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Iranian *Pimpinella* L. (Apiaceae): A taxonomic revision

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Abstract

In the family Apiaceae subfamily Apioideae, the genus *Pimpinella* L. with about 150 species is one of the largest genera. This widespread and taxonomically complex genus has 20 species distributed throughout Iran, of which, eight species are endemic. The resolution of relationships among these approximately 20 species remains largely obscure. In this study, Morphological analyses were conducted using NTSYS to assess relationships among *Pimpinella* species with emphasis on Iranian *Pimpinella*. Based on the most significant morphological characters, a dendrogram was sketched ending up giving the following results: In phenon line 0.54 and 0.56, two clusters are clearly distinct. In the first cluster three distinct branches could be observed: (1) annual species of genus *Pimpinella* L., although *P. affinis* shows similarity to them, (2) four species includes *P. anisactis, P. khorasanica, P. khayyamii* and *P. tragium* and (3) Reutera group (*P. aurea, P. deverroides, P. tragioides, P. dichotoma* and *P. pastinacifolia*). At 0.56 the second cluster separated *P. kotschyana*, *P. oliverioides*, *P. olivieri* and *P. gedrosiaca* from the second subcluster which includes *P. peucedanifolia*, *P. rhodantha*, and *P. saxifraga*. Morphologically speaking, these species exhibit blatant differences compared with others. In addition, the identification key is also provided to represent the similarities and relationships between the species. This study presents a complete description, general distribution and its distribution in Iran for each species as well as some distribution maps for all Iranian species.

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Introduction

Apiaceae Lindl. (Umbelliferae Juss.) is a family of some 455 genera and is widely distributed in Central Asia (Pimenov and Leonov, 1993). The largest and most taxonomically complex subfamily, Apioideae, comprises 404 genera and 2827–2935 species (Pimenov and Leonov, 1993). South-West Asia as a whole is a region of high diversity for the family; after China and Turkey, Iran is the third Asian country with the greatest biodiversity (Pimenov and Leonov, 2004). Some of the endemic genera of Apiaceae in Iran are: *Szovitsia* Fisch. & C.A.Mey., *Rhabdosciadium* Boiss., *Dicyclophora* Boiss., *Thecocarpus* Boiss., *Haussknechtia* Boiss., *Polylophium* Boiss., *Kelussia* Mozaff., *Opsicarpium* Mozaff., *Lomatopodium*Fisch. & C.A.Mey.

Among the genera of Apiaceae, *Pimpinella* L. has 150 species all over the world and it is one of the largest genera of this family (Pimenov and Leonov, 1993). Taxonomically, this genus is placed in subfamily *Apioideae* and the major constituent of tribe *Pimpinelleae* Spreng.(Downie *et al.*, 2010). *Pimpinella* is distributed in most part of Iran especially in the north and west. As stated in Flora of Iran (Mozaffarian, 2007) genus *Pimpinella* L. totally includes 22 species in Iran, with *P. anisum* L. as a cultivated specie; but anatomical studies confirm morphological differences between *P. anthriscoides* Boiss. and other species of *Pimpinella*. Therefore, this species is affiliated into a distinct, new genus *Pseudopimpinella anthriscoides* (Boiss.) F.Ghahrem., Khajepiri & Mozaff.(Khajepiri *et al.,* 2010). In this regard, according to Zakharova *et al.*, 2012 new combinations of this species are published: *Pseudopimpinella anthriscoides* (Boiss.) F.Ghahrem. & al. is transferred to *Aegopodium* L., as *Aegopodium tribracteolatum* Schmalh.; and *Pseudopimpinella anthriscoides* var. *cruciate* (Bornm. & H.Wolff.) F.Ghahrem. & al. shows true affinity with the Balkan – Near Eastern-Caucasian genus *Tamamschjanella* Pimenov & Kljuykovso this variety is to be excluded from *Pimpinella* and transferred to *Tamamschjanella* as *Tamamschjanella cruciata* (Bornm. & H.Wolff.) Pimenov & Zakharova.

Eight Iranian endemic species are as follows: *P. anisactis* Rech.f., *P. deverroides* Boiss., *P. khayyamii* Mozaff., *P. khorasanica* Engstrand, *P. pastinacifolia* H.Wolff., *P. tragioides* (Boiss.) Benth. & Hook.f., *P. gedrosiaca* Bornm. & *P. dichotoma* H.Wolff. (Mozaffarian, 2007). Some of the most important morphological characters in this genus are: duration, stem indumentum, presence of the fibrous collar, shape and division of basal and cauline leaves (pinnate or rarely simple), existence or nonexistence of sheath and petiole, presence of bracts and bracteoles and number of them, relative size of rays and pedicels and their indumentum, petal color, fruit shape and stylopodium type in maturity, presence of indumentum (include: hair, papilla, vesicle) and their distribution in mature fruit.

In this paper, the most important characteristics for the separation of the species, the relationships between the species, an identification key and distribution maps (Fig. 1) for all Iranian species are presented.

Materials and methods

Plant material

For this research, all required plant specimens of genus *Pimpinella* L. were provided from several herbaria. For this reason, at first, all specimens of Iranian species of this genus were studied at the department of Botany of Naturhistorisches Museum Wien (W). In addition all *Pimpinella* L. specimens which are deposited at TARI, FAR, T, TUH and FUMH herbaria also examined.

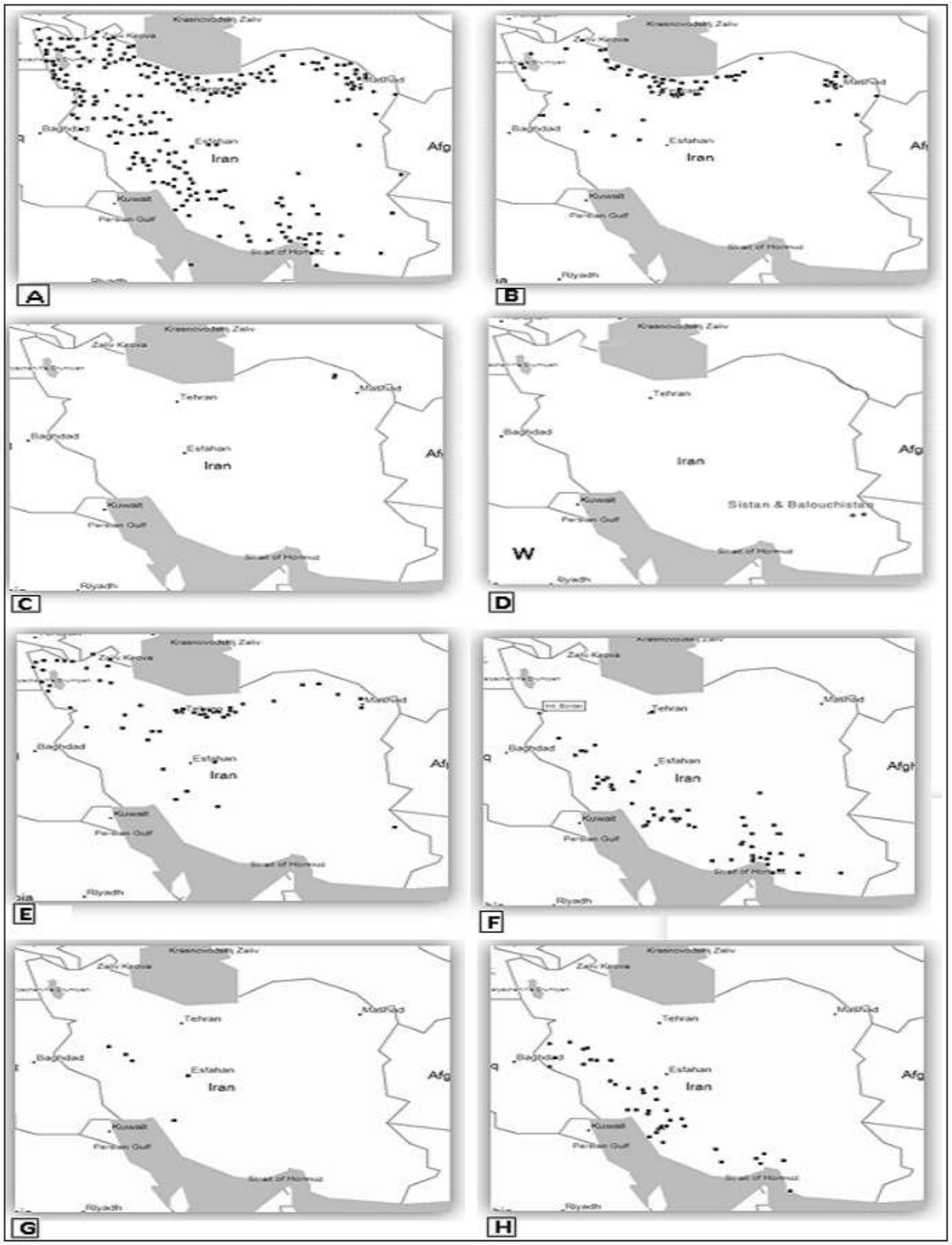
Morphological analysis

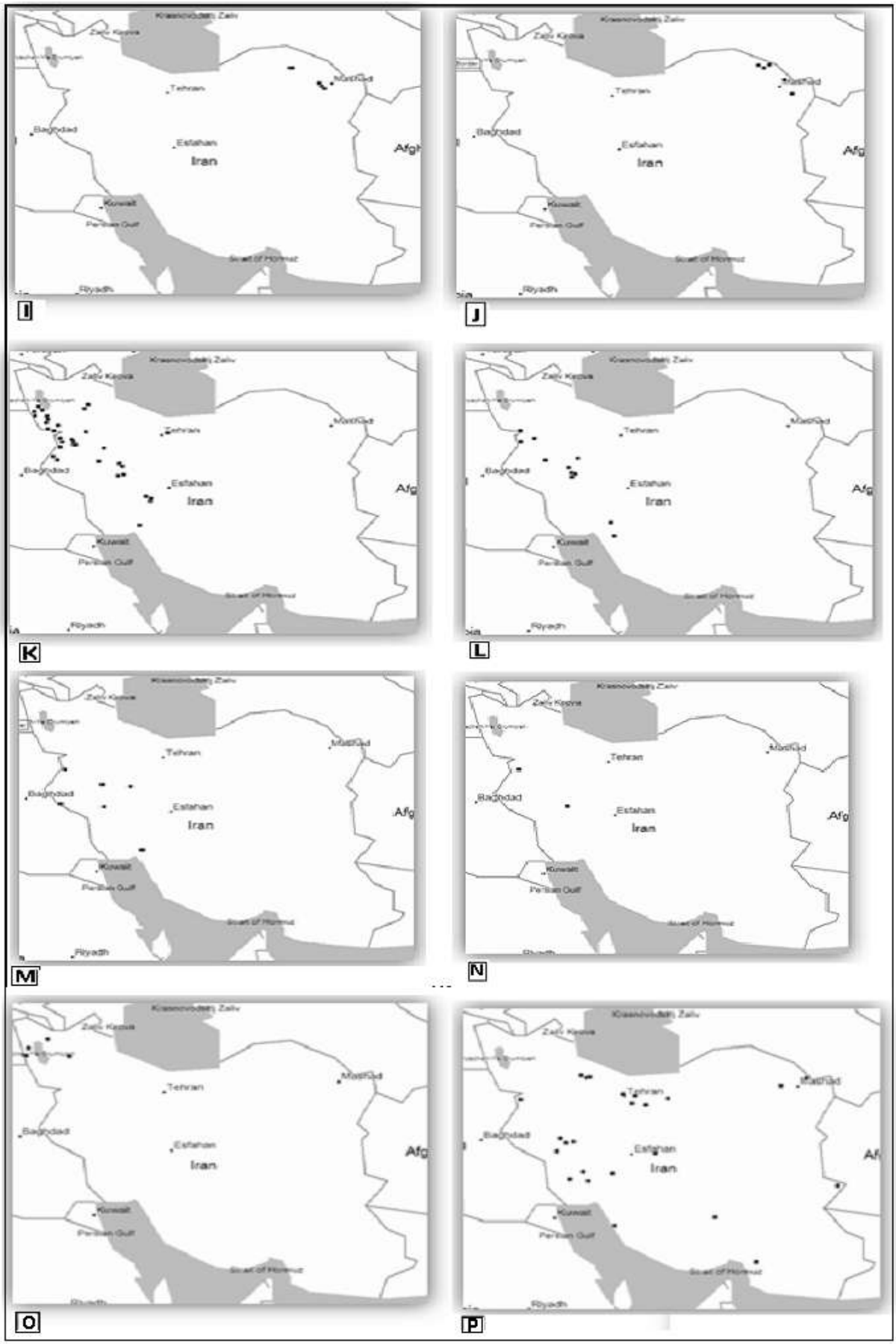
Analysis of morphological data was conducted using NTSYS-pc version 2.02e (Rohlf, 2000). Morphological data were converted into a similarity matrix, using the simple matching coefficient (Sneath and Sokal, 1973) with the SIMQUAL function. A dendrogram was generated from the similarity matrix by the unweight pair-group method using arithmetic

averages (UPGMA) (Sokal and Michener, 1958) with the SAHN function.Distribution maps are sketched by means of Map Source software.

A description of genus Pimpinella L. follows

Pimpinella L., Spec. Plant. 263 (1753) incl. *Reutera* Boiss. (1838); Gen. Plant. ed. 5: 128 (1754). Lectotype: *P. saxifraga* L. (Britton & Brown, 1913; Hitchcoch & Green, 1929; Jarvis *et al.*, 1993).

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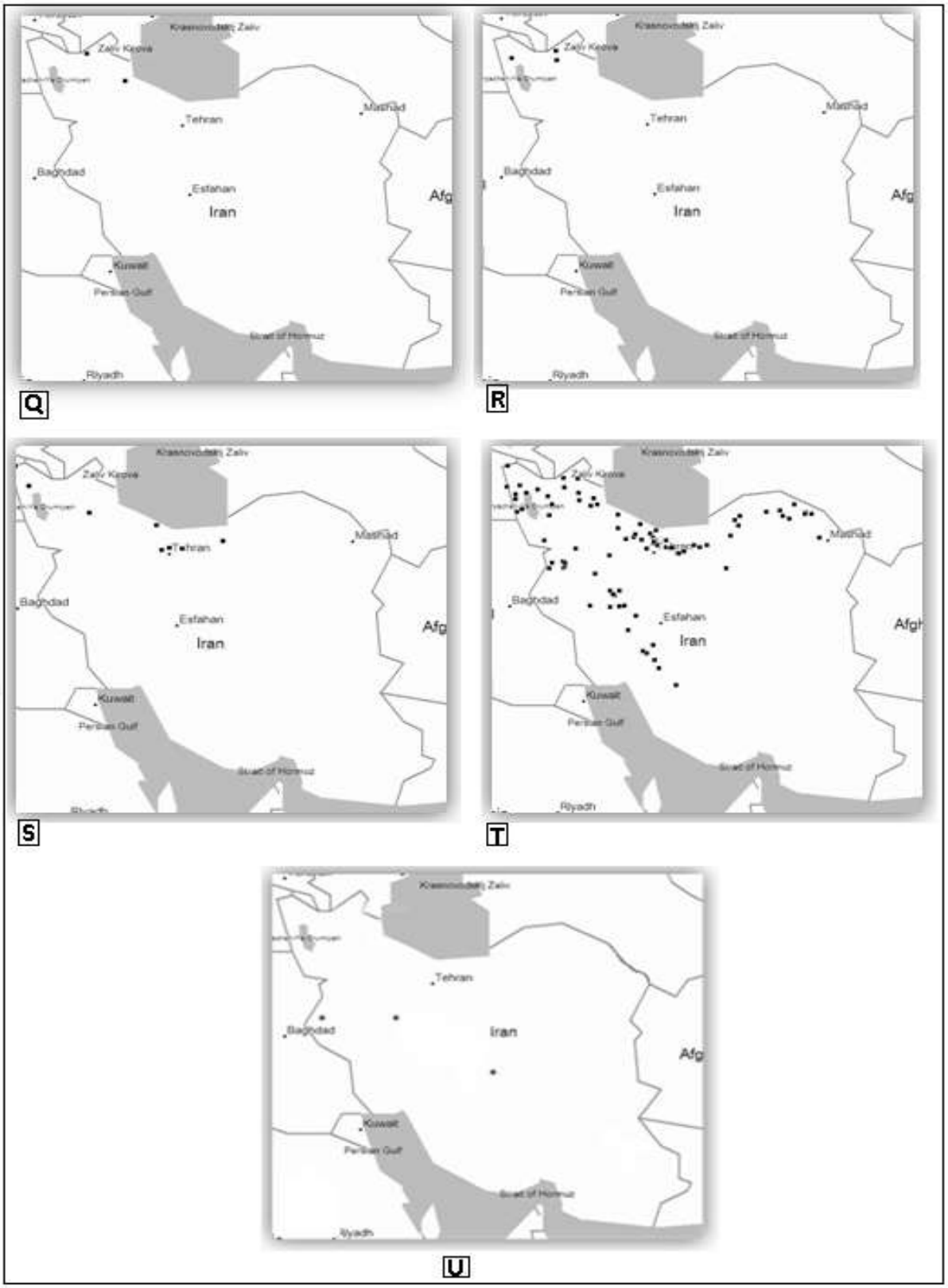


Fig. 1. Distribution maps. **A**: genus *Pimpinella* L. **B**: *P. affinis*. **C**: *P. anisactis*. **D**: *P. gedrosiaca*. **E**: *P. aurea*. **F**: *P. barbata*. **G**: *P. deverroides*. **H**: *P. eriocarpa*. **I**: *P. khayyamii*. **J**: *P. khorasanica*. **K**: *P. kotschyana*. **L**: *P. olivierioides*. **M**: *P. olivieri*. **N**: *P. pastinacifolia*. **O**: *P. peucedanifolia*. **P**: *P. puberula*. **Q**: *P. rhodantha*. **R**: *P. saxifraga*. **S**: *P. tragioides*. **T**: *P. tragium*. **U**: *P. dichotoma*

Plant herbaceous, annual, biennial or perennial, sometimes woody at base, pubescent, puberulous or glabrous, fibrous collar present or absent. Basal leaves ovate, oblong or triangular, simple or 1-4-pinnate, petiolate. Cauline leaves ovate or triangular-ovate, simple or 1(-3)-pinnate, petiolate or sometimes only with sheath.Inflorescence a compound umbel. Bracts and bracteoles absent or present. Flowers bisexual; Calyx teeth inconspicuous; Petals all equal, white, yellow or rarely pinkish or purple, ovate, obovate or cordate, with inward curved tip, glabrous or hairy on the outer side. Fruit ovate, elliptic, oblong or subglobose, slightly compressed laterally, pubescent, puberulous, glabrous or rarely tuberculate; Stylopodium conical, mamillate or depressed; Styles erect, divergent or recurved, glabrous or rarely puberulous.

Geographical distribution

Asia, Europe, Africa and North America.

Distribution in Iran

North, West, South, East, Center (Fig. 1A).

Identification key

1. Plant annual 2
- Plant biennial or perennial 4
2. Basal leaves 1-3-pinnate, all segments linear-filiform ..... 5. *P.barbata* (DC.) Boiss.
- Basal leaves simple, lamina round or ovate..... 3
3. Stylopodium in ripe fruit depressed ..... 15. *P.puberula* (DC.) Boiss.
- Stylopodium in ripe fruit elongate-conical.....7. *P.eriocarpa* Banks & Soland.
4. Plant monocarpic, with corymbose branches 5
- Plant perennial, not corymbosely branched 7
5. Ripe fruit tuberculate or papillate, stylopodium mamillate or depressed-conical style glabrous .....12.
6. *P.olivieri* Boiss.
- Ripe fruit pubescent, stylopodium depressed, style puberulous 6
7. Segments of basal leaves without petiolule, lower cauline leaves 1-3-pinnate, petals hairy along the midrib on the outer side ..... 10. *P.kotschyana* Boiss.
- Segments of basal leaves petiolulate, lower cauline leaves 1-2-pinnate, petals hairy on the outer side.....11. *P.oliverioides* Boiss. & Hausskn.
8. Petals yellow or cream 8
- Petals white, pinkish or purple 12
9. Basal leaves 2-3-pinnate, lower cauline leaves 1-2-pinnate, ripe fruit subglobose..... ..... *P.aurea* DC.
- Basal leaves 1-pinnate, lower cauline leaves simple or 1-pinnate, ripe fruit ovate-elliptic or ovate-oblong..... 9
10. Ripe fruit pubescent 10
- Ripe fruit puberulous or subglabrous or glabrescent 11
11. Lower cauline leaves 1-pinnate, fruit elliptic or ovate, stylopodium mamillate ....*P.deverroides* (Boiss.) Boiss.
- Lower cauline leaves simple, fruit ovate-oblonge, stylopodium conical-mamillate ..... *P.dichotoma* (Boiss.) Boiss.
12. Segments of basal leaves with or without petiolule, bracteole absent or present .... 18. *P.tragioides* (Boiss.) Benth. & Hook.f. ex Drude
- Segments of basal leaves petiolulate, without bracteole .....13. *P.pastinacifolia* (Boiss.) Wolff
13. Plant glabrous or puberulous 13
- Plant pubescent 15
14. Fruit ovate-oblong

15. .....14. *P.peucedanifolia* Fisch. ex Ledeb.

- Fruit ovate-elliptic 14

16. Basal leaves 1-pinnate, segments of basal leaves without petiolule, bract and bracteole..... absent or present, petals white ..... 17. *P.saxifraga* L.

- Basal leaves 1-2-pinnate, segments of basal leaves petiolulate, without bract and bracteole, petals white or pinkish ..... 16. *P.rhodantha* Boiss.

17. Stylopodium elongate-conical, in ripe fruit is divided in two ..... 1. *P.affinis* Ledeb.

- Stylopodium mamillate or depressed, in ripe fruit not divided 16

18. Lower segments of lower cauline leaves with or without petiolule, bract and bracteole absent or present, rays equal or unequal 17

- Lower segments of lower cauline leaves always with petiolule, bract and bracteole absent, rays totally unequal 19

19. Plant erect or sometimes prostrate, segments of basal leaves usually without petiolule, fruit pubescent 18

- Plant erect, segments of basal leaves with petiolule, fruit glabrous ..... 8. *P.khayyamii* Mozaff.

20. Plant erect or prostrate, basal leaves ovate or ovate-oblong, Lower segments of lower cauline leaves usually without petiolule, bracts absent or rarely 1..... *P. tragium* Vill.

- Plant always prostrate, basal leaves triangular-ovate, Lower segments of lower cauline leaves with petiolule, bracts 4-5 ..... *P. gedrosiaca* Bornm.

21. Basal leaves triangular-ovate, petiolule of their segments 7-15 mm, lower cauline leaves 1-2-pinnate, upper cauline leaves simple or 1-pinnate ..... 2. *P.anisactis* Rech.f.

- Basal leaves ovate or narrow ovate, petiolule of their segments 1-7 mm, lower cauline leaves 1-pinnate, upper cauline leaves simple ..... 9. *P.khorasanica* Engstrand.

Description of species of genus Pimpinella L. in Iran

1. *P. affinis* Ledeb., Fl. Ross. (Ledeb.) 2(1,5): 257. 1844.

= *P. reuteriana* Boiss. (1849); *P. griffithania* Boiss., (1856); *P. ambigua* W.D. Koch ex Wolff, (1921); *P. multiradiata* (Boiss.) Korov., (1949); *P. korovinii* R.Kamelin, (1971).

Characteristics

Plant biennial, erect, pubescent or puberulous. Basal leaves oblong, 1-pinnate, with petiole and sheath. Cauline leaves ovate or triangular-ovate or lanceolate, simple or 1(-2)-pinnate, petiolate or sometimes petiole absent and only with sheath. Rays 6-30(-50), almost unequal; Pedicels 6-35(-46), almost unequal. Without Bracts and Bracteoles. Petals white, obcordate, hairy on the outer side. Fruits elliptic or ovate-globose, pubescent; Stylopodium elongate-conical, Divided in ripe fruits; Styles glabrous.

Geographical distribution: Anatolia, Iraq, Iran, Turkmenistan, Afghanistan, Caucasus, Transcaspia.

Specimens seen in Iran

Azarbaijan: Terme, Matine & Zargani 40492-E (W), Mozaffarian & Nowroozi 34901, 34891 (TARI), Rechinger 49012 (W), Sabeti 8819 (TARI), Sabeti 8813 (TARI), Rechinger 43637 (W), Sabeti 2945 (TARI), Sabeti 8812 (TARI); Esfahan: Jardine 794 (W); Fars: Mozaffarian 47002 (TARI); Gilan: Jardine 920-A (W), Wendelbo & Assadi 18366 (TARI), Mozaffarian & Maussoumi 6960 (TUH), Mozaffarian 7117 (TUH), Wendelbo & Assadi 18358 (TARI), Saidi 18625 (TUH), Naqinezhad 27693 (TUH), Wendelbo & Assadi 18566 (TARI), Jamzad 33721 (TARI), Steiner 21 (W); Golestan: Rechinger 6149-a (W), Riazi 8752 (TARI), Hewer 3929 (TARI), Zargani 41668 (W),

Assadi 25561 (TARI), Assadi & Mozaffarian 40990(TARI), Assadi & Mozaffarian 41049 (TARI); Hamedan: Assadi & Mozaffarian 36707 (TARI); Kermanshah: Rechinger 14592 (W), Lashkar Bolooki & Hatami 209 (TARI), Hamzehee &Hatami 1348 (TARI), Lashkar Bolooki & Hatami 164 (TARI); Khorasan: Runemark & Sardabi 23483 (TARI), Assadi & Mozaffarian 35560 (TARI), Mozaffarian 48767 (TARI), Mozaffarian 45574 (TARI),Mozaffarian 48991 (TARI), Mozaffarian 48827 (TARI), Termeh & Tehrani 35163-E (W), Faghihian & Zangooei 22470 (FUMH), Faghihian & Zangooei 24162 (FUMH), Rafeie &Zangooei 27359 (FUMH), Joharchi & Zangooei 14812 (FUMH), Joharchi & Zangooei 15640 (FUMH), Faghihian & Zangooei 18929 (FUMH), Akbarzadeh & Kharaghani 13255 (FUMH), Joharchi 34199 (FUMH), Zangooei 10684 (FUMH), Mozaffarian & Rezaei 10571 (FUMH), Ayatollahi & Zangooei 14953 (FUMH), Rezaei & Bakhshoodeh 10502 (FUMH), Ghorashi 307 (FUMH), Joharchi & Zangooei 16965 (FUMH), Zokaie 1102 (FUMH), Zangooei & Hossein-Zadeh 24254 (FUMH), Faghihian & Zangooei 22154 (FUMH), Joharchi & Zangooei 17697 (FUMH), Ghorashi 1765G (FUMH), Rafeie & Zangooei 25775 (FUMH); Kordestan: Assadi 60380 (TARI); Lorestan: Runemark & Lazari 26407 (TARI), Veiskarami 24017 (TUH); Mazandaran: Starm. 290 (W), Foroughi 8765 (TARI), Termeh & Zargani 40481-E (W), Sabeti 1770 (TARI), Sabeti 2247 (TARI), Barkhordari 40397-E (W), Assadi & Massoumi 51451 (TARI), Runemark & Massoumi 20744 (TARI), Runemark & Massoumi 20659 (TARI), Runemark & Massoumi 21593 (TARI), Foroughi 844 (TARI), Foroughi 857 (TARI), Foroughi 896 (TARI), Foroughi 921(TARI), Foroughi 910 (TARI), Runemark & Mozaffarian28226 (TARI), Assadi & Mozaffarian 41066 (TARI), Matine & Termeh 41693 (W), Domanchik 31940, 31942 (TARI), Sabeti 10415 (TARI), Assadi & Massoumi 51472 (TARI), Assadi & Massoumi 51684 (TARI), Assadi & Massoumi 51528 (TARI), Panahi 2461 (TARI), Athari 2474 (TARI), Assadi & Massoumi 51449 (TARI), Gheissari 2389 (TARI), Foroughi 473 (TARI), Sabeti 8824 (TARI), Assadi 33726 (TARI), Sabeti 8766 (TARI), Sabeti 2282 (TARI), Sabeti 8822 (TARI); Tehran: Aellen 1380, 1394 (W), Mozaffarian 33865 (TARI), Mozaffarian & Mohammadi 49222 (TARI), Gheissari 2812 (TARI), Ahmadi 2731 (TARI), Foroughi 624 (TARI), Athari 2513 (TARI), Termeh 40394 (W), Furse 3085 (W), Mozaffarian 54317 (TARI), Mozaffarian 39835 (TARI), Mozaffarian 32528 (TARI), Mozaffarian 32198 (TARI), Assadi & Mozaffarian 33211 (TARI), Amin & Bazargan 19596 (TARI), Sabeti in Gauba 893 (W), Mozaffarian 45457 (TARI), Foroughi &Sanei?& Amini 12393 (TARI), Wendelbo & Foroughi & Assadi 14468 (TARI). (Fig. 1B).

2. *P. anisactis* Rech.f., Repert. Spec. Nov. Regni Veg. 48: 124. 1940.

This species is one of the endemic species in Iran which distributes only in a small part of the east.

Characteristics

Plant perennial, erect, pubescent. Basal leaves triangular-ovate, 1-pinnate, petiolate. Cauline leaves ovate or triangular-ovate or linnear-lanceolate, simple or 1(-2)-pinnate, with petiole and very short sheath or sometimes only with sheath. Rays 1-6, totally unequal; Pedicels 3-11, totally unequal. Without Bracts and Bracteoles. Petals white, ovate, hairy on the outer side. Fruit ovate-globose, pubescent; Stylopodium conical-depressed; Styles glabrous.

Geographical distribution: Iran (Endemic).

Specimens seen in Iran

Khorasan: Rechinger 1714, 1739 (W). (Fig. 1C).

3. *P. aurea* DC., Prodr. [A. P. de Candolle] 4: 120. 1830.

= *P. ramosissima* DC., (1831); *Reutera cervariaeafolia* Boiss., (1844) non. Freyn & Sint. (1895); *R. flava* (C.A.Mey.) Boiss., (1844); *R. aurea* (DC.) Boiss., (1872).

Characteristics

Plant perennial, erect, pubescent, puberulous or in upper parts subglabrous. Basal leaves ovate, 2(-3)-

pinnate, with petiole and sheath. Cauline leaves narrow ovate or lanceolate or subulate, simple or 1(-2)-pinnate, with petiole and sheath sometimes petiole absent. Rays 2-4(-11), almost equal; Pedicels 4-12(-16), unequal. Bracts and bracteoles absent or very rarely with 1-2 linear-narrow lanceolate bracts. Petals yellow, ovate, hairy on the outer side. Fruit subglobose, pubrulous, subglabrous or sometimes glabrous; Stylopodium conical; Styles glabrous.

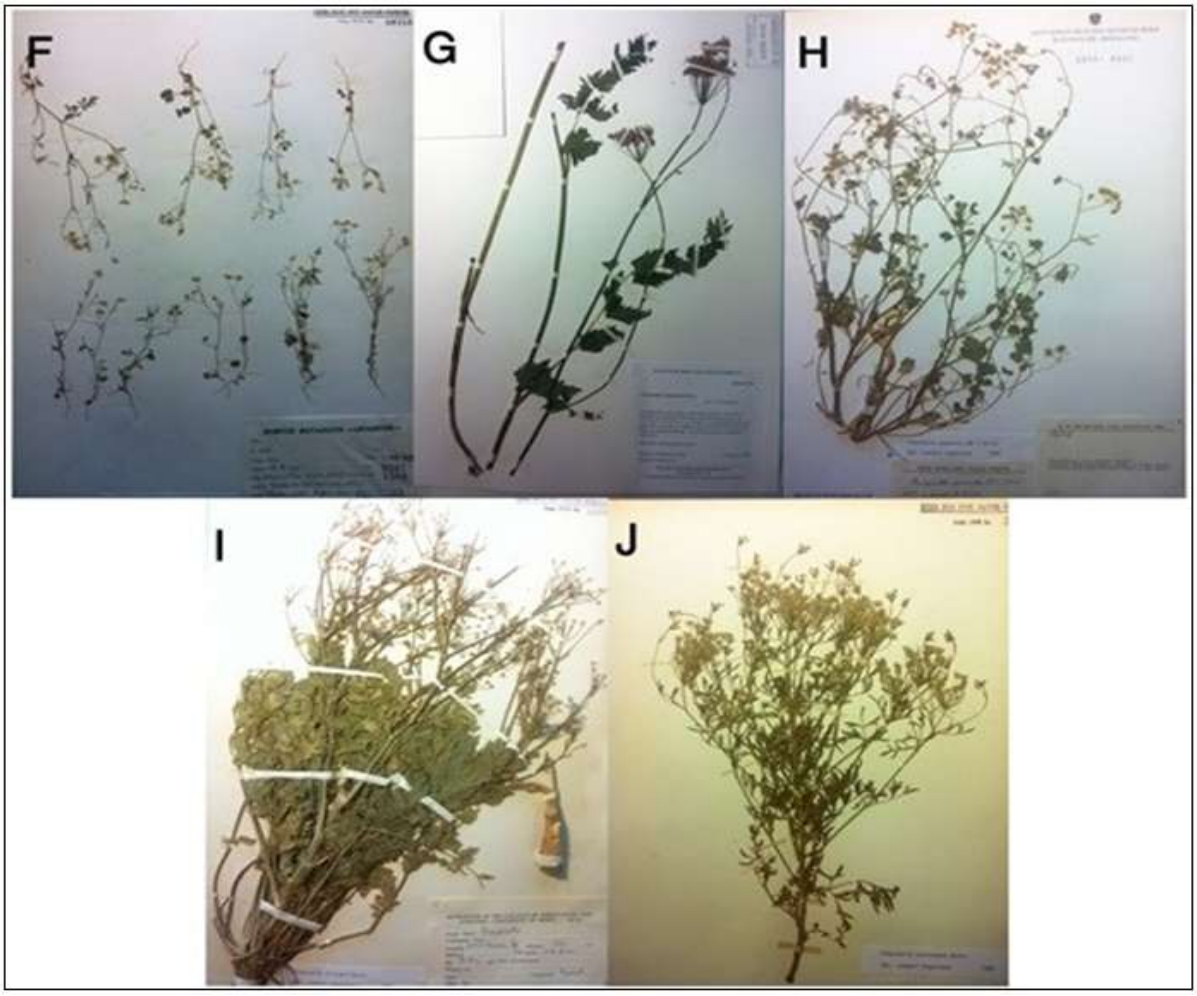
Fig. 3. A: P. gedrosiaca, B: P. tragium, C: P. dichotoma, D: P. saxifraga, E: P. peucedanifolia.

Geographical distribution: East of Anatolia, Iran, Turkmenistan, Armenia, Georgia.

Specimens seen in Iran

Ardebil: Rajamand 8821 (TARI), Mozaffarian 64252 (TARI); Azarbaijan: Rechinger 43783 [=Terme 43783] (W), Mozaffarian & Mohammadi 37403 (TARI), Foroughi & Assadi 13736 (TARI), Mozaffarian & Mohammadi 37719 (TARI), Assadi & Sardabi 24431 (TARI), Sabeti 8837 (TARI), Rechinger 32662, 32679 (W), Zehzad & Siami 3263 (TARI), Zehzad & Siami 3569 (TARI), Kuhafkan & Amini 7446 (TARI), Rechinger 49541 (W), Assadi & Olfat 68629 (TARI), Siami & Zehzad 3654 (TARI); Chaharmahal & Bakhtiari: Mozaffarian 57736 (TARI); Esfahan: Yusefi 1411 (TARI), Yusefi 1603 (TARI), Yusefi 1942 (TARI), Yusefi 1314 (TARI); Khorasan: Rechinger 53734 (W), Assadi & Massoumi 21382 (TARI), Assadi & Massoumi 21371 (TARI), Assadi & Massoumi 21273 (TARI); Khuzestan: Pabot 887 (TARI); Kohgiluye & Boyer Ahmad: Assadi & Abouhamzeh 46069 (TARI), Riazi 8838 (TARI); Kordestan: Rechinger 42741 (W), Rechinger 49203 (W); Markazi: Mozaffarian & Massoumi 48125 (TARI), Mozaffarian 63823 (TARI), Assadi & Shirdelpur 13138 (TARI), Assadi & Mozaffarian

36748 (TARI); Mazandaran: Dini & Arazm 22497 (TARI); Qazvin: Foroughi & Hariri 22180 (TARI); Semnan: Wendelbo & Cobham 13665 (TARI), Assadi & Mozaffarian 40336 (TARI), Assadi & Mozaffarian 40483 (TARI), Assadi & Mozaffarian 40763 (TARI), Wendelbo & Foroughi 12986 (TARI), Assadi & Massoumi 21210 (TARI), Assadi & Mozaffarian 40422 (TARI); Sistan & Baluchestan: Mozaffarian 52958 (TARI); Tehran: Aellen 1294 [=Manoutcheri & Aellen 1294] (W), Mozaffarian 53827 (TARI), Mozaffarian 54020 (TARI), Dini & Arazm 22119 (TARI), Dini & Arazm 22304 (TARI), Dini & Arazm 22430 (TARI), Amin 22474 (TARI), Mozaffarian 54147 (TARI), Assadi & Mozaffarian & Jamzad 33600, 33601, 33602 (TARI), Mozaffarian 45425 (TARI), Assadi & Mozaffarian 30815 (TARI), Assadi & Mozaffarian 30818 (TARI), Bighdeli 78403 (TARI), Mozaffarian 37344 (TARI). (Fig. 1E).



(Fig. 3. continued) F: P. eriocarpa, G: P. rhodantha, H: P. puberula, I: P. olivieri, J: P. kotschyana.

4. *P. barbata* Boiss., Ann. Sci. Nat., Bot. sér. 3, 1: 129. 1844.

= *Ptychotis barbata* DC., (1830); *Pimpinella glaucescens* Boiss., (1830).

Characteristics

Plant annual, erect, puberulous or subglabrous. Basal and cauline leaves triangular, simple or 1-3-pinnate, petiolate or sometimes in cauline leaves only with sheath; all segments linear-filiform. Rays 2-9, almost equal; Pedicels 6-18, almost equal. Without Bracts and Bracteoles. Petals white or pink, obcordate or obovate, glabrous or rarely hairy on the base of outer side. Fruit ovate, pubescent; Stylopodium conical; Styles glabrous.

(Fig. 3 continued) K: P. tragioides, L: P. olivieroides, M: P. khorasanica, N: P. pastinacifolia, O: P. deverroides.

Geographical distribution: Iraq, West and South of Iran.

Specimens seen in Iran:

Chaharmahal & Bakhtiari: Koelz 15271 (W), Mozaffarian 54898 (TARI); Fars: Mozaffarian 45849 (TARI), Mozaffarian 45965 (TARI), Mozaffarian 46730 (TARI), Jamzad & Taheri & Javidtash 69311 (TARI), Jamzad & Taheri & Javidtash 69303 (TARI), Riazi 9316 (TARI), Riazi 8829 (TARI), Bobek 16 (TARI); Hormozgan: Mozaffarian & Banihashemi & Shahinzadeh 44005 (TARI), Mozaffarian & Banihashemi & Shahinzadeh 44047 (TARI), Mozaffarian & Banihashemi & Shahinzadeh 39148 (TARI), Mozaffarian & Banihashemi & Shahinzadeh 39315 (TARI), Mozaffarian & Banihashemi & Shahinzadeh 39166 (TARI), Mozaffarian & Banihashemi & Shahinzadeh 39264 (TARI), Mozaffarian 44388 (TARI), Mozaffarian & Banihashemi & Shahinzadeh 44183 (TARI), Mozaffarian 44881 (TARI), Mozaffarian & Banihashemi & Shahinzadeh 39565 (TARI), Mozaffarian & Banihashemi & Shahinzadeh 39502 (TARI), Mozaffarian & Banihashemi & Shahinzadeh 39488 (TARI), Mozaffarian & Banihashemi & Shahinzadeh 43975 (TARI), Mozaffarian & Banihashemi & Shahinzadeh 39738 (TARI), Mozaffarian 44974 (TARI), Babakhanlou 23088 (TARI), Mozaffarian 59202(TARI), Mozaffarian 49700 (TARI), Mozaffarian 49728 (TARI), Behboudi 800 E (W), Ghahreman & Mozaffarian 5662 (TUH), Mozaffarian 52192 (TARI), Mozaffarian 49620 (TARI), Mozaffarian 49805 (TARI), Mozaffarian 49868 (TARI), Mozaffarian & Banihashemi & Shahinzadeh 39652 (TARI); Kerman: Edmondson & al 1892 (TARI), Assadi & Miller 25136 (TARI), Assadi & Miller 25240 (TARI); Kermanshah: Safaeian 447 (TARI); Khuzestan: Riazi 9527 (W), Dadashzadeh 753 (TARI), Assadi &Abouhamzeh 38759 (TARI), Pabot 29961 (TARI), Pabot 1110 (TARI); Lorestan: Pabot 2004 (TARI), Veiskarami 24018 (TUH), Rechinger 47872 (W), Jacobs 6789 (W); Tehran: Babakhanlou

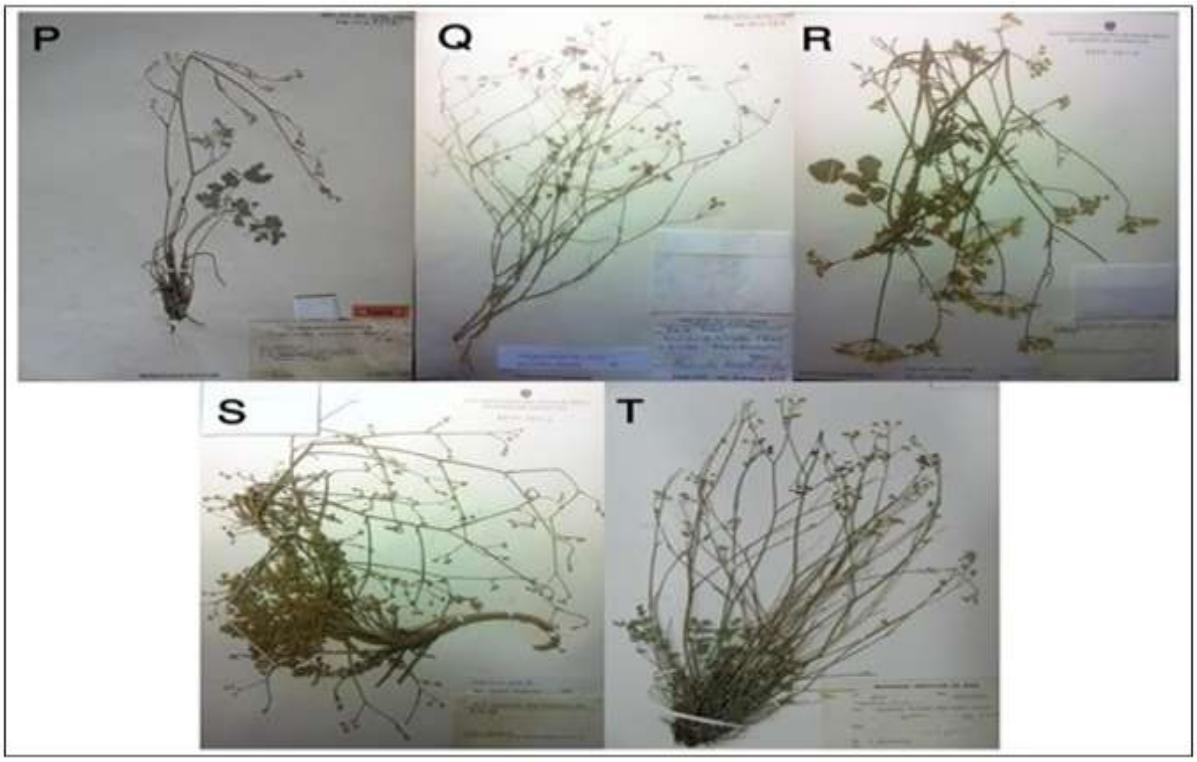
23087 (TARI).(Fig. 1F).

5. *P. deverroides* Boiss., Fl. Orient. [Boissier] 2: 873. 1872.
= *Reutera deverroides* Boiss., (1844).

This species is one of the endemic species in Iran and it grows in west and south parts of Iran.

Characteristics
Plant perennial, erect, pubescent or in upper parts subglabrous. Stem dichotomously branched above. Basal leaves oblong, 1-pinnate, petiolate. Cauline leaves ovate, linear or lanceolate, simple or 1-pinnate, with petiole and sheath or in upper leaves only with sheath. Rays 2-6, almost equal; Pedicels 2-8, almost equal. Bracts and bracteoles absent or rarely with 1 linear bract. Petals yellow, ovate or obovate, hairy on the outer side. Fruit ovate or elliptic, pubescent; Stylopodium mamillate; Styles glabrous.
Geographical distribution: Iran (Endemic).

Specimens Seen in Iran
Esfahan: Auch. 4634 (W), Stapf 1436 (W); Hamedan: Moussavi & Satei 40402-E (W), Mozaffarian 65092 (TUH); Lorestan: Koelz 18491 (W). (Fig. 1G).



(Fig. 3. continued) P: P. anisactis, Q: P. barbata, R: P. affinis, S: P. aurea, T: P. khayyamii.

6. *P. dichotoma* H.Wolff. Pflanzenr. (Engler) Umbellif.-Apioid.-Ammin. 225. 1927.
= *Reutera dichotoma* Boiss. & Hausskn. (1972).

Characteristics
Plant perennial, erect, pubescent. Stem dichotomously branched above. Basal leaves pinnatisect, petiolate. Cauline leaves reduced, linear or lanceolate. Rays 2-6, almost equal. Bracts and bracteoles absent. Petals yellow, hairy on the outer side. Fruit ovate-oblong, pubescent; Stylopodium conical-mamillate.

Geographical distribution: Iran (Endemic).

Specimens Seen in Iran
Kermanshah: Mirabdollahi 2732 (TARI); Esfahan: Mozaffarian 58251 (TARI); Yazd: Foroughi 1920 (TARI); Tehran: Mozafffarian 63816 (TARI); Arak: Mozaffarian 63799 (TARI). (Fig.1U).

7. *P. eriocarpa* Banks & Sol. Nat. Hist. Aleppo, ed. 2 [A. Russell] 2: 249. 1794.
= *P. tenuis* Sieber ex Schultes (1820) non Wolff (1972); *P. moabitica* Post, (1895).

Characteristics
Plant annual, erect, puberulous or in upper parts glabrous. Basal leaves simple, lamina round or ovate, with petiole and sheath. Cauline leaves ovate or triangular or triangular-ovate, 1-3-pinnate, with petiole and sheath or in upper leaves only with sheath. Rays 2-14, almost equal; Pedicels 7-19, almost equal. Without Bracts and Bracteoles. Petals white or pink, obcordate or obovate, hairy on base of the outer side. Fruit ovate, pubescent; Stylopodium elongate-conical; Styles glabrous.

Geographical distribution: Southeast of Anatolia, Palestine, North of Syria, Iraq, West and South of Iran.

Specimens Seen in Iran
Bushehr: Runemark & Mozaffarian 26825 (TARI), Runemark & Mozaffarian 26889 (TARI), Runemark & Mozaffarian 27104 (TARI); Chaharmahal & Bakhtiari: Mozaffarian 54668 (TARI), Mozaffarian 54902 (TARI), Mozaffarian 59903 (TARI), Nowroozi 2636 (TARI), Mozaffarian 54480 (TARI); Fars: Kasi 413 (W), Mozaffarian 45839 (TARI), Mozaffarian 45877 (TARI), Wendelbo & Foroughi 17778 (TARI), Assadi & Sardabi 41798 (TARI), Riazi 9285(TARI), Riazi 9305 (TARI); Hormozgan: Mozaffarian 44369 (TARI), Mozaffarian 44686 (TARI), Mozaffarian 44817 (TARI), Foroughi 16154 (TARI), Mozaffarian 59163 (TARI), Ghahreman & Mozaffarian 5598 (TUH), Mozaffarian & Banihashemi & Shahinzadeh 39780 (TARI), Foroughi 16122 (TARI), Mozaffarian 44957 (TARI), Mozaffarian & Banihashemi & Shahinzadeh 39472 (TARI), Foroughi 1174 (TARI), Mozaffarian 49944 (TARI); Ilam: Jacobs 6838 (W); Khuzestan: Riazi 9501 (TARI), Assadi & Abouhamzeh 38767 (TARI), Assadi & Abouhamzeh 38745 (TARI), Assadi & Abouhamzeh 38728 (TARI), Riazi 9421 (TARI), Assadi & Abouhamzeh 39033 (TARI); Kohgiluye & Boyerahmad: Bakhtiar & Iravanzadeh 3 (TARI); Lorestan: Koelz 15721 (W), Veiskarami 24019 (TUH), Raehani 25124 (TARI), Iranshahr & Moussavi 40299-E (W). (Fig. 1H).

8. *P. gedrosiaca* Bornm. Beih. Bot. Centralbl. lix. E. 294. 1939.
= *Trachyspermum gedrosiacum* (Bornm.) Hedge, (1987).

Characteristics
Plant perennial, prostrate, pubescent. Basal leaves triangular-ovate, 3-4-pinnate, petiolate. Cauline leaves similar to basal leaves but reduced, 1-4-pinnate. Rays 5-8, unequal; Pedicels 10-20. Bracts 5, linear-lanceolate; Bracteoles 5-8, linear-lanceolate. Petals white or red, ovate, hairy on the outer side. Fruit ovate, pubescent; Stylopodium conical.

Geographical distribution: Iran (Endemic).

Specimens Seen in Iran
Baluchestan: Mozaffarian 53039 (TARI), Mozaffarian 53087 (TARI), Mozaffarian 22844 (TARI). (Fig.1D).

9. *P. khayyamii* Mozaff. Bot. Zhurn. (Moscow & Leningrad) 88(4): 122 (-123; fig. 7). 2003.

P. khayyamii is also one of the endemic species in Iran and its distribution is limited to a small part in east of Iran.

Characteristics
Plant perennial, erect, pubescent. Basal leaves 1-pinnate, ovate or narrow ovate, with petiole and sheath. Cauline leaves absent or reduced, lanceolate or narrow ovate or linear, simple or 1-pinnate, with petiole and sheath or in upper leaves without petiole.

Rays 3-12, unequal; Pedicels up to 8, unequal. Bracts rarely 1(-2), lanceolate; bracteoles rarely 1, linear. Petals white, obcordate or ovate, glabrous or puberulous. Fruit ovate, glabrous; Stylopodium depressed; Styles glabrous.

Geographical distribution: Iran (Endemic).

Specimens Seen in Iran

Khorasan: Mozaffarian 48943 (TARI), Mozaffarian 48910 (TARI), Mozaffarian 48633 (TARI), Mozaffarian 48672 (TARI). (Fig. 1I).

10. *P. khorasanica* Engstrand, Fl. Iranica [Rechinger] 162: 328. 1987.

This species is endemic in Iran and distributes only in the east.

Characteristics

Plant perennial, erect, pubescent or sometimes in upper parts subglabrous. Basal leaves ovate or narrow ovate, 1-pinnate with petiole and sheath. Cauline leaves triangular, lanceolate, narrow ovate, subulate or linear, simple or 1-pinnate, with petiole and sheath or upper leaves only with sheath. Rays 2-7, totally unequal; pedicels 3-15, unequal. Without Bracts and Bracteoles. Petals white, obcordate or obovate, hairy on the outer side. Fruit ovate, pubescent; Stylopodium mamillate; Styles glabrous.

Geographical distribution: Iran (Endemic).

Specimens Seen in Iran

Khorasan: Iranshahr & Zargani 15356-E (W), Termeh & Moussavi & Tehrani 41506-E (W), Iranshahr & Zargani 40398-E (W), Iranshahr 15348-E (W), Assadi & Masoumi 21371 (TARI), Assadi & Masoumi 21382(TARI). (Fig. 1J).

11. *P. kotschyana* Boiss., Ann. Sci. Nat., Bot. sér. 3,1: 133. 1844.

= *P. apiifolia* Boiss., (1849); *P. corymbosa* Boiss. var. *kotschyana* (Boiss.) Post, (1896); *Athamantha hemisphaerica* Stapf & Wettst., (1886), (1905); *P. haussknechtii* Rech.f. & H.Riedl, (1961).

Characteristics

Plant perennial, monocarpic, erect, pubescent, stem corymbosely branched. Basal leaves oblong, ovate or triangular, 1-3-pinnate, with petiole and sheath. Cauline leaves ovate or triangular-ovate or lanceolate-subulate, simple or 1-3-pinnate, with petiole and sheath or in upper leaves only with sheath. Rays 5-21, almost equal; Pedicels 7-21, unequal. Bracts (0-)1-5(-7), lanceolate or pinnate; Bracteoles 1-5(-9), linear or lanceolate. Petals white, obcordate, hairy along the midrib on the outer side. Fruit ovate or globose, pubescent; Stylopodium depressed; Styles puberulous.

Geographical distribution: Anatolia, North of Iraq, Iran.

Specimens Seen in Iran

Azarbaijan: Lamond & Iranshahr 40841 (W), Rechinger 42130 (W), Mozaffarian 70047 (TARI), Zehzad & Siami 3448 (TARI), Mozaffarian 87417 (TARI), Rechinger 42110 (W), Mozaffarian 70043(TARI), without collector 3011(TARI); Chaharmahal & Bakhtiari: Mozaffarian 57358 (TARI), Mozaffarian 57866 (TARI), Mozaffarian 57499 (TARI); Hamedan: Mozaffarian 65066 (TARI), Mozaffarian 64580 (TARI); Kermanshah: Assadi 60698 (TARI), Hamzehee 1180 (TARI), Attar & Mirtajadini & Sheikholeslami 19878 (TUH), Hamzehee & Hatami 1347 (TARI); Kordestan: Rechinger 49135 (W), Fattahi & Tavakoly & Hatami 2409 (TARI), Rechinger 42748 (W), Fattahi & Khaledian 219 (TARI), Assadi 60515 (TARI), Assadi 75263 (TARI), Ghahreman & Mozaffarian 18287 (TARI), Rechinger 42893 (W), Rechinger 42509 (W), Rechinger 42993 (W), Babakhanlou 31032 (TARI), Rechinger 43118 (W); Markazi: Mozaffarian 64081 (TARI), Mozaffarian 63861 (TARI); Tehran: Assadi & Jamzad 55262 (TARI), Rechinger 53815 (W); Zanjan: Sabeti 22068 (TARI). (Fig. 1K).

12. *P. oliverioides* Boiss. & Hausskn. ex Boiss. Fl. Orient. [Boissier] 2: 871. 1872.

Characteristics

Plant perennial, monocarpic, erect, pubescent, stem corymbose- branched. Basal leaves ovate-oblong, ovate or triangular-ovate, 1-3-pinnate, with petiole

and sheath. Cauline leaves ovate, triangular-ovate or lanceolate, simple or 1-2-pinnate, with petiole and sheath, sometimes petiole absent. Rays 5-13(-16), almost equal; Pedicels 8-26, almost equal. Bracts 2-9, linear, lanceolate or sometimes pinnate; Bracteoles 5-15, linear or narrow lanceolate. Petals white, obcordate, hairy on the outer side. Fruit ovate or subglobose, pubescent; Stylopodium depressed; Styles puberulous.

Geographical distribution: Iran, Iraq.

Specimens Seen in Iran
Kermanshah: Attar & Mirtajadini & Sheikholeslami 19928 (TUH); Kohgiluye & Boyerahmad: Behboudi 1191-E (W), Assadi & Mozaffarian 31146 (TARI); Kordestan: Rechinger 43084 (W), Attar & Dadjou & Mehdigholi & Okhovat 14278 (TUH), Mozaffarian 87376 (TARI); Lorestan: Rechinger 47676 (W), Assadi & Mozaffarian 37025 (TARI), Assadi & Mozaffarian 37199 (TARI), Assadi & Mozaffarian 37053 (TARI), Koelz 18445 (W), Koelz 18232 (W); Markazi: Mozaffarian 48290 (TARI).(Fig. 1L).

13. *P. olivieri* Boiss. Ann. Sci. Nat., Bot. sér. 3, 1: 132. 1844.

Characteristics
Plant perennial, monocarpic, erect, pubescent to subglabrous or sometimes in upper parts glabrous, stem corymbosely branched. Basal leaves oblong, ovate or narrow ovate, 1-3-pinnate, with petiole and sheath. Cauline leaves ovate, oblong, triangular-ovate or lanceolate, simple or 1-2-pinnate, with petiole and sheath, sometimes petiole absent. Rays 3-17, unequal; Pedicels 5-15, unequal. Bracts 0-5, oblong-narrow lanceolate; Bracteoles 0-5, linear. Petals white, obovate or obcordate, glabrous or hairy on the outer side. Fruit ovate-elliptic to globose, tuberculate or papillate; Stylopodium mamillate or depressed-conical; Styles glabrous.

Geographical distribution: Syria, Iraq, West of Iran.

Specimens Seen in Iran
Kermanshah: Farahbakhsh 6126-E (W); Khuzestan: Riazi 9396 (W); Lorestan: Koelz 18628 (W); Markazi: Mozaffarian 11115 (TUH). (Fig. 1M).

14. *P. pastinacifolia* H.Wolff. Pflanzenr. (Engler) Umbellif.-Apioid.-Ammin. 226 (1927).
= *Reutera pastinacifolia* Boiss. (1844).

This is one of the endemic species of Iran and distributes in the West and South.

Characteristics
Plant perennial, erect, puberulous or subglabrous. Lower leaves ovate or oblong-ovate, 1-pinnate, with petiole and short sheath. Upper leaves lanceolate or linear-lanceolate, simple or 1-pinnate, usually without petiole and only with sheath. Rays 3-6(-10), almost equal; Pedicels 6-10, almost equal. Without Bracts and Bracteoles. Petals yellow, ovate, hairy on the outer side. Fruit ovate, glabrescent; Stylopodium mamillate; Styles glabrous.

Geographical distribution: Iran (Endemic).

Specimens Seen in Iran
Kordestan: Haussknecht *s.n.* (W). (Fig. 1N).

15. *P. peucedanifolia* Fisch. ex Ledeb. Fl. Ross. (Ledeb.) 2(1,5): 256. 1844.

Characteristics
Plant perennial, erect, in lower parts pubescent, in upper parts subglabrous. Basal leaves ovate-oblong, ternate-pinnate, with petiole and sheath. Cauline leaves ovate, triangular, lanceolate or linear, simple or 1-2-pinnate, usually only with sheath. Rays 4-10(-17), unequal; Pedicels 6-15, unequal. Bracts and bracteoles absent, or rarely with 1-2 linear or lanceolate bracts. Petals white or pink, ovate, glabrous or hairy on the outer side. Fruit oblong-ovate, glabrous; Stylopodium mamillate; Styles glabrous.

Geographical distribution: Turkey, Iran, Soviet Units.

Specimens Seen in Iran

Azarbaijan: Mozaffarian 72750, 74894 (TARI), Akbarzadeh 41 (TARI), Zehzad 3214 (TARI), Sabeti 8804 (TARI), Moazffarian 77150 (TARI). (Fig. 1O).

16. *P. puberula* Boiss. Ann. Sci. Nat., Bot. sér. 3, 1: 129. 1844.

= *Ptychotis puberula* DC. (1830); Pimpinella petraea Nab. (1923); *P. cretica* Poir. var. *petraea* (Nab.) Zohary (1972).

Characteristics

Plant annual, erect, pubescent. Basal leaves simple, lamina round or ovate, with petiole and sheath. Cauline leaves ovate or triangular, simple or 1-4-pinnate, with or without petiole. Rays 3-26, unequal; Pedicels 5-25, unequal. Without Bracts and Bracteoles. Petals white, obcordate, hairy on the outer side. Fruit ovate or ovate-globose, pubescent; Stylopodium depressed; Styles glabrous.

Geographical distribution: Southeastern of Anatolia, Jordan, Iraq, Iran, Turkmenistan, Afghanistan, Northwestern of Pakistan.

Specimens Seen in Iran:

Chaharmahal & Bakhtiari: Mozaffarian 54979 (TARI), Koelz 15446 (W); Esfahan: Yusefi 1568 (TARI); Gilan: Lamond & Iranshahr in Rechinger 40969 (W), Sabeti 22523 (TARI); Hormozgan: Mozaffarian & Banihashemi & Shahinzadeh 39571 (TARI), Mozaffarian 49557 (TARI); Khorasan: Iranshahr 15355-E (W), Assadi & Masoumi 21397 (TARI), Assadi & Mozaffarian 35991 (TARI), Assadi & Massoumi 21242 (TARI), Assadi & Mozaffarian 36123 (TARI); Khuzestan: Iranshahr & Moussavi 40393-E (W), Mozaffarian 72143 (TARI), Mozaffarian 72252 (TARI); Kordestan: Rechinger 42981 (W); Lorestan: Rechinger 5722 (W), Safaeian 498 (TARI), Runemark & Lazari 26111 (TARI);Semnan: Assadi 56643 (TARI), Wendelbo & Foroughi 13005 (TARI), Riazi 8816 (TARI);Sistan: Mozaffarian 63462 (TARI), Valizadeh, T.Ramak Maasoumi 72 (TARI);Tehran: Babakhanlou & Amin & Bazargan 22244 (TARI), Assadi & Mozaffarian & Jamzad 33573 (TARI), Bighdeli 78405 (TARI), Sabeti 22026 (TARI).(Fig. 1P).

17. *P. rhodantha* Boiss. Asie Min., Bot. (P.A. Tchichatscheff) i. 414. 1860.

= *P. dissecta* M.B. (1808).

Characteristics

Plant perennial, erect, glabrous or puberulous. Basal leaves oblong-ovate, 1-2-pinnate, with petiole and sheath. Cauline leaves ovate or narrow ovate, 1-2-pinnate, with petiole and sheath or only with sheath. Rays 9-20, almost equal; Pedicels 12-20, almost equal. Without Bracts and Bracteoles. Petals white or pink, obcordate, glabrous or hairy on the outer side. Fruit ovate, glabrous; Stylopodium depressed; Styles glabrous.

Geographical distribution: Eastern part of Anatolia, Northern part of Iran, Armenia.

Specimens Seen in Iran

Azerbaijan: Lamond & Terme 9926 (W). (Fig. 1Q).

18. *P. saxifraga* L., Sp. Pl. 1: 263. 1753.

= *P. rotundifolia* Scop. (1772); *P. calverti* Boiss. (1856); *P. saxifrage* L. var. *dessectifolia* Boiss. (1872); *P. saxifrage* L. subsp. *eusaxifraga* Thellung (1926).

Characteristics

Plant perennial, erect, puberulous or subglabrous. Basal leaves oblong-ovate, 1-pinnate, with petiole and sheath. Cauline leaves ovate or linear-lanceolate, simple or 1-pinnate, without petiole and only with sheath. Rays 5-18, almost equal; Pedicels 7-25, almost equal. Bracts absent or rarely up to 5, linear or subulate; Bracteoles absent or rarely up to 5, linear. Petals white, obcordate or obovate, glabrous or hairy on the outer side. Fruit ovate or elliptic, glabrous; Stylopodium depressed-mamillate; Styles glabrous.

Geographical distribution: Europe to center and southwestern part of Asia.

Specimens Seen in Iran

Azarbaijan: Terme 13654-E (W), Akbarzadeh 10 (TARI), Runemark & Assadi 21886 (TARI). (Fig. 1R).

19. *P. tragioides* (Boiss.) Benth. & Hook.f. ex Drude in Engler & Prantl, Natürl. Pflanzenfam. III., 8: 196. 1898.

This is one of the other species in Iran and it distributes in North, West and Center of Iran.

Characteristics

Plant perennial, erect, usually glabrous sometimes in lower parts pubescent. Basal leaves oblong, 1-pinnate, with petiole and sheath. Cauline leaves ovate or linear-subulate, simple or 1-pinnate, with petiole and sheath or sometimes only with sheath. Rays 2-11, almost equal; Pedicels 3-13, almost equal. Bracts and bracteoles absent or rarely with 1-2 linear bracteoles. Petals yellow, ovate, glabrous or hairy on the outer side. Fruit ovate-elliptic, glabrous or puberulous; Stylopodium mamillate; Styles glabrous.

Geographical distribution: Iran (Endemic).

Specimens Seen in Iran

Azarbaijan: Foroughi & Assadi 13716 (W), Grant 16228 (W), Rechinger 32668 (W); Mazandaran: Auch. 4604 (W);Tehran: Gauba 889 (W), Terme 13682-E (W), Terme 14021-E (W). (Fig.1S).

22. *P. tragium* Vill., Prosp. Hist. Pl. Dauphiné 24. 1779.

Characteristics

Plant perennial, erect or sometimes prostrate, usually pubescent to subglabrous in upper parts. Basal leaves ovate or oblong-ovate, 1-pinnate, with petiole and sheath. Cauline leaves ovate, triangular-ovate, lanceolate or linear, simple or 1-pinnate, with petiole and sheath or sometimes petiole absent. Rays 2-34, equal or unequal; Pedicels 5-26. Bracts absent or with 1(-2) linear-lanceolate bracts; Bracteoles 0-5, linear or subulate. Petals white, obcordate, hairy on the outer side. Fruit ovate or rarely subglobose, pubescent; Stylopodium mamillate; Styles glabrous.

Geographical distribution: Southern and Central part of Europe, Northern part of Africa, Southwestern of Asia.

Specimens Seen in Iran

Ardebil: Lamond 4709 in Rechinger 44044 (W), Said Amini 24140 (TARI), Rajamand 8853 (TARI), Mozaffarian & Nowrozi 34212 (TARI), Mozaffarian & Nowrozi 35000 (TARI), Rechinger 43483 (W), Wendelbo & Assadi 18453 (TARI), Mozaffarian & Mohammadi 37757 (TARI), Zehzad & Jamzad & Taheri & Izadpanah 70490 (TARI); Azarbaijan: Rechinger 49346 (W), Tarighi 11174 (TUH), Rechinger 48874 (W), Termeh & Moussavi & Habibi 38801 (W),Runemark & Assadi 21857 (TARI), Assadi & Sardabi 24192 (TARI), Mozaffarian & Nowrozi 35177 (TARI), Mozaffarian & Mohammadi 37400, 37509 (TARI), Rechinger 43904 (W), Mozaffarian & Mohammadi 37675 (TARI), Rechinger 43547 (W), Olfat & Jabbari 284 (TARI), Rechinger 49345 (W), Mozaffarian 69927 (TARI), Rechinger 41861 (W), Assadi & Taheri & Izadpanah 68477 (TARI), Rechinger 48738 (W), Rechinger 43940 (W), Assadi & Olfat 68911 (TARI), Assadi & Mozaffarian 30466 (TARI); Chaharmahal & Bakhtiari: Mozaffarian 57254 (TARI), Mozaffarian 57221 (TARI), Mozaffarian 57586 (TARI), Mozaffarian 57526 (TARI), Mozaffarian 58112 (TARI); Esfahan: Renz in Rechinger 47653 (W); Fars: Mozaffarian 45790 (TARI); Gilan: Hariri & Foroughian 22148, 22149 (TARI); Golestan: Rechinger 6060 (W), Amini 8814 (TARI), Wendelbo & Foroughi53133 (W), Wendelbo & Cobham 14244 (TARI), Wendelbo & Foroughi 12670 (TARI), Assadi & Masoumi 21506 (TARI); Hamedan: Mozaffarian 64966 (TARI), Safaeian 693 (TARI); Kermanshah: Hamzehee 1244 (TARI), Assadi 60698 (TARI); Khorasan: Rechinger 1666, 4785 (W), Rechinger 1639 (W), Mozaffarian 48850 (TARI), Edmondson 1291 (TARI), Assadi & Masoumi 21437 (TARI), Mozaffarian 48738 (TARI), Mozaffarian 48424 (TARI), Mozaffarian 48495 (TARI), Saghafi & Mohammadzadeh 87 (TARI), Rechinger 53547 (W); Kohgiluye & Boyerahmad: Assadi & Abouhamzeh

46392 (TARI), Assadi & Mozaffarian 31476 (TARI), Assadi & Mozaffarian 31406 (TARI); Kordestan: Rechinger 42837 (W), Assadi 60478 (TARI), Mozaffarian 71597 (TARI), Assadi 60612 (TARI), Zehzad & Siami 2960 (TARI), Rechinger 42775 (W), Fattahy & Khaledian 117 (TARI), Lamond & Terme in Rechinger 42554 (W), Ghahreman & Mozaffarian 18294 (TUH), Rechinger 42912 (W); Lorestan: Mozaffarian & Sardabi 42512 (TARI), Runemark & Lazari 26140 (TARI), Assadi & Mozaffarian 37181, 37182 (TARI), Mozaffarian & Sardabi 42458 (TARI), Runemark & Lazari 26552 (TARI); Markazi: Mozaffarian 64175 (TARI), Mozaffarian 63768 (TARI), Mozaffarian 64147 (TARI), Mozaffarian Maassoumi 47744 (TARI), Mozaffarian 48228 (TARI), Mozaffarian 63741(TARI), Mozaffarian 48234 (TARI), Mozaffarian 63941(TARI), Mozaffarian 63984 (TARI), Mozaffarian 48314 (TARI); Mazandaran: Terme 13670-E, 13672-E (W), Terme 15327-E (W), Furse 2760 (W), Rechinger 860 (W), Assadi & Maasoumi 51467 (TARI), Foroughi 455(TARI), Pabot 4818 (TARI), Assadi & Mozaffarian 33045 (TARI), Runemark & Masoumi 21813 (TARI), Assadi & Maasoumi 51345 (TARI), Assadi & Maasoumi 51203 (TARI); Qazvin: Assadi & Mozaffarian 36639, 36651 (TARI), Assadi & Maasoumi 50942 (TARI), Babakhanlou & Amin 21890 (TARI), Babakhanlou & Amin 22218 (TARI), Babakhanlou & Amin 22213 (TARI), Mirfakhrai 23154 (TARI), Assadi & Maasoumi 51043 (TARI); Semnan: Renz & Iranshahr 16811 (W), Rechinger 56350 (W), Assadi & Mozaffarian 40561, 40624 (TARI), Assadi & Masoumi 21545 (TARI), Assadi & Mozaffarian 40655 (TARI);Tehran: Moussavi, Habibi & Tehrani 39732-E (W), Wendelbo & Assadi 13265 (W), Pabot 4400(TARI), Termeh & Matin 36505-E (W), Rechinger 1172 (W), Dini & Arazm 22332 (TARI), Assadi & Mozaffarian 33201 (TARI), Amin 21916 (TARI), Babakhanlou & Amin 21915 (TARI), Amin & Bazargan 19516 (TARI), Babakhanlou & Amin 21932 (TARI), Hariri 11116 (TUH), Dini & Arazm 22404 (TARI), Pabot 4157 (TARI), Dini & Arazm 22193 (TARI), Dini & Arazm 22282 (TARI), Dini & Arazm 22299 (TARI). (Fig. 1T).

Dicussion

After taxonomical studies on genus *Pimpinella* L. in Iran some of the most important characters are selected (Table 1).

Based on these characters and by means of NTSYS, a dendrogram was sketched giving the following results (Fig. 2):

In this dendrogram two major clusters are seen:
The first (upper) cluster falls into two subclusters including 13 species.The second one in turn, has two subclusters, including seven species.

In the upper cluster and in the first subcluster four species (*P. affinis*, *P. barbata*, *P. eriocarpa* and *P. puberula*) can be separated from the others at 0.54. *P. barbata*, *P. eriocarpa* and *P. puberula* are the annual species of genus *Pimpinella* in Iran whereas *P. affinis* is a biennial one. These are mainly distributed in western and southern parts of Iran. However, *P. puberula* is also distributed in central and eastern parts. Among these annual species, *P. barbata*, can be distinguished by linear-filiform leaf segments. Other two annuals are morphologically similar to each other.

In addition, these two species were placed close to each other in a recent research (Tabanca *et al.*, 2005) based on DNA sequence data. The main difference between them is that the stylopodium shape in ripe fruit is depressed in *P. puberula* and elongate-conical in *P. eriocarpa*. These two species are separated at 0.90.

The Second subcluster of this cluster includes nine species which are categorizesd in two groups. In this clade *P. anisactis*, *P. khorasanica*, *P. khayyamii* & *P. tragium* forms the first group. These four species have some common morphological similarities. In addition, the first three species are ecologically very close to each other. They are endemic to Iran and are distributed only in a small part of Khorasan province. On the other hand, the first two species (*P. anisactis*

and *P. khorasanica*) are separated from the other two at 0.75. the characteristics of *P. khayyamii* and *P. tragium* are: absence of petiolule in lower cauline leaves, absence or presence of bract and bracteole and relative size of rays (equal or almost unequal) whichare can be considered as the differences between these two speciesand *P.anisactis* - *P. khorasanica*.The dissimilarity between *P. anisactis* and *P. khorasanica* is in basal leaves shape (triangular-ovate in *P. anisactis* and ovate or narrow ovate in *P. khorasanica*), length of petiolule of basal leaves (7-15 mm in *P. anisactis* and 1-7 mm in *P. khorasanica*), division type of lower cauline leaves (1-2-pinnate in *P. anisactis* and 1-pinnate in *P. khorasanica*) and division type of upper cauline leaves (simple or 1-pinntae in *P. anisactis* and simple in *P. khorasanica*). These two species are separated from each other at 0.84. On the other hand *P. tragium* can be distinguished from *P. khayyamii* at 0.90 by absence of petiolule in basal leaves and pubescent fruits.

The species of the second group belong to Reutera group and the most important difference between these species and others is their yellow petals. Here, at first *P. aurea* is discerned from others at 0.80 due to its 2-3-pinnate basal leaves, 1-2-pinnate lower cauline leaves and subglobose ripe fruits. Then other two species, *P. deverroides* and *P. tragioides* can be distinguished at 0.90 based on pubescent ripe fruits in *P. deverroides* while in *P. tragioides* ripe fruits are puberulous or subglabrous. At 0.92, *P. dichotoma* and *P. pastinacifolia* are also discriminated based on pubescent ripe fruits in *P. dichotoma* and glabrescent ripe fruits in *P. pastinacifolia*.

The second (lower) major cluster consists of seven species in two subclusters: four of them (*P. kotschyana*, *P. oliverioides*, *P. olivieri* and *P. gedrosiaca*) are in one subcluster and three other species (*P. peucedanifolia*, *P. rhodantha* and *P. saxifraga*) are in the second one. These two subclusters are discerned at 0.56.

In the first subcluster, at 0.67, *P. gedrosiaca* is well-defined from the other three species by its characteristic of prostrate life form. In the same way, in the group of three species, *P. olivieri* can be clearly discerned at 0.77 based on presence of vesicle or papilla instead of hair in its fruits. *P. kotschyana* and *P. oliverioides* can be separated at 0.87. The differences of *P. oliverioides* and *P. kotschyana* are: absence of petiolule in basal leaves and distribution type of hair in petals (only along the midrib on the outer side) in *P. kotschyana* while *P. oliverioides* has petiolulate basal leaves and its petals are hairy at whole outer side. In the last group of the second subcluster, *P. peucedanifolia* is clearly separated from *P. saxifrage* and *P. rhodantha* by ovate oblong fruits. On the other hand *P. saxifraga* and *P. rhodantha* are separated from each other at 0.80. These are morphologically similar. Also it has been presented that the DNA sequence data strongly support *P. saxifraga* and *P. rhodantha* as sister taxa (Tabanca *et al.*, 2005). But they can be distinguished by division type of their basal leaves (1-pinnate in *P. saxifraga* and 1-2-pinnate in *P. rhodantha*), petiolule of basal leaves (absent in *P. saxifraga* and present in *P. rhodantha*), absence of bract and bracteole and pinkish petals that are rarely seen in *P. rhodantha*.

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References

Downie SR, Spalik K, Katz-Downie DS, Reduron JP. 2010. Major clades within Apiaceae subfamily Apioideae as inferred by phylogenetic analysis of nrDNA ITS sequences. Plant Diversity and Evolution **128 (1-2),** 111-136.

Hedge IC, Lamond JM, Rechinger KH. 1988.

Flora Iranica vol. 162: Umbeliferae. Akademische Druck-U. Verlogsanstalt. Graz- Austria.

Khajepiri M, Ghahremaninejad F, Mozaffarian V. 2010. Fruit anatomy of the genus Pimpinella L. (Apiaceae) in Iran. Flora- Morphology, Distribution, Functional Ecology of Plants, **205(5),** 344-356.

Mozaffarian V. 2003. New species and new records of Iranian Umbelliferae. Bot. Jour. **88(4),** 104-124.

Mozaffarian V. 2007. In: Assadi, M., Maassoumi, A.A., Khatamsaz, M. (Eds.). Flora of Iran 54. Research Institute of Forests and Rangelands. Tehran, Iran.

Pimenov MG, Leonov MV. 1993. The Genera of Umbelliferae: A nomenclator. Kew: Royal Botanic Garden.

Pimenov MG, Leonov MV. 2004. The Asian Umbelliferae Biodiversity Database (ASIUM) with particular reference to South-West Asian taxa. Turkish Journal of Botany **28,** 139-145.

Rohlf FJ. 2000. NTSYS-pc. Numerical taxonomy and multivariate analysis system, version 2.1. Exeter software. Setauket, New York, USA.

Sneath PHA, Sokal RR. 1973. Numerical taxonomy: the principles and practice of numerical classification. W. H. Freeman, San Francisco, California, USA.

Sokal RR, Michener CD. 1958. A statistical method for evaluating systematic relationships. University of Kansas Science Bulletin **38,** 1409-1438.

Tabanca N, Douglas AW, Bedir E, Dayan FE, Kirimer N, Baser KH, Aytac Z, Khan IA, Scheffler BE. 2005. Patterns of essential oil relationships in *Pimpinella* (Umbelliferae) based on phylogenetic relationships using nuclear and chloroplast sequences. Plant Genetic Resources **3(2),** 149-169.

Zakharova EA, Degtjareva GV, Pimenov MG. 2012. Redefined generic limits of Carum (Umbelliferae, Apioideae) and new systematic placement of some of its taxa. Willdenowia-Annals of the Botanic Garden and Botanical Museum Berlin-Dahlem **42(2),** 149-168.