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REDISCOVERY OF DIONYSIA BACHTIARICA (PRIMULACEAE) IN KUH-E KALLAR AFTER 119 YEARS

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Botanical exploration in 2022 in the province of Chaharmahal and Bakhtiari, resulted in the collection of *Dionysia bachtiarica*, a narrow endemic species first collected in 1902 and described in 1905. This species has not been seen since 1903. Some morphological features were incompletely recorded, absent, or untrustworthy in earlier descriptions, due to limited herbarium material. In this study, new morphological data are provided based on analysis of live flowering and fruiting material, illustrated with photographs of the plant and its habitat, as well as line drawings. A full description of the species, its ecology, and phenology, as well as a key to all purple-flowered species in the Zagros Mountains, are provided. The possible relations of this enigmatic species are discussed. Due to its extremely limited known area of occurrence and a small number of individuals, it is considered to be Critically Endangered.

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Keywords: Chaharmahal and Bakhtiari; narrow endemic; Sabz Kuh, subnival–nival species; threatened species; Zagros

کشف مجدد Dionysia bachtiarica (تیره Primulaceae) در کوه کلار بعد از ۱۱۹ سال

امین زراعتکار: استادیار پژوهش، بخش منابع طبیعی، مرکز تحقیقات و آموزش کشاورزی و منابع طبیعی استان چهارمحال و بختیاری، سازمان تحقیقات، آموزش و ترویج کشاورزی، شهرکرد، ایران

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مطالعات گیاه‌شناسی که در سال ۱۴۰۱ در استان چهارمحال و بختیاری انجام گرفت، منجر به جمع‌آوری گونه Dionysia bachtiarica گردید. این گیاه انحصاری و دارای جمعیتی بسیار کوچک است که نخستین‌بار در سال ۱۹۰۲ جمع‌آوری و در سال ۱۹۰۵ شرح داده شد و از سال ۱۹۰۳ به بعد هرگز دیده نشد. در شرح‌های اولیه به علت نمونه‌های هرباریومی اندک، برخی از ویژگی‌های ریخت‌شناسی این گیاه به صورت ناقص، غایب، نادرست یا غیر قابل اعتماد گزارش داده شده است. طی این مطالعه، براساس تشریح نمونه‌های هرباریومی و نیز زنده در زمان گلدهی و رسیدن میوه، به همراه

تصاویری از گیاه در رویشگاه و نقاشی، اطلاعات جدید ریخت‌شناسی برای این گونه فراهم شد. یک شرح کامل گیاه‌شناسی، شرایط اکولوژی و فنولوژی و نیز یک کلید برای تمام گونه‌های گل‌بنفش این جنس در کوه‌های زاگرس تهیه شد. روابط خویشاوندی احتمالی این گونه مورد بحث قرار گرفت. به دلیل وسعت بسیار کم سطح تحت اشغال و تعداد کم افراد بالغ، این گیاه در وضعیت بحران انقراض قرار می‌گیرد.

INTRODUCTION

Dionysia Fenzl (Primulaceae), a genus comprising 64 true *chasmophytic* species, are natural jewels in Iran's floral heritage with a center of diversity in the Zagros Mountains (Zeraatkar & Khajoei Nasab 2022). Although the first species was found already in 1772, several species have been discovered only in the last few decades. For instance, out of a total of 64 species, 21 have been described since 2000 (Zeraatkar & al. 2022; Lidén & Mehregan 2023).

Many species of the genus appear to be stenoendemic and are only known from one or a few populations. They are threatened by the expansion of mines, construction of roads, and urbanization over the last four decades, and may also be highly sensitive to a changing climate with erratic precipitation and increased temperature. Hence many species *are expected to be* critically endangered, and several populations may already be extinct (Zeraatkar & al. 2022).

With 14 species, the genus *Dionysia* contributes remarkably to the high diversity of Chaharmahal and Bakhtiari province; 11 taxa are endemic or regional endemic to this province (Liden & Mehregan 2023). In general, the vast rocky habitats in the province harbor a high number of endemics and still supply suitable environments for the occurrence and diversification of *Dionysia* and other chasmophytes.

Dionysia bachtiarica Bornm. & Alex. is a hitherto poorly known endemic species, until now known only from three old collections by Alexeenko, the type material having been collected on Kuh-e Kallar in September 1902.

In his monograph, Wendelbo (1961) considered the name *Dionysia bachtiarica* to be a synonym of the older name *Primula sawyeri* G. Watt, of which the type specimen was early lost. However, as shown by a careful comparison of the protologues, the name *Primula sawyeri* applies to a species quite different from *D. bachtiarica*, in distribution as well as in morphological characters of leaves and calyx, and is probably a synonym of *D. archibaldii*. The potentially disruptive name *Primula* (*Dionysia*) *sawyeri* was therefore proposed to be put on the list of rejected names (Lidén 2021).

Several attempts by various workers to recollect *Dionysia bachtiarica* in Kuh-e Kallar have failed (Lidén 2007; Lidén & Mehregan 2023), because of too limited search efforts and the plant's rarity.

The first author finally rediscovered *Dionysia bachtiarica* in the spring and summer of 2022, 120 years after the original find. It is now possible to more precisely understand its morphology, habitat, taxonomic affinities, and ecology. For the first time, the species is also photographically documented.

An identification key to all violet/purple flowered species occurring in the Zagros Mountains is provided.

MATERIALS AND METHODS

Fieldwork targeting *Dionysia bachtiarica* was carried out at the type locality in Kuh-e Kallar in the Chaharmahal and Bakhtiari province from May 2022 to September 2022. Several specimens were collected and photographed in their natural habitats. The morphological features of living and herbarium specimens were examined using a ZEISS stereo-binocular microscope. Voucher specimens were deposited in the herbarium of Chaharmahal and Bakhtiari Agricultural and Natural Resources Research and Education Center (D) and the herbarium of the Research Institute of Forests & Rangelands (TARI), (acronyms according to Thiers 2023).

RESULTS AND DISCUSSION

Dionysia bachtiarica Bornm. & F.N.Alex. ex Bornm., Bull. Herb. Boissier, ser. 2. 4: 515 (1904). (Figs 1–7)
Type: Persia occidentalis [W Iran]. montes Bachtiarici [Chaharmahal and Bakhtiari province], in umbrosis rupium jugi Kellar [Kallar], fr., 3 September 1902, F.N. Alexeenko 2722 (Holotype [B100295211]).
Dionysia sawyeri auct., sensu Wendelbo 1961a, Grey-Wilson 1989 and Lidén 2007, non *Primula sawyeri* G.Watt. (see Lidén (2021) and Jamzad (1999)).

Cushions rather lax, smaller than in most other species of the genus, 1–3.5 (rarely 20) cm in diam. Branches with closely imbricate marcescent leaves in overlapping but clearly discernable whorls in the upper part, becoming bare below. Defoliated stems up to 1.5 mm thick, glabrous; stem epidermis and petiolar leaf base straw-yellow, pale grayish brown, and reddish brown. The bark of older stems thick and longitudinally fissured. Petiolar leaf base and leaf ciliate. Flowering shoots start to elongate in spring and early summer, reaching 2–6 mm in length. Leaves green to somewhat

bluish green, flat, heteromorphic, conspicuously ciliate throughout with up to 0.8 mm long coarse hairs; early emerging leaves entire (very rarely with 1–2 fine teeth in upper part), spathulate-oblanceolate, 9–15 × 1–3 mm, abaxially with a few eglandular trichomes to 0.3 mm long and a few minute sessile glands, adaxially with rather sparse eglandular trichomes in distal part, apex obtuse to subacute; terminal (overwintering) leaves entire, oblong to ovate-triangular, obtuse to subacute, 3–6 × 0.5–1.5 mm, with a few eglandular trichomes to 0.3 mm long abaxially, adaxially with some eglandular hairs to 0.8 mm long in distal half. Bracts 0 or 1, narrow, oblong, apex acute to subobtuse, shorter than calyx, c. 3 mm long, margin ciliate in the upper half. Flowers single, very shortly stalked; pedicel < 1 mm long, with a few eglandular trichomes. Calyx 3–5 mm long, divided for 3/4 to 4/5 of its length into linear-oblong to oblanceolate subacute to subobtuse lobes, ciliate in distal half. Corolla pale lilac to lavender (when dry often violet) with a whitish eye; tube pale yellow, completely glabrous, 7–15 mm long; limb 7–14 mm across, lobes obovate, apex deeply emarginate (lobules sometimes again divided; Fig. 4, upper right). Style of short-styled flowers up to 7 mm long, reaching about halfway through the tube; that of long-styled flowers not exserted, up to 14 mm long. Anthers c. 1.3 mm, inserted in the throat or just below the middle of the corolla tube. Ovary small, rounded, with 12–27 ovules. Capsule rounded, ca. 4 mm, with up to 17 dark brown polyhedral obtusely angular seeds, 0.8–0.9 mm long; the outermost cell layer colliculate.

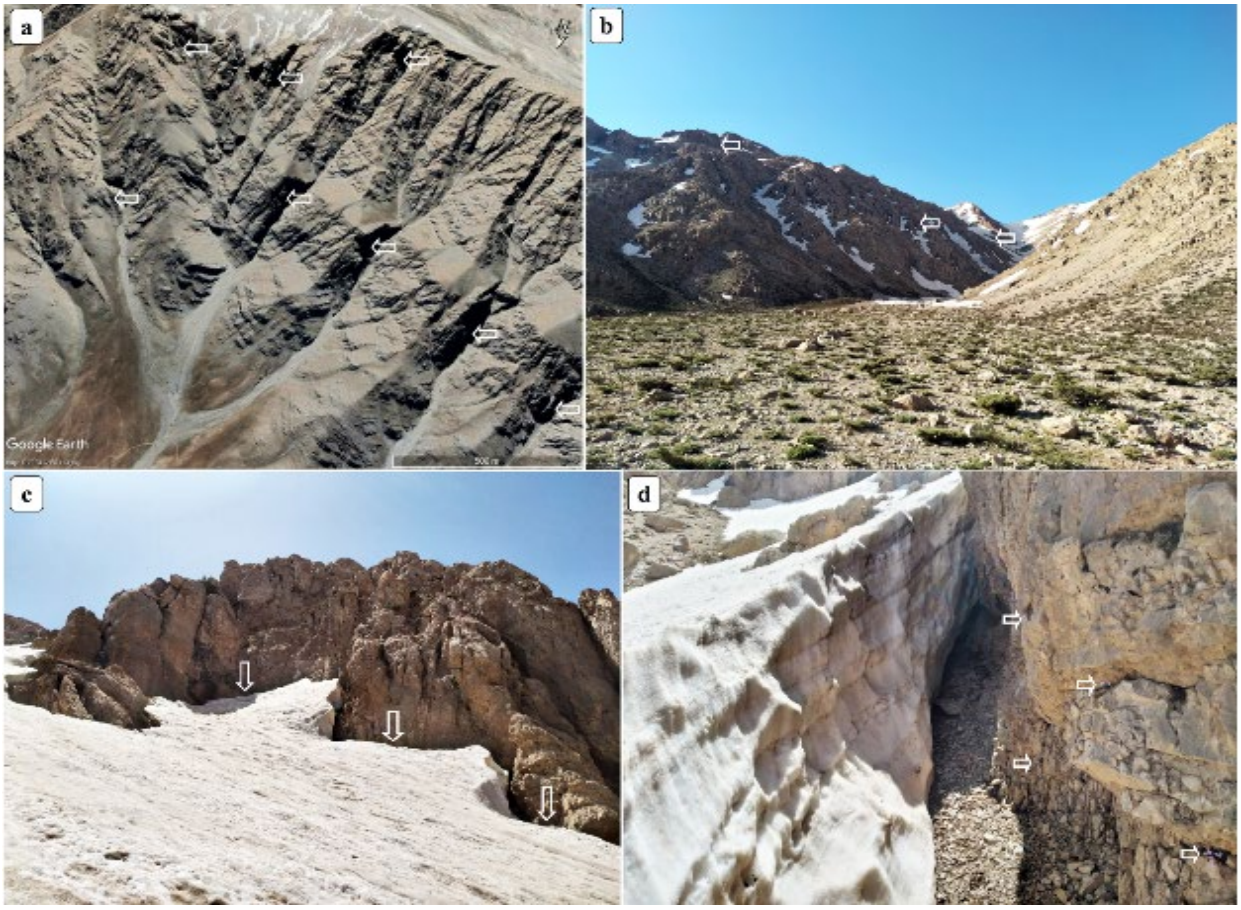

Fig. 1. Habitats of *Dionysia bachtiarica*. Distant and close-up views of habitats are shown by arrows (Photographs by AZ, mid-May 2022).

Fig. 2. Habitat of *Dionysia bachtiarica* (lilac) and *Dionysia lamingtonii* (yellow) Stapf in Kuh-e Kallar where they are sympatric (Photograph by AZ, mid-May 2022).

Notes on morphological features of *Dionysia bachtiarica:* Due to the conditions of the original material, Lidén (2021) and Lidén & Mehregan (2023) were reluctant to judge the flower color, although it was clearly stated to be "violaceus" in the protologue. We can now confirm that the original description is indeed correct.

Alexeenko 821 (LE), illustrated by Lidén (2007), appears to differ from the majority of plants seen by us in slightly broader calyx lobes (Fig. 6d).

More materials from two populations in flowering and fruiting times provide additional support for the existence of heteromorphic leaves in the species (as mentioned by Lidén (2007)). However, in contrast to earlier descriptions (Bornmüller 1904; Lidén 2007; Lidén 2021; Mehregan & al. 2021) that the abaxial surface of summer leaves is said to be glabrous, we observed that the abaxial surface of leaves has a few very small eglandular trichomes on the blade (Figs. 6a–b and 6e–f).

The ovule numbers are very variable and range from 12–27 per ovary.

Distribution: The species is known from a restricted area in the north slope of Kuh-e Kallar and on Sabz Kuh, a closely neighboring mountain to the south, that forms part of the same massif. The Kuh-e Kallar finds may be close to the type locality, and the Sabz Kuh finds is possibly close to Alexeenko's second finds, but we can never be sure. The species may of course grow in other stations in this massif, but it is certainly very rare (Fig. 3).

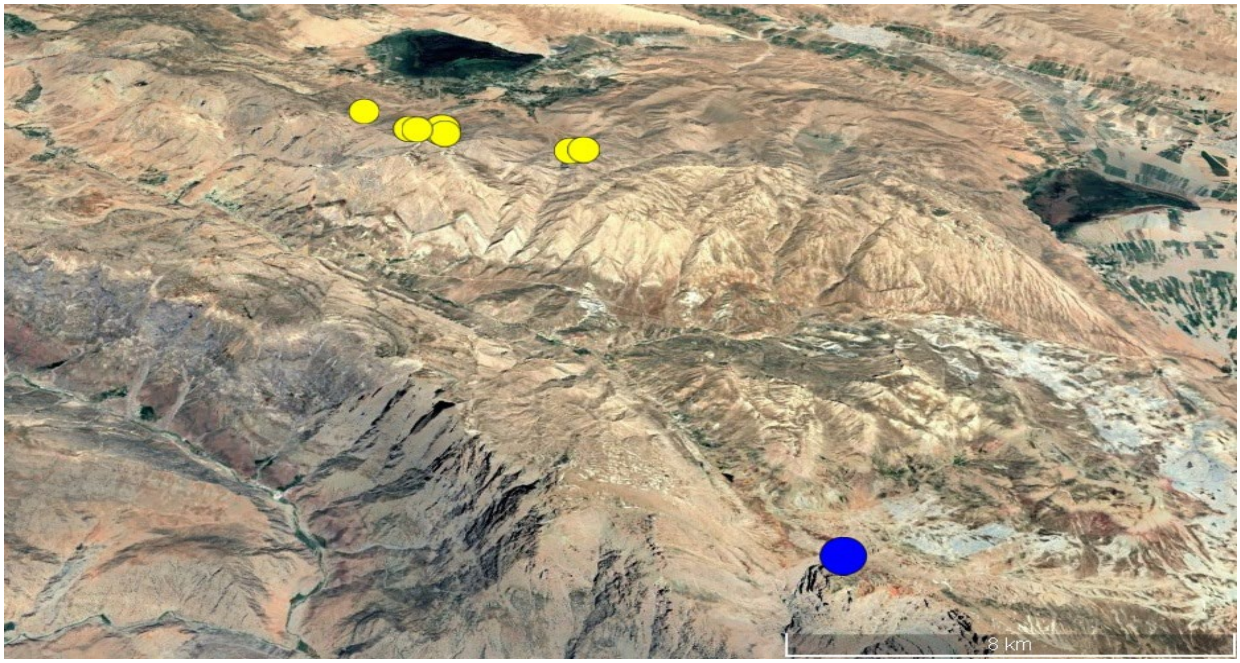

Fig. 3. Distribution of *Dionysia bachtiarica* in Kuh-e Kallar (yellow dots) and Sabz Kuh (blue dot).

Fig. 4. Flowers in *Dionysia bachtiarica* (Photographs by AZ, mid-May 2022).

Occurrence of *Dionysia bachtiarica* and notes on its habitat: During our field study in 2022, we found that the species has specialized habitat requirements. It always occurs as localized and very small groups of individuals *on* north-facing slopes of narrow valleys where snow dominates the landscape for most of the year (7–8 months) and a minimum amount of sunlight is received. Our observations provide some evidence that *Dionysia bachtiarica* is a chionophilous (snow-dependent) and shade-loving species, and is only found in habitats with the appropriate amount of snow and a deep shade (Figs. 1 and 2).

In Kuh-e Kallar, the genus *Dionysia* has 4 species, i.e. *D. revoluta* Boiss., *D. bachtiarica*, *D. lamingtonii* Stapf, and *D. cespitosa* (Duby) Boiss. Here, *D. revoluta* and *D. cespitosa* (Duby) Boiss. are sensitive to lower temperatures and are restricted to altitudes between 2000–2900 m. In contrast, *Dionysia bachtiarica* and *Dionysia lamingtonii* grow from 2800–3500 m in our area (*D. lamingtonii* can be found down to 1700 m in some localities further to the NW). In Kuh-e Kallar, individuals, rather patchily distributed, Fig. 3.

they share the same general habitat type in narrow valleys. The exposure of the rock face is important in determining their fine-scale preferences. *Dionysia lamingtonii* grows abundantly on both lower and upper parts of the limestone cliffs, but usually with more sun exposure, whereas *D. bachtiarica* always chooses to live in the lower portions of the cliffs which are shaded most of the day (Fig. 2).

Phenology: Flowering: early April to late June. Fruiting: September-November. Altitudes between 2850–3500 m a.s.l. Many *Dionysia* species in the Zagros Mountains, for example, *D. avia*, *D. drabifolia* Bunge, *D. splendens* Alipour, Mehregan & Lidén, *D. mallos* and *D. jamzadiae* Lidén, M.Irvine, Alvén & Mehregan, prefer elevations above 2500 m.

Conservation status: We have found that the entire population of *Dionysia bachtiarica* occupies an extremely limited area of only 950 m^2 in Kuh-e Kallar and Sabz Kuh, falling well under the thresholds for the Critically Endangered (CR) category under criterion B2a (IUCN 2022). We estimated that there were less than 50 mature

Fig. 5. *Dionysia bachtiarica* in fruiting time (Photograph by AZ, mid-June 2023).

Additional specimens examined: Iran, Chaharmahal and Bakhtiari province, Borujen, Choghakhor rural district, Kuh-e Kallar, 31.8482°N, 50.9419°E, 2950 m a.s.l, 15 May 2022, fl., A. Zeraatkar & al. 7077 (D!, TARI!); ibidem, 31.84452°N, 50.939461°E, 3020 m a.s.l, 15 May 2022, fl., A. Zeraatkar & al. 7078 (D!); ibidem, 31.846728°N, 50.941917°E, 3050 m a.s.l, 15 May 2022, fl., A. Zeraatkar & al. 7079 (D!); ibidem, 31.851056°N, 50.897079°E, 3500 m a.s.l, 15 May 2022, fl., A. Zeraatkar & al. 7081 (D!); ibidem, 31.8609°N, 50.8942°E, 3000 m a.s.l, 26 September 2022, fr., A. Zeraatkar & al. 7080 (D!); ibidem, 3100 m a.s.l, 22 June 1997, fr., F. Haghighian 1536 (D!); ibidem, ("ad rupes N jugi Kellar", 8.9.1903 [cal. jul.], Alexeenko 821 (LE); "Vallis Sebze (presumably referring to Sabz Kuh) in declivibus ad jugi Kellar ad rupes N", 4.1902 [cal. jul.], Alexeenko 827 (LE). Mashayekh rural district, Naghan district, Kiar county, mount Sabz Kuh, Tang-e Zendan, 31.700318°N, 50.991579°E, 2850 m a.s.l, 22 September 2020, fr., H. Shirmardi & al. 7076 (D!).

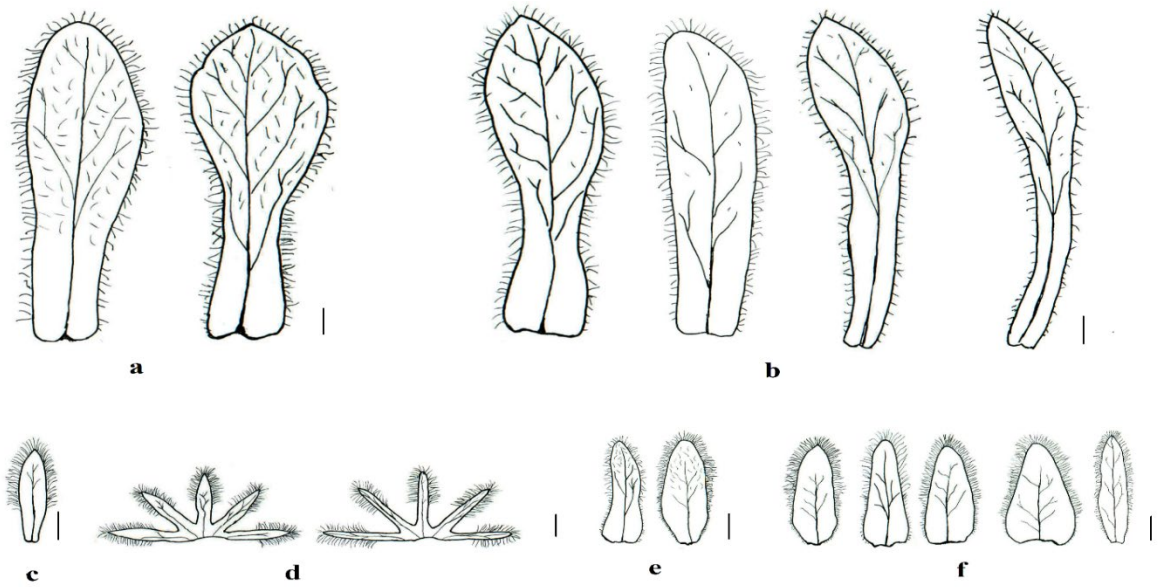

Fig. 6. Illustrations of the leaves type, calyx, and bract of *Dionysia bachtiarica*. a, summer leaves (adaxial side); b, summer leaves (abaxial side); c, bract; d, calyces; e, overwintering leaves (adaxial side); f, overwintering leaves (abaxial side). Scale bars: a, b, c: 1 mm. d, e, f: 1.5 mm.

Taxonomic affinities: According to Lidén & Mehregan (2023), *Dionysia bachtiarica* belongs to the section *Dionysia*. In vegetative characters (the weakly sclerified flat oblanceolate leaves with pronounced seasonal dimorphism) it is similar to *Dionysia avia*. In *Dionysia bachtiarica*, however, the difference between early and terminal leaves is much larger (3–5 times vs 2–3 times), and it is unusual in the section in the high number of ovules (12–27 per ovary, vs usually less than 12) and the small seeds. Only *D. splendens* has a comparable number of ovules (15–25), but its seeds are large and ellipsoid.

Dionysia bachtiarica is also strikingly similar to *D. archibaldii* and *D. zschummelii* in the glabrous corolla with a pale tube and violet/lilac/purple limb with a whitish or yellowish eye and deeply emarginate lobes, but the flat or slightly involute entire leaves suggest that they are not closely related. However, a hybridogeneous derivation of this enigmatic species cannot be ruled out (cf. *Dionysia* sect. *Tapetodes*; Lidén & Mehregan 2023).

Key to violet/purple-flowered species of *Dionysia* occurring in the west and southwest of Iran

1. Leaves apically divided into 3 (to 5) lobes; plants forming dense dark green cushions ... *D. mozaffarianii*
- Leaves entire or laterally dentate; cushions dense or lax 2
2. Inflorescence long-stalked, several-flowered; bracts large, dentate ..... *D. splendens*
- Inflorescence sessile or subsessile, flowers single or paired; bract(s) small, entire 3
3. Leaves often crenate-dentate; margin distinctly revolute 4
- Leaves entire; margin flat or slightly involute 5
4. Cushions lush, with dense acute hairs to 0.3 mm..... .....*D. archibaldii* Wendelbo
- Cushions very dense, glabrous, or with sparse minute hairs .....*D. zschummelii* Lidén
5. Leaves with short glandular hairs only.. *D. bryoides*
- Conspicuous long eglandular hairs present, glandular hairs small or absent 6
6. Cushions very dense, with dense silvery-grey..... pubescence; ovules 2 to 3 7
- Cushions lush; green to bluish green; anisophyllous; ovules 12 to 27 ..... *D. bachtiarica*
7. Corolla glabrous; fruiting valves spiraling after dehiscence; calyx split to 1/2 ..... *D. iranshahrii*
- Corolla pubescent; fruiting valves not spiraling; calyx split to the base ..... *D. mallos*

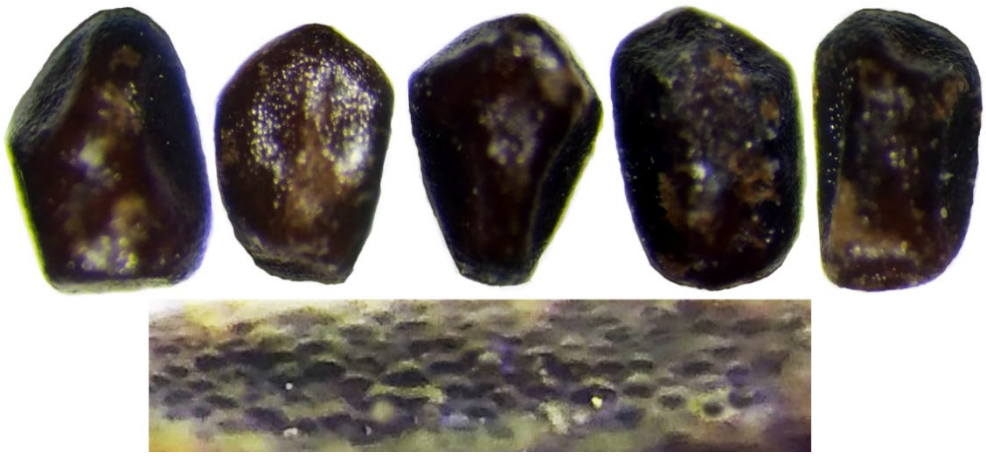

Fig. 7. Seed and exotesta of *Dionysia bachtiarica* (Photograph by AZ).

REFERENCES

Bornmüller, J. 1904: *Zur Kenntnis der Gattung Dionysia (Zwei neue Arten aus West-Persien)*. -Bulletin de l'Herbier Boissier 2(4): 513–521.

IUCN Standards and Petitions Committee (2022) Guidelines for Using the IUCN Red List Categories and Criteria. Version 15.1. Prepared by the Standards and Petitions Committee. Downloadable from https://www.iucnredlist.org/documents/RedListGuidelines.pdf.

Jamzad, Z. 1999: Primulaceae. In: Flora of Iran (Assadi, M., Massoumi, A. A., Mozaffarian, V. & Khatamsaz, M., eds.) no. 25: 43–44. -Tehran.

Lidén, M. 2021: (2812) Proposal to reject the name *Primula sawyeri* (*Dionysia sawyeri*) (Primulaceae). -Taxon 70 (2): 442–443.

Lidén, M., Mehregan, I. 2023: *Dionysia* (Primulaceae) – the cushion primroses. -Symbolae Botanicae Upsalienses 41: 1–256.

Mehregan, I., Younesi, S., Liden, M. 2021: *Donysia avia* (Primulaceae), a new species from Zagros Mountains, Iran. -Phytotaxa 511(3): 296–300.

Thiers, B. 2023: Index Herbariorum: A global directory of public herbaria and associated staff. New York Botanical Garden's Virtual Herbarium. Available from: http://sweetgum.nybg.org/ih/ (accessed 1 June 2023)

Zeraatkar, A., Jamzad, Z., Jalili, A., Khajoei Nasab, F. 2022: The conservation status of endemic SW Iranian *Dionysia* species. -Iran Nature 7(2): 143–155. doi: 10.22092/irn.2022.357964.1450

Zeraatkar, A., Khajoei Nasab, F. 2022: A new natural hybrid in *Dionysia* (Primulaceae). -Phytotaxa 559(1): 64–72. doi: https://doi.org/10.11646/phytotaxa.559.1.7