

EXPERIMENTAL TAXONOMY OF THE GENUS SALIX L. (SALICACEAE) IN IRAN

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Received 10.05.2008. Accepted for publication 5.03.2009

Maassoumi, A. A., 2009 06 30: Experimental taxonomy of the genus *Salix* L. (*Salicaceae*) in Iran. - *Iran. J. Bot.* 15 (1): 3-20. Tehran.

The genus *Salix* in Iran is revised. In this study a living collection of the species in Iran was prepared and used in taxonomic and experimental studies. As a result of this study the total number of species in Iran was increased from 12 to 31. Also, 7 hybrids were recognized in Iran.. The species *S. daviesii*, *S. dinsmorei*, *S. persica* and *S. australior* were excluded from the synonymy of their related species, *S. acmophylla* and *S. excelsa*. Comparing the species in natural habitats and in cultivation several cryptic characters were reevaluated for preparing the key and descriptions. *S. zygostemon* is shown to be a biparental hibrid of *S. cinerea* and *S. elbursensis*. Several new records for Iran such as: *S. daviesii*, *S. persica*, *S. dinsmorei*, *S. australior*, *S. tetrasperma*, *S. fragilis*, *S. denticulata*, *S. pentandra*, *S. atrocinerea*, *S. cinerea*, *S. caprea*, *S. pedicellata* subsp. *pedicellata*, *S. pseudomedemii*, *S. caucasica*, *S. caspica*, and *S. fedtschenkoi* were recognized. *S. firouzkouhensis*, *S. lacus-tari*, *S. viridiformis* and *S. elymaitica* for the first time is described. For all species occurring in Iran key, short notes, habitat, distribution and general distribution are given. All living plants are in Karaj experimental station and the herbarium materials are preserved in the National Herbarium of Iran (TARI).

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Key words. *Salix*, Taxonomy, experimental studies, Iran, new species, distribution.

جنس بید با تأسیس بیدستان در محیط یکنواخت که از قسمت‌های مختلف ایران جمع‌آوری شده بودند به طور تجربی و تاکسونومیکی کاملاً مرور شده‌اند. در این مطالعه تعداد کلی گونه‌های بید از ۱۲ عدد به ۳۱ گونه منفک و ۷ دورگ افزایش یافته است. در این تحقیق *S. issatissensis* از *S. excelsa* var. *rodonii* به عنوان گونه مستقل ابقاء شده است و گونه‌های *S. daviesii*، *S. dinsmorei* و *S. persica* و *S. australior* از حالت مترادفی از گونه‌های *S. acmophylla* و *S. excelsa* استخراج شده و به عنوان گونه‌های مستقل و پایدار معرفی شده‌اند. با مقایسه نمونه‌های جمع‌آوری شده از طبیعت با نمونه‌های کاشته شده و صفات پنهانی، برای کلید شناسایی و شرح گونه‌ها دوباره ارزیابی شده‌اند. *S. zygostemon* به عنوان یک دورگ دوالدی از *S. cinerea* و *S. elbursensis* معرفی می‌گردد. گونه‌های زیر برای اولین بار از ایران گزارش می‌گردد.

S. tetrasperma, *S. dinsmorei*, *S. pedicellata* subsp. *pedicellata*, *S. caprea*, *S. cinerea*, *S. atrocinerea*, *S. fedtschenkoi*, *S. caspica*, *S. caucasica*, *S. daviesii*, *S. persica*, *S. australior*, *S. pentandra*, *S. denticulata*, *S. fragilis*, *S. pseudomedemii*.

گونه‌های زیر به عنوان گونه جدید معرفی می‌گردند.

S. lacus-tari, *S. viridiformis*, و *S. elymaitica*, *S. firouzkouhensis*.

برای همه گونه‌ها یادداشت کوتاه، اطلاعات رویشگاه، پراکنندگی در ایران و پراکنندگی جهانی داده شده است. همه گیاهان زنده در ایستگاه تجربی کرج و نمونه‌های هرباریومی در هرباریوم مرکزی ایران نگهداری می‌گردند.

INTRODUCTION

The species of the genus *Salix* are deciduous trees and shrubs, much larger and more complicated than the genus *Populus* in *Salicaceae* family. From the time of Linnaeus representation of a reasonable grouping of all species of the genus *Salix* to subgenera and sections has been a subject of disagreement. Scopoli (1760) presented a classification system in which the basis of his morphological concept was deeply different from that of Linnaeus. Then the revisional works of the whole genus were provided by several authors (Dumortier 1825, 1862; Rafinesque 1817, 1838; Schneider 1904, 1918; Seringe 1815; Koch 1828) but partly without delimitation of infrageneric ranks or using unusual ranks, in few cases the infrageneric ranks were presented without correct pagination (Dumortier 1825). The first monumental revision of the genus solved nearly all nomenclatural complexities (Wimmer 1854; De Candolle 1832; Andersson 1867). Other publications concerning the genus from European and non-European parts (Far-East, Japan; West Asia, China and East Asia, India) gave nearly a clear concept of the genus (Andersson 1845, 1851, 1858a, 1858b, 1858c). Later on, numerous Salicologists in their regional or local revisions totally used and omitted contradictory infrageneric classifications, particularly on the sections, subsection, groups and series (Floderus 1923, 1926a, 1926b, 1930, 1931). With this short introductory history, nearly all fundamental works on the genus *Salix* showing sharp contradictions and discrepancies, not only the realistic systematic position of the species, but also the concept of the species based on morphological and ecological characters (Skvortsov 1955, 1956b, 1957a, 1969). Probably the main reason for disagreements seems to be about the exaggeration of hybridization problems, and partly to be the ecological, seasonal and environmental plasticities which are frequent in the genus. Beside these problems, the adequacy of the fresh materials without paying particularly attention to the *Salix* biology on flowering and fruiting stage seems to be the reasons to creating the collapse in the genus. A short survey on the previous work of Flora Europaea (Rechinger 1964), Flora of the USSR (Nazarov 1936), and Flora of Central Europe (Rechinger in Hegi 1981) are examples.

Based on recent publications (Fang-Zhen 1987, Skvortsov 1999, Argus 1997, 2007, Ohashi 1999) about 526 distinct species are recognized for the genus *Salix* worldwide. Former Soviet Union has 120 species, the New World 103, China 275, Europe 65, Pakistan 26 and Iran 31 and 6 hybrids.

The first attempt on the taxonomy of the genus in Iran and adjacent areas goes back to Flora Orientalis

(Boissier 1879). More investigations have been later provided (Bornmüller 1908, 1915; Görz, 1922, 1933, 1934a, 1934b, 1934c, 1937), then for Iran, Flore de l'Iran (Parsa 1949) the number of species increased to 15. Skortsov (1968) treated the genus and reduced the number of species to 12 distinct species. Later on, in Flora of Turkey (Skvortsov & Edmondson 1982), some more species were reported for Turkey/Iran. In Chorology of Trees and Shrubs in S.W. Asia (Browicz & Zielinsky 1990), some of the species were reduced to synonymy.

According to the new investigations (Hörandl 1992, Elvira & al. 2005, Belyaeva 2005, personal comm.), there are still discussions on the number of species in some groups such as the section *Cinerella*.

In a plan for the establishment of living collections of the Iranian species of the genus *Salix* in Karaj city and also some other cities of Iran, collection of living materials was started by me and some other colleagues in the Research Institute of Forests and Rangelands from 1996. The author as well as collaborating in collection of living materials, took the responsibility to identify them. This was an opportunity for the author to study the materials in the field and also in cultivation. Further studies showed that the number of species in Iran is more than previously known from Iran. Also some new species were formally described (Maassoumi & al. 2008). For better understanding the realistic taxonomic position, the author planned the study of Phylogeny and Molecular analysis by using the sequencing of the nucleotides (Abdollahzadeh 2008), in this investigation the most parsimonious tree was prepared in the form of cladogram; this cladogram showed homoplasy and several polytomies in some groups, but closely supported the taxonomic treatments. In this paper a key to the species is presented, sequence of the species is given, some new taxa are described and some notes on problematic species are considered.

MATERIALS AND METHODS

Specimens

In this study herbarium specimens of TARI, TUH, M, GAZI, ANK and HUB and also living materials in the field and living collection of Karaj were studied. In cases where the species were separated morphologically, sequencing results were used to confirm morphology (Abdollahzadeh 2008).

Taxonomic characters

VEGETATIVE CHARACTERS

In this period all vegetative characters on living plants in the field and the dried specimens such as: vegetative form (trees, shrubs, shrublets): crown direction (erect,

pendulous, semipendulous) crown shape (spherical and elliptic); cortex color (intense green, greenish yellow, brown, chestnut brown, yellow, carmine red etc.); decorticated wood (smooth, scattered striate, dense long striate); physical features of wood (dense compact, fragile, flexible); shape of stipules (abortive stipules, linear, narrowly lanceolate, cordate or reniform, oblique semicordate) and stipule margin and dentation (dentate, glandulose dentate, entire), stipule indumentum (type of indumentum); leaf shape (ovate, obovate); leaf apex; leaf margin (dentate or undulate); leaf base; leaf colour (concolorous or discolorous); petioles; buds (shape, colour, size, direction, scale and position relative to the stem; indumentum (type and direction of the hairs) were considered.

REPRODUCTIVE CHARACTERS

Inflorescence appearance

a) Precocious (catkins clearly appear before the appearance of the leaves, like: *S. aegyptiaca*, *S. cinerea*, *S. caprea*, *S. atrocinerea*, *S. pseudomedemii*, *S. baladehensis*, *S. firouzkuhensis* and *S. zygostemon*). In this type, the catkin shape is thick, short cylindrical to elliptic or spherical with short or long peduncles (phylloclade or brachyblast with presence or absence of cataphylls).

b) Subprecocious (catkins appear together with the leaves, like: *S. alba*, *S. excelsa*, *S. babylonica*, *S. caramanica*, *S. denticulata*). In this type the catkin is narrow and long cylindrical, erect or deflexed, always with long peduncles (brachyblast).

Catkin structure

a) Catkin is male or female, thick or narrow, long or short, erect or deflexed, pedunculate or sessile.

b) Bract characters including shape and size, indumentum, colour (dark black, brown, yellow or pale yellow), and length of bracts comparing to the pedicels.

c) Filament characters such as distinct filaments or adnate filaments, number of filaments, size of filaments, hairs of filaments and anther characters.

d) Ovary and capsule characters including shape, size, indumentum, stipitate or sessile; style size; stigma size, stigma division (bifid or tetrafid) and surface of stigma.

e) Nectaries' shape, size and color.

RESULTS AND DISCUSSION

Salix L., Sp. Pl. 2: 1015. 1753.

LECTOTYPE, designated by Britton and Shafer, 1908: *Salix alba* L.

Sequence of species

I. Subgenus Protitea

Sect. Humboldtianae

1. *S. acmophylla*
2. *S. elymaitica*
3. *S. daviesii*

Sect. Tetraspermae

4. *S. tetrasperma*

II. Subgenus Salix

Sect. Salicaster

5. *S. pentandra*

Sect. Triandrae

6. *S. songarica*
7. *S. triandra*

Sect. Salix

8. *S. fragilis*
9. *S. alba*
10. *S. excelsa*
11. *S. issatissensis*
12. *S. viridiformis*

Sect. Subalbae

13. *S. babylonica*
14. *S. matsudana* var. *tortuosa* (Exotic)

Sect. denticulata

15. *S. denticulata*

Sect. Hastatae

16. *S. fedtschenkoi*

III. Subgenus

sect. Cinerella

17. *S. aegyptiaca*
18. *S. pedicellata* subsp. *pedicellata*
19. *S. cinerea*
20. *S. atrocinerea*
21. *S. caprea*
22. *S. pseudomedemii*
23. *S. baladehensis*
24. *S. firouzkuhensis*

25. *S. lacus-tari*

26. *S. caucasica*

Sect. Helix

27. *S. pycnostachya*

28. *S. caramanica*

29. *S. elbursensis*

30. *S. caspica*

Sect. Cheilophilae

31. *S. wilhelmsiana*

List of hybrids

1. *S.* × *zygostemon* = *S. cinerea* × *S. elbursensis*

2. *S. alba* × *S. babylonica*

3. *S.* × *dinsmorei* = *S. acmophylla* × *S. excelsa*

4. *S. acmophylla* × *S. alba*

5. *S. × viridis* = *S. alba* × *S. fragilis*

6. *S. × persica* = ?*S. acmophylla* × *S. alba*

Key to species

1a- Large trees or shrubs, 4-8 m high. Leaves pale green to nearly silvery, very rarely dark green. Buds oblique, wide angle with twigs, covered with scales; scales with free margin, overlapping each other. Male flowers with 4-5 stamens, very rarely up to 8. Female catkins short and very dense; ovary usually glabrous, rarely hairy 2

-Large trees with erect or pendulous crown or rarely shrubs, up to 40 m high. Leaves dark green or rarely pale green. Buds erect and nearly connate to the twigs, covered with scales; scale margins united to each other. Male flowers with 2-5 stamens. Female catkins long, with numerous capsules; ovary glabrous or hairy 7

2a-Leaves elliptic to ovate, acute, obtuse or retuse, two times longer than the wide 3

- Leaves lanceolate to ovate, narrowly ovate-lanceolate, sharply attenuate toward the apex, c. 5-10 times longer than wide 4

3a-Leaves elliptic, obtuse to retuse or emarginated

2. *S. elymaitica*

-Leaves ovate, abruptly attenuate toward the apex

3. *S. daviesii*

4a-Nectars numerous, close to each other, surrounding the capsule stipe

4. *S. tetrasperma*

- Nectars 1-2, separate from each other at the base of capsule stipe 5

5a- Leaves dark green, leaf margin distinctly dentate. Buds c. 4-5 mm long

***S. × dinsmorei* (*S. acmophylla* × *S. excelsa*)**

- Leaves pale green or bluish green, margin minutely dentate or entire 6

6a-Leaves pale green, sparsely hairy or glabrescent in age; margin entire or minutely undulate or shortly dentate; lower surface silvery. Male flowers downward, with 5 distinct stamens. Female catkins with dense capsule; capsules glabrous

1. *S. acmophylla*

-Leaves pale green, densely hairy, at the margin dentate, both sides concolor. Male flowers with 5 distinct downward stamens. Female catkins with dense capsule, capsules hairy

***S. × persica* (*S. acmophylla* × *S. alba*)**

7a-Large trees, with wide trunks, longitudinally furrowed. Crowns erect or pendulous. Male flowers with 2-4 distinct or jointed stamens 8

-Large trees or small shrubs, with main stems or without main stems, in this case numerous shoots at the base. Male flowers with 2-5 stamens; stamens free or filaments connate to each other 24

8a- Large trees with pendulous crowns. All young twigs pendulous. Male flowers with 2 stamens; filaments free from each other 9

-Large trees with erect crowns. Male flowers with 2-4 stamens; filaments free or adnate to each other 12

9a-Twigs undulate, sigmoid

14. *S. matsudana* var. *turtuosa* (Exotic)

- Twigs erect, straight 10

10a-Young current year twigs c. 1 mm thick. Leaves yellowish green or pale green. Male catkins c 3-5 mm wide

13. *S. babylonica*

-Young current year twigs c. 2 mm thick. Leaves green or silvery. Male catkins c 5-6 mm wide 11

11a- Leaves light green, silvery, both sides covered with short appressed hairs, margins dentate. Stipules linear or falcate. Anthers c. 0.5-0.7 mm long. Capsules c. 4 mm long; style and stigma c. 0.5-1 mm long

9. *S. alba*

- Leaves bluish green or pale green, usually glabrous, margins entire, rarely undulate. Stipules broad, more developed, c. 2.5 cm long

S. alba* × *S. babylonica

12a-Male flowers with 4 stamens; stamens erect, free from each other. Female catkins narrowly ovoid, with long and thin stipe, at the base with several amplexicaule glands surrounded at the base of the stipe

4. *S. tetrasperma*

- Male flowers with 2 stamens; stamens free from each other 13

13a- Leaves ovate, widest part at the base, abruptly attenuate toward the apex, acute 14

- Leaves elliptic or lanceolate, widest part at the middle, gradually attenuate toward the apex, with long tips 16

14a- Leaves silvery, densely hairy. Bracts dentate at the apex

15. *S. denticulata*

- Leaves dark green. Bracts obtuse, entire 15

15a-Leaves long petiolate; petioles c. 3-5 cm long, pendulous or deflexed

11. *S. issatissensis*

- Leaf petioles c. 2-3 cm long, always erect

S. acmophylla* × *S. alba

16a- Bracts pale yellow or yellowish or yellowish green 17

- Bracts dark brown or black 23

17a-Leaves elliptic, abruptly attenuated toward the apex and base, shortly tipped at apex 18

- Leaves lanceolate, abruptly attenuate toward the base but gradually attenuate at the apex, with long tips 19

18a- Buds lanceolate to oblong, c. 2 mm wide, inner side flat. Bracts c.1 mm wide. Anthers c. 0.5-0.7 mm long. Mature capsules c. 4-5 mm long; style and stigma c. 0.5-1 mm long

5. *S. alba*

-Buds ovate-lanceolate or ovate-triangular, c. 2.5 mm wide, inner side convex. Bracts more than 1 mm wide, ciliate at the margin with long hairs. Anthers 0.7-0.9

mm long. Mature capsules c. 5-7 mm long; style and stigma c. 0.8-1 mm long

10. **S. excelsa**
19a- Leaves c. (0.7)1-1.2 cm wide, twigs of current year minutely pendulous, red colour or brownish red to purple

27. **S. caramanica**
-Leaves c. 2-3.5 cm wide, twigs of current year usually erect, green or pale brown or greyish green

20a- Leaves green to light green, usually silvery, covered with long hairs, base of limbs usually with 1 pair of marginal glands

- Leaves dark green or opaque, usually sparsely covered with short hairs or glabrescent, base of limbs usually with 2-3 pairs of marginal glands

21a- Female catkins with dense capsules

16. **S. fedtschenkoi**
-Female catkins with remote capsules, axis visible

26. **S. caucasica**
22a- Stipules broadly semicordate or reniform

S. fragilis
- Stipules linear or narrowly oblique falcate

S. × viridis (*S. alba* × *S. fragilis*)
23a-Leaves dark green, both sides concolorous, margins glandulous dentate, base of limb with 1-2 pairs of glands

12. **S. viridiformis**
- Leaves pale green, both sides concolorous, margins entire or minutely short dentate, base of limb without glands

27. **S. pycnostachya**
24a- Male flowers with 3-5 stamens; filaments free from each other. Decorticated stems of 2-3 years old smooth, not edged

- Male flowers with 2 stamens; filaments free or jointed to each other. Decorticated stems of 2-3 years longitudinally straight edged

25a- Male catkins always with 2, 3 or 5 stamens; female catkins with dense capsule; phylloclades (peduncle) with numerous developed stipules

5. **S. pentandra**
- Male flowers always with 3 stamens. Female catkins with remote capsules; phylloclades (peduncle) without stipules

26a- Leaf margins entire or irregularly glandular-dentate or dentate. Leaf petiole with small glands situated at the base of limb. Male catkins narrow, c. 0.4-0.6 cm wide; filaments 0.3-0.5 cm long. Stipules linear or narrowly falcate

6. **S. songarica**
- Leaves on half upper part clearly dentate. Leaf petiole glandular at the base of the limb. Male catkins somewhat thicker, c. 0.6-0.8 cm wide; filaments c. 0.5-0.8 cm long. Stipules semicordate or reniform

27a- Male catkins c. 0.6-0.8 cm wide. Leaves on both sides concolorous

7. **S. triandra** subsp. **triandra** f. **concolor**
- Male catkins 0.2-0.4 cm wide. Leaves on both sides discolorous

7. **S. triandra** subsp. **triandra** f. **discolor**
28a-Leaves lanceolate, 3-7 times longer the wide. Filaments adnate to each other

- Leaves oblong-elliptic, 2-2.5 times longer than wide. Filaments free, very rarely few filaments adnate to each other. Usually with atavistic feature (anther change to capsule)

29a-Male catkins 3-6 mm in diameter
- Male catkins 15 mm or more in diameter

30a- Leaves narrowly linear, with parallel margins; densely hairy or silvery

30. **S. wilhelmsiana**
-Leaves lanceolate, widest part at the middle, glabrous or sparsely hairy

31a- Leaves entire. Female catkins narrow, long, deflexed (flexible), with remote small capsule, capsules c. 2 mm long

30. **S. caspica**
- Leaves marginally dentate. Female catkins thick, short and erect with dense and long capsule, capsules c. 4 mm long

29. **S. elbursensis**
32a-Leaves c. 13 mm wide. Male catkins borne on the long phylloclade (peduncles) c. 2-4 cm long. Catkins c. 8-10 mm in diameter

26. **S. pycnostachya**
- Leaves c. 15-27 mm wide. Male catkins borne on the short phylloclade (peduncles), c. 2-7 mm long. Catkins c. 12-15 mm in diameter

S. × zygostemon (*S. cinerea* × *S. elbursensis*)
33a- Leaves coriaceous, waxy, without reticulate nervation, glabrous or sparsely covered with appressed hairs

- Leaves not waxy, densely covered with spreading or subappressed hairs, upper side with reticulate nervation

34a- Catkins appearing before leaves (precocious). Leaves on the margins entire or minutely dentate

S. zygostemon (*S. cinerea* × *S. elbursensis*)
-Catkins appearing with the leaves (subprecocious). Leaves at the margin dentate or undulate-dentate

35
35a- Female catkins c. 4-5 cm long; Brachyblasts c. 1 mm long. Stipules falcate or abortive

24. **S. firouzkuhensis**
- Female catkins c 8-10 cm long; capsules remote. Brachyblasts c. 2.5 cm long, with cataphylls. Stipules well developed, semicordate or reniform

25. **S. lacus-tari**
36a- Bracts glabrous or sparsely tomentose, covered with spreading hairs. Female catkins narrow, c. 6-8 mm wide

23. **S. baladehensis**
- Bracts densely covered with long straight hairs, two times longer than the bracts. Male catkins thick, c. 17 mm wide

37a- Leaves obovate or elliptic, c. 4-6 cm wide, widest part of limb in half upper part (plant from N. Iran)

17. **S. aegyptiaca**
- Leaves ovate or oblong elliptic, attenuating toward the apex and base, widest part at the middle

38a- Male catkins globose or minutely elliptic, without phylloclade (sessile). Anthers c. 0.7-1.2 mm long. Stigma c. 0.5-0.8 mm long. Decorticated stems of 2-3 years old smooth, frequently with atavistic features

21. **S. caprea**

- Male catkins elliptic to cylindrical, with short or long phylloclade (sessile or shortly pedunculate). Anthers 0.6-1 mm long. Stigma c. 0.2-0.4 mm long. Decorticated stems with longitudinal straight edges 39

39a- Leaves discolorous, upper side dark green, lower side pale green, leaf margin entire near the base, primary and secondary nervation paler than the leaf texture

22. **S. pseudomedemii**

- Leaves concolorous, yellowish green or grayish green, leaf margin at the base entire or rarely dentate, primary, secondary and rarely tertiary venation same color of the leaf texture, pilose and elevated 40

40a- Leaves c. 7-8 cm long and 1.5- 2.5 cm wide. Female catkins c. 2 cm long and 0.5 cm in diameter; phylloclade (peduncle or stipe) c. 2-5 mm long. Male catkins shortly elliptic

21. **S. caprea**

- Leaves c 14-16 cm long and up to 4.5 cm wide, lower side grayish yellow 41

41a- Male catkins cylindrical, c. 3 cm long and 1.5 cm in diameter. Bracts acute. Female catkins with obovate bracts; style c. 0.2 mm long, pilose; stigma bilobed or tetralobed, smooth (from woodland in Kurdistan)

19. **S. cinerea**

- male catkins cylindrical, c. 3.5 cm long and 1.5 cm in diameter. Bracts acute. Female catkins c. 3.5 cm long and 1.2 cm in diameter 42

42a- Capsules with short stipes. Bracts lanceolate, as long as pedicel or shortly longer. Style short. Stigmata short, glandulose, minutely curved, dorsally hairy

20. **S. atrocinerea**

- Capsules with long stipes. Bracts small, half as long as of the pedicel or shorter. Style short. Stigma without glands

18. **S. pedicellata** subsp. **pedicellata**

Notes: *S. australior* as a distinct species and *S. aegyptiaca* var. *longifrons* need more investigation and have not been inserted to the key

A. Subgenus **Protitae** Kimura, Bot. Mag. (Tokyo) 42: 290 (1928)

Typus: *S. chaenomelioides* Kimura

I. Salix section **Humboldtianae** (Andersson) Andersson, in DC., Prodr. 16 (2): 199: 1868.

TYPUS: *Salix humboldtiana* Willdenow

1. S. acmophylla Boiss., Diagn. Pl. Or. 7: 98 (1846).

Described from Iran, Shiraz, Kuh-e Dena.

Notes: Species with 5 deflexed stamens is immediately separable from all other Iranian taxa.

Habitat: arid continental regions; Banks of rivers and streams at the gorges of the mountain areas.

Dist. N. (Guilan), NW. (Ardabil, W. Azerbaijan), W. (Kurdistan, Kermanshah), S. (Bushehr, Khuzestan, Hormozgan, Baluchestan), C. (Fars, Bakhtiari, Esfahan, Kerman, Yazd, Tehran), E. (Khorassan).

Gen. Dist. Turkey, Jordan, Syria, Palaestine, Sinai, Iraq, Iran, Turkmenistan, Afghanistan, Pakistan and India.

2. Salix elymaitica Maassoumi, **sp. nov.** –Fig. 1.

Species ab gemmis imbricatis et foliis obovatis, retusis vel emarginatis insignis.

Probably tall shrub. Twigs greenish yellow, sparsely covered with short spreading white hairs or glabrous, on the nodes densely hairy, flowering buds ovoid, c. 2 mm long, bud scales overlapped, obtuse or acuminate, densely covered with short subappressed to spreading hairs, wide angled with the stem, decorticated wood smooth. Leaves discolorous, obovate to elliptic, broadest part near the apex, c. 2.5-4.5 cm long and 1.5-2 cm wide, acute or retuse to emarginate, minutely mucronulate at apex, tapering toward the base, minutely dentate at the margin, both sides glabrous or covered with few scattered short appressed hairs, secondary venation prominent, reticulate, between the secondary venation glabrous; petiole 5 mm long, sparsely pilose, later glabrescent. Stipules semicordate or reniform, sparsely pilose, caducous. Catkins not seen.

Typus: Ilam: Eivan, Shire-Cheghai village, 13.10.1988 (25.07.1367, Persian calendar), Hatami, 2203 (holotypus TARI; isotypus Kermanshah Research Centre herbarium).

Notes. New species with its distinctive vegetative characters described without sexual organs. Tried by author to find more materials, but never found with catkins.

Habitat: Banks of rivers and streams.

Dist. W. (Ilam).

Gen. Dist. Endemic.

3. S. daviesii Boiss., op. cit.

Notes: This species previously doubtfully treated as a synonymous of *A. acmophylla* (Skvortsov 1969). New collected materials with 4 erect stamens in male flower (not 5 deflexed stamens) separate this species from *S. acmophylla*. Molecular analysis confirms it as a distinct species.



Fig. 1. *Salix elymaitica*.

Habitat: Arid continental regions; Banks of rivers and streams

Dist. C. (Fars and Bakhtiari).

Gen. Dist.: Endemic.

II. Sect. Tetraspermae (Andersson) Schneider in Sargent, Pl. Wilson. 3: 93 (1916).

Type: *S. tetrasperma* Roxb.

4. *S. tetrasperma* Roxb., Pl. of coast Coromandel 1: 66 (1797)..

Described from India.

Notes: Similar to *S. acmophylla* Boiss. but is distinguished by having broad and semicordate stipules and narrow leaves. This species is characterized by female flowers with having narrowly ovoid capsules and long thin stipe surrounded by numerous amplexiscent glands.

Habitat: Tropical and subtropical regions; Banks of rivers and streams.

Dist. E. (Baluchistan).

Gen. Dist. India, Indochina, Pakistan and Iran.

B. Subgenus **Salix**.

Typus: *Salix alba* L.

III. sect. **Salicaster** Dumortier

=sect. *Pentandrae* (Borrer) Schneider, Handb. 1: 29 (1904).

Typus: *Salix pentandra* L.

5- S. pentandra L., Sp. Pl. 1016 (1753).

Typus: Europe.

Habitat: Banks of rivers and streams.

Dist. NW (Ardabil).

Gen. Dist. Europe, former Soviet Union, Turkey and Iran.

IV. Sect. **Triandrae** Koch, Syn. Fl. Germ. Helv.: 644 (1837).

= Sect. *Amygdalinae* Koch

Typus: *Salix triandra* L.

6. S. songarica Anderss, Monogr. Salic.: 53 (1867).

Typus: In Songaria ad Ajagus et in ripis fl. Tschu et Ili—Schrenk, (LE).

Notes: The species only grows in the eastern part of the country. This species with 3 stamens is similar to *S. triandra*, but it differs from it by having entire leaves (not dentate), stipules lanceolate to linear (not semicordate), male catkins long, narrowly cylindrical, flexible (not short and straight). From *S. elbursensis* it differs in having 3 distinct stamens (not 2 fused stamens).

Habitat: Margin of rivers situated in low altitudes with fine sandy soils.

Dist. E. (Khorassan).

Gen. Dist. Tadjikistan, Uzbekistan, Turkmenistan, Iran and Afghanistan.

7. S. triandra L., Sp. Pl.: 1016 (1753).

Typus: In Helvetia.

Notes: Similar to *S. elbursensis* but it differs from it by having semicordate stipules (not linear or lanceolate), stamens 3 and distinct (not 2 and fused), leaves in lower part dentate (not all margins dentate). This species frequently showing atavistic features. This is a fact to show a wide range morphological variation and creating the numerous intermediate populations.

In the field there are two different forms.

A- f. **concolor** in which both sides of the leaves are the same colour.

B- f. **discolor** [= *S. triandra* var. *discolor* (Wimmer & Grabowski) Andersson, Prod. 12.2: 203(1868)] in which the upper side is usually dark green but the lower side is pale green or greyish green.

Notes: It is remarkable that in both forms all reproduction organs like male and female catkins do not show any differences but one specimen collected

from Mazandaran in the size of male catkins differs from all other collected materials. This specimen with long and very thin male catkins and with 3 short stamens is separable from all other specimens. This feature needs more investigations.

Habitat: Banks of rivers and riversides, usually growing in the rivers and stream beds at the foothills and widely enlarge to low and high altitudes in Elburz and Zagros ranges.

Dist. N. (Gorgan and Mazandaran), **NW.** (Ardabil, E. Azerbaijan, W. Azerbaijan), **W.** (Kurdistan, Kermanshah and Hamadan) and **C.** (Markazi and Tehran).

Gen. Dist. Africa, Europe, Siberia, Turkey, Armenia, Caucasus, Iran, Turkmenistan, Afghanistan and Far East.

V. **Salix** Section **Salix**

Typus: *Salix alba* L.

8. S. fragilis L., Sp. Pl. 1017 (1753).

=*S. australior* var. *pseudofragilis* Goerz, Feddes Repert. 32: 393 (1933).

Typus: In Europae borealibus. Fl. Lapp. N 394 et tab. 8 f. B; Fl. Suec. N 795.

Notes: Trees up to 10 m high. Stipules semicordate, glabrous. Leaves lanceolate, dark green, concolor, glabrous, dentate at the margins. Capsules glabrous, at the base c. 1 mm stipitate. Closely related to *S. excelsa* but differs from it by the dark green leaves and semicordate stipules. Male catkin's flowers with 2,3,4,5 distinct stamens distinguishable from allied species such as *S. excelsa*. Female catkin never collected, my knowledge for this taxon is poor.

Habitat: Very scattered growing in banks of streams of the high altitude mountains and sometime growing beside the mountain lakes.

Dist. NW (Ardabil, border of Azerbaijan and Armenia).

Gen. Dist. Europe, former Soviet Union, Azerbaijan, Armenia, Turkey, and Iran.

9. S. alba L., Sp. Pl.: 1021 (1753).

Typus: Ad pagos et urbes Europae. Hort. Cliff. 473; Fl. Suec. N 812.

Notes: In Elburz range around Damavand, toward Tar lake, there is a specimen in shrub habit with dark green leaves and narrow and long male catkins which clearly differs from typical *S. alba*. At the moment there are insufficient materials and female catkins are not available, so, it may be needed to establish a new form. For more information see *S. excelsa* Gmelin.

Habitat: Riversides, banks of valley and margins of streams at high altitudes in Elburz mountain up to 2200 m, along the rivers, in flood plains and in the meadows.

Dist. N. (Gorgan, Mazandaran and Guilan "cult."), NW. (Ardabil, Zanjan and W. Azerbaijan), W. (Kermanshah and Hamadan), C. (Bakhtiari, Esfahan, Kuhgilooeyeh, Lorestan and Tehran) and E. (Khorassan).

Gen. Dist. N. Africa, Europe, Turkey, Caucasus, Iran and Afghanistan.

10. *S. excelsa* S. G. Gmelin, Reise 3: 308 (1774).

Typus: Persia, Rescht. S. G. Gmelin (LE).

Notes: Similar to *S. alba* L. but it differs from it by having large leaves, buds and catkins. In several natural habitats, these species growing together. Identification of these species in their habitat needs more experience. It was suggested to reduce as a synonym of *S. alba* L. (Skvortsov 1999), but the new molecular analysis segregates these two species from each other (Abdollahzadeh, 2008). Also according to molecular analysis *A. australior* is a separate taxon and close to *S. alba*.

Habitat: Banks of rivers and valleys as those of *S. alba*. In few cases cultivated in drier areas with sufficient rainfall. In Caspian area it is found at the margin of forests with black stems.

Dist. N. (Gorgan, Mazandaran and Gilan), NW. (Ardabil, Zanjan, W. Azerbaijan and E. Azerbaijan), W. (Kermanshah and Hamadan), C. (Markazi, Bakhtiari, Esfahan, Kuhgilooeyeh, Lorestan and Tehran) and E. (Khorassan).

Gen. Dist. Turkey, Syria, Lebanon, Iraq, Iran, Transcaucasus, Afghanistan, Pakistan and Kashmir.

11. *S. issatissensis* Maassoumi, Moeeni & Rahaminejad, Iran. Journ. Bot. 14 (1): 3 (2008).

= *S. excelsa* S. G. Gmelin var. *rodonii* A. Skv., Nov. Syst. Pl. Vasc: 97 (1965).

Described from Iran, Kohgilooeyeh.

Notes: This species with ovate leaves, semicordate stipules, long and deflexed petioles is morphologically separable from *S. excelsa* Gmelin. Molecular analysis also separates this species from *S. excelsa*, under which it was formerly treated as a variety.

Habitat: Banks of rivers and streams in low and high altitudes in central part of the country.

Dist. N. (Gorgan) and C. (Fars, Yazd, Kuhgilooeyeh and Kerman).

Gen. Dist. Endemic.

12. *Salix viridiformis* Maassoumi, sp. nov. –Fig. 2.

Affinis ab *S. excelsa* Gmelin sed differt capsulis dense tomentosus (nec glabris), bracteis intense nigris (nec luteis), pedunculis brevissimis (nec longis).

Small tree c. 8 m high. Twigs greenish brown to purple, sparsely covered with short white appressed hairs, later becoming glabrescent, flowering buds ovoid, flat, scales adnate, c. 2 mm long, shortly acuminate, sparsely covered with short appressed hairs, nearly attached to the stem, decorticated wood smooth. Leaves concolorous, narrowly ovate to lanceolate, broadest part at the base, c. 10-14 cm long and 2.5-3 cm wide, acute, gradually tapering to the apex, younger leaves densely tomentose on both sides, entire, older ones clearly dentate at the margin, two paired glands at the base of limb, both sides sparsely covered with few short appressed hairs or glabrous, the midrib more densely covered with short spreading hairs, secondary venation prominent, nearly 22 pairs, between the secondary venation sparsely covered with few short appressed hairs or glabrous; petiole 10-13 mm long, at young stage densely silky hairy, later glabrous. Stipules linear to lanceolate, caduceus. Catkins appearing with the leaves or before the leaves, cylindrical. Bracts dark brown to black, elliptic to ovate, obtuse, c. 5-7 mm long, densely covered with long hairs, overtopping the apex by 1.5 mm, inner side sparsely covered with long hairs toward the apex; male catkin unknown; female catkin cylindrical, curved, horizontal, c. 4-4.5 cm long, at the base shortly pedunculate, peduncle (phylloclade) c. 1 cm long, densely covered with silky appressed hairs; cataphyll with long appressed hairs to subappressed to spreading hairs, later upper side glabrescent. Ovary tomentose; capsule (immature) c. 3 mm long, narrowly conical, stipitate at the base, stipe c. 0.4 mm long. Style brown, c. 0.2 mm long; stigma dark brown, spatulate, bifid, c. 0.4 mm long, glandulose pilose.

Typus: Azerbaijan: Khoy, Pir kandy, Goli daracy, N: 38° 45', E: 45° 04', 1120 m, 18.10.2006, Maassoumi, Safavi & Alizadeh 90214, sterile (holotypus TARI); ibid., Maassoumi & Safavi 90437 (same tree, female, TARI).

Paratype: ibid., Maassoumi et al. 90219.

Habitat: Isolated in streams and mountain gorges.

Dist. NW. (West Azerbaijan).

Gen. Dist. Endemic.

VI. Sect. Subalbae Koidzumi, Bot. Mag. Tokyo 27: 88.1913.

Typus: *Salix pierotii* Miq.

13. *S. babylonica* L., Sp. Pl.: 1017 (1753).

Typus: « In Oriente. Hort. Cliff.: 454; Royen Lugd.

Notes: This species with long pendulous branches and with yellowish green leaves is immediately separable.

Habitat: Cosmopolitan. Domesticated and cultivated in the parks. Never collected in the wild.

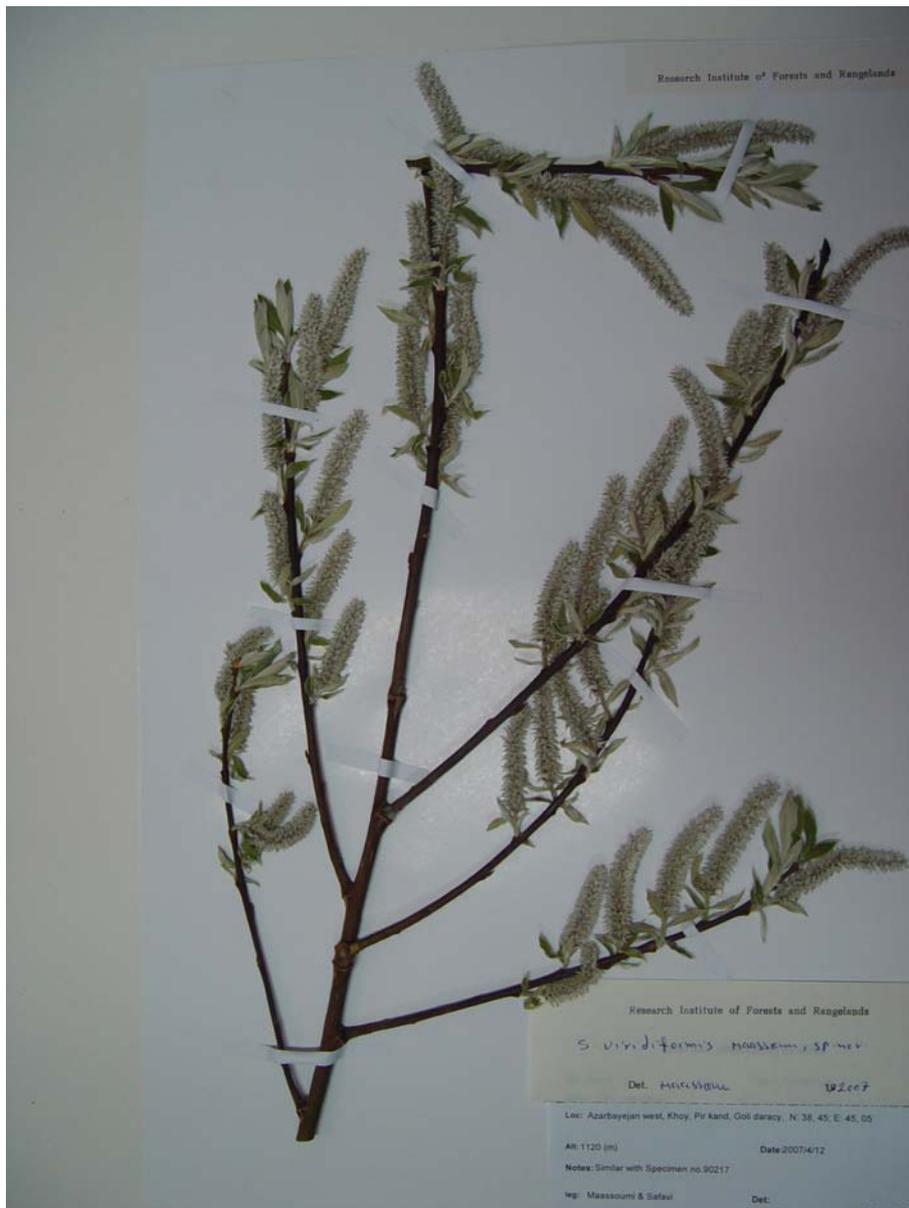


Fig. 2. *Salix viridiformis*.

Dist. N, E, W, C. (Widely cultivated).

Gen. Dist. Cosmopolitan, cultivated in Europe, Asia, former Soviet Union and the New World.

14. *S. matsudana* Koidz. var. *turtuosa* Vilm. in Jour. Soc. Nat. Hort. Fr., Ser. 4, 25: 350 (1924).

Notes: Cultivated in Iran.

VII. Sect. *Denticulatae* C. K. Schneider in Sargent, Pl. Wilson. 3: 117 (1916).

15. *S. denticulata* Andersson in Kung, Svenska Vet.-Akad. Handl.: 481 (1850).

Described from Kamaon, India.

Notes: Close to *S. excelsa* Gmelin but it is separable from above species by the ovate leaf shape which abruptly attenuates toward the apex and the dentate bracts at the apex.

Habitat: Banks of rivers and meadows created by rivers.

Dist. E. (Khorassan) and **C.** (Semnan).

Gen. Dist. Iran, Afghanistan, Pakistan, Kashmir and Nepal.



Fig. 2. cont. *Salix viridiformis*.

VIII. Sect. Hastatae Kerner, N.-Öst. Weid.: 241 (1860).

Typus: *Salix hastata* L.

16. S. fedtschenkoi Gorz, Salic. As. 1: 21(1931); id., Feddes Repert. 32: 121(1933).

Typus: Schugnan. ad trajectum Shtam. - a. 1904 B. Fedtschenko" [Goerz, Sal. Asiat. (exs.) N 25] (LE, TAK).

Described from West Pamir.

Notes: Species with long, lax and dispersed capsules along the female catkin with the visible axis distinguishable.

Habitat: Banks of rivers and meadows created by rivers.

Dist. E. (Khorassan).

Gen. Dist. Tadjikistan, Afghanistan, Iran and Pakistan.

C. Subgenus Vetric (Dumortier) Dumortier, Bull. Soc. Roy. Bot. Belg. 1: 141. 1862.

Typus: *Salix caprea* L.

IX. Section Cinerella Seringe, Exemplaires desseches de la revision inedit du genre *Salix*, 2nd page [no pagination]. 1824.

= *sect. Vetrica* Dumortier, Verh. Gesl. Wilgen 14 (1825).

Typus: *Salix cinerea* L.

17. *S. aegyptiaca* L., Cent. Pl. 1: 33 (1755).

Typus: wrongly "In Aegypto (Febr. 1751)"

Notes: This species shows a large variation in the leaf shape, indumentum and male catkin length. The species prefers to grow in the more humid and flood plain areas and in broad leaved forests by the Caspian and in a few cases in alluvial areas. It is remarkable that in a few cases on male and female catkins there are the atavistic feature. This species grows naturally in the Caspian forest and the forest margin, but in all other parts of country male trees for some traditional usage were widely cultivated. In the area where the winter is warm the last year's leaves become larger and longer. In any case identification and segregation of this species from *S. caprea* and *S. cinerea* in the field and living plants need more experience.

Habitat: Mixed with the broad leaved trees in the open forests and banks of streams. Never seen on riversides. Frequently cultivated in Azerbaijan, Khorassan and central parts with irrigation.

Dist. N. (Gorgan, Mazandaran and Gilan), NW. (Ardabil, E. Azerbaijan, W. Azerbaijan), W. (Kurdistan and Kermanshah), E. (Khorassan) and C. (Tehran, Arak, Kerman).

Gen. Dist. Turkey, Transcaucasus, Iran, from Egypt to Kashmir, Uzbekistan, Turkmenistan. Widely cultivated.

16.1. **var. longifrons** Bornm., Bot. Centrbl. Beih. Abt. 2, 24: 4 (1908).

Described from Iran, Arak.

Habitat: Cultivated at the margin of fields.

Dist. Iran.

Gen. Dist. Endemic.

18. *S. pedicellata* Desf., Fl. Atlant. 2: 362 (1800).

Typus: Ad rivulos Sbibaie in regno Tunetano (n. v.).

18. 1. subsp. pedicellata

Notes: Close to *S. cinerea*, but with several cryptic characters is separable from the above mentioned species. It is frequently growing in N. Zagros range, Kurdistan and W. Azerbaijan areas mixed with *Quercus brantii* and *Q. libani*. These two related species by the type of indumentum, leaf colour and shape are separable from *S. aegyptiaca* L. which is

widely distributed in the Caspian area. New molecular analysis (Abdollahzadeh 2008, unpublished) segregates these two taxa from each other. In Flora Iranica the distribution pattern of *S. aegyptiaca* extends from north to west (Skvortsov 1969).

Habitat: Growing in meadows with sufficient humidity and banks of streams in the open forests or woodlands in Zagros ranges at low altitudes up to 1700 m. It has never been seen on riversides. Distribution patterns of these two related species are nearly overlapping.

Dist. NW. (W. Azerbaijan).

Gen. Dist. Europe, European Russia, Greece, Turkey, Caucasus, Armenia and Iran.

19. *S. cinerea* L., Sp. Pl.: 1021 (1753).

Typus: In Europae nemoribus paludosis. Fl. Suec. N 805; Fl. Lapp. N 358.

Notes: Species in catkin characters similar to *S. aegyptiaca*, but with several cryptic characters is separable from above mentioned species as previously explained.

Habitat: Growing in meadows with sufficient humidity and banks of streams in the open forests or woodlands in Zagros ranges in low altitudes up to 1700 m. Never seen on riversides.

Dist. NW. (W. Azerbaijan).

Gen. Dist. Europe, European Russia, China, Greece, Turkey, Caucasus, Armenia, and Iran.

20. *S. atrocineera* Brotero, Fl. Lusit. 1: 31(1804).

Typus: Margenes do Mondego. Brotero (LISU).

Notes: This species is very close to *S. cinerea*, but by the shape of leaves and morphology of catkins is separable from it. Only on living plants by checking the catkins in the natural habitat separation of the species is possible.

Habitat: Wetlands and damp places, very rarely growing in small seasonal streams with few runoffs.

Dist. NW. (W. Azerbaijan).

Gen. Dist. Europe (England, Belgium, France, Corsica), Iberia, N. Africa (Algeria, Tunisia), Turkey and Iran.

21. *S. caprea* L., Sp. Pl.: 1020 (1753).

Typus: «In Europae siccis. Fl. Suec. N 811; Fl. Lapp.

Notes: Similar to *S. aegyptiaca* but with several artificial taxonomic characters are separable from each other, This species grows at the margin of forests in tree line at the wetlands, where there is enough humidity. In Iran this species growing at the forest tree line area from Gorgan (Ziarat), Mazandaran (Tonekabon and Javaherdeh, Ardabil (Heiran and Fadoghlu). New molecular analysis confirms

segregation of this species from *S. aegyptiaca*, *S. cinerea* and *S. atrocinerea*.

Parsa (1949) without materials recorded this species from Iran, but Akhani (1998) based on new collection confirms the presence of this species in the Gorgan area.

Habitat: Post forest habitats, usually growing at the timberline and forest edge and deforested areas in Elburz ranges. In Azerbaijan area showing a tendency to localize in the meadows and flood plains by the melting snow runoffs.

Dist. N. (Gorgan) and **NW.** (Ardabil).

Gen. Dist. Europe, European Russia, Caucasus, Armenia, Turkey, Iran and Far East.

22. *S. pseudomedemii* E. Wolf, Trudy St. Petersb. Bot. Sada 28, 3: 397 (1909).

Typus: Leningrad, culta. Provenit e Tiflis (Hb. Academiae Forestalis, Leningrad).

Notes: This species in several characters is similar to *S. aegyptiaca* L. and *S. cinerea* L. Recently accurate analysis separate these species from each other by several morphological characters. This species highly showing the atavistic features, this is because of morphological variation. This taxon was reduced as a synonym of *S. cinerea* L. by Browicz & Zielinsky (1990).

Habitat: Meadows and damp places, usually cultivated at field margins with irrigation.

Dist. NW. (Ardabil, W. Azerbaijan and E. Azerbaijan).

Gen. Dist. Caucasus, Azerbaijan, Daghistan, Armenia and Iran.

23. *S. baladehensis* Maassoumi, Moeeni & Rahiminejad, Iran. Journ. Bot. 14 (1): 1 (2008).

Habitat: Growing in high altitudes, up to 2700 m and in meadows with sufficient humidity.

Dist. N. (Elburz rang, Baladeh).

Gen. Dist. Endemic.

24. *S. firouzkuhensis* Maassoumi, **sp. nov.** –Fig. 3.

Affinis ab *S. aegyptiaca* L. sed differt foliis juniores utrinque dense brevissime appresse pilosis, deinde glabris vel sparse pilosis et discoloris (nec dense permanens patenter pilosis). Amenta feminea subprecocia, anguste cylindrica, horizontalia, breviter curvata, c. 7 mm lata (nec precocia, erecta, crassa). Bracteae bruneae (nec intense nigrae). Stigma bifida, spathulata. Stipulae anguste lanceolatae vel anguste semireniformiae, glaberrimae (nec late cordatae vel reniformae, dense pilosae). Ab *S. zygostemon* Boiss. foliis maturis sparse appresse pilosis (nec toto glabris), margine profunde serrato-undulatis (nec integris), petiolo dense patenter pilosis.

Tall shrub or small tree c. 3 m high. Twigs greenish yellow, densely covered with short tangled white spreading hairs, later becoming glabrescent, flowering buds ovoid, c. 12 mm long, shortly acuminate, densely covered with short spreading hairs, nearly attached to the stem. Decorticated wood predominantly numerous scattered, longitudinally striate and edged. Leaves discolorous, ovate to elliptic-lanceolate, broadest part at the middle, c. (5-) 7.5-10 (-12) cm long and 2.5-3 cm wide, acute, abruptly tapering to the apex; younger leaves minutely dentate; older leaves deeply serrate-undulate at the margins, upper side covered with short appressed hairs, c. 0.2-0.4 mm long, soon becoming glabrate at maturity; lower side covered with sparse short appressed hairs, later glabrescent, the midrib more densely covered with short spreading hairs, secondary venation prominent; between the secondary venation sparsely covered with short appressed hairs, later glabrescent; petiole 7-15. mm long, in young stage sparsely pilose, later densely covered with short spreading hairs. Stipules oblique lanceolate to narrowly oblique reniform, glabrescent, at the margin glandulose-dentate, caducous. Catkins appearing with the leaves, cylindrical. Bracts brown, elliptic to ovate or obovate, acute at the apex, c. 1.5 mm long, densely covered with long hairs, overtopping apex by 1.5 mm, at inner side densely covered with long hairs; male catkin absent; female catkin cylindrical, curved, horizontal, c. 2.5-3 cm long, at the base shortly pedunculate, peduncle (phylloclade) c. 1 cm long, densely covered with spreading hairs; cataphyll with short scattered appressed hairs or later glabrescent. Ovary tomentose; capsule (immature) c. 3 mm long, conical, stipitate at the base; stipe c. 0.5 mm long. Style brown, glabrous, c. 0.2 mm long; stigma brown, spathulate, bifid, divergent, c. 0.4 mm long, at the outer side glabrous.

Typus: Mazandaran: Haraz road, Lasem area, Bahan village, 29.05. 2007, 2200 m, Maassoumi 90595 (holotypus TARI).

Paratypus: Tehran: Firouzkuh, Arjomand area, around Andariyeh village, 2200 m, Maassoumi and Sadati 90488, 90494; Arjomand area, 2000 m, Maassoumi & Sadati 90487. – Mazandaran: c. 23 km on the road from Pol-e Zangouleh to Baladeh, 2900 m, Maassoumi 90553; Haraz road, Ab-e Ask, 1700 m, Maassoumi 90588.

Habitat: Banks of rivers at high altitudes in Elburz ranges.

Dist. N. (Elburz ranges), south slope of Elburz mountains.

Gen. Dist. Endemic.



Fig. 3. *Salix firouzkuhensis*.

25. *S. lacus-tari* Maassoumi & Kazempour, sp. nov. – Fig. 4.

Affinis *S. aegyptiacae* L. sed differt foliis juniores utrinque dense brevissime appresse pilosis, deinde glabris vel sparse pilosis et discoloris (nec dense permanens patenter pilosis). A *S. firouzkuhensis* Maassoumi amenta feminea subprecocia, cylindrica,

erecta, c. 8-10 cm longa, basi breviter pedunculata (nec brevior et curvata, c. 2.5-3 cm longa). A *S. zygostemon* Boiss. foliis matures majoribus, sparse appresse pilosis (nec toto glabris), margine dentatis (nec integris, petiolo dense patenter pilosis); filamenta partim adnata vel libra (nec toto adnata).



Fig. 3. cont. *Salix firouzkuhensis*

Tall shrub or small tree c. 3-4 m high. Twigs greenish yellow, densely covered with short tangled white spreading hairs, later becoming glabrescent, flowering buds ovoid, c. 12 mm long, shortly acuminate, densely covered with short spreading hairs, nearly angled to the stem. Decorticated wood weakly numerous scattered, longitudinally striate and edged. Leaves discolorous, ovate to elliptic-lanceolate, broadest part at the upper parts, c. (5-) 7.5-10 (-12) cm long and 2.5-4 cm wide, acute, abruptly tapering to the apex; younger leaves minutely dentate; older leaves deeply serrate-undulate at the margin, upper side sparsely covered

with short appressed hairs, c. 0.2-0.4 mm long, soon becoming glabrate at maturity; lower side covered with sparse short appressed hairs, later glabrescent, the midrib more densely covered with short spreading hairs, secondary venation prominent; between the secondary venation glabrous or sparsely covered with short appressed hairs, later glabrescent; petiole 3-15 mm long, in young stage glabrous or sparsely pilose, later densely covered with short spreading hairs. Stipules oblique lanceolate to narrowly oblique reniform, glabrescent, at the margin glandulose-dentate, caducous. Catkins appearing with the leaves,

cylindrical. Bracts pale brown, elliptic to ovate or obovate, acute at the apex, c. 1.5 mm long, densely covered with long hairs, overtopping apex by 1 mm, at inner side densely covered with long hairs; male catkin sessile or shortly pedunculate, cataphylls on both sides hairy, catkin shortly cylindrical or elliptic, c. 2-3.5 cm long and 1-1.2 cm wide. Stamens 2, filament distinct, sometime partly jointed to each other; female catkin cylindrical, erect, c. 8.10 cm long, at the base shortly pedunculate, peduncle (phylloclade) c. 1.5 cm long, densely covered with appressed to spreading hairs; cataphyll with appressed hairs or later glabrescent. Ovary tomentose; capsule c. 5 mm long, conical, stipitate at the base; stipe c. 1.5 mm long. Style brown, glabrous, c. 0.2 mm long; stigma brown, spatulate, bifid, divergent, c. 0.4 mm long, at the outer side glabrous.

Typus: Tehran, Damavand, Humand toward Tar lake, 2100 m, 28.05.2007, Maassoumi 90574 (holotypus TARI).

Paratypus: Tehran, Damavand, Humand toward Tar lake, 2100 m, 28.05.2007, Maassoumi 90573.

Notes: The area is between 2100-2800 meters. In the deep valleys occur a high number of species and also the species always show the big and sharp variation. More investigation at high altitude of Elburz ranges is needed.

Habitat: Banks of rivers at the margin of forest zone in high altitudes up to 2400 m.

Dist. N. (Elburz).

Gen. Dist. Endemic

26. *S. caucasica* Anderss., Monogr. Salic.: 68 (1867).

Typus: Caucasus — Nordmann (LE).

Notes: Species with very broad leaves, sparsely covered with short appressed hairs and with long female catkins with remote capsules and visible axis like *S. fedtschenkoi* separable from other relative species.

Habitat: Banks of rivers.

Dist. N. (NW, Azerbaijan).

Gen. Dist. Caucasus, Azerbaijan, Daghistan, Turkey and Iran.

X. Section **Helix** Dumortier, Verh. Gesl. Wilgen 15. 1825

Lectotypus, designated by Skvortsov, 1968a: *Salix purpurea* L.

27. *S. pycnostachya* Anderss., J. Linn. Soc. 4: 44 (1860); id., in DC. Prodr. 16, 2: 309 (1868).

Typus: India, Zanskar, alt. 13,000 ft — Thompson (K).

Notes: In young stage similar to *S. elbursensis*, but it differs in having long male and female catkins, and with bigger capsules. This species in medium age is a large tree (not shrubby habit). In several specimens frequently the atavistic features were observed, so it is reasonable to show a tendency to create the intermediates.

Habitat: Banks of streams and rarely growing in riversides at high altitudes.

Dist. N. (Gorgan), **NW.** (W. Azerbaijan), **W.** (Kurdistan and Hamadan), **C.** (Kerman, Tehran) and **E.** (Khorassan).

Gen. Dist. Turkey, Iran, Afghanistan, Pakistan, Turkmenistan and Tadjikistan.

28. *S. carmanica* Bornm. ex Gröez, Feddes Reprt. 35: 285 (1934); Bornm. Beih. Bot. Centrabl. 33: 202 (1915).

Described from Iran, Kerman.

Notes: Species in wintertime show the red to purplish red colour, therefore this species is widely cultivated in the parks and gardens as an ornamental plant. In molecular analysis this species nested with *S. purpurea* L.

Habitat: Banks of rivers and streams at high altitudes.

Dist. C. (Natural habitat Kerman).

Gen. Dist. Iran and Afghanistan.

29. *S. elbursensis* Boiss., Diagn. Pl. Or. Nov. 12: 117 (1853).

Typus: In Monte Elburs prope Derbend. 15. V 1843. - T. Kotschy, Pl. Pers. bor. N. 154 (LE, JE, W).

Notes: Medium sized shrub, always growing on the riversides. This species is closely similar to *S. triandra*, but it differs from it by having 2 fused stamens (not 3 distinct stamens); leaves in half upper part clearly dentate and in lower part entire (not all parts dentate). Skvortsov & Edmondson (1982) in Flora of Turkey suggested to reduce it to synonymy with *S. purpurea* L. Some anatomical characters separate these two species from each other. New molecular analysis (Abdollahzadeh 2008) from Iran with using DNA Bank data accurately showing segregation of these two taxa belong to different clades.

Habitat: Banks of valleys, riversides and margin of streams with sandy soils from low to high altitudes of Elburz ranges and Zagros mountains.

Dist. N. (Mazandaran), **NW.** (E. Azerbaijan and W. Azerbaijan), **E.** (Khorassan) and **C.** (Tehran).

Gen. Dist. Turkey, Iran, Armenia, Azerbaijan and Caucasus.

30. *S. caspica* Pall., Fl. Ross. 1, 2: 74 (1788).

Typus: In arenis inter australem Volgam et Rhynum itamque ad Sarpa et Kuma.

Notes: Species is characterized by thin and flexible branches, 2 fused stamens and nearly wide catkins. This species is close to *A. elbursensis* but with long and narrow female catkin separable from mentioned species.

Habitat: Semidesert steppes with sufficient humidity and along stream banks.

Dist. E. (Khorassan).

Gen. Dist. Caucasus, N. Kazakhstan and Iran.

XI. Salix sect. Cheilophilae Hao, Syn. Chin. *Salix*: 102 (1936).

Typus: *Salix cheilophila* Schneid. (sec. Hao, l. c.).

31. S. wilhelmsiana M. B., Fl. Taur.-Cauc. 3: 627 (1819).

Typus: Iberia — Wilhelms (LE).

Notes: This unique species in shrubby habit, linear leaves, 2 fused stamens and short and thin catkins is separable from all other Iranian species.

Habitat: Banks of rivers and meadows created by rivers and very rarely in sandy or loamy-sandy dried soils.

Dist. N. (Mazandaran), **NW.** (W. Azerbaijan and E. Azerbaijan), **C.** (Lorestan and Kohgiluyeh, Fars and Tehran).

Gen. Dist. Turkey, Caucasus, Armenia, Iran, Turkmenistan, Middle Asia and China.

Hybrids

1. **S. × zygostemon** Boiss. Diagn. Pl. Or. Nov. ser. 12: 118 (1853).

= *S. aegyptiaca* × *S. elbursensis*

Described from Iran, Pasghaleh (Elburz mt.).

Notes: This nototaxon has been formed from *S. cinerea* × *S. elbursensis*. The new molecular analysis confirms this biparental hybrid. This species belongs to the sect. *Cinerella* with having 2 fused stamens and long and thick male catkins is separable from other related species. Until now the female shrub of this species has never been seen. This species is widely cultivated for its hard wood.

Habitat: Banks of small streams at high altitudes in Elburz ranges.

Dist. N. (Mazandaran), **NW.** (W. Azerbaijan), **W.** (Kermanshah), **C.** (Fars) and **E.** (Khorassan).

Gen. Dist. Endemic.

2. **S. acmophylla** × **S. rodonii**

Dist. C. (Kuhgiluyeh & Fars).

3. **S. alba** × **S. babylonica**

Det. Belyaeva, 2005.

Dist. NW. (Ardabil).

S. × dinsmorei Enander ex Post, 1933, op. cit. 2: 529.

Typus: In alpe Kuh-Daëna, Kotschy Pl. Pers. austr. no. 620, et prope urbem Schiraz id. no. 323 (G, LE!, JE!, W!).

= *S. acmophylla* × *S. excelsa*.

Dist. C. (Fars and Kuhgiluyeh) and **E.** (Khorassan).

S. × persica Boiss., 1846, op. cit. 7: 99.

= *S. acmophylla* × *S. alba*.

Dist. C. (Fars).

S. × viridis Fries, Novit. Fl. Svec. ed. 2: 283 (1825).

= *S. alba* × *S. fragilis*.

Notes. This hybrid is very rare in Azerbaijan. Christiansen (1997) used the specific name *S. x rubens* Scherak for this taxon.

Dist. NW. (Azerbaijan).

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