gypsum slopes, c.100 m, 34°56'32" N 33°33'49" E, 07 May 2009, R. Hand & C.S. Christodoulou (B!)

Morocco: Prov. Taza, S of road Azrou-Fes, lake Dayat Aoua, N-side; 1480 m, 23 June 1996, A.chhal el Kadmiri & E. Vitek 96-0889 (W!)

Italy: Dorgali, Sudhang des Mte. Bardia oberh. Cala Gonnone. Ca. 450 m, 20 April 1966, H. Merxmuller & F. Oberwinkler 21129 (MSB!)

Spain: Almeria, Sierra Alhamilla, cerca del Cortijo 1000 m, 14 April 1921, E Gros 19/27 (W!, BC!); Formentera, Cap de Berberia, ca. 2 km sudl. Von Can Fita, Bodenaushubflache am Wege, 8 Jun 1972, H. Kuhbier U. G. Finschow (MSB!); Aranjuez (Madrid), 15 May 1945, Rivas Goday et Monasterio (MSB!); LA RIOJA, Leza de Rio Leza. 30TWM4988, 500 m., 28 June 1985, A.S. Rodriguez, (MSB!, BC!); Cadiz: Sierra del Pinar, ad 1550 m., 1 July 1925, P.Font, I. Quer & E. Gros, (MSB!, BC!); Toledo: Yepes, 30SVK4717, 700 m., 11 June 1984, Amich Y Ehas. (BC!); Yebra de Basa, Mont Seraton, au nord du village, 970 m, 30TYN2308, 28 May 1988, P. Montserrat n JACA 112388 (MSB!, BC!)

General distribution: Algeria, Balears, Greece, France, Italy, Morocco, Spain, Tunisia and Turkey.

Chaenorhinum rubrifolium is a species with a complex taxonomy consisting of many subspecies, varieties and

forms depending upon the treatment of different authors (Fernandes 1971, Speta 1980, Sutton 1988, Benedí-González 1991). These taxonomic problems are mainly based on the distribution area of these taxa and the lack of sufficient collections of materials belonging to this species. In fact, these species are relatively rare despite their wide range from SW Europe and NW Africa to SW Asia (Speta 1980, Sutton 1988, Benedí-González 1991). Our research indicated that seeds of this species have a high-level of dormancy, and they germinate only when some fire-related germination cues are applied (Tavşanoğlu et al. 2017). This germination behaviour of this annual species can explain why it is scarce, and can be found in recently burned Mediterranean sites (Céspedes et al. 2014, Tavşanoğlu et al. 2017). Fernandes (1971) defined three subspecies and two forms for European *C. rubrifolium*, and following his treatment, Sutton (1988) divided the species into four subspecies: subsp. *rubrifolium*, subsp. *formenterae* (Gand.) R. Fernandes (1971:227), subsp. *raveyi* (Boiss.) R. Fernandes (1971:227) and subsp. *gerense* (Stapf) D.A.Sutton (1988:114), while some authors have treated all these subspecies as separate species (Benedí and Güemes, 2009).

Davis (1978b) in his account on Turkish *Chaenorhinum* species listed five species of the genus and he did not include *C. rubrifolium*. In the Flora of Turkey and East Aegean Islands (Davis 1978a), later, he reported this species from two closely located sites in SE Anatolia based on his collections (Mardin, coll. numb. 28577, coll. numb. 28529 and Cizre, coll. numb. 42705). Davis (1978a) mentioned differences in seed characteristics and non-persistent basal rosette leaves at the flowering time of these samples with West Mediterranean materials but treated these samples as *C. rubrifolium*. We assume that he evaluated the differences in these specimens as intraspecific variation and did not believe that these characteristics were sufficient for these taxa to be considered separate species. Sutton (1988), during the revision of the genus identified these materials as *C. rubrifolium* subsp. *gerense*. In the more recently published Flora Iranica by Podlech and Iranshahr (2015), the authors followed the Sutton classification and evaluated this taxon as *C. rubrifolium* subsp. *gerense*. Our detailed work on SE Anatolian samples revealed that the indumentum, branching pattern and long calyx teeth of *C. gerense* resemble those of *C. rubrifolium*, but it is remarkably different from this species by the small, cream corolla with red blotch, ascending or patent pedicels in fruit, calyx teeth two times longer than the capsule and triangular or rectangular with blunt seed ornamentation type (Tab. 1, Figs. 1–3). Considering all the above, we confirmed the Sutton decision about materials collected from SE Anatolia by Davis, but we believe these specimens should be treated as a separate species, *C. gerense*. Consequently, these two species have increased the species number of *Chaenorhinum* in Turkey to nine, in which five are endemic. In any case, further research is still needed to clarify the relationships among *Chaenorhinum* taxa at inter- and intra-species levels.

Table 1. Morphological comparison of *Chaenorhinum gerense* with *C. rubrifolium*.

Characters	<i>C. rubrifolium</i>	<i>C. gerense</i>
Height (cm)	4-22	2.5-12 (25)
Basal leaves	Leaves sessile, ovate to ovate-oblong	Leaves petiolate, elliptic-ovate
Basal leaf size (mm)	7-25 × 5-11	8-12 × 3-4
Pedicels (mm)	5-15, erect	3-10, ascending
Flower	Erect	Patent
Corolla colour	White with violet upper lip	Cream with red patch in upper lip
Corolla size (mm)	8.5-10.5	5-7(9)
Spur (mm)	2-3	1.5-2
Calyx teeth (mm)	6-8 unequal slightly longer than capsule	5-7 unequal 2 × longer than capsule
Capsule (mm)	4.5-6	2-3
Seed ornamentation	Crest echinate (spiny)	Crest triangular or rectangular with blunt and obtuse apex
Seed size (mm)	0.65-0.70 × 0.45-0.50	0.30-0.50 × 0.3-0.35

Identification key to the genus *Chaenorhinum* in Turkey

- 1a. Flowers subsessile; calyx lobes 8–15 mm; corolla 14–20 mm (excl. spur); seeds cuneate-oblong, appearing pitted between main ribs 2
- 1b. Flowers conspicuously pedicellate; calyx lobes 2–6 mm; corolla 6–10 mm (excl. spur); seeds ovoid-ellipsoid to broadly oblong, not appearing pitted 3
- 2a. Corolla spur 2–3 mm *calycinum*
- 2b. Corolla spur 9–12 mm *huber-morathii*
- 3a. Capsule longer than calyx lobes; seeds 0.5–1 mm, seeds with distinctly broad crest; plant not chasmophytic 4
- 3b. Capsule shorter or as long as calyx lobes, spherical; seeds 0.3–0.7 mm, echinate or with discontinuous crest; plants chasmophytic 5
- 4a. Seeds 0.5–0.7 mm; capsule 3–5 mm, slightly longer than broad; branches usually flexuous *minus*
- 4b. Seeds 0.8–1 mm; capsule longer than 5 mm; spherical; branches ± straight *litorale subsp. pterosporum*
- 5a. Plant with basal leaves; median leaves elliptic to lanceolate 6
- 5b. Plant without basal leaves; leaves all ovate 7
- 6a. Leaves petiolate; capsule 2–3 mm; seeds 0.3–0.5 mm, cresta discontinuous, triangular or rectangular with blunt apex *gerense*
- 6b. Leaves subsessile; capsule 4.5–6 mm; seeds 0.6–0.7 mm, cresta echinate *rubrifolium*
- 7a. Calyx lobes 4–5 mm; seeds shallowly ribbed *semispeluncarum*
- 7b. Calyx lobes 2–3 mm; seeds distinctly ribbed 8
- 8a. Inflorescence secund; pedicels recurved in fruit; seeds 0.5–0.6 mm *yildirimii*
- 8b. Inflorescence multilateral, pedicels erect in fruit; seeds 0.7–0.9 mm *cryptarum*

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