

A new spiny, cushion-like *Euphorbia* (Euphorbiaceae) from south-west Iran with special reference to the phytogeographic importance of local endemic species

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Euphorbia acanthodes Akhani is described as a new gypsophilous species from south-west Iran. The affinity, morphological and carpological features, and habitat of the species are discussed. A list of a further 36 interesting endemic species of south-western Iran and adjacent areas is given with notes on their affinities and distribution. These include *Centaurea gudrunensis* Boiss. & Hausskn., as a new record from Iran. The specific status of *Pteropyrum naufelum* Al-Khayat is confirmed and it is suggested that *P. noëanum* Boiss. ex Meisn. is synonymous with *P. aucheri* Boiss. The biogeographic importance of the so-called ‘Persian foothills’, and biodiversity conservation status of the area are discussed, together with distribution maps of 12 species. It is concluded that the majority of the endemic species in the southern and south-western parts of Iran are Irano–Turanian or have their origins in the Irano–Turanian region. Therefore, it is questionable to consider the area as part of either the Saharo–Sindian, Sudanian or Sudano–Zambeian regions. © 2004 The Linnean Society of London, *Botanical Journal of the Linnean Society*, 2004, 146, 107–121.

ADDITIONAL KEYWORDS: biodiversity – *Centaurea* – conservation – gypsophilous flora – Irano–Turanian – *Pteropyrum* – Saharo–Sindian.

INTRODUCTION

The low-altitude rocky slopes of south-western Iran in the Ilam, Lorestan and Khuzestan provinces (western foothills of Zagros mountains) are composed mostly of gypsum and calcareous hills with limestone and conglomerate rocks which connect the Khuzestan plain to the Zagros oak forest (*Quercus brantii*) (Fig. 1). Large parts of the area were occupied by military troops during the Iran–Iraq war. As a result the area has been poorly investigated botanically in comparison with many other parts of Iran. However, the area has been visited by several collectors in the past, e.g. H. C. Haussknecht from 1865 to 1868 (Haussknecht, 1868), F. Nábělek in 1910 (Nábělek, 1923, 1925, 1926, 1929), M. F. Köie in the 1940s and 50s (Köie, 1945; Köie & Rechinger, 1954–55), Jacobs in 1964 and E. Behboudi. Recent visits to the area by

the author, just at the beginning of the cease-fire on 3–7.viii.1989, and subsequently during May 1992, October 1993 and March 2001, have provided further botanical collections. During the last excursion to the area, an interesting *Euphorbia* was discovered on gypsum hills between Mehran and Dehloran, which is described here. Furthermore, a number of interesting endemic genera and species with similar range and habitat were encountered. The distribution maps of 12 species are provided using the computer programme DMAP (Morton, 2001). The original material of collections made during 1989 and 1992 are held in MMTT (Natural History Museum of Iran), mostly duplicated in the private herbarium of H. Akhani. Those of 1993 and 2001 are held in the Laboratory of Plant Systematics and Plant Geography of the Biological Department of Tehran University. Some duplicates of the earlier collections are gifted to the Botanische Staatssammlung München (M) and the holotype and isotype of new species to IRAN and BM.

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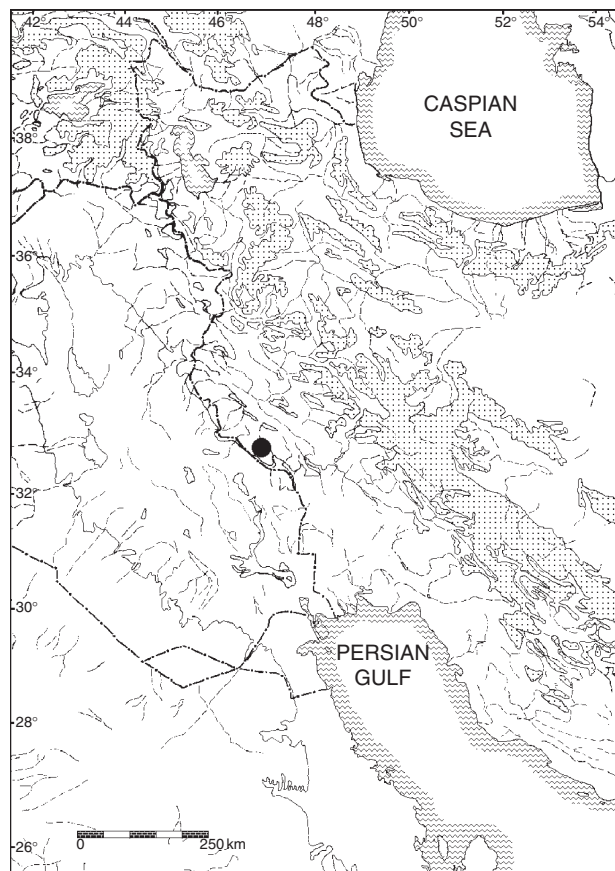


Figure 1. Map of western Iran showing the location where plants of *Euphorbia acanthodes* sp. nov. were collected.

DESCRIPTION

EUPHORBIA ACANTHODES AKHANI SP. NOV.

(FIGS 2–5, SEEDS; FIGS 6–7, HABIT).

Type: South-west Iran: Ilam: 34 km from Dehloran on the road towards Mehran, gypsum hills dominated by *Pteropyrum naufelum*, 32°17'9"N, 47°00'57"E, 395 m, 31.iii.2001. H.Akhani 14782. (Holotype: IRAN; Isotype: BM, Hb. Akhani, Hb. Zehzad.)

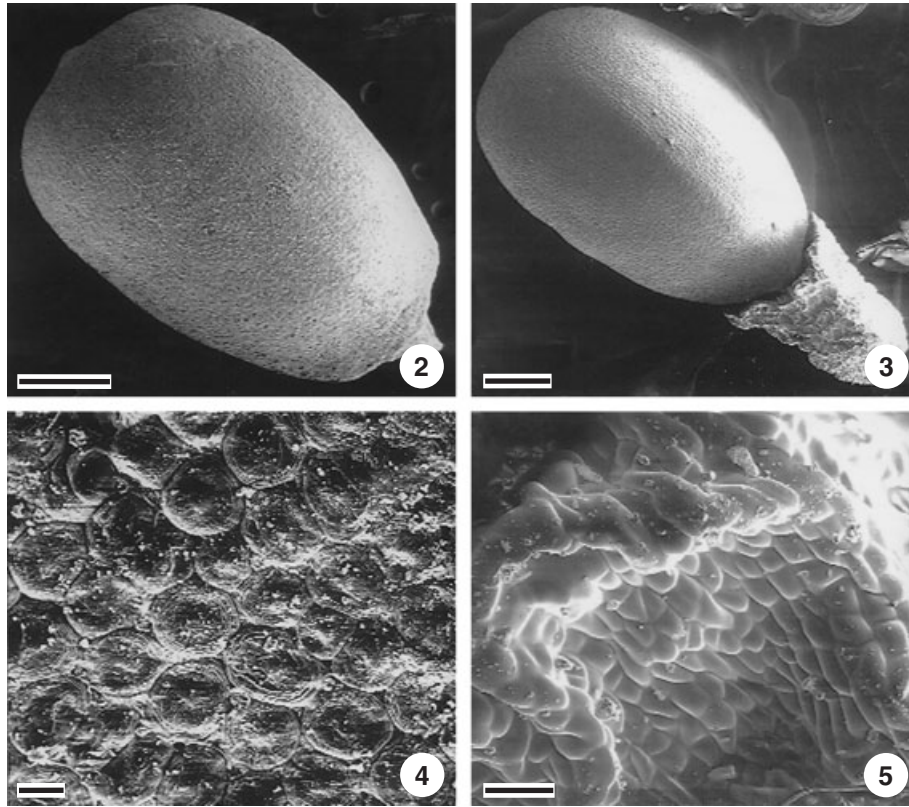
Diagnosis: Planta suffrutescens, humilis, pulvinata, spinosa, glaberrima, dumos usque ad 15 cm altos et 20 cm diametro formans, densissime intricato-ramosissima, foliis oblanceolatis glauco-viridibus; ramulos rigidos demum spiniformes preferens.

Description: Small suffruticose pulvinate plant, spiny, glaucous, glabrous, up to 15 cm tall, 20 cm diameter, strongly and intricately branched from the base, branching rigid and become spiny with old, last year's

branches remaining on the plant, new branches arising from the middle of last years branches; young branches and young leaves pubescent. LEAVES cauline, alternate, oblanceolate, entire, pubescent at the margin and on the lower surface (on high magnification), 6–9 mm long, 2–3 mm broad, usually obtuse at the apex, but sometimes subacute and emarginate; leaves of the pseudoumbels obovate, slightly broader than the cauline leaves, up to 3.5 mm broad; leaves with a prominent midrib and two obscure lateral veins on the lower surface. INFLORESCENCE with cymes in 2(–3)-rayed pseudo-umbels; rays rigid (5–)10–12 mm long, sometimes bifurcate with sessile cyathia. Cyathium ± sessile, 2–3 mm long, yellowish, lobed, with ovate and at margin finely fimbriate lobes; glands 4, brown, shallowly crescentic, 1.5–2.1 mm across. STAMENS c. 18 per cyathium, 2–3 mm long, included or slightly exerted, at base densely associated with hair-like bracteoles; anther thecae globose, 0.52–0.55 mm diameter. STYLES, 1.4 mm long, stigmas bifid. Capsule with a pedicle up to 8 mm long, ovoid, 5 mm long, 3 mm broad, smooth on surface. SEEDS ovoid, 2.5–3 mm long, 1.5–1.7 mm broad, smooth at normal magnification, but colliculate at high magnification, with a prominent caruncle c. 1.2 mm long.

Affinities: The new species seems to be isolated without close affinity with other Iranian species except possibly the widespread Iranian *Euphorbia heteradena* Jaub. & Spach, Ill. Pl. Or. 2: t. 131 (1845) of sect. *Chylogala*. However, the habit of the new species, the form of its cyathial lobes and size of its caruncle are completely different from that herbaceous species. The habit of *E. acanthodes* sp. nov. is superficially similar to *E. acanthothamnos* Heldr. & Sart. of the sect. *Helioscopia*, which occurs along the east Mediterranean coasts. *Euphorbia acanthodes* differs from this in several characters: *E. acanthothamnos* is ditrichotomously branched from the base to inflorescence, but only the inflorescence of *E. acanthodes* is 2- or 3-forked; the capsules of *E. acanthothamnos* are rounded with verrucose surface, whereas those of *E. acanthodes* are ovoid and smooth; the cyathia of *E. acanthothamnos* are stipitate but those of *E. acanthodes* are sessile.

Euphorbia gypsicola Rech. f. & Aell. [Anz. Math.-naturw. Kl. Österr. Akad. Wiss. 1951: 218 (1951)] is another narrowly endemic gypsophilous *Euphorbia* of Iran. This was described from gypsum hills located in the north-central parts of Iran, in Semnan province: In deserto gyps. Ad Sorkheh 15.iv.1948, Rechinger 2791 (W!). This species is completely different from *E. acanthodes* in its nonspinose branches and densely hairy indumentum.



Figures 2–5. SEM images of the seed surface of *Euphorbia acanthodes* sp. nov.: Fig. 2. Seed, scale bar = 500 μm; Fig. 3. Seed with caruncle, scale bar = 500 μm; Fig. 4. Seed surface, scale bar = 20 μm; Fig. 5. Caruncle surface, scale bar = 50 μm.

Ecology: *Euphorbia acanthodes* was found on top of a small gypsum hill as a very rare plant. In spite of intensive search, only two plants were found, in association with *Onobrychis gypsicola*, *Helianthemum lippii*, *Anthemis* sp. and *Stipa capensis*. The vegetation of the gypsum hills of the area is composed of the recently described endemic shrub *Pteropryum naufelum* Al-Khayat (see below). Table 1 presents the species composition and their cover-abundance according to three phytosociological relevés, following the Braun-Blanquet (1964) method of phytosociology.

Endangered status: In spite of intensive search, only two specimens of this curious species were found in the study area. Many grazing herds occupied the area, so unless the present nature management is changed, severe damage of the habitat of *E. acanthodes* is expected, even though its thorny and poisonous defences may help prevent it being grazed. With no further data, a 'strictly endangered' status for the species is suggested according to the threatened categories of IUCN (1994).

ENUMERATION OF INTERESTING ENDEMIC SPECIES FROM SOUTH-WEST IRAN

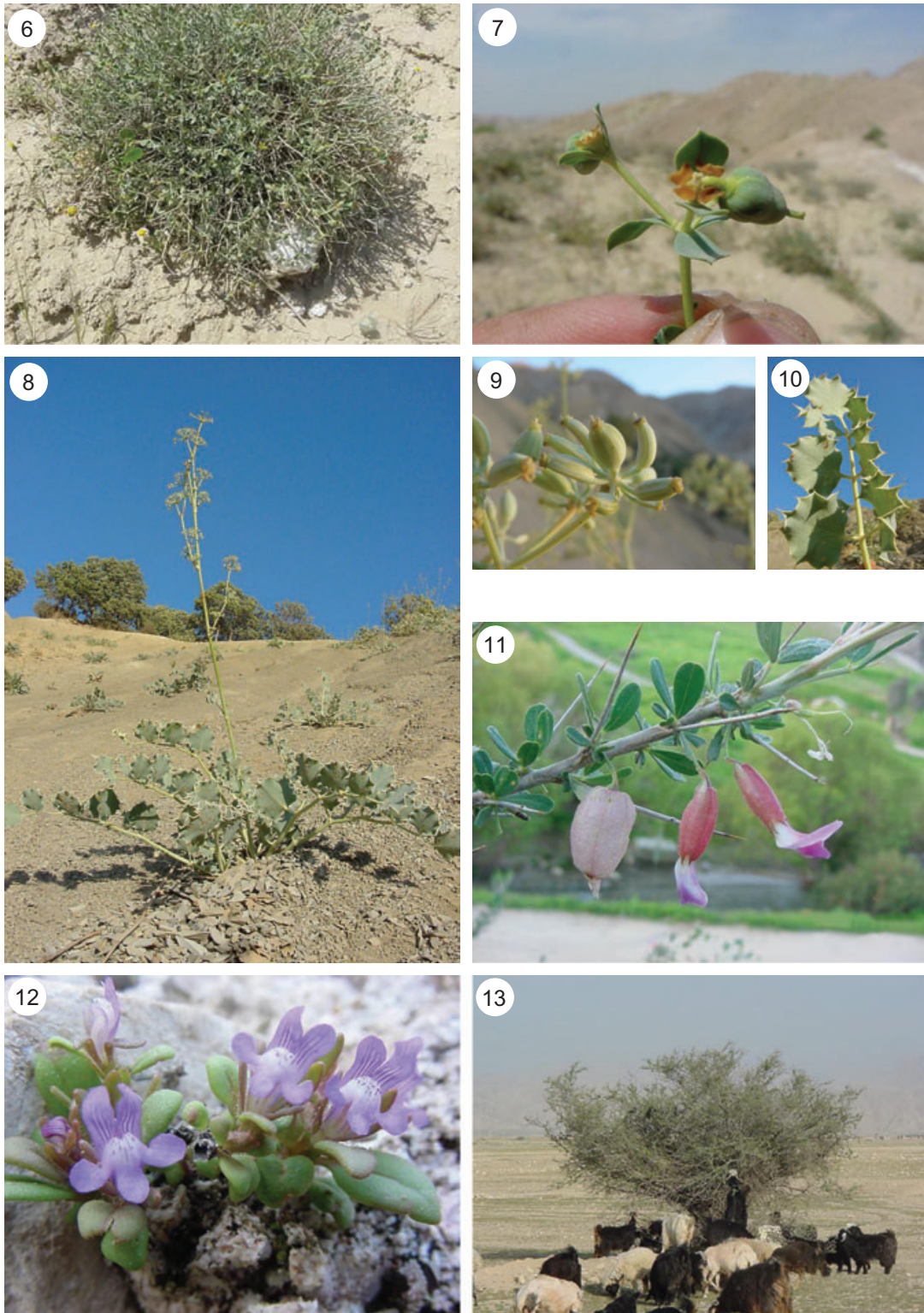
The following list is mainly based on personal collections and field studies in the area. The list has been expanded and annotated by additional information gained from pertinent literature particularly from Flora Iranica (Rechinger, 1963–2001). It is necessary to mention that the list includes those species that are either typical or peculiar because of their phytogeographical interest. There are several other species whose ranges fall into the concerned area.

ALLIACEAE

Allium olivieri Boiss., Fl. Or. 5: 284 (1882).

Ilam: 16 km south of Zarrinabad (Pahaleh) towards Mehran–Dehloran road, Anaran Mts. 800 m, 3.v.1992, H.Akhani 8424 (det: F. Khassanov).

A species endemic to south-west Iran and adjacent areas in Iraq and Syria (Fig. 14). In Flora Iranica (Wendelbo, 1971: 78) only two localities are given from Iran.



Figures 6–13. Photographs of several selected plant species from south-west Iran. Figs 6 and 7, habit and close-up of cyathium of *Euphorbia acanthodes* sp. nov. Figs 8–10. *Azilia eryngioides*: Fig. 8, habit and habitat; Fig. 9, fruiting umbellules; Fig. 10, basal leaf. Fig. 11, *Astragalus baba-alliar*. Fig. 12, *Albraunia fugax*. Fig. 13, example of overgrazing in south-west Iran, near Dehloran. Note that the ground vegetation is completely absent and goats are trying to eat the leaves of extremely thorny *Zizyphus nummularia* shrubs.

Table 1. Species composition of the *Pteropyrum naufelum* community (habitat of *Euphorbia acanthodes* sp. nov.) based on three phytosociological relevés from gypsum hills located 34 km from Dehloran towards Mehran, 31.iii.2001: surface area: 25 m² (5 × 5 m). The symbols indicate cover-abundance of each species in each plot according to the method of Braun-Blanquet (1964), where 1 = < 5% [or over 50 small plant or 1–5 large plants], + = < 1% [1–5 small plants], r = < 1% [1, little plant] and – = absence of species

| Relevé number | 1 | 2 | 3 |
|---|-----------|------------|------------|
| Coordinates: 32°47'N, 47°00'E | 9°N, 57°E | 12°N, 56°E | 16°N, 54°E |
| Sample area (m ²) | 25 | 25 | 25 |
| Inclination (°) | 25 | 45 | 10 |
| Altitude (m) | 393 | 420 | 420 |
| Aspect | WSW | W | SE |
| Total cover (%) | 5 | <5 | 5 |
| Vegetation height (cm) | 25 | 20 | 30 |
| Characteristic gypsophilous plants | | | |
| <i>Pteropyrum naufelum</i> Al-Khayat | 1 | 1 | 1 |
| <i>Gypsophila linearifolia</i> (Fisch. & C. A. Mey.) Boiss. | 1 | 1 | 1 |
| <i>Diplotaxis harra</i> (Forssk.) Boiss. | + | 1 | 1 |
| <i>Albraunia fugax</i> (Boiss. & Noë) Speta | + | + | 1 |
| <i>Crepis aspera</i> L. | – | 1 | 1 |
| <i>Onobrychis gypsicola</i> Rech. f. | – | r | 1 |
| <i>Scabiosa leucactis</i> Patzak | – | + | + |
| <i>Cleome glaucescens</i> DC. | 1 | + | – |
| <i>Convolvulus gonocladus</i> Boiss. | + | – | – |
| <i>Verbascum</i> sp. | 1 | – | – |
| Widespread species also occurring in other habitats | | | |
| <i>Galium setaceum</i> L. | 1 | 1 | 1 |
| <i>Stipa capensis</i> Thunb. | 1 | 1 | 1 |
| <i>Senecio glaucus</i> L. | + | 1 | 1 |
| <i>Plantago ovata</i> Forssk. | + | r | + |
| <i>Callipeltis</i> cf. <i>microstegia</i> Boiss. | 1 | 1 | – |
| <i>Gagea</i> sp. | r | + | – |
| <i>Reichardia orientalis</i> (L.) Hochr. | + | r | – |
| <i>Koelipinia chrysoglochis</i> Rech. f. | – | + | + |
| <i>Pimpinella</i> cf. <i>puberula</i> (DC.) Boiss. | – | + | 1 |
| <i>Bromus tectorum</i> L. | – | + | 1 |
| <i>Erodium glaucophyllum</i> (L.) Aiton | – | 1 | + |
| <i>Erodium cicutarium</i> (L.) L'Hér. ex Aiton | – | r | + |
| <i>Anthemis</i> sp. | – | + | r |
| <i>Taeniatherum caput-medusae</i> (L.) Nevski | – | r | + |
| <i>Filago pyramidata</i> L. | + | – | + |
| <i>Lasiopogon muscoides</i> (Desf.) DC. | + | – | 1 |
| <i>Poa bulbosa</i> L. | – | – | r |
| <i>Anagallis arvensis</i> L. | – | – | + |
| <i>Lysimachia linum-stellatum</i> L. | – | – | r |
| <i>Urospermum picroides</i> (L.) F. W. Schmidt | – | – | 1 |
| <i>Medicago laciniata</i> (L.) Mill. | – | – | + |

APIACEAE

Azilia eryngioides (Pau) Hedge & Lamond in Flora Iranica 162: 386 (1987).

Lorestan: c. 110 km west-south-west of Aligudarz, 13 km east of Shulabad towards Sefiddasht, 33°12'29"N, 49°6'37"E, 1990 m, on steep, scree/shale slopes, 20.viii.2001, H.Akhani & M.Salimian 15514.

A most distinct genus on account of its habitat on scree shale steep slopes and spiny pinnate leaves (Figs 8, 9, 10). The colour of its flowers, which was not known in the original description, is greenish yellow. According to field observations the species grows as rather pure stands on the steep scree and rocky valleys surrounded by *Quercus brantii* forests. It is an aromatic plant and apparently palatable for domestic

animals, as the severely grazed stands show. As stated by Hedge & Lamond (1987) the species is very isolated and unlike anything else in south-west Asian Umbelliferae, and gives the impression of being an ancient relict surviving in a few specialized niches in western Iran (Fig. 15). It is highly interesting that the species looks very different from the genus *Prangos*, in which it was first described. But more interesting still are the results of recent molecular studies based on nrDNA ITS sequences (Valiejo-Roman *et al.*, 2002), which show that *Azilia* and *Prangos* are indeed very close! Very recently Mozaffarian (2003) described a new monotypic genus *Opsicarpium insignis* Mozaff. from western Iran that seems to be very close to *Azilia*.

Ergocarpon cryptanthum (Rech. f.) C. C. Towns., Kew Bulletin 17: 438 (1964).

Ilam: c. 7 km north-east of Dehloran, in valley of Ghare-Khoffash, 250–350 m, 5.v.1992, H.Akhani 8513.

An isolated monotypic genus restricted in distribution to south-west Iran and adjacent areas in Iraq (Fig. 16). See Bornmüller (1941), Hedge & Lamond (1987) and Townsend (1964) for further localities and notes on the morphological distinction and taxonomic isolation of the species.

Ferula behboudiana (Rech. f. & Esfand.) D.F.Chamb., Flora Iranica 162: 395 (1987).

Type: Ilam: Konjancham, Behboudi 19 (Holo: W!).

Ilam: 10 km south-west of Zarrinabad towards Fasil (Mehran–Dehloran road), Anaran Mountain, c. 1050 m, 4.v.1992, H.Akhani 8465; 34 km from Ilam towards Salehabad, near Banroushan village, 700–800 m, 1.v.1992, H.Akhani 8250; c. 25 km south of Salehabad, 5–6 km after Konjancham towards Shoor-Shirin, gypsum hills, along Iran/Iraq frontier, 350–400 m, 1.v.1992, H.Akhani 8168.

The species was known in Flora Iranica (Chamberlain & Rechinger, 1987: 396) only from the type locality. The cited localities are also near the type locality. The habitat of this species is on calcareous rocks in open scrub of *Quercus brantii*.

Hausknechtia elymaitica Boiss. Fl. Or. 2: 960 (1872).

Type: In declivibus montis Bors ad fluvium Chyrstan, Hausknecht, August 1868. (Holotype: G-Boiss., hoc loco designatus, Isolectotype: M!)

Fars: 8 km north of Garekan along the road between Norrabad and Ardakan, 16.viii.2002, Y.Ajani (s.n).

Kohkiluyeh va Boyerahmad: Yassuj, around Abshar camping, 800 m, 17.vi.2002, Y.Ajani (s.n).

A remarkable isolated species known from some localities in Fars, Ilam, Khuzestan, Chaharmahal-e Bakhtiari, Kohgiluyeh va Boiarahmad and Lorestan Provinces (Rechinger, 1987: 385; Mozaffarian, 1994).

Oliveria decumbens Vent., Descr. Pl. Jard. Cels.: tab. 21 (1801).

Ilam: c. 23 km west-north-west of Dehloran, 8 km along the road between Meymeh and Barzieh, c. 200 m, in open *Zizyphus nummularia* comm. 5.viii.1989, H.Akhani 5503.

A highly aromatic annual plant that flowers during the hot summer months. Its strong smell is a guide for finding it easily in the field. It has a typical 'Persian foothills' range from southern Iran to northern Iraq (Fig. 17).

Pycnocycla flabellifolia (Boiss.) Boiss., Diagn. Pl. Or. Nov Ser. 2, 2: 105 (1856).

Ilam: c. 40–45 km north-east of Mehran along the road towards Ilam, 800 m, 16.x.1993, H.Akhani 9012; 40–45 km from Dehloran towards Mehran, 17.x.1993, H.Akhani, 9056; c. 30 km south-east of Mehran along the road towards Dehloran, 450 m, 3.viii.1989, H.Akhani 5452.

A gypsophilous species with flabellate pinnae. The leaves of this species are very similar to the pinnae of *Azilia eryngioides*. The species is an endemic species confined to south-west Iran and adjacent parts of Iraq (Fig. 18).

ASTERACEAE

Achillea conferta DC. Prod. 6: 32 (1838).

The range of this species is from the lowlands of Khuzestan and Kermanshah Provinces in south-west and west Iran, extending into Iraq and Syria (Huber-Morath, 1986).

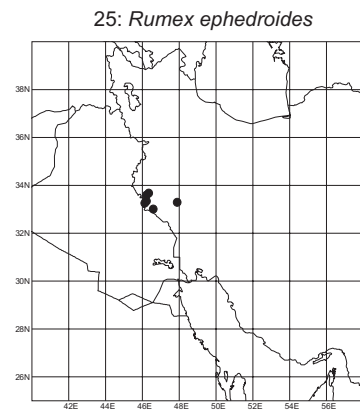
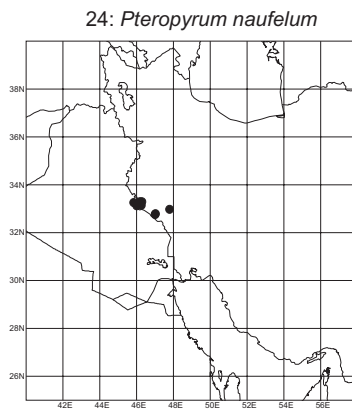
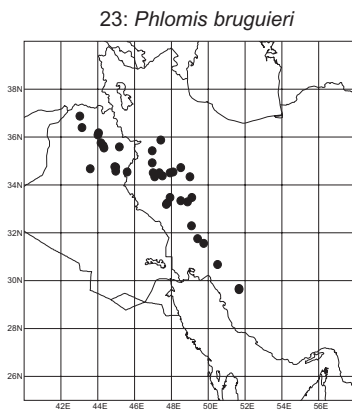
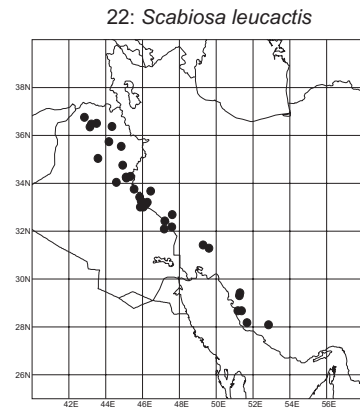
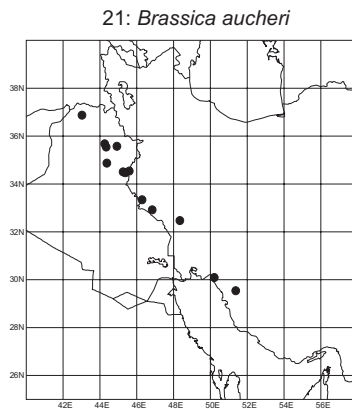
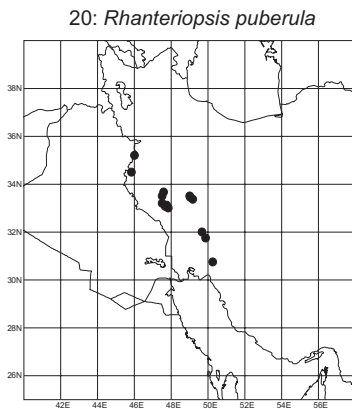
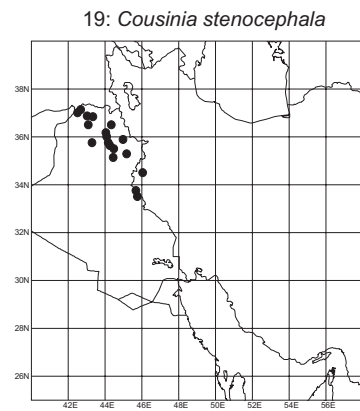
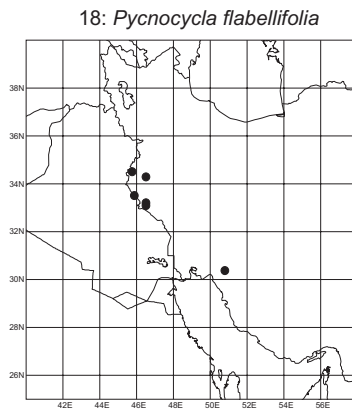
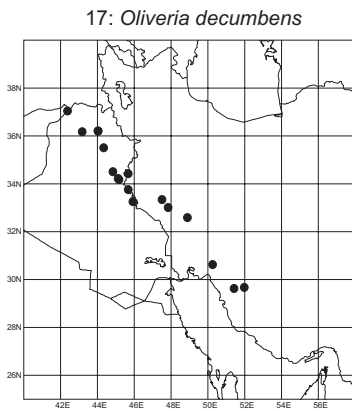
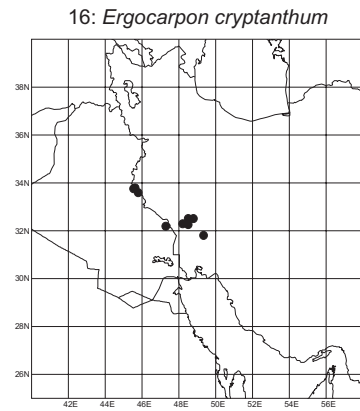
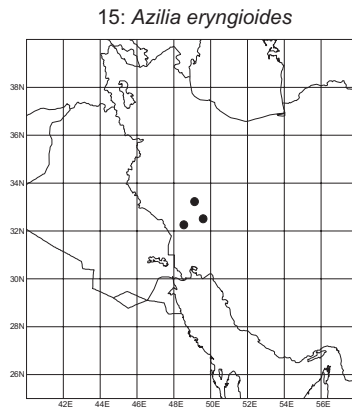
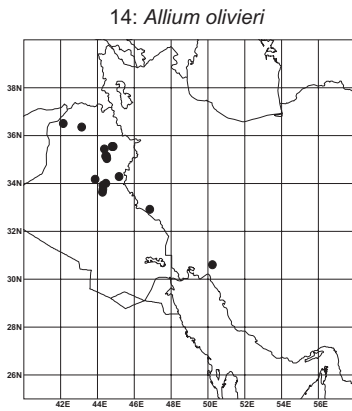
Centaurea gudrunensis Boiss. & Hausskn., in Boiss., Flora Orientalis 3: 673 (1875).

Type: Iraq: Pir Omar Gudrun, June 1867, Haussknecht, 585 (G-BOISS!).

Ilam: c. 23 km south-east of Dehloran, near Mousina, along the margin of the Deurej river, c. 100 m, 5.v.1992, H.Akhani 8553.

A new record for Iran. The species was reported only twice from the Iraqi side of the Iran–Iraq border by Wagenitz (1980).

Figures 14–25. Distribution maps of several selected endemic species along the 'Persian foothills' (south-west Iran and adjacent parts of Iraq).



Cousinia stenocephala Boiss., Diagn. Pl. Or. Nov. Ser. 1, 6: 115 (1845).

An endemic species known from a few localities in south-west Iran and several localities in adjacent areas in Iraq by Rechinger (1972: 168; Fig. 19), who considered it a characteristic species of the surrounding lowlands of the west Iranian highlands ('Persian foothills').

Rhanteriopsis puberula (Boiss. & Hausskn.) Rauschert in Taxon, 31(3): 558 (1982). (Syn: *Postia puberula* Boiss. & Hausskn.)

Ilam: 15 km east of Darreh Shahr, Eastern slopes of Kabirkuh, Darreh-e Ujandar (valley), open *Quercus brantii* forest, 33°4'20"N, 47°29'44"E, 710–830 m, 29.iii.2001, H.Akhani 14666.

A typical chasmophyte species of south-western Iran (Fig. 20) that dominates on some calcareous steep rocky slopes or associated with *Quercus brantii* stands.

The genus *Rhanteriopsis* was known in *Flora Iranica* (Rechinger, 1980) under *Postia* but replaced by Rauschert (1982), because of nomenclatural reasons. According to a recent monograph of the genus by Wilkund (1987), *Rhanteriopsis* consists of four species: the following and two other species in Lebanon and Syria: *Rh. languinosa* (DC.) Rauschert and *Rh. microcephala* (Boiss.) Rauschert.

Rhanteriopsis bombycina (Boiss. & Hausskn.) Rauschert, Taxon 31 (3): 558 (1982) (syn. *Postia bombycina* Boiss. & Hausskn.).

A local endemic restricted to south-west Iran that overlaps distribution with *Rh. puberula* (Rechinger, 1980; Wilkund, 1987: 33, fig. 3).

BORAGINACEAE

Heliotropium crassifolium Boiss. & Noë in Boiss., Diagn. pl. or. nov., 2. Ser., 3: 131. 1856

Ilam: c. 15 km north-east of Mehran, Konjanham river bed, c. 350 m, 3 & 7.viii.1989, H.Akhani 5442, 5592; c. 25–28 km north of Mehran along the Konjanham river margin and surrounding gypsum slopes, c. 300 m, 16.x.1993, H.Akhani 9026; c. 45 km from Mehran towards Dehloran, Changooleh river margin, c. 300 m, 16.x.1993, H.Akhani 9039.

This species grows along rivers and roads on gypsum or a calcareous substrate covered by gravel and sand. It is associated with *H. suaveolens*, *H. noeanum*, *Cornulaca monacantha*, *Rumex ephedroides*, *Amaranthus albus* and *Halimocnemis purpurea*. See Akhani & Förther (1994) for further details on the taxonomic characteristics and morphological peculiarities of this species.

Heliotropium denticulatum Boiss. & Hausskn. in Boiss., Fl. or. 4: 145. 1879.

Ilam: c. 40 km north-east of Mehran in ploughed land beside the road towards Ilam, 700 m, H.Akhani 5435 (MMTT); c. 40–45 km north-east of Mehran along the road towards Ilam, 800 m, 16.x.1993, H.Akhani 9014; c. 35 km north-east of Mehran at the road towards Ilam, 16.x.1993, H.Akhani 9018.

A perennial species with woody base. In its long intercalary corolla lobes, this isolated species resembles the endemic central and north-east Iranian annual *H. samoliflorum*. However, in other characters it seems to be more related to *H. brevilimbe* of south-eastern Iran and adjacent parts of Pakistan and UAE (Akhani & Förther, 1994).

Heliotropium kaserunense Bornm., Beih. Bot. Centralbl. 61 (2): 87 (1941).

Holotype: Steile felsige Hänge des Passes Kotal Mallu zwischen Kumaredsch und Konar-Takhteh der Marschroute Kaserun-Buschir, 500–700 m, 13.xii.1892, Bornmüller 3920 (B!).

A poorly known species related to *H. crassifolium*.

Mattiastrum luristanicum (Nábělek) Riedl in Flora Iranica 48: 111 (1967).

Ilam: c. 25 km south of Salehabad, 5–6 km after Konjanham towards Shoor-Shirin, gypsum hills along Iran/Iraq frontier, 350–400 m, 1.v.1992, H.Akhani 8186; c. 30 km south-east Abdanan towards Dehloran, 19 km to Murmuri, dry limestone or lime and gypsum hills, 32°49'32"N, 47°36'50"E, 875–940 m, 30.iii.2001, H.Akhani 14730.

This species has been reported in *Flora Iranica* only from the type locality (Riedl, 1967: 111): Posht-Kuh supra Dehloran Nábělek 593.

Onosma dasytrichum Boiss., Diagn. Pl. Or. Nov. Ser. 1, 7: 33 (1846).

Ilam: 19–20 km north-east-north of Zarrinabad (Pahaleh), 1000–1100 m, 4.v.1992, H.Akhani 8442; 34 km after Ilam towards Salehabad, near Banroushan village, 700–800 m, 1.v.1992, H.Akhani 8242; c. 25 km south of Salehabad, 5–6 km after Konjanham towards Shoor-Shirin, gypsum hills along Iran/Iraq frontier, 350–400 m, 1.v.1992, Akhani 8122.

This is a frequent species on rocky slopes dominated by *Quercus brantii*. The flowers are variously coloured from pinkish to red and yellow. According to Teppner (1980: 152 & 155), *Onosma dasytrichum* is distinguished from other species of the *O. albo-roseum* group by its broadly lanceolate leaves, appressed white star-like hairs, densely hairy lower parts of the calyx and its bushy habit. The identity of the above collections has been confirmed by comparison with the

isotype of the species: Prope Kaseroun, Kotschy 146 (M).

BRASSICACEAE

Brassica aucheri Boiss., Ann. Scienc. Nat. Ser. 2, 17: 88 (1842) (syn. *Sinapis aucheri* (Boiss.) O. E. Schulz). Ilam: c. 20 km after Salehabad towards Mehran, c. 450 m, 1.v.1992, H.Akhani 8117; 24 km south of Zarrinabad (Pahaleh) towards Fasil (Mehran-Dehloran road), Anaran Mountain, 500–600 m, 3.v.1992, H.Akhani 8402.

An endemic species of eastern Iraq and western Iran (Fig. 21). This species, which was treated by I. C. Hedge under *Sinapis* in Flora Iranica (Hedge & Rechinger, 1968), is retained in *Brassica* by Al-Shehbaz & Warwick (1997) and Akhani (2003).

CHENOPODIACEAE

Salsola lachnantha (Botsch.) Botsch., Nov. Syst. Pl. Vasc. 17: 124 (1980).

A species similar to the widespread polymorphic species *S. tomentosa* (Moq.) Spach. Its distribution is restricted to the lowlands of south-west Iran and some adjacent parts in Iraq and northernmost parts of Arabia (Freitag, 1997).

Another interesting species of Chenopodiaceae with a distribution in the south-western and southern parts of Iran is *Halimocnemis purpurea* Moq. (see Akhani, 1996).

CLUSIACEAE

Hypericum dogonbadanicum Assadi, Iranian J. Bot., 2(2): 89 (1984).

Kohkiloyed va Boyerahmad: 20 km from Gatchsaran to Dehdasht, 20.vi.2000, 1100 m, S. Mehregan (s.n). Known from a few localities around the type locality from Dogonbadan in north Khuzestan. The species has its nearest affinity with the Socotran plant *H. socotranum* ssp. *smithii* of the sect. *Campylospor* (Robson, 1987).

CONVOLVULACEAE

Convolvulus gonocladus Boiss. Diag. Pl. Or. Nov. 1 (7): 22 (1846).

Ilam: 47 km from Dehloran towards Mehran, gypsum hills, 350 m, 4.v.1992, Akhani 8490.

An endemic species described from Fars: Dalaki, Kotschy 207 (Sa'ad, 1967).

DIPSACACEAE

Scabiosa leucactis Patzak, Ann. Nat. Mus. Wien 65: 23 (1962).

Ilam: c. 12 km north-east of Mehran towards Ilam, hills around the road, 320 m, 3.v.1992, H.Akhani 8369; c. 42 km east Dehloran in the road towards Abdanan, 11 km from Murmuri towards Dehloran, gypsum hills, 32°41'27"N, 47°35'31"E, 551 m, 30.iii.2001, H.Akhani 14745.

A characteristic species distinguished from its close relative *S. calocephala* Boiss. by its white flowers and distinctly radiate marginal flowers. Rechinger (in Rechinger & Lack, 1991) compared the range of this species with *Phlomis bruguieri* and *Cousinia stenocephala* (Fig. 22).

EUPHORBIACEAE

Euphorbia craspedia Boiss. Diagn. Ser. 1, 7: 95 (1846).

Ilam: c. 10 km west-south-west of Darrehshahr towards Abdanan, Kabirkuh, *Quercus brantii* forest and associated grassland, 33°5'45"N, 47°19'53E, 1170 m, 30.iii.2001, H.Akhani 14692.

An endemic species in south-west Iran, Iraqi Kurdistan and south-east Turkey.

FABACEAE

Astragalus akhanii Podlech, Sendtnera 6: 142 (1999). Ilam: 18 km south-west of Salehabad, 17 km after Konjancham towards Shoor-Shirin, gypsum hills along Iran/Iraq frontier, 500–550 m, 1.v.1992, H.Akhani 8207. (Holo: MSB; Iso: Hb. Akh.)

As stated by Podlech (1999a: 143), the species is related to another gypsophilous species *A. gypsicola* Maassoumi in Iran. J. Bot. 6: 202 (1994) described from gypsum hills in Khuzestan: c. 25–30 km from Masjed Soleyman to Andica, against Karoon river, 500 m, 20.iv.1990, V.Mozaffarian 70190. The recent statement by Maassoumi (2003) considering *A. akhani* as a synonym of *A. fortuitus* Maassoumi needs to be checked by comparing the types.

Astragalus baba-alliar Parsa, Kew Bulletin 1948: 192 (1948).

Ilam: c. 25 km south of Salehabad, 5–6 km after Konjancham towards Shoor-Shirin, gypsum hills, along Iran/Iraq frontier, 350–400 m, 1.v.1992, Akhani 8153 [subsp. *nudicarpus* (Sirj & Rech. f.) Tietz, det. S. Zarre]; c. 5 km west-south-west of Darreh Shahr towards Abdanan, foothills of Kabirkuh, slopes around the road, 33°5'57"N, 47°20'57"E, 790 m, 30.iii.2001, H.Akhani 14690.

This characteristic spiny species with inflated calyx (Fig. 11), with two subspecies (*baba-alliar* and *nudicarpus* (Sirj & Rech. f.) Tietz, has a characteristic south-western Iranian distribution with adjacent localities in Iraq, mostly in the western slopes of Zagros foothills (Podlech, 2001: 84; Tietz, 1988: 259 and karte 12, p. 362).

Astragalus ensifer Nábělek, Spisy Prir. Fak. Masarykovy Univ. 35: 79 (1923).

A rare species known only from three localities in south-western Iran and adjacent parts of Iraq (Podlech, 1999b: 127).

Astragalus kentrophyllus Podlech, Sendtnera 6: 156 (1999).

Ilam: 10 km south of Zarrinabad, Anaran Mountain, 1200–1300 m, 6.viii.1989, H.Akhani 5540.

A spiny species recently described from several localities in Ilam, Khuzestan and S. Fars by Podlech (1999a).

Onobrychis gypsicola Rech. f. Fl. Iranica 160: 436 (1986).

Ilam: 34 km from Dehloran in the road towards Mehran, gypsum hills dominated by *Pteropyrum naufelum*, 32°17'9"N, 47°00'57"E, 395 m, 31.iii.2001, H.Akhani 14783.

The species has been described from a few localities on gypsum hills in Khuzestan and Fars provinces.

LAMIACEAE

Phlomis bruguieri Desf., Mém. Mus. Hist. Nat. Paris 11: 9 (1824).

See also Rechinger 1962: 62, Karte 2.

An endemic species in Iraq, south-west Iran and south-east Turkey (see Rechinger, 1982: 302–303) (Fig. 23).

Stachys nephrophylla Rech. f., Pl. Syst. Evol. 134: 291 (1980).

Ilam: c. 10 km east of Darreh Shahr, eastern slopes of Kabirkuh, Qaleh Bahram-e Chubin, near Aramu village, vertical cliffs, 33°5'9"N, 47°27'9"E, 710–750 m, 29.iii.2001, H.Akhani 14682.

The specimen is young and lacks flowers, and therefore its identity is doubtful. However, the vegetative characters and illustration of the type specimen given in *Flora Iranica* (Rechinger, 1982: table 336), habitat and altitude, all support its identification.

Teucrium oliverianum Ging. in Benth., Lab. Gen. Sp. 668 (1835).

Ilam: 36 km from Dehloran towards Mehran, gypsum hills, *Pteropyrum* community, 320 m, 4.v.1992, H.Akhani 8503.

The distribution of this species extends from south-west Iran to northern Iraq. See Rechinger (1982) for further localities.

PAPAVERACEAE

Papaver rechingeri Kadereit, Notes R. Bot. Gard. Edinburgh, 45(2): 249 (1988 publ. 1989).

Type: Iraq: Distr. Kut Al-Imara, Ad confines persiae in ditioe oppidi Badra, in collibus saxosis, c. 33 N, 46 E, 16 km south-east of Badra, 12–13.iv.1957, Rechinger 9209 (W!).

Ilam: Mehran, Yara-Bur, 31.iii.1960, Herb. Min. Ir. Agric. 5073E (W), 18.iv.1963, Jacobs 6317 (W).

A species related to *P. dubium* which was known only from a few localities in south-west Iran and adjacent areas of Iraq (Kadereit, 1988: fig. 7).

POLYGONACEAE

Pteropyrum

The genus *Pteropyrum* in *Flora Iranica* (Rechinger & Schiman-Czeika, 1968) contained three species: *P. aucheri* Jaub. & Spach, *P. olivieri* Jaub. & Spach and *P. noëanum* Boiss. ex Meisn. The first two were represented in several localities, although their distinction is not always easy. *Pteropyrum noëanum* was based on a specimen collected from Diayala: 10 km east of Mandali, Rechinger 9640 (W). This specimen has been studied by the author. It is a young sterile plant that may belong to *P. naufelum* Al-Khayat (see below). In the identification key of *Flora Iranica*, *P. noëanum* was compared with *P. olivieri* with the annotation that it may not differ from it. After study of the types of all three names in P and G herbaria, I found that *P. noëanum* has no reliable differences with *P. aucheri*, and is placed synonymously with the latter.

Pteropyrum aucheri Jaub. et Spach, Ill. Pl.Or. 2: 8, table 107 (1844).

Type: In collibus aridis Persiae septentrionalis, ad amnem Kizil Ouzein, Aucher-Eloy 5269 (G, P).

= *P. noëanum* Boiss. ex Meisn. in DC., Prodr. 14: 31 (1856). Syn. nov.

Type: Hanneky ad ripam Diala, 1851. Noë 1002 (G, P).

Pteropyrum naufelum Al-Khayat, Nordic J. Bot., 13(1): 33 (1993).

Ilam: c. 12 km north-east of Mehran towards Ilam, hills around the road, 320 m, 3.v.1992, H.Akhani, 8374; 36 km from Dehloran towards Mehran, gypsum hills, 320 m, 4.v.1992, H.Akhani 8500; c. 40–45 km north-east of Mehran on the road towards Ilam, 800 m, 16.x.1993, H.Akhani 9013; 35–40 km from

Dehloran towards Mehran, gypsum hills, *c.* 250–300 m, 16.x.1993, H.Akhani 9049; *c.* 18 km south-west of Salehabad, 17 km after Konjanham towards Shoor-Shirin, gypsum hills along Iran/Iraq frontier, 500–5500 m, 1.v.1992, Akhani 8188; *c.* 25 km south of Salehabad, 5–6 km after Konjanham towards Shoor-Shirin, gypsum hills along Iran/Iraq frontier, 350–400 m, 1.v.1992, H.Akhani 8132.

Pteropyrum naufelum was recently described from Iraq close to the Iranian border (Al-Khayat, 1993) (Fig. 24). It is a remarkable gypsophilous species which covers large parts of the gypsum hills between Mehran and Dehloran and along the Iran–Iraq border (Table 1). The species is also reported and illustrated erroneously under *P. noëanum* from Khuzestan by Mozaffarian (1994): *c.* 60 km from Andimeshk to Malavi, around Jelugir, *c.* 1000 m, Mozaffarian 72206 (TARI).

The distribution of *P. aucheri* overlaps with *P. naufelum* in south-west Iran. In contrast to the latter species which is restricted mostly to gypsum hills, *P. aucheri* occurs along rivers and in riverine habitats.

Rumex ephedroides Bornm., Russk. Bot. Zhurn. 6: 92 (1909).

Ilam: *c.* 10–15 km from Ilam on the road towards Kermanshah, 15.x.1993, H.Akhani 9004; *c.* 40–45 km north-east of Mehran on the road towards Ilam, 800 m, 16.x.1993, H.Akhani 9009; *c.* 35 km north-east of Mehran, on the road towards Ilam, 16.x.1993, H.Akhani 9015; *c.* 35–40 km from Dehloran towards Mehran, gypsum hills, *c.* 250–300 m, 16.x.1993, H.Akhani 9048; *c.* 25 km S of Saleabad, 5–6 km after Konjanham towards Shoor-Shirin, gypsum hills along Iran/Iraq frontier, 350–400 m, 1.v.1992, H.Akhani 8133; 34 km from Ilam towards Saleh-abad, near Banroushan village, 700–800 m, 1.v.1992, H.Akhani 8247 (Hb. Akh.). Lorestan: road from Khorramabad to Malavi, Afrineh, 830 m, 33°19'N, 47°53'E, 14.xi.1985, R.Mozaffarian 58415 (TARI, W, n.v)

A very peculiar late flowering species (October) with articulated and *Ephedra*-like branching. The species is restricted to rocky slopes and sometimes on gypsum hills in the area (Fig. 25). According to Rechinger (1989a), the species belongs to sect. *Hastati* of the subgenus *Acetosa* and is related to *R. hastatus* D. Don, a species distributed in East Afghanistan (Hindukush) to the Western Himalaya and as disjunct in several localities in south-west China. Sect. *Hastati* is a predominantly Afro-Asiatic section in which most species are distributed in East Africa.

Taverniera nummularia DC., Prodr. 2: 339 (1825).

This species is known from three south-western Iranian Provinces: Ilam, Khuzestan and Kermanshahan

and several localities in adjacent areas in Iraq (Rechinger, 1984: 468).

SCROPHULARIACEAE

Albraunia fugax (Boiss. & Noë) Speta, Bot. Jahrb. 103 (1): 38, tables 6 and 8 (1982).

Ilam: *c.* 10 km east of Darreh Shahr, eastern slopes of Kabirkuh, Qaleh Bahram-e Chubin, near Aramu village, conglomerate limestone, 33°5'9"N, 47°27'9"E, 710–750 m, 29.iii.2001. H.Akhani 14674.

A showy species (Fig. 12) of the gypsum and calcareous habitats of south-west Iran, Iraqi Kurdistan and south-east Turkey (see its distribution map in Speta, 1982: 36, Abb. 7). Three other Anthirrhineae species described or given as endemic and subendemic to south-western Iran by Speta (1980) are *Albraunia foveopilosa* Speta (of the gypsum hills), *Chaenorhinum foroughii* Speta (in crevices of limestone rocks described from the type locality in Fars) and *Ch. gereense* (Stapf) Speta, a species which occurs outside Iran in north-east Iraq and Cyprus.

PHYTOGEOGRAPHIC AND CONSERVATION REMARKS

The distribution ranges of many of the species show a rather similar pattern (Figs 14–25). Most are restricted to the western foothills of the Zagros Mountains in south-western Iran and adjacent areas in Iraq. This area has been named by Rechinger (1972) and Rechinger & Lack (1991) as 'Persian foothills', and mentioned several times as of biogeographical importance. The ranges of some species penetrate into suitable microhabitats in surrounding lower or higher altitudes. This transition zone separates the higher altitude of the Zagros Mountains with true Irano–Turanian floristic stock to the west and north-west, from Khuzestan and the lowlands of Iraq with a Saharo–Sindian floristic pool to the south and south-east. According to the available phytogeographical concepts of south-west Asia, this area corresponds to the eastern and north-eastern parts of the Mesopotamian province (Zohary, 1966: map 2; 1973; Takhtajan, 1986). This province belongs to the Irano–Turanian area and occupies northern parts of Iraq, nearly the whole of Syria, south-east Anatolia and south-west Iran. The ranges of most of the species in this paper are restricted to Iran and adjacent parts of Iraq. Some species such as *Oliveria decumbens* Vent. (Rechinger, 1987; Fig. 17), *Cousinia stenoccephala* Boiss. (Rechinger, 1972; Fig. 19), *Phlomis bruguieri* Desf. (Rechinger, 1982; Fig. 23), *Scabiosa leucactis* Patzak (Rechinger in Rechinger & Lack, 1991; Fig. 22), *Brassica aucheri* Boiss. (Al-Shehbaz,

1985; Al-Shehbaz & Warwick, 1997; Fig. 21) cover the entire western foothills of Zagros and demonstrate a common and well defined distribution pattern.

Many of the species are gypsophilous species, e.g. *Euphorbia acanthodes*, *Pteropyrum naufelum*, *Astragalus akhanii*, *Onobrychis gypsicola*, *Mattias-trum luristanicum*, *Heliotropium denticulatum*, *Pycnocycla flabellifolia* and *Albraunia fugax*. Local endemism on gypsum habitats has already been observed in other parts of Iran. One putative example is the gypsum hills located on the northern border of Iranian great Kavir (Dasht-e Kavir), near Semnan. Rechinger (1989b) pointed out the importance of local endemism and listed the following species which are more or less restricted to this area: *Euphorbia gypsicola* Rech. f. & Aellen, *Anthochlamys multinervis* Rech. f., *Astragalus fridae* Rech. f., *A. semnanensis* Bornm. & Rech. f., *Gypsophila mucronifolia* Rech. f., *Moltkia gypsicola* Rech. f., *Nepeta eremokosmos* Rech. f., and *Seseli staurophyllum* Rech. f. The present author described *Salsola zehzadii* as an extremely xero-halophytic gypsophilous plant from the gypsum hills along the Iran–Afghanistan border in Khorassan Province (Akhani, 1996).

Many of these species are highly isolated, some without close affinities and some with tenuous affinities with species very distant from the area, both indicating a relict nature of this flora. Examples are *Euphorbia acanthodes* (see above), *Heliotropium denticulatum* (distantly related to *H. brevilibre* from the lowlands of south-east Iran, adjacent areas in Pakistan, and UAE; see Akhani & Förther, 1994), *Azilia eryngioides* (perhaps an isolated relict; see Hedge & Lamond, 1987), *Haussknechtia elymaitica*, *Rumex ephedroides* (belonging to sect. *Hastati* of the subgenus *Acetosa* and related to *R. hastatus*, a species in Hindukush, West Himalaya and south-west China, see Rechinger, 1989a), *Hypericum dogonbadanicum* (a species of the sect. *Campyloporus*, related to the Socotran endemic *H. socotranum*; see Robson, 1987), *Ergocarpon cryptanthum* (an isolated genus; see Bornmüller, 1941; Townsend, 1964; Hedge & Lamond, 1987). Some of these species are palaeoxeromorphic species that exist in the outer fringes of the Zagros mountains. It is probable that these species may have had a wider distribution eastwards, but extended their range westwards during the colder climatic conditions of the Holocene. The recent discovery of *Pterocarya fraxinifolia* in Lorestan, which is indeed not far from our area, indicates a remnant of previously warmer conditions in Central Zagros (Akhani & Salmian, 2003).

A comparison of the floristic isolation of this area with that of the isolated Mountain, Kuh-e Genu, in southern Iran, near Bandar Abbas, is of great biogeographical interest.

However, Rechinger (in Rechinger & Wendelbo, 1985) considered that the Kuh-e Genu area belongs to the Nubo–Sindian Province of Sudanian or Sudano–Zambeian Region *sensu* Zohary (1973) and Takhtajan (1986). Clearly there are marked differences between the flora of Kuh-e Genu and adjacent parts and the western foothills of Zagros, but there are several interesting points which need to be considered:

(a) Many species found in Kuh-e Genu are very isolated. These include *Zhumeria majdae* Rech. f. Wendelbo (a very isolated genus without close relatives; Bokhari & Hedge, 1976), *Pterocephalus wendelboi* Rech. f. (a very isolated species, with spiny branches and cushion-like form, restricted to the mountain peak of Kuh-e Genu), *Podolotus hosachioides* Royle ex Benth. (a species with a disjunct distribution in Kuh-e Genu and West Himalaya in Afghanistan, Pakistan and India; see Rechinger, 1984: map on p. 348), *Andrachne merxmulleri* Rech. f. (a species similar to some species in Central Asia and Afghanistan), *Amygdalus wendelboi* Freitag (a species related to *A. communis* L. and some east Afghanistan species like *A. kuramica* Korsh., *A. zabulica* Serafimov and *A. stocksiana* Boiss. from Baluchestan), and *Dicyclophora persica* Boiss. (a monotypic genus distributed from Khuzestan to West Baluchestan).

(b) The known affinities of the isolated and endemic species in both areas indicate a more Irano–Turanian character than a Sudanian or Saharo–Arabian character (according to the system of Zohary, 1973) or a Saharo–Sindian or Somalia–Masaian character (according to the system of Léonard, 1989). An excellent example of the expression of the flora of this area by the Irano–Turanian elements is shown in *Bienertia cycloptera* Bunge ex Boiss. (Akhani, Ghobadnejhad & Hashemi, 2003).

(c) The lowland flora of both areas is strongly influenced by Saharo–Sindian and Somalia–Masai elements (*sensu* White & Léonard, 1991). As has been mentioned by Rechinger (in Rechinger & Wendelbo, 1985) and elaborated by White & Léonard (1991), the Saharo–Sindian flora is very poor in endemic taxa, most of the elements being widely distributed species. It was for this reason that the latter authors applied the concept of a Saharo–Sindian regional zone to their phytogeographical interpretation of the area. Even large numbers of endemic species of the southern Arabian Peninsula are indeed elements of the Somalia–Masai regional centre of endemism or Afro-montane elements.

In conclusion, the author is in favour of two solutions regarding the phytogeographic position of the large parts of southern Iran. First, large parts of southern Iran are considered a transition zone where

Irano-Turanian, Saharo-Sindian and Somalia-Masai elements meet each other. Secondly, southern Iran is considered a provincial part of the Irano-Turanian area where many elements of the Saharo-Sindian regional zone occupied the lowlands because of suitable climatic conditions. Information on the geological and palaeogeographical history of the area is needed to corroborate either of these hypotheses.

The scientific community is aware of the foundation of old civilizations in Mesopotamia and the origin of many domesticated plants and animals in the so-called 'fertile crescent' (Zohary & Hopf, 1993). As is evident from the facts presented above and many published data in other sources, the flora of this area harbours very old relict species whose extinction would be of great loss not only for science, but also for humanity. Therefore, the conservation of the natural and cultural heritage in this part of the world is vital and a priority for the scientific community, national and international organizations. But in reality, we are speaking about an area which, in spite of its rich oil resources, suffers from the economic problems caused mostly by two of the largest wars in the world of the last two decades, and many other internal conflicts. During the author's last excursion in early spring, a time which is extremely important for germination and growing of plants, the study area was overcrowded with grazing animals particularly sheep and goat herds (Fig. 13). This situation makes it extremely difficult for rare plants and plant communities to survive. Although similar situations are found in nearly all parts of the country, the urgent conservation of south-west Iran is especially critical because of the traditionally nomadic life of its people and their dependence on plants for grazing and fuel, and the absence of any adequately protected area or National Park.

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