**Erysimum hezarense**, a new species and **Rhammatophyllum gaudanense**, a new record of Brassicaceae from Iran

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**Abstract**

Two Brassicaceae novelties are reported from Iran. *Erysimum hezarense* (Erysimeae) is described and illustrated as a newly discovered species. It resembles *E. subulatum*, *E. laxiflorum* and *E. iraqense* but can be readily distinguished by the indumentum of stem, leaves and pedicels; bicolor petals; and number of flowers on the main inflorescence. It is also separated geographically being restricted to Hezar mts. (prov. Kerman, South Iran) where none of the related species occurs. Because of the very limited distribution and high risk of its habitat destruction, inclusion of *E. hezarense* into IUCN Red List with a status vulnerable (VU) is proposed. Besides, *Rhammatophyllum gaudanense* (Euclidieae) is reported from NE Iran representing the first record of the genus for the country. Contrary, the previous record of *R. gaudanense* from Afghanistan is considered doubtful and not confirmed. Detailed morphological description, illustration and synonymy of *R. gaudanense* is provided along with the key differences from the closely related taxa. Distribution maps for both *E. hezarense* and *R. gaudanense* are given.

**Key words**: Cruciferae, Erysimeae, Euclidieae, Iran, new species, new record.

**Introduction**

During a field trip to S Iran as well as the treatment of herbarium material of several herbaria in the context of the PhD project of the first author, some novelties have been detected, two of which are reported herein. The first is a new species of *Erysimum* Linnaeus (1753: 660), *E. hezarense*, collected from the south of Iran, province of Kerman. The second novelty is the first record of both *Rhammatophyllum gaudanense* (Litvinov 1902: 33) Al-Shehbaz & O. Appel (2002: 3) and the genus *Rhammatophyllum* O.E. Schulz (1933b: 190) from Iran.

**Taxonomic treatment**

1. *Erysimum*

*Erysimum* is one of the largest genera of the Brassicaceae (Cruciferae). It is well known for its taxonomic complexity due to tremendously overlapping morphological characters, and its diversity estimations range from 150 (Zhou *et al.* 2001, Al-Shehbaz 2010) to 290–350 species (Polatschek & Snogerup 2002). The diversity of *Erysimum* is centered in SW Asia and Eastern Mediterranean where new species are still being described (e. g., Polatschek 2008, 2011; Moazzeni *et al.*, 2014).

According to the *Flora Iranica* account (Polatschek & Rechinger 1968) and subsequent additions (Polatschek 2008, 2010, 2011; German 2014), 31 *Erysimum* species occur in Iran. One more species described herein was discovered during the botanical investigation of Hezar (Hezar-Lalezar) mountains which formerly had been rarely studied by botanists. Taking this novelty into account, 32 *Erysimum* species are recorded at the moment from Iran, seven of which are endemics.
**Erysimum hezarense** Moazzeni, *sp. nov.* (Fig. 1)

TYPE: IRAN. Kerman, Rayen, Bab-Zangi village in foothills of Hezar mount. 29° 33’ 52” N, 57° 24’ 55” E. 3700 m, 17 July 2010, H. Moazzeni & A. Pirani, 45200 (holotype TUH!, isotypes FUMH!, GB!, TARI!, TUH!).

**Plants** biennial or rarely annual. **Stems** erect to ascending, (15)20–35(45) cm high, usually with several branches at the base, trichomes on stems 2–(3)–((4))-rayed. **Leaves** covered with 2–3–(4–5)-rayed trichomes, predominantly or exclusively basal. **Basal leaves** spatulate, keeled, (15)25–40(55) × (2)3–5(8) mm, acute (rarely round) at apex, attenuate at base. **Cauline leaves**, if present, up to 4, sessile, linear to oblanceolate, entire, (10)30–35 × 3–4 mm, acute at apex, attenuate at base. **Inflorescence** (15)25–35-flowered, ebracteate raceme, considerably elongated in fruit. **Fruiting pedicels** horizontal or descending (angle 90–120 degrees) to reflexed (angle 140–160 degrees), (1.5)3–5(8) mm, with 2–3–(4)–((5))-rayed trichomes.

**Sepals** oblong, dark green to lilac, 6–8 mm long, pubescent as pedicels. **Petals** yellow turning bicolor (yellow at the top and purple proximally), withering purple, 8–10(11.5) × (1.5)2–2.5(3) mm, glabrous or rarely with 2–3–4-rayed trichomes outside. **Fruits** dehiscent siliques (25)50–60(80) × 0.5–1 mm, terete, horizontal to deflexed, densely covered with ((2))–3–4–5–((6–7))-rayed trichomes; style distinct, 1–2 × 0.5 mm; stigma capitate or slightly bilobe. Seeds wingless or rarely winged, oblong, 2 × 1 mm; 5–10 per locule; cotyledons accumbent.

**Distribution**: endemic (Kerman, S Iran).

**Phenology**: June (flowering period), July (fruiting period).

**Additional specimens examined**: IRAN. Kerman, near Sarcheshmeh copper mine, 2700 m, 08 July 1986, Assadi.
Key characters and affinities

*Erysimum hezarense* is morphologically similar to *E. laxiflorum* J. Gay (1842: 4), *E. subulatum* J. Gay (1842: 8) and a recently described *E. iraqense* Polatschek (2008: 160), with which it shares habit, lax inflorescence, thick and rather short pedicels and terete fruits. However, it sufficiently differs from them in type of indumentum on stem, leaves and pedicels, bicolor flowers, number of flowers on main stem and descending pedicels and fruits (Table 1). Bicolor flowers is one of the most obvious diagnostic features of the new species that vary from yellow to purple and both colors can be found on one individual (Fig. 1.). As found through the field observations, the flowers are uniformly yellow when just opened, but then gradually becoming purple except for the distal part of blade which stays yellow almost till petal withering.

**Etymology:** *Erysimum hezarense* is named after the Hezar mts., where its *locus classicus* is situated.

**TABLE 1.** Morphological comparison of *Erysimum hezarense* and its close relatives. The characters are based on studies of the two known populations of *E. hezarense* (54 individuals), 53 population of *E. subulatum*, 23 populations of *E. laxiflorum* and five populations of *E. iraqense*.

<table>
<thead>
<tr>
<th>Character</th>
<th>E. laxiflorum</th>
<th>E. subulatum</th>
<th>E. hezarense</th>
<th>E. iraqense</th>
</tr>
</thead>
<tbody>
<tr>
<td>Habit</td>
<td>biennial</td>
<td>biennial</td>
<td>biennial, rarely annual</td>
<td>biennial</td>
</tr>
<tr>
<td>Stem trichomes</td>
<td>2–((3))-rayed</td>
<td>2–((3))-rayed</td>
<td>2–((3))-rayed</td>
<td>2–((3))-rayed</td>
</tr>
<tr>
<td>Leaf trichomes</td>
<td>2–(3)-rayed</td>
<td>2–(3)-rayed</td>
<td>2–3–(4–5)-rayed</td>
<td>2–(3)-rayed</td>
</tr>
<tr>
<td>Petal length</td>
<td>(6)–9(10) mm</td>
<td>(5)–8(9) mm</td>
<td>8–10(11.5) mm</td>
<td>9–11 mm</td>
</tr>
<tr>
<td>Petal color</td>
<td>yellow</td>
<td>yellow</td>
<td>yellow to purple</td>
<td>yellow</td>
</tr>
<tr>
<td>Petal trichomes</td>
<td>absent</td>
<td>absent</td>
<td>absent or few 2–3–4-rayed</td>
<td>absent</td>
</tr>
<tr>
<td>No. of flowers on main raceme</td>
<td>&lt;15</td>
<td>20–35</td>
<td>(15)25–35</td>
<td>15–25</td>
</tr>
<tr>
<td>Pedicel length</td>
<td>1.5–3 mm</td>
<td>(1.5)2–4(7) mm</td>
<td>(2.5)3–6(8) mm</td>
<td>(2.5)3–4(5) mm</td>
</tr>
<tr>
<td>Pedicel trichomes</td>
<td>2–(3)-rayed</td>
<td>2–((3))-rayed</td>
<td>2–3–(4–5)-rayed</td>
<td>2–(3)-rayed</td>
</tr>
<tr>
<td>Fruit length</td>
<td>(25)30–40(50) mm</td>
<td>(25)25–45 mm</td>
<td>(25)50–60(80) mm</td>
<td>(25)35–45(55) mm</td>
</tr>
<tr>
<td>Fruit width</td>
<td>ca. 0.5 mm</td>
<td>ca. 0.5 mm</td>
<td>0.5–1 mm</td>
<td>1–2 mm</td>
</tr>
<tr>
<td>Fruit trichomes</td>
<td>2–(3)–((4–5))</td>
<td>(2(3)–3–4–5–(6))</td>
<td>(2–3)–3–4–5–((6–7))</td>
<td>(2–3)–4–5(6)</td>
</tr>
<tr>
<td>Fruit orientation</td>
<td>ascending to horizontal</td>
<td>ascending to horizontal</td>
<td>horizontal to reflexed</td>
<td>horizontal</td>
</tr>
<tr>
<td>Style length</td>
<td>± 1 mm</td>
<td>1–1.5(2) mm</td>
<td>1–2 mm</td>
<td>0 mm</td>
</tr>
<tr>
<td>Distribution in Iran</td>
<td>S</td>
<td>S, W, N</td>
<td>S</td>
<td>W</td>
</tr>
</tbody>
</table>

**Distribution and habitat**

*Erysimum hezarense* is a local endemic to Hezar (Hezar-Lalezar) mountain range (Fig. 1D) where it grows in open habitats at high (2700–3700 m a.s.l.) elevations. Hezar-Lalezar is situated in Kerman province in the south east of Iran. It is rather isolated mountain range representing a center of local endemism. Recently intensified floristic studies of Hezar mts. have resulted in discovery of a number of new species such as *Astragalus hezarensis* Zarre & Podlech (in Podlech et al. 2001: 186), *Ferula hezarlalehzarica* Y. Ajani (in Ajani & Ajani 2008: 428), *Senecio subnivalis* Y. Ajani, J. Noroozi & B. Nord. (in Noroozi et al. 2010: 47), *Lactuca hazaranensis* Djavadi & N. Kilian (in Kilian et al. 2012: 68) endemic to this area.

**IUCN Red List category**

The new species is only known from two localities, one situated near the Sarcheshmeh copper mine (Assadi & Bazgosha 56420) and therefore is highly destructed. The next (type locality) is very close to Bab-Zangi village. Both
populations contain dozens of individuals (ca. 40). Therefore, the risk of local extinction in both cases is rather high. For these reasons, *E. hezarense* is here assessed as vulnerable (VU) according to IUCN Red List criteria (IUCN 2013).

2. *Rhammatophyllum*


**Distribution**: Iran and Turkmenistan (endemic to Kopet-Dagh). Plants subshrubs. Trichomes on stems, leaves, pedicels, sepals, and fruits softly malpighiaceous or submalpighiaceous, with two (rarely three) equal or unequal, unbranched or rarely branched principal rays, usually crisped and predominantly bearing a few lateral minute branches; simple on petals. **Stems** erect to ascending, (20)30–45 cm tall, usually several at base, branched below (annual shoots unbranched) and slightly swollen at nodes. **Basal leaves** fasciculate, spatulate, 5–15 × 1–2(3) mm, round at apex, attenuate at base. **Cauline leaves** sessile or shortly petiolate, linear to oblanceolate, entire, often longitudinally plicate, 10–35 × 1–2 mm. **Racemes** 6–16-flowered, ebracteate, ebracteate, corymbose, considerably elongated in fruit. Fruiting pedicels straight, slender, divaricate-ascending to suberect, (4)5–8(10) mm. **Sepals** oblong, membranous at margin, 3–4 mm long. **Petals** creamy white, becoming yellow when drying, 5–8 × 2–3 mm, pubescent outside. Stamens 6, tetradynamous; filaments not dilated or slightly flattened at base; anthers oblong, apiculate at apex. **Fruits** dehiscent siliques 25–50 × 1.5–2 mm, linear, latiseptate, sessile or shortly stipitate, suberect, straight or slightly flexuous, shallowly constricted between seeds; valves torulose, with a narrow midvein; style obsolete or distinct, up to 2 mm long; stigma capitulate, 2-lobed. Seeds winged at top, oblong, strongly flattened; seed coat not mucilaginous when wetted; cotyledons accumbent.

**Specimen examined**: IRAN. Khorasan, S Kalat-e Naderi, between Baghkand and Ortekand. 1900 m, 10 July 2002, *Joharchi 34207* (FUMH!)

**Key characters and delimitation of Rhammatophyllum**

*Rhammatophyllum gaudanense* is a member of Irano-Turanian genus *Rhammatophyllum* O.E. Schulz [syn. *Mitophyllum* O.E. Schulz (1933a: 872), *Prionotrichon* Botschantzev & Vvedensky (1948: 8), *Koeiea* Rechinger (1954: 60)] distributed from Turkmenistan and W Kazakhstan through Dzungaria to W Mongolia (Mongolian Altai) (Botschantzev 1987, Al-Shehbaz & Appel 2002, Kamelin 2002, German et al. 2006). The key morphological characters of the genus are woody (subshrubby or rarely shrubby) habitat; simple annual shoots; indumentum of soft and often crisped, predominantly subappressed submalpighiaceous (short-stalked or sessile 2-fid with long pectinate principal rays, i. e. bearing minute lateral branches), rarely malpighiaceous (with simple rays) or subdendritic trichomes; narrow entire leaves; fruits readily dehiscent angustiseptate siliques with torulose valves and usually winged or margined, uniseriate seeds (Al-Shehbaz & Appel 2002, Kamelin 2002). This set of characters perfectly separates *Rhammatophyllum* from any other genus of Cruciferae of Iran or *Flora Iranica* area. Detailed morphological description of the genus as currently circumscribed is given in Al-Shehbaz & Appel (2002), Kamelin (2002), and Appel & Al-Shehbaz (2003). The species currently assigned to *Rhammatophyllum* were treated in *Flora Iranica* as member of two unrelated genera – *Erysimum* (E. gaudanense, Polatschek & Rechinger 1968) and *Koeiea* [K. *afghanica* Rechinger (1954: 60), K. *flexuosa* Rechinger (1964: 426), and K. *ghorana* Rechinger (1964: 425), Rechinger 1968], a viewpoint not supported by both morphological (Botschantzev 1966, 1987, Al-Shehbaz & Appel 2002, Kamelin 2002) and molecular (Warwick et al. 2007) studies. Botschantzev yet in 1966 transferred both *Erysimum gaudanense* and *Koeiea afghanica* (a type of *Koeiea*) to *Prionotrichon*. Later Botschantzev (1987) did the same with another two Afghan *Koeiea* species, and subsequent authors (Al-Shehbaz & Appel 2002, Kamelin 2002) merged *Prionotrichon* with *Rhammatophyllum*. 
FIGURE 2. *Rhammatophyllum gaudanense*. Drawing prepared from *Jouharchi 34907* (FUMH). A: part of fruit, B: seed with wing, C: plant. Scale bar in A: 2 mm; B: 0.5 mm; C: 1 cm.
Distribution and habitat of \textit{R. gaudanense}

Since long time \textit{R. gaudanense} has been known only from the small area around its \textit{locus classicus} (Gaudan) in central Kopet-Dagh (Botschantzev 1966) unless Polatschek & Rechinger (1968) reported it from the single locality in Afghanistan. This information was accepted by some authors (Al-Shehbaz & Appel 2002, Podlech, 2012) while others apparently found it doubtful (Botschantzev 1987, Kamelin 2002). Thus, Botschantzev (1987) put distribution in Afghanistan under question mark while Kamelin (2002) did not take Afghan locality into consideration at all and reported the species (on the map) as endemic of central Kopet-Dagh in Turkmenistan. Similarly the species was treated in the Red Book of USSR (Rotov 1984). Unfortunately, we did not manage to locate the single Afghan specimen of \textit{“Erysimum gaudanense”} (\textit{“Katawaz, [H.] Neub[auer] 49/1387 [1950]}) reported by Polatschek & Rechinger (1968) which would be expected to be stored in W (neither as \textit{Erysimum} nor as either \textit{Rhammatophyllum}, \textit{Prionotrichon}, or \textit{Koeiea}). However, we believe that this report is wrong and there are several strong arguments supporting such a viewpoint. First, no other records of \textit{R. gaudanense} are known from Afghanistan. Second, the locality is situated in SE Afghanistan, more than 700 km apart from rather compact distribution area of the species and in completely different phytogeographic district. Third, all three Afghan species are distributed in central and eastern Afghanistan, one of them \textit{(R. flexuosum)} in the same province (Ghazni; Podlech 2012) from which \textit{R. gaudanense} was reported. All these arguments favor the suggestion that occurrence of \textit{R. gaudanense} in Afghanistan is based on misidentification, and current knowledge of the distribution of the species suggests that its finding in that country is very unlikely.

All representatives of the genus occur in dry open, rocky or clayey habitats; \textit{R. gaudanense} grows on stony and gravelly slopes, often in \textit{Artemisia} Linnaeus (1753: 845) or xerophytic grasses dominated communities in lower, middle and sometimes upper belt (1200–2000 m a.s.l.) of Kopet-Dagh (Botschantzev 1966, Nabiev 1974, Rotov 1984, Nikitin & Geldikhanoval 1988). As soon as it was described and hitherto known from S Turkmenistan adjacent to Iran, its presence in NE Iran is not surprising. However, the new locality is remote from all others and it extends the distribution area of the species to some 180 km south-eastwards. Nevertheless, it is situated on the same range and in a similar phytogeographic environment, and \textit{R. gaudanense} remains to be known as endemic to Kopet-Dagh (Fig. 1D). Most likely, its distribution area is not so sharply disjunct and further findings between the new and previously known localities along Turkmenian/Iranian border can be expected.

Relationship of \textit{R. gaudanense} to geographically and morphologically close taxa

Despite being morphologically close to Afghan taxa, \textit{R. gaudanense} readily differs from all of them. Most distinct \textit{R. afganicum} has wider fruits, (2.5)3–4.5 mm wide, seeds broadly winged all round, yellow petals and indumentum of predominantly subdendritic trichomes. The other two species have indumentum similar to \textit{R. gaudanense} but their pedicels are usually divericate and somewhat curved. Besides, in \textit{R. flexuosum}, the fruits are very gradually (vs. more or less abruptly) narrowed towards both ends and strongly stipitate (with gynophores 1–3 mm long) and in \textit{R. ghoranum}, the leaves are flat (not plicate) and the seeds are winged all round (Rechinger 1968, Botschantzev 1987, Al-Shehbaz & Appel 2002). Botschantzev (1966, 1987) also separated \textit{R. gaudanense} from other species by pubescent petals but Kamelin (2002) found that this is typical also for \textit{E. pseudoparrya} (Botschantzev & Vvedensky 1948; 8) Al-Shehbaz & O. Appel (2002: 3) (Kyrgyzstan and Tajikistan) and this character is to be checked in Afghan taxa. Finally, distribution of \textit{R. gaudanense} is rather distinct.

A note on tribal placement and the number of species of \textit{Rhammatophyllum}

Unlike in previous, exclusively morphologically based treatments where species of \textit{Rhammatophyllum} were assigned by different authors to various tribes (e. g., to Alysseea by Rechinger, 1954; Arabideae by Botschantzev, 1966, 1987; Hesperideae by Polatschek & Rechinger, 1968; Matthioleae by Rechinger, 1968), nowadays the genus belongs to Euclidieae (Al-Shehbaz, 2012) and this position is firmly established by relevant molecular works (e. g., Warwick et al. 2007, German et al. 2009). Contrary, the number of species in the genus is not yet fixed. Al-Shehbaz & Appel (2002) and Appel & Al-Shehbaz (2003) reported nine species though more recently, Al-Shehbaz (2012) reduced the number to eight based on the synonymization of \textit{R. frutex} Botschantzev & Vvedensky in Botschantzev (1952: 9) with \textit{R. pachyrhizum} (Karelin & Kirilov 1842: 144) O.E. Schulz (1933b: 190) proposed by Kamelin (2002). This number might be further changed: as reported by German (2007), with more material becoming available for \textit{R. ersismoides} (Karelin & Kirilov 1842: 145) Al-Shehbaz & O. Appel (2002: 3) and \textit{R. kamelinii} (Botschantzev 1987: 98) Al-Shehbaz & O. Appel, (2002: 3) both geographical and morphological differences between them (being from the very beginning exclusively quantitative) became so negligible that the distinctness of the latter is now highly doubtful. Thus, it is likely that not more than seven species can be finally recognized in \textit{Rhammatophyllum}, majority of which (four) occur within \textit{Flora Iranica} area and one of them, \textit{R. gaudanense}, grows in Iran.
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