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Comparative Morphology of the Genus *Tamarix* (Tamaricaceae) in Iran

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Abstract. *Tamarix* L. is the largest genus of the Tamaricaceae with almost 54 species. This study was carried out on species of *Tamarix* growing in Iran. Morphological characters were obtained for 23 species recognized by recent taxonomic treatments from Iran. In this study we use 10 characters to identify species of *Tamarix* growing in Iran. For SEM studies, we used dry samples of leaves and flowers. Some characters are useful for segregating certain species, such as gross leaf morphology (vaginate vs. sessile), number of floral parts, certain aspects of androecial disk morphology, petal shape, presence or absence of hairs on the raceme rachis, and whether the filament is inserted under or from the side of the androecial disk. In some species the number of sepals, petals and stamens are constant and reliable. One of the problems regarding *Tamarix* is that, in many species the number of certain floral organs is inconstant thus the number of floral parts alone cannot serve as a diagnostic marker without being correlated with the relative position of the organs and their range of numerical variability.

Introduction

Tamarix is one of five genera in the family Tamaricaceae and is represented by 55 species world-wide [1]. The family Tamaricaceae grows most successfully in temperate and sub-tropical regions. The Tamaricaceae family has previously been placed as a sister family to Frankeniaceae because they share characters such as secondary chemistry, gland structure, and scale-like leaves [2]. These two families were classified until recently in the order Violales [3,4]and, they have been placed in their own order, Tamaricales [5,6] but recent molecular sequence data analyses have altered the traditional ordinal placement of many plant families, and Tamaricaceae are now included in the Caryophyllales [7]. The Tamaricaceae currently contains three larger genera: *Tamarix* L., *Myricaria* Desv. (10 species of shrubs), and *Reaumuria* L. (12 small shrub species), and two smaller genera, *Myrtama* Ovcz. & Kinzikaeva and *Hololachna* Ehrenb. that are taxonomically problematic [8,2]. Among the genera of the Tamaricaceae, *Tamarix* is the largest with 55 species [1]. *Tamarix* are native to the Mediterranean countries, southern Europe, China, India, Mongolia, North Africa and south western Africa [1,9]. The genus is thought to have been named after the Tamaris River in Spain [10]. *Tamarix* plants are shrubs, semi-shrubs and tall trees that can grow up to 18 m in height. They are adaptable halophytic or xerophytic plants mostly with multiple stems and slender branches [11]. This family consists of 5 genera *Hololachna* Ehrenb., *Myricaria* Desv., *Reaumuria* L., *Tamarix* L., *Myrtama* Ovcz. and Kinzik. and about 100 species.

Tamarix consists of many species, some of wich are morphologically very similar. Most *Tamarix* species cannot distinguished without flowers or fruit present. Baum's (1978) [12] and Crins' (1989) [8] studies agree that some characters are useful for segregating certain species, such as gross leaf morphology (vaginate vs. sessile), number of floral parts, and certain aspects of androecial disc morphology. The value of other characters, such as petal shape, presence or absence of hairs on the raceme rachis, and whether the filament is inserted under or from the side of the androecial disc are debated. The number of floral parts is sometimes constant but this parameter

cannot be considered valid for any identification of specimens when it is not correlated with the position of flowers on the raceme, the reciprocal position of floral parts, the variability in their numbers, etc. The difficulties in the identification of *Tamarix* species are sometimes caused by inaccurate descriptions and by problems in analytical keys.23 species of Tamarix exist in Iran. *Tamarix* species that distribute in different regions of Iran, are mentioned in Table 1.

Table 1. List of taxa investigated in our analysis and herbaria where the vouchers are deposited TARI= Herbarium of Research Institute of Forests and Rangelands, IAUH= Islamic Azad University Avicennia Herbarium.

Taxon	Origin, voucher	
T. dioica Roxb. Ex Roth.	Iran: Prov. Hormozgan; between Minab and Bandare Lenge, 110 m, Mozaffarian, (TARI 38106).	
T. kermanensis Baum.	Iran: Prov. Hormozgan; between Bandare Charak and Bandare Lenge, 30 m, Mozaffarian, (TARI 45247).	
T. stricta Boiss.	Iran: Prov. Hormozgan; between Gahkom and Sarchahan, 650 m, Mozaffarian, (TARI 55920).	
T. aphylla (L.) Karst.	Iran: Prov. Isfahan; between Ardestan and Zavareh, 1089 m , Arianmanesh, (IAUH 000014837).	
T. ramosissima Ledeb.	Iran: Prov. Isfahan; Varzaneh,1479 m , Arianmanesh, (IAUH 000014842).	
T. rosea Bge.	Iran: Prov. Yazd; between Bafgh and Ravar, 2200 m, Assadi and Bazgosha, (56068 TARI).	
T. arceuthoides Bge.	Iran: Prov. Golestan; Atrak river, 180 m, Assadi and Massoumi, (55407a TARI).	
T. indica Willd.	Iran: Prov. Balochestan; Mirjaveh, 660 m, Assadi, (TARI 22670).	
T. korolkowii Regel & Schmalh.	Iran: Prov. Khorasan; 6 km south of Sabzehvar, 1000 m, Assadi and Massoumi, (55891 TARI).	
T. karakalensis Freyn.	Iran: Prov. Kerman; Bam, 1110 m, Arianmanesh, (IAUH 000014838).	
T. aralensis Bge.	Iran: Prov. Isfahan; 20 km Meymeh to Delijan, 2113 m , Arianmanesh, (IAUH 000014840).	
T. mascatensis Bge.	Iran: Prov. Fars; Kazeroon, Parishan lake, 1970 m, Arianmanesh, (IAUH 000014848).	
T. serotina Bge, ex Boiss.	Iran: Prov. Sistan; between Kohmaleke and Zabol, 700 m, Rechinger, (TARI 4099).	
T. hispida Willd.	Var. *hispida*	Iran: Prov. Hormozgan; between Gahkom and Sarchahan, 650 m, Mozaffarian, (TARI 45012).
	Var. *karelinii*	Iran: Prov. Isfahan; Zavareh, 992 m , Arianmanesh, (IAUH 000014836).
T. dubia Bge.	Iran: Prov. Kerman; between Anar and Share Babak, 1930 m, Assadi and Bazgosha, (TARI 45009).	
T. kotschyi Bge.	Iran: Prov. Ghom; Ghom,1029 m , Arianmanesh, (IAUH 000014847).	
T. androssowii Litw.	Iran: Prov. Isfahan; between Naein and Ardestan, 2062 m, Arianmanesh, (IAUH 000014844).	
T. tetragyna Ehrenb.	Var. *meyeri*	Iran: Prov. Isfahan; Isfahan,1578 m, Arianmanesh, (IAUH 000014843).
	Var. *deserti*	Iran: Prov. Isfahan; Varzaneh,1481 m, Arianmanesh, (IAUH 000014841).
T. octandra (M. B.) Bge.	Iran: Prov. West Azerbaijan; Urmia lake, 1330 m, Assadi and Shirdelpour, (12011 TARI).	
T. passerinoides Del. Ex Desv.	Var. *passerinoides*	Iran: Prov. Isfahan; between Meymeh and Delijan, 2113 m, Arianmanesh, (IAUH 000014839).
	Var. *macrocarpa*	Iran: Prov. Ghom; West of Namak lake, 950 m, Assadi and Bazgosha, (56601 TARI).
T. leptopetala Bge.	Iran: Prov. Isfahan; 75 km Esfahan to Kashan, 770 m, Arianmanesh, (IAUH 000014845).	
T. szowitsiana Bge.	Iran: Prov. Isfahan; 83 km Esfahan to Kashan, 780 m, Arianmanesh, (IAUH 000014846).	

Materials and methods

Specimen were collected in the field or preparation from herbaria in Iran (TARI, IAUH). Specimen, collected in the field were identified in IAUH= Islamic Azad University Avicennia Herbarium using various sources [13-18]. Morphological study was carried out on 23 species of *Tamarix* existing in Iran. For SEM studies, we used dry samples of leaves and flowers. The specimen were then observed under the Scanning Electron Microscope (SEM – Model No. Hitachi S – 530) maintaining accelerating voltage of 25 kv. The samples were viewed, studied and finally photomicrographs were taken at different magnifications. The SEM study was carried out in Collage of Basic Science, Science and Research Branch, Islamic Azad University, Tehran, Iran. The morphological characters were described in terms of leaf morphology, androecial disk morphology, number of floral parts, long of racemes, broad of racemes, long of sepals, shape of sepals, long of petals, shape of sepals and bract length related to pedicel length. This research has carried out in 2014-2015.

Results and Discussion

General morphological characters of the genus Tamarix

Leaves herbaceous, small, scalelike, entire, alternate, exstipulate, glabrous or papillose (or hairy), sessile with narrow base or somewhat amplexicaul (or vaginate), with salt-secreting glands. Inflorescence of simple or compound racemes, often paniculately branched, occurring on branches of previous and/or current year′s growth. Flowers small, perfect (imperfect), 4- or 5-merous, actinomorphic. Bracts shorter than, equal to, or longer than their subtended pedicels, single (2 or 3 in *Tamarix rosea* Bunge), scalelike, entire, glabrous or papillose (or hairy), sessile with narrow base or somewhat amplexicaul (or vaginate). Sepals 4 or 5 (6), connate for a short distance near base, entire to denticulate (incised), glabrous or papillose (or hairy), imbricate. Petals 4 or 5 (6), white, pink, or red, ovate or elliptic to obovate, entire to emarginate, equilateral or not, persistent or deciduous after anthesis, contorted in bud. Androecium diplostemonous, the outer whorl of 4 or 5 antesepalous stamens, the inner whorl abortive and developed into a nectariferous hypogynous disk with antepetalous lobes (or of 4-10 antepetalous stamens); stamens free, inserted onto the central disk; anthers dithecal, usually cordate, apiculate or not. Pollen usually tricolpate (rarely tetracolpate), prolate to spheroidal. Gynoecium consisting of 3(-5) carpels, each with a parietal placenta; styles and stigmas 3(-5). Fruit a loculicidal, many seeded capsule. Seeds elongate-obovoid, straight, comose at chalazal end, otherwise glabrous (or hairy near apex); hairs of coma unicellular, hygroscopic, with wavy thickenings near base; endosperm none.

Morphological features and their diagnostic value

Indumentum

The young green branchlets or the rachis of the racemes, may be papillose. The papillae may be dense, long and hair-like or very short. Accordingly, the plant is hairy or papillulose, respectively.

The Leaves

The leaves of *Tamarix* are usually herbaceous, small and scale-like. Five main leaf forms can easily be recognized and all are diagnostically valuable:

1. sessile with narrow base;
2. sessile with auriculate base;
3. amplexicaul;
4. vaginate;
5. pseudo-vaginate, i.e., strongly amplexicaul with close pressed margins, adpressedto the branchlets along their major part, and closely resembling vaginate leaves (see Fig 1).

Inflorescence

The inflorescence of *Tamarix* is racemose. Simple inflorescences consist of solitary racemes; compound inflorescences have many racemes, are often paniculately branched, and occur on current-year branches, either densely congested or loosely scattered on the common axis.

Racemes

While the width of the racemes varies somewhat from species to species, the length is more variable within the species. Aestival racemes are usually somewhat narrower than vernal ones, and the flowers are slightly to considerably smaller in aestival racemes than in vernal ones.

Bracts

The flowers of *Tamarix* are usually subtended by single bract. Bracts posses several diagnostic characteristics:
1. Length of bract: In some species the bracts are shorter than the pedicels; in others they are longer than the pedicels.
2. Structure: Some species have purely herbaceous bracts. In several species the upper part of the bract is diaphanous and the lower herbaceous, and in others the bracts are altogether diaphanous.
3. Shape: Bracts, like leaves, appear sessile, auriculate, amplexicaul or vaginate.

Sepals

The aestivation of sepals is imbricate. Thus, in pentamerous calyces there are two outer and two inner sepals, and one intermediate, and in tetramerous ones there are two outer and two inner sepals only. The shapes and dimensions of the outer and the inner sepals may be reliably used as characteristics. The margins of the sepals, entire, dentate or incised, is also an important characteristic in identification.

Petals

The aestivation of the petals is contorted. The petals provide most useful diagnostic characteristics in the following respect:
1. Persistence: Persistent petals may remain until ripening of the fruit. In subpersistent, only one or two petals may remain until maturity. Caducous petals are shed immediately after anthesis.
2. Shape: The shape of the petals is usually constant. There are a few species with a wide range of variability in the petals. Three main types may be distinguished as to shape: (a) ovate; (b) elliptic; (c) obovate. In several species the petals display a particular form.

Androecium

The androecium provides the most important distinguishing characteristics in *Tamarix*.
1. Number of stamens: The antesepalous stamens are constant in number in most species while the antepetalous ones are less constant, sometimes varying greatly in number within the species.
2. Insertion: A filament may come out beneath the disk, sometimes very near its margia or from the periphery of the disk.
3. Configuration of the disk: Three main types of disk are distinguished:
   a. Hololophic: In a hololophic disk the primary five lobes are apically distinct, though always connate below and either free from or concrescent with the bases of the filaments.
   b. Paralophic: In a paralophic disk the lobes are deeply bipartite and each halph-lobe closely approaches the base of the adjoining filament and becomes concrescent with it.
   c. Synlophic: In a synlophic disk the half-lobes of the bipartite discal lobes are very strongly confluent with the bases of the filaments, giving the impression that the filaments themselves have a broad base (see Fig 2).

Gynaecium

The ovary of *Tamarix* usually consists of three, sometimes of four and rarely of five, carpels.

Seeds

The fruit of *Tamarix* is a many-seeded capsule. Neither the form nor the size of the seeds is diagnostically important. The seed bears an apical papous. The apex is rostrate due to the twisted base of the unicellular hygroscopic hairs forming the papous.

Number of floral parts

In some species the numbers of sepals, petals and stamens are constant and reliable. One of the problems in *Tamarix* is that in many species the number of certain floral organs is inconstant.

Morphology of salt glands

The salt glands of halophytic plants are considered to be effective desalination devices and apparently maintain the salt balance in the leaves by the secretion of excess salts. *Tamarix* is an important bush plant that grows widely in sandy wastelands and in saline-alkali areas of arid and semiarid regions. It has attracted attention for its specific biological and ecological characteristics as well as its important roles in ecology and the social economy [19]. In *Tamarix* spp. the salt glands consist of two basal collecting cell and outer six highly cytoplasmic secretory cells and the position of the gland may be a lateral register with epidermis [20]. To observe SEM photograph of salt glands of some members of the genus *Tamarix,* refer to Fig 3.

The infrageneric taxonomy of Iranian Tamarix

The infrageneric taxonomy of *Tamarix* has undergone many revisions. Bunge divided the genus into sections on the basis of seasonality of flowering and used numbers of floral parts, raceme and vegetative morphology, filament insertion patterns, petal persistence, and capsule and style morphology as the basis for further subdivisions. Howere, Baum (1967) [9] and others have shown that seasonality of flowering is unreliable and that many species have both vernal and aestival (or continuous) anthesis. One of the most useful sets of characters derives from disc morphology. The three sections recognized by Baum (1978) [12] are characterized by features of the disc, as well as by raceme width, petal lent, and stamen number and position.

Species of sect. **Tamarix** generally have racemes less than 5 mm broad, petals 1-2.25 mm long, and five antesepalous stamens. Series within this section differ in vegetative features such as the peresence or absence of papillae and leaf morphology. Species of Iranian *Tamarix* belong to sect. **Tamarix** include: *T. dioica*, *T. aphylla*, *T. ramosissima*, *T. arceuthoides*, *T. indica*, *T. korolkowii*, *T. karakalensis*, *T. aralensis, T. smyrnensis, T. mascatensis*, *T. serotina* and *T. hispida.*

Species of sect. **Oligadenia** have broader vernal racemes, some tetrandrous members, and discs with nectariferous lobes. The series within this section differ in bract length relative to pedicel length, petal shape and length, and raceme morphology. Species of Iranian *Tamarix* belong to sect. **Oligadenia** include: *T. rosea*, *T. kotschyi*, *T. androssowii*, *T. tetragyna*, *T. octandra*, *T. leptopetala* and *T. szowitsiana*.

Species of sect. **Polyadenia** also have broad racemes but have more stamens and disks that lack nectariferous lobes. Its two series differ in the number of antepetalous stamens arising from the disc. Species of Iranian *Tamarix* belong to sect. **Polyadenia** include: *T. stricta*, *T. dubia* and *T. passerinoides*.

Identification of species

T. aralensis and *T. ramosissima* can be identified by their sessile leaves, pentamerous flowers and hololophic androecial disks (refer to Tab. 1). Crins (1989) [8] claims that their morphology is similar, and that it is difficult to recognize these two taxa as different species. *T. aralensis* is distinguished from *T. ramosissima* by its caducous petals at the time of seed maturation.

Based on morphological characteristics, it is difficult to distinguish the two species *T. arceuthoides* and *T. korolkowii*. In *T. arceuthoides*, raceme is no dense and flowers are placed at a distance, in addition, in the observed sample, the flower color is red but in *T. korolkowii*, raceme is dense and in the observed sample, the flower color is white. Assadi (1987) [16] stated, further researches may prove that the two types of species are the same as each other.

The two species, *T. ramosissima* and *T. smyrnensis* are known synonymous by Assadi (1987) [16] but Baum (1978) [12] knows *T. ramosissima* independent of *T. smyrnensis*. The major difference in the literature as to the separation of the two species is in the shape of petals. In *T. smyrnensis*, petals are ovate to suborbicular, strongle keeled especially in their lower part but in *T. ramosissima*, petals are obovate and not keeled.

Based on morphological characteristics, *T. kotschyi* and *T. androssowii* are very similar and it is difficult to distinguish the two species. Assadi (1987) [16] stated, further researches may prove that the two types of species are the same as each other. In *T. androssowii*, bracts are shorter than the pedicels and inflorescence is no dense or semi-dense.

T. aphylla is highly similar to *T. kermanensis* and to distinguish them from each, we can use the features of the filament. In *T. kermanensis* the filaments are gradually thick at the base and then connected to the lobes of disk while in *T. aphylla* the filaments are connected to the disk without thickening or lobes of disk are located between the filaments.

T. leptopetala and *T. mascatensis* are known synonymous by Baum (1978) [12] while *T. leptopetala* and *T. kotschyi* are known synonymous by Qaiser (1983) but Assadi (1987) [16] knows each of them as independent species. *T. leptopetala* has pentamerous flowers but *T. kotschyi* has tetramerous flowers as well as *T. leptopetala* has synlo to hololophic disk but *T. mascatensis* has synlophic disk.

T. serotina and *T. hispida* are known synonymous by Baum (1978) [12] while *T. serotina* and *T. karelinii* are known synonymous by Qaiser (1983) [17] but unlike the other two species in *T. serotina,* petals remain until ripening of the fruit as well as racemes are short and dense with 2 cm length.

Two species *T. meyeri* and *T. tetragyna* are known as distinct species by Baum (1978) [12] but Assadi (1987) [16], for *T. tetragyna*, has identified two varieties: var. *meyeri* and var. *deserti*. In *T. tetragyna* var. *meyeri* racemes are dense with 8-10 mm broad but in *T. tetragyna* var. *deserti* racemes are not dense with 5-8 mm broad.

Two species *T. karelinii* and *T. hispida* are known as distinct species by Qaiser (1983) [17] but Baum (1987) [12], for *T. hispida*, has identified two varieties: var. *hispida* and var. *karelinii*. In *T. hispida* var. *hispida* very hairy on all parts to (rarely) inconspicuously papillose but in *T. hispida* var. *karelinii* as a rule, inconspicuously papillose, sometimes also hairy.

Two species *T. passerinoides* and *T. macrocarpa* are known as distinct species by Baum (1987) [12] but Assadi (1987) [16], for *T. passerinoides* has identified two varieties: var. *passerinoides* and var. *macrocarpa. T. passerinoides* var. *passerinoides* has 10-11 stamens, racemes are not dense with 7-10 mm broad but *T. passerinoides* var. *macrocarpa has* 6-9 and rarely 10 stamens and racemes are dense with 5-8 mm broad.

Evolutionary trends in Tamarix

On the basis of the conventionally agreed upon morphological progressions, some evolutionary trends can be noted concerning both individual organs and relationships between the taxa. The evolutionary trends of the androecium in *Tamarix* have been discussed by Zohary and Baum (1967) [9]. The following five phyletic processes are quite obvious and are in some way linked together in *Tamarix*:

1. A trend towards the formation of smaller flowers and narrower racemes (all species of section **Tamarix**).
2. A transition from diplostemony to haplostemony leads gradually to complete abortion of the antepetalous stamens.
3. Fusion or adnation of the antepetalous whorl of stamens to the antesepalous one.

4. Persistence of the corolla is no doubt secondary to caducity. This characteristic is limited to the majority of the hypodiscal species and is surprisingly only found in the glyciphilous species.
5. Glycophily is no doubt a less advanced characteristic than halophily. Most of the hypodiscal species are glycophytes, while the bulk of the species are halophytes. This is in agreement with the view that non-salt-tolerant species are less specialized than salt-tolerant ones.
These five closely-linked evolutionary processes are conventionally accepted by taxonomists and are very helpful in discussing the relationships between the species.

Table 2. Morphological characters of the Iranian species of *Tamarix.*

Name of the taxa	Section	Leaf morphology	Number of floral parts	Androecial disk morphology	Racemes length	Racemes width	Sepals length	Sepals shape	Petals length	Petals shape	Bract length relative to pedicel length
T. dioica	TAMARIX	Vaginate	Pentamerous	Hololophic	3-8 cm	7-8 mm	1 mm	Ovate	2 mm	Obtriangular-obovate	Longer
T. kermanensis	TAMARIX	Vaginate	Pentamerous	Synlophic	1-6 cm	6 mm	1-1.2 mm	Ovate	2 mm	Elliptic	Equalling or shorter
T. stricta	POLYADENIA	Vaginate	Pentamerous	Paralophic	2-6 cm	4-5 mm	1.75 mm	Ovate	2-2.25 mm	Obovate-elliptic	Shorter
T. aphylla	TAMARIX	Vaginate	Pentamerous	Hololophic	3-6 cm	4-5 mm	1.5 mm	Ovate to elliptic	2-2.25 mm	Elliptic to obovate-	Longer
T. ramosissima	TAMARIX	Sessile with narrow base	Pentamerous	Hololophic	1.5-7 cm	3-4 mm	0.5-1 mm	Trullate-ovate	1-1.75 mm	Obovate-elliptic	Longer
T.rosea	OLIGADENIA	Sessile with narrow base	Pentamerous	Hololophic	5-12 cm	6-12 mm	1-2 mm	Trullate-ovate	2-3.5 mm	Ovate to ovate-elliptic	Shorter
T. arceuthoides	TAMARIX	Sessile with narrow base	Pentamerous	Hololophic	1.5-5 cm	3-4 mm	0.5-0.75 mm	Trullate-ovate	1-1.5 mm	Obovate	Equalling or scarcely longer
T. indica	TAMARIX	Sessile with narrow base	Pentamerous	Hololophic	4-15 cm	3-5 mm	0.75-1 mm	Ovate or trullate-ovate	1.5-2 mm	Elliptic to obovate	Longer
T. korolkowii	TAMARIX	Sessile with narrow base	Pentamerous	Hololophic	2-15 cm	3-4 mm	0.75-1.25 mm	Ovate	1.5-1.75 mm	Obovate-elliptic	Longer
T. karakalensis	TAMARIX	Sessile with narrow base	Pentamerous	Hololophic	0.5-4 cm	3-4 mm	0.5-0.75 mm	Trullate-ovate	1.25-1.5 mm	Obovate-elliptic	Equalling or longer
T. aralensis	TAMARIX	Sessile with narrow base	Pentamerous	Hololophic	2-6 cm	3.5-5 mm	0.75-1 mm	Trullate-ovate	1.75-2 mm	Obovate-elliptic	Longer
T. smyrnensis	TAMARIX	Sessile with narrow base	Pentamerous	Hololophic	0.5-2.5 cm	4 mm	1 mm	Trullate-ovate	2-2.75 mm	Ovate	Longer
T. mascatensis	TAMARIX	Amplexicaul	Pentamerous	Synlophic	1.5-3 cm	3-4 mm	0.75-1 mm	Ovate	1.25-1.75 mm	Ovate-elliptic	Longer
T. serotina	TAMARIX	Amplexicaul	Pentamerous	Synlophic	1-2 cm	2.5-3 mm	0.8 mm	Ovate	1.8 mm	Obovate	Longer
T. hispida	TAMARIX	Sessile with narrow base	Pentamerous	Synlophic	1.5-15 cm	3-5 mm	0.75-1 mm	Ovate	1.5-2 mm	Obovate-elliptic	Longer
T. dubia	POLYADENIA	Sessile with narrow base	Pentamerous	Paralophic	2-4 cm	7-9 mm	1.5-1.75 mm	Ovate	3-3.5 mm	Elliptic	Longer
T. kotschyi	OLIGADENIA	Amplexicaul	Tetra-Pentamerous	Synlo to Para-Synlophic	1-3 cm	3-4 mm	0.75-1 mm	Trullate-ovate	2-2.25 mm	Elliptic to obovate	Longer
T. androssowii	OLIGADENIA	Sessile with narrow base	Tetra-Pentamerous	Synlo to Para-Synlophic	1.5-4 cm	3-5 mm	1 mm	Trullate-ovate	2-2.25 mm	Elliptic-ovate to obovate	Equalling or shorter
T. tetragyna	OLIGADENIA	Sessile with narrow base	Tetra-Pentamerous	Paralophic	5-15 cm	8-10 mm	2 mm	Trullate-ovate	3.5-5 mm	Obovate to ovate	Longer
T. octandra	OLIGADENIA	Sessile with narrow base	Tetramerous	Paralophic	4-9 cm	8-12 mm	2-3.5 mm	Trullate-ovate	4-6 mm	Elliptic-ovate to obovate	Equalling
T. passerinoides	POLYADENIA	Sessile with auriculate base	Pentamerous	Disc without lobes	2-5 cm	8-10 mm	2.5-2.75 mm	Trullate-ovate	3.5-4 cm	Elliptic to ovate	shorter
T. leptopetala	OLIGADENIA	Amplexicaul	Pentamerous	Synlo to Hololophic	0.5-3 cm	3-4.5	0.7-0.9 mm	Ovate to elliptic	1.3-1.7 mm	Obovate	Equalling or longer
T. szowitsiana	OLIGADENIA	Sessile with narrow base	Tetramerous	Synlophic	2-4 cm	6 mm	1-1.25 mm	Trullate-ovate	2.25-2.5 mm	Elliptic-ovate to obovate	Equalling or longer

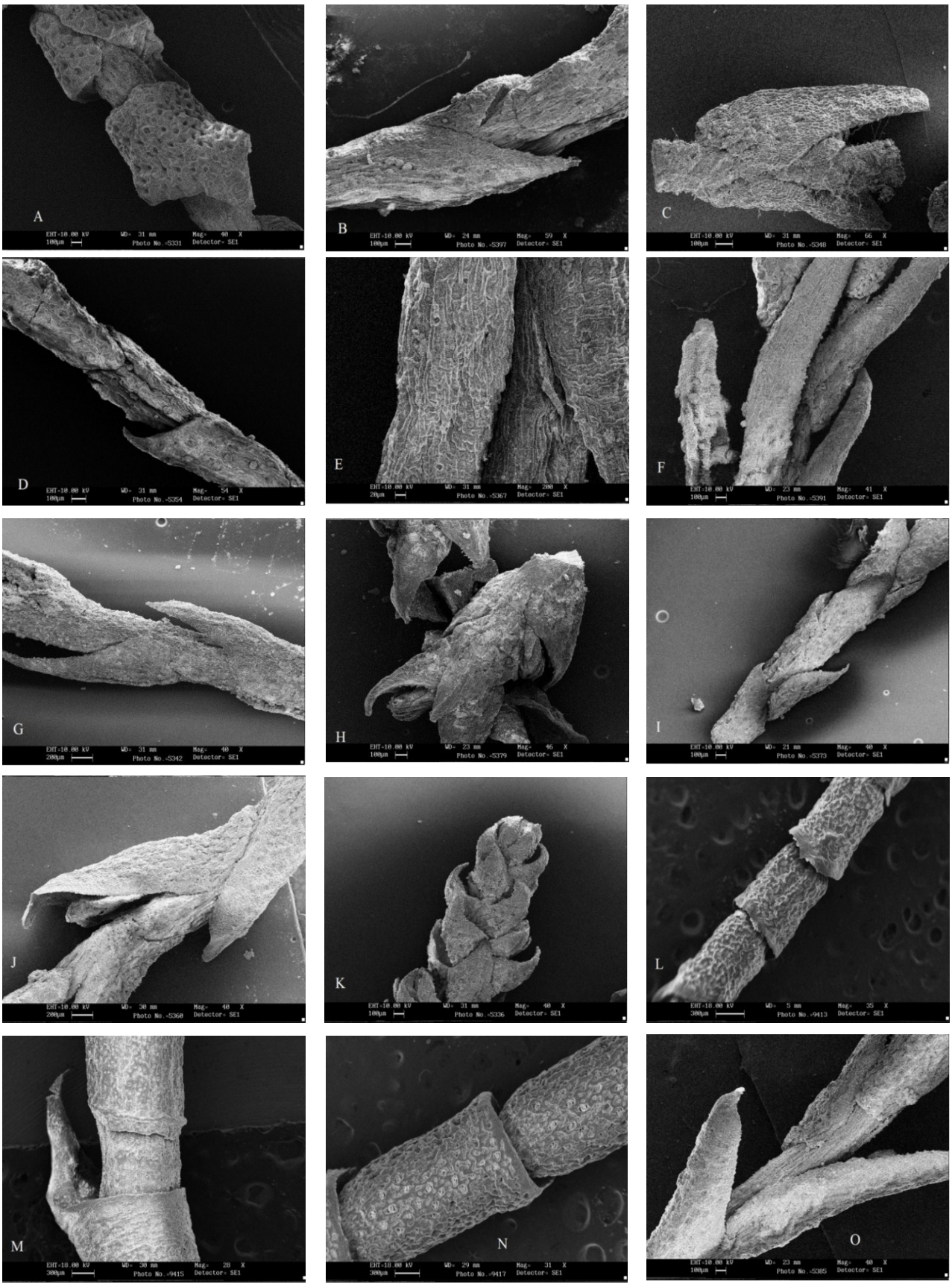

Fig. 1. SEM photograph of leaf forms of some members of the genus *Tamarix*.
A: *T. passerinoides* var. *passerinoides*. **B**: *T. hispida* var. *karelinii*. **C**: *T. szowitsiana*. **D**: *T. karakalensis*. **E**: *T. ramosissima*. **F**: *T. tetragyna* var. *meyeri*. **G**: *T. aralensis*. **H**: *T. kotschyi*. **I**: *T. androssowii*. **J**: *T. mascatensis*. **K**: *T. leptopetala*. **L**: *T. dioica*. **M**: *T. stricta*. **N**: *T. aphylla*. **O**: *T. tetragyna* var. *deserti*.

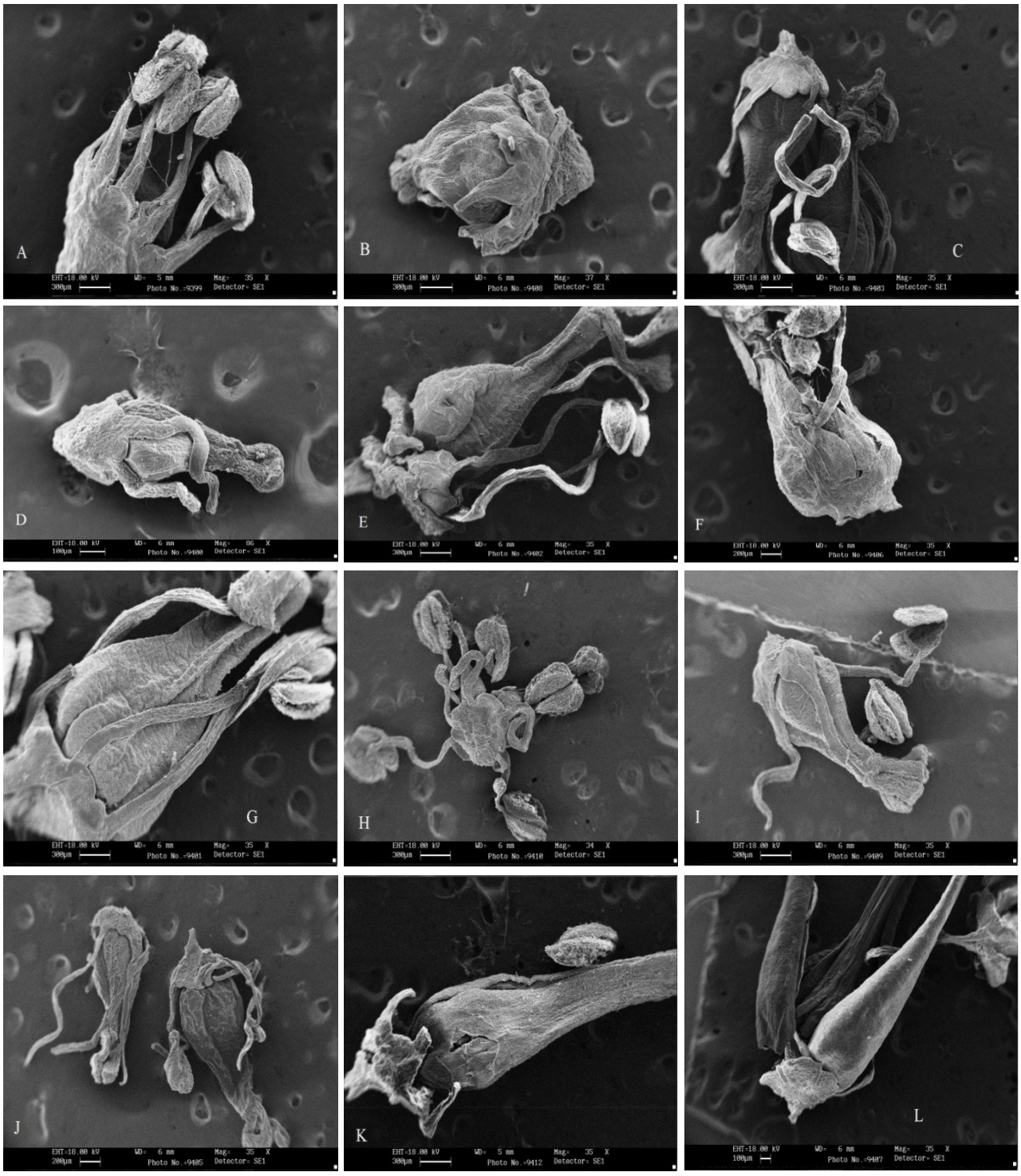

Fig. 2. SEM photograph of disk morphology of some members of the genus *Tamarix*.
A: *T. passerinoides* var. *passerinoides*. **B**: *T. passerinoides* var. *macrocarpa*. **C**: *T. hispida* var. *karelinii*.
D: *T. karakalensis*. **E**: *T. tetragyna* var. *meyeri*. **F**: *T. aralensis*. **G**: *T. tetragyna* var. *deserti*.
H: *T. androssowii*. **I**: *T. mascatensis*. **J**: *T. leptopetala*. **K**: *T. szowitsiana*. **L**: *T. ramosissima*.

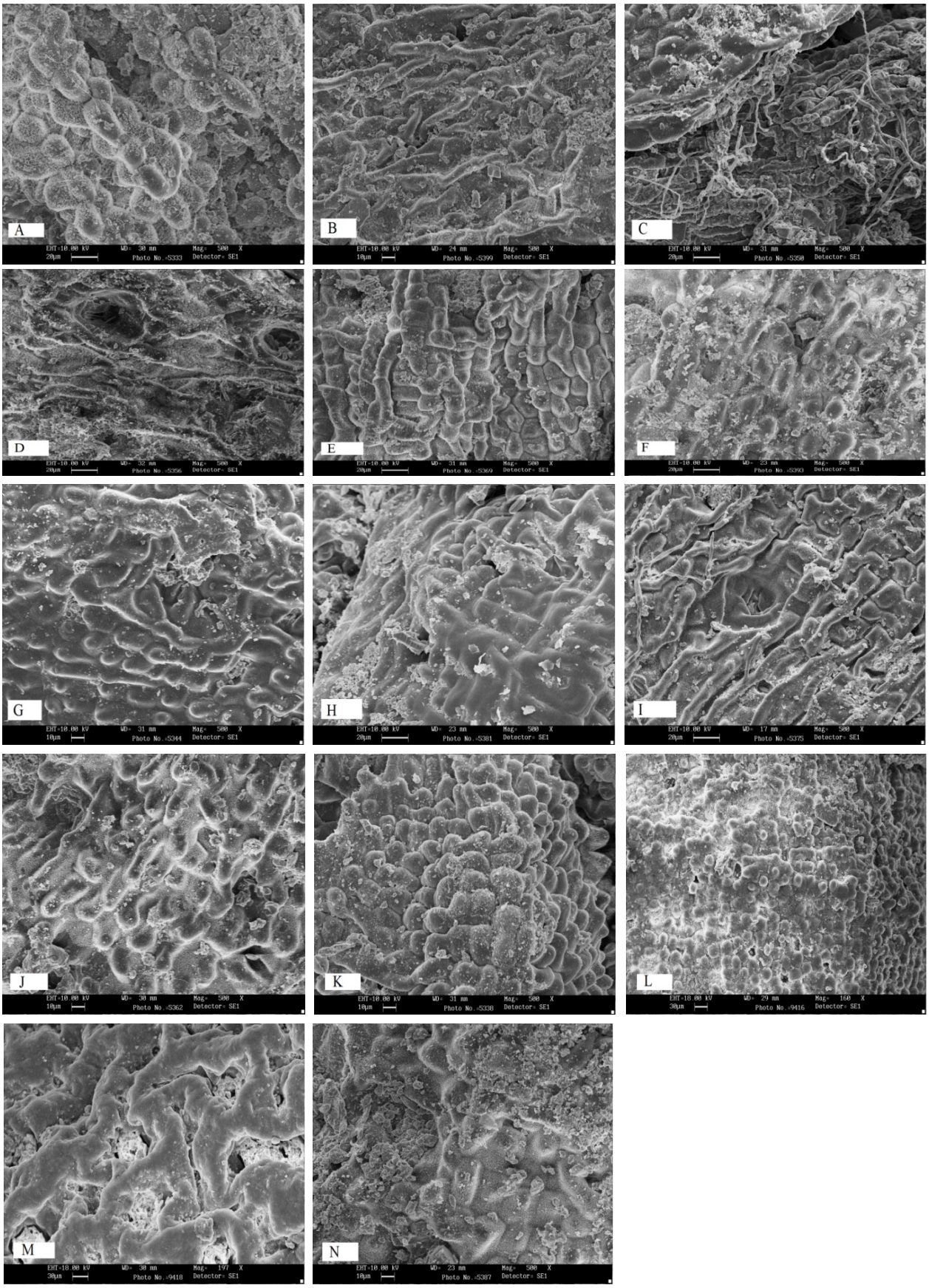

Fig. 3. SEM photograph of salt glands of some members of the genus *Tamarix*.
A: *T. passerinoides* var. *passerinoides*. **B**: *T. hispida* var. *karelinii*. **C**: *T. szowitsiana*. **D**: *T. karakalensis*.
E: *T. ramosissima*. **F**: *T. tetragyna* var. *meyeri*. **G**: *T. aralensis*. **H**: *T. kotschyi*. **I**: *T. androssowii*.
J: *T. Tetragyna* var. *deserti*. **K**: *T. leptopetala*. **L**: *T. stricta*. **M**: *T. aphylla*. **N**: *T. mascatensis*.

Conclusions

The genus *Tamarix* is composed of about 54 species of flowering plants. This study was carried out on 23 species of *Tamarix* that growing in Iran. *Tamarix* consists of many species, some of which are morphologically very similar. Most species cannot be identified without flowers and intermediate states exist for several morphological characters (and can even vary on a single individual or from season to season). Some characters are useful for segregating certain species, such as gross leaf morphology (vaginate vs. sessile), number of floral parts, certain aspects of androecial disk morphology, petal shape, presence or absence of hairs on the raceme rachis, and whether the filament is inserted under or from the side of the androecial disk. In some species the number of sepals, petals and stamens are constant and reliable. One of the problems in *Tamarix* is that in many species the number of certain floral organs is inconstant thus the number of floral parts alone cannot serve as a diagnostic marker without being correlated with the relative position of the organs and their range of numerical variability. Despite the existence of a fairly recent monograph of the genus (Baum, 1978) [12] *Tamarix* remains an exceedingly complex genus.

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