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Paracaryum bingoelianum (Boraginaceae), a new species from Turkey

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Abstract: *Paracaryum bingoelianum* Behçet & İlçim is described as a new species. It is confined to Bingöl in Eastern Anatolia, Turkey. *Paracaryum bingoelianum* is closely similar to *P. cristatum* subsp. *cristatum* and *P. kurdistanicum*. It mainly differs from them in that it has a shrub-like woody base and numerous stems with sterile shoots, longer corolla, and bigger nutlets. The diagnostic characters are discussed and taxonomic comments are presented. Seed and pollen characteristics were investigated using light and scanning electron microscopy. Notes on its ecology are also presented. A distribution map of the new and related species is provided.

Key words: *Paracaryum*, taxonomy, Flora, Turkey

1. Introduction

Boraginaceae is one of the largest angiosperm families, comprising approximately 100 genera and almost 2000 species distributed worldwide (Taia, 2006). The species of the family occur in dry, open habitats, mountains valleys, and even in disturbed habitats. Members of the family are annual or perennial herbs, shrubs, or trees. Most of the family members have stiff hairs; inflorescence is cymose, the cymes being scorpioid or circinnate or rarely thyrsoid (Mill, 1979; Akçin et al., 2013).

The genus *Paracaryum* (DC) Boiss. belongs to the tribe *Cynoglosseae* (Aytaç and Mill, 2005; Hilger et al., 2005). The new species described here belongs to *Paracaryum* subgenus *Modestomattiastrum* (Brand) R.R.Mill. The anthers are situated below the scale bases in this new species as in the subgenus *Modestomattiastrum* (Mill, 1977, 1979).

The first thorough arrangement of the genus *Paracaryum* was given by Mill (1979), who recognized 27 species, 3 subspecies, and 4 varieties. Since then 1 new species, *P. hedgei* Aytaç & R.R.Mill of the subgenus *Mattiastrum* (Boiss.) R.R.Mill., has been identified from Turkey (Aytaç and Mill, 2005). According to Koca and Yıldırımlı (2010), the genus *Paracaryum* is represented in Turkey by 28 species, 1 subspecies, and 2 varieties. However, in the recent checklist of *Flora of Turkey* (Güner et al., 2012), the genus is represented by 28 species, 3 subspecies, and 4 varieties. The distribution of *Paracaryum* in neighboring countries is as follows: 9 species in the former USSR (Shiskin, 1953), 42 (17 *Paracaryum*, 25 *Mattiastrum*) in the *Flora Iranica* area (Riedl, 1967), 7 in *Flora of Syria* (Mouterde, 1966), and 1 in *Flora Europaea* (Ferguson, 1972).

The species described in this paper was collected in Bingöl in Turkey in 2012 by Dr L Behçet. At first glance it resembled *P. cristatum* (Schreber) Boiss. subsp. *cristatum* and *P. kurdistanicum* (Brand) R.Mill. However, it differs considerably from them based on comparative morphological and palynological studies. Therefore, this study aims to describe a new species from Turkey in the genus *Paracaryum*.

2. Materials and methods

The specimens were cross-checked with the keys provided by Mill (1979) and the *Paracaryum* accounts given in the relevant literature, including *Flora Iranica* (Riedl, 1967) and *Flora of Syria* (Mouterde, 1966). Specimens that were used for cross-checking were deposited at various Turkish herbaria (ANK, GAZI, HUB, and VANF).

In the course of scanning electron microscopy studies, mature nutlets, seeds, and pollens were mounted using double-sided tape on SEM stubs and coated with gold in a Polaron SC502 sputter coater. They were examined with a JEOL JSM 5500 LV SEM at 5 kV at Mustafa Kemal University.

3. Results

Paracaryum bingoelianum Behçet & İlçim **sp. nova** (Figures 1–6).

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Figure 1. Habit of *Paracaryum bingoelianum* Behçet & İlçim (*L. Behçet* 8606).

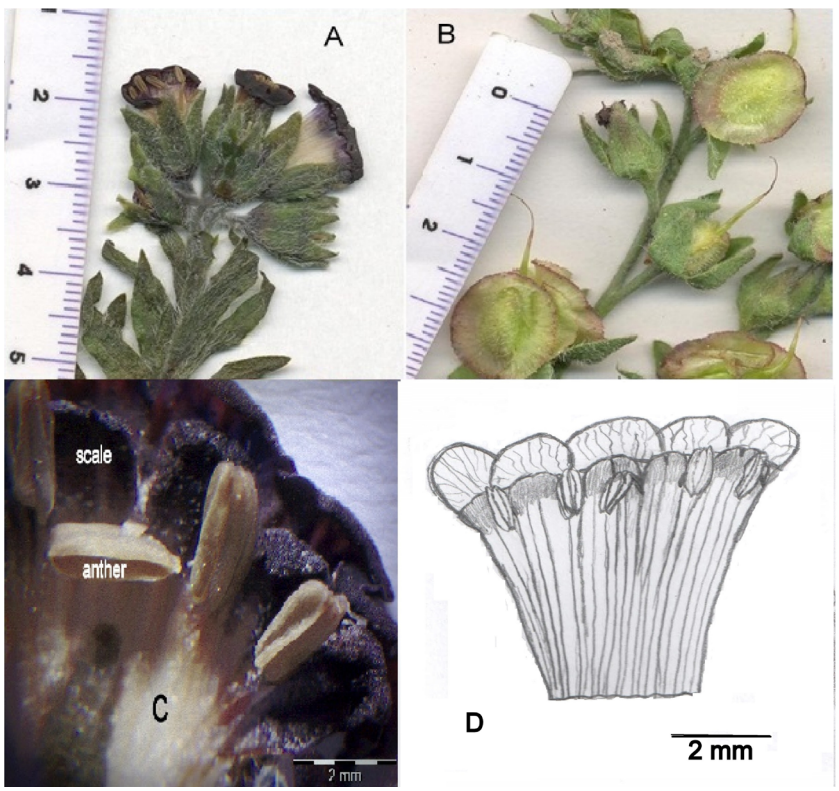

Figure 2. A- Flowering (*L. Behçet* 8606) and B- Fruiting sample (*L. Behçet* 8165) of *Paracaryum bingoelianum* C, D- Dissected corolla.

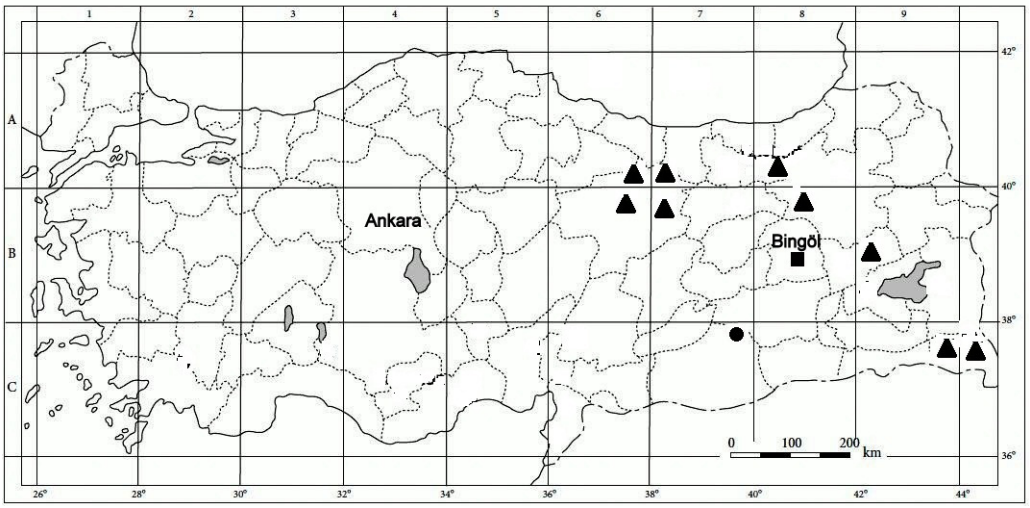

Figure 3. Distribution map of *Paracaryum bingoelianum* (■), *P. cristatum* subsp. *cristatum* (▲), and *P. kurdistanicum* (●).

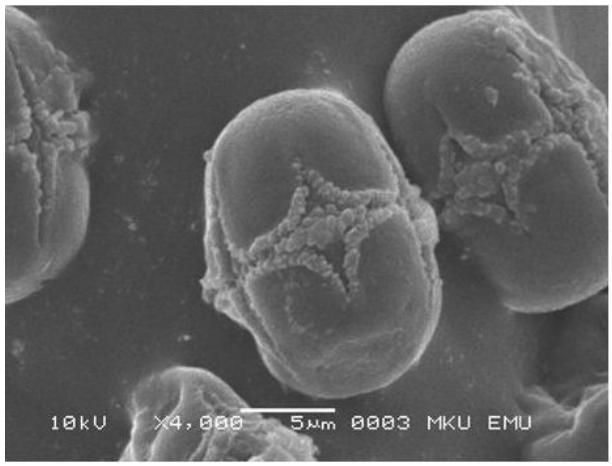

Figure 4. General view of the pollen grain of *P. bingoelianum* (*L. Behçet* 8606) in equatorial view.

Paracaryum bingoelianum: Type: Turkey. B8 Bingöl: SE of Genç, Şamdağı, NW rocky slopes, 1950–2000 m. 11.vii.2012, *L. Behçet* 8606 (in flower) (Holotype: Mustafa Kemal Univ. Herb. Isotypes: ANK, Bingöl Univ. Herb.).

3.1. Diagnoses: *Paracaryum bingoelianum* is closely similar to *P. cristatum* subsp. *cristatum* and *P. kurdistanicum. P. bingoelianum* mainly differs from those in that it has a shrub-like woody base and numerous stems with sterile shoots (not herbaceous and without sterile shoots as found in *P. cristatum* subsp. *cristatum* and *P. kurdistanicum*), longer corolla 11–15 mm (neither 3–6 mm long as in *P. cristatum* subsp. *cristatum* nor 6.5–11 mm as in *P. kurdistanicum*; Fig. 1C), bigger nutlets 15–18 × 15–18 mm (not 8–12.5 × 6.5–10 mm as in *P. cristatum* subsp. *cristatum*, and 10–10.7 × 8.5–9.5 mm as in *P. kurdistanicum*), and styles 6–10 mm (neither 1.3–4.5 mm as in *P. cristatum* subsp. *cristatum* nor 2.3–4.3 mm as in *P. kurdistanicum*).

3.2. Description: Perennial, woody and branched at base, stems numerous, 11–25 cm, with 10–14-cm-long sterile shoots. Stems erect, simple to branched above. Basal leaves narrowly lanceolate-obovate, 6–8.5 × 0.5–0.8 cm, attenuating into long (1–3 cm) petiole, with sparse simple 0.5–1.5-mm-long hairs. Leaves on sterile shoots 30–81.5 × 2.5–8.5 mm. Stem leaves similar to basal ones, 1–5.5 × 0.3–0.8 cm. Cymes terminal, 8–13-flowered, pedicels 1.5–10 mm in flower, 3–22 mm in fruit, with dense simple hairs, calyx 8–10 mm in flower, 11–13 mm in fruit, triangular-oblong, obtuse, with simple long hairs, divided to 4/5. Corolla violet, 11–15 mm in length, tube whitish-violet, purple or violet, tube to 11 mm in length, limb to 4 mm in length, corolla lobes ovate, scales subquadrate, without appendage, notched, 1–1.5 × 1.5–1.8 mm, apex incurved, densely papillate (2C), filaments 0.5–0.8 × 0.2–0.3 mm, anthers 1.5–2 × 0.5 mm, anthers base borne below the scale bases, linear-oblong, style 6–10 mm in flower, usually included, later somewhat exserted, 9–14 mm in length in fruit. Nutlets suborbicular, 15–18 × 15–18 mm, disc 8–11 × 6–9 mm, ovate, with long and short glochids (Figure 5C). Nutlet wing 3–5 mm broad, dorsal surface with sparse glochids, margin cristate, teeth broad (Figure 5A).

3.3. Distribution and suggested conservation status and ecology

Paracaryum bingoelianum is a local endemic species known in only 2 localities, B8: Genç District (Bingöl Province), East Anatolia (Figure 3). Additionally, it is an Irano-Turanian element. The species is rare in the area. Due to grazing and erosion, the populations of species are threatened by extinction in the wild if protection measures are not taken. Therefore, we recommend that the

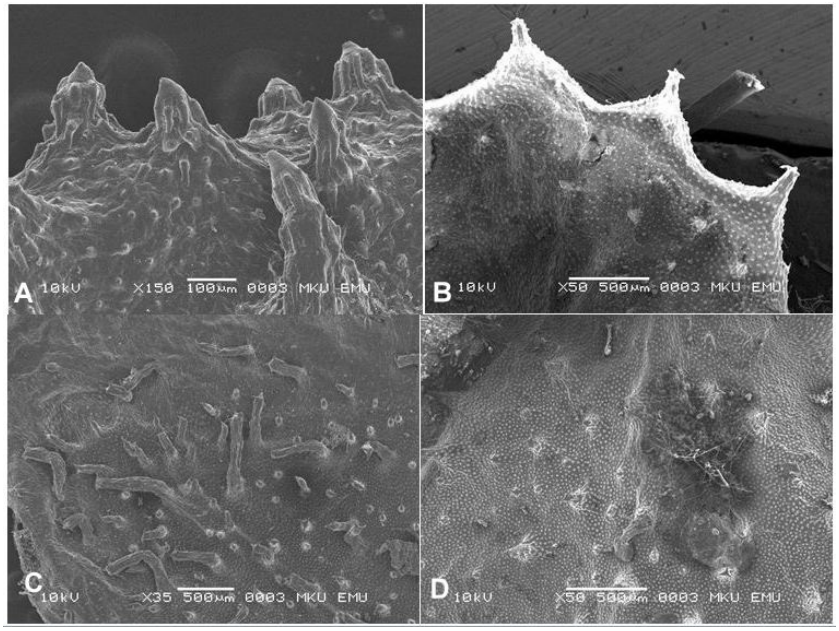

Figure 5. SEM micrographs of nutlets of *Paracaryum* species. A- *P. bingoelianum* (*L. Behçet* 8165), nutlet margin. B- *P. cristatum* (*L. Behçet* 4886), nutlet margin. C- *P. bingoelianum*, disc view. D- *P. cristatum*, disc view.

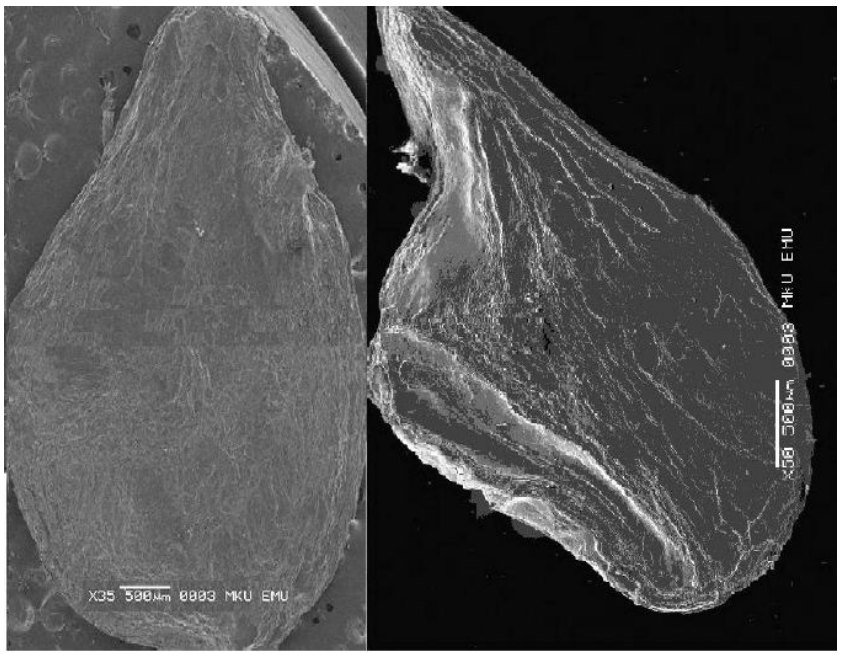

Figure 6. The seed of A- *P. cristatum* (*L. Behçet* 4886), B- *P. bingoelianum* (*L. Behçet* 8165).

threatened categories of *Paracaryum bingoelianum* should be Critically Endangered (CR), because the estimated whole range is less than 10 km^2 (criteria B2 a b (i, iii) of IUCN 2013).

Paracaryum bingoelianum grows in the subalpine steppe of Bingöl Province, at altitudes of 1750–2000 m on rocky slopes. The vegetation in this area is formed by herbaceous plants including *Achillea vermicularis* Trin, *Alopecurus aucheri* Boiss., *Alyssum pateri* Nyár subsp. *prostratum* (Nyár) Dudley, *Anthemis auriculata* Boiss., *Arenaria cucubaloides* Sm., *Asperula xylorrhiza* Nàb., *Bromus erectus* Huds, *Cephlorrynchus rechingeranus* Tuisl, *Cerastium longifolium* Willd., *Cyclotrichum leucotrichum* (Stapf ex Rech.f.) Leblebici, *Erysimum pulchellum* (Willd.)

J.Gay, *Gundelia tournefortii* L. var *tournefortii, Hypericum scabrum* L., *Myosotis amoena* (Rupr.) Boiss., *M. olympica* Boiss., *Nepeta baytopii* Hedge & Lamond, *Origanum vulgare* L. subsp. *gracile* (C.Koch) Iestwaarts, *Ornithogalum narbonense* L., *Poa caucasica* Trin, *Prangos pabularia* Lindl, *Ranunculus diversifolius* Boiss. & Kotschy, *Rindera caespitosa* (A.DC.) Bunge, *Rosularia radiciflora* (Steud.) Boriss. subsp. *radiciflora*, *Rumex alpinus* L., *R. ponticus* E.H.L.Krause, *Salvia poculata* Nàbélek, *S. trichoclada* Benth., *Scrophularia libanotica* Boiss. var. *urartuënsis* R.Mill, and *Urtica dioica* L.

3.4. Etymology: The specific epithet is derived from the name of the city Bingöl.

4. Discussion

The first thorough arrangement of the genus *Paracaryum* was given by Mill (1979), who recognized 27 species, 3 subspecies, and 4 varieties. Since then 1 new species, *P. hedgei* Aytaç & R.R.Mill of the subgenus *Mattiastrum* (Boiss.) R.R.Mill., has been identified from Turkey (Aytaç and Mill, 2005). The subgenus *Modestomattiastrum* (Brand) R.R.Mill. is represented by 15 taxa (9 species, 4 subspecies, and 2 varieties) in the *Flora of Turkey* (Mill, 1979). This new species is similar to the subgenus *Mattiastrum* with its large nutlet, long corolla, and sterile shoots. However, when we examined the flora of Turkey and Russia, we observed that some species have characters between the subsections *Mattiastrum* and *Modestomattiastrum* like *P. bingoelianum*. For example, *P. laxiflorum* Trautv. has flower and nutlet characters between the subgenus *Mattiastrum* and the subgenus *Modestomattiastrum*. *Paracaryum bingoelianum* belongs to the subgenus *Modestomattiastrum* with its anthers base borne below the scale bases, and the nutlets wings flat. Within the subgenus *Modestomattiastrum*, the new species is closely similar to *P. cristatum* subsp. *cristatum* and *P. kurdistanicum*. According to Mill (1979), *P. cristatum* has 2 subspecies in Turkey. This new species clearly differs from the similar species by its branched woody structure and sterile shoots and by its longer corolla 11–15 mm (neither 3–6 mm as in *P. cristatum* subsp. *cristatum* nor 6.5–11 mm as in *P. kurdistanicum*). *Paracaryum bingoelianum* differs from *P. kurdistanicum* by larger nutlets with dense long and short glochids on disc (not sparsely tuberculate) and larger nutlet wings 3–5 mm with sparse glochids (not always glabrous). A more detailed comparison of the species is given in the Table.

The pollen grains of *P. bingoelianum* were studied by light microscopy and SEM. The pollen grains are elliptical in equatorial view and ±hexagonal in polar view, prolate (P/E = 1.52), 6-heterocolpate, and ectocingulate (Figure 4). The aperture margins are strongly thickened. The tectum is psilate, smooth to slightly rugulose. The exine thickness as seen under the light microscope is 0.8–1.02 µm. *P. bingoelianum* shares the same basic pollen morphology with other *Paracaryum* species. These fall into 2 groups as defined by Bigazzi et al. (2006); the first group, comprising *P. artvinense* R.Mill, *P. cappadocicum* Boiss. & Bal., *P. polycarpum* (Rech.fil.) R.Mill, and *P. rugulosum* (DC.) Boiss., has very small prolate grains (P/E = 1.62–1.89), while the second comprises *P. ancyritanum* Boiss., *P. laxiflorum* Trautv., *P. leptophyllum* (A.DC.) Boiss., and *P. racemosum* (Schreber) Britten, which have slightly larger grains with a prolate-spheroidal shape (P/E = 1.13–1.25). The first group of species belong to the subgenus *Modestomattiastrum*, which has prolate pollen shape as

Table. Comparison of the diagnostic characteristics of *Paracaryum bingoelianum, P. cristatum* subsp. *cristatum*, and *P. kurdistanicum*.

Character	*P. bingoelianum*	*P. cristatum* subsp. *cristatum*	*P. kurdistanicum*
Stem	11–25 cm long, woody and branched at base	12–40 cm long, usually simple, not woody at base	23–30 cm long, simple, not woody at base
Sterile shoots	present,	sometimes present	absent
Basal leaves	narrowly lanceolate-obovate, 6–8.5 × 0.5–0.8 cm	obovate (0.8–)2.5–8.5 × 0.3–1.5 cm	narrowly obovate, 2.5–6 × 0.4–0.8 mm ,
Cauline leaves	narrowly lanceolate	Obovate	narrowly oblong
Inflorescence	terminal-paniculate	terminal, bifurcate	cymose terminal and axillary
Pedicel length	1.5–10 mm in flower, 3–22 mm in fruit	1.5–6 mm in flower, 1.5–13 mm in fruit	3.5–6 mm in flower, 7–12.5 mm in fruit
Corolla length (mm)	11–15	3–6	6.5–11
Style length (mm)	6–10	1.3–4.5	2.3–4.3
Nutlets	suborbicular, 15–18 × 15–18 mm	suborbicular, 8–12.5 × 6.5–10 mm	suborbicular, 10–10.7 × 8.5–9.5 mm
Nutlets wing	3–5 mm broad, dorsal surface with sparse glochids, margin cristate.	2–3.3 mm broad, dorsal surface always with sparse glochids, margin cristate, teeth large and broad	2.5–3 mm broad, always glabrous, margin shallowly and obscurely muricate-dentate

in *P. bingoelianum*. The seed of *P. bingoelianum* clearly differs by its long beak (Figure 6B) from *P. cristatum* subsp. *cristatum* (Figure 6A).

After the present contribution the total number of *Paracaryum* is 29 species, 3 subspecies, and 4 varieties in Turkey.

4.1. Additional examined specimens

Paratypes: Turkey. B8 Bingöl: SE of Genç, Şamdağı, NW rocky slopes, 1950–2000 m, 25.vii.2012 *L. Behçet* 8165 (in fruit); Bingöl: NE of Çirişli village, stony slopes and steppe, 1750–1850 m, 01.05.2013 *L. Behçet* 8581 (Mustafa Kemal Univ. Herb. ANK, Bingöl Univ. Herb.).

Paracaryum cristatum: B9 Bitlis: Tatvan, Nemrut Mountain, 2400–2900 m, volcanic slopes, 07.1973, *A.Tatlı*, (HUB), B7 Erzincan: Rabat stream, moving stony slopes, 860 m, 03.07.2007, *M.N.* Özbek 2524 (HUB), A7 Gümüshane: 10 km to Şiran, after Aksaray village, stony places, 1300 m, 17.06.2007, *A.D. Koca* 3284, (HUB), A7 Gümüshane: Alucra, Şiran, 2 km to Sarıca village, steppe and rocky slopes, 1295 m, 02.07.2008, *A.D. Koca* 3527 (HUB), B9 Bitlis: Tatvan, Söğürt to Nemrut Mountain, 2200 m, 22.06.2007, *A.D. Koca* 3351 (HUB), B9 Ağrı: Eleşkirt, Güneykaya to Sancan village, rocky places, 1900 m, 22.06.2007, *A. D. Koca,* 3352 (HUB). C6 Kahramanmaraş: Engizek Mountain, Aksu neighborhood, 1000 m, 02.06.1986, *Duman* 3008, (GAZI), B8 Muş: 15 km to Muş, limy rocks, 26.vi.1983, *T. Ekim,* 7776 (GAZI), C6 Kahramanmaraş: Ahırdağı, around TV mast, Ulucak hill, Bakacak ridges, 1200–1500 m, 21.v.1992, oak clearings, *Aytaç* & *Duman* 4603 (GAZI), C6 Malatya: around Erkenek 3 km, Deveyatağı area, limy rocks, 28.v.1989, *B. Yıldız* 8653 (GAZI), B6 Kayseri: Sarız, Yalak, Binboğa Mountain, around Tekke kayası, rocky steppe, 2000–2400 m, 18.vii.1992, *Aytaç & Duman* 5268 (GAZI), C6 Kahramanmaraş: Erince Mountain, 1300–1500 m, 22.v.1987, oak clearing, *H. Duman* 2795 (GAZI), C9 Şırnak: Beytüşşebap, Mezra district, 1797 m, 15.05.2010 water edges, *L. Behçet* 3783 (VANF), B9 Van: Erciş, east of Doğancı village, 2250 m, 18.06.2007, steppe, *O. Karabacak* 6462 (VANF), B9 Van: Gürpınar, between Zernek dam and Üçgen village 1700–1900 m, steppe, 10.06.2007, İ. *Demir* 448 (VANF), B9 Muş: Malazgirt, around Yapraklı village, 1591 m, steppe, 29.05.2006, *L. Behçet & LFM* 564 (VANF), B9 Bitlis: A. Nabat mountain, 1700 m steppe, *L. Behçet* 2416 (VANF), B9 Bitlis: Tatvan, Kesan creek, 20 km, 1500–1800 m, rocky slopes, 29.05.2005, *T* . Çelik 479 (VANF), B9 Van: Muradiye, west of Akçadağ visit, 2300 m steppe, 12.06.2001 *O. Karabacak* 1708 (VANF), B9 Bitlis: Adilcevaz, Kef castle, slopes of Ziyaret hill, 1300 m, steppe, 14.07.1988, *L. Behçet* 1173 (VANF), B10 Van: Özalp, upper parts of Y. Turgutlu village, 2250 m, steppe, 10.06.1997 *F.* Özgökçe, 5874 (VANF), B9 Van: Muradiye, between Adaklı village and Lake Süphan, 2500 m, steppe, 28.06.1998, *M.* Ünal 4201(VANF), B9 Bitlis: Hizan, Karbastı village, Yamaç hamlets, 1600 m, road edges, 26.06.1990, *Y. Altan & L. Behçet*, *Y. Altan* 2251 (VANF), B7 Elazığ: Baskil, Meydancık village, 900–1700 m forest clearing, 02.06.1998. *L. Behçet*, 5855 (VANF), B7 Elazığ: Baskil, Haroğlu village around TV mast, 1700–1900 m, 23.06.1995. *L. Behçet* 4886 (VANF), B7 Elazığ: North of Baskil, Daşanan village 1200–1800 m rocky places, 15.05.1995. *L. Behçet* 4808 (VANF). ***Paracaryum kurdistanicum:*** C7 Şanlıurfa: Karacadağ, Kollubaba hill, 1950 m, rocky slopes, 28.05.2005, Ö.F. Kaya 1745 (HUB), C7 Şanlıurfa: Siverek, north of Karacadağ, 1250 m, 19.05.1957, *Davis & Hedge* (ANK).

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