

STUDIES ON THE CARYOLOGY OF SOME SPECIES OF THE GENUS *SUAEDA* (CHENOPODIACEAE) IN IRAN

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Abstract

Caryological studies were carried out on ten species of the genus *Suaeda* belonging to 27 samples of different populations in Iran. Important chromosome features including numbers, lengths, centromere locations and caryotypes were studied. All the species have basic chromosome numbers of $x=9$. Chromosome counts of *S. acuminata* (C.A.Mey.) Moq. ($2n=18$), *S. aegyptiaca* (Hasselq.) Zoh., ($2n=18$), *S. baluchistanica* Akhani and Podl. ($2n=72$), *S. crassifolia* Pall., ($2n=18$), and *S. microsperma* (C.A.Mey.) Fenzl, ($2n=18$) are given for the first time. Another chromosome number for *S. fruticosa* J.F.Gmelin ($2n=72$) is also reported.

Introduction

The family of Chenopodiaceae is one of the most important families of dicotyledonous plants, the species of which inhabit saline and dry soils. However, the number of species of this family in Iran (c. 140 species) is not comparable with that of the total flora of Iran (c. 7000-7500 species), but their species play the most important role in the vegetation of extensive areas of Iranian saline soils. About 53% of known halophytes of Iran belong to this family [1]. The genera of *Anabasis*, *Atriplex*, *Halo-thamnus*, *Salsola* and *Suaeda* are the largest ones and in many cases the most critical groups from a taxonomic point of view. On the other hand, the genus *Suaeda* seems to be one of the most problematic genera in which the boundary of several species is not clear due to the extreme polymorphism of taxonomic characters. All

the species are obligate halophytes; their leaves, young shoots and perianths are fleshy. The fleshy nature of taxonomically important organs disappears in normally dried herbarium specimens, so determination of dry materials is mostly difficult. Also, most of the characters are very variable according to soil salinity and water supply. The genus consisted of 16 species in Flora Iranica area, 13 species are found in Iran [2].

The caryology and chromosome numbers of different species of the genus *Suaeda* have been studied by some authors: Malik and Tandon, Mehra and Malik in Kumar and Subramanian [7], Basset and Crampton [3] and Subramanian [10]. Hekmat-Shoar [5] and Hekmat-Shoar and Manafi [6] have studied three species including *S. altissima*, *S. maritima* and *S. microphylla* from the province of Azarbaijan in Iran. In this contribution, the results of caryological studies of 10 species on the basis of 27 samples are

Keywords: Caryology; Taxonomy; *Suaeda*; Chenopodiaceae; Iran

presented.

Materials and Methods

The seeds from 10 species of the genus *Suaeda* were collected during 1987 and 1990 by Akhani from different parts of Iran. The list of species, sample numbers, localities and herbarium vouchers are given in Table 1.

The seeds were grown in Petri dishes in laboratory conditions (c.25-30°C). Seedlings were prefixed in a 0.002 M 8-hydroxyquinoline solution for a period of 4-5 hours [9]. After prefixation, the seedlings were transferred to a primary fixation solution consisting of three parts of 96% ethyl alcohol and one part of glacial acetic acid. After 48 hours, the samples were transferred to a storage fixator of 70% ethyl alcohol. For staining, the samples were first hydrolyzed by HCl (1 N) for 3-20 minutes. After washing, the materials were stained with 2% acetocarmine by squash method. The prepared samples were studied by a Vanex-S-AHz light and phase contrast microscope.

Results

The results of chromosome numbers, percentage of each chromosome set and chromosome lengths are given in Table 2. The karyotypes of all the species are discussed below:

1-*Suaeda acuminata* (C.A.Mey.) Moq.

Sample nos.: 1-5

Chromosome number: $2n=2x=18$

Chromosome size: 0.9-2.3 nm

Karyotype: Fig. 1-a

Chromosomes of the above species have been studied from five localities. The lengths and frequency of aneuploidy state are similar in four samples. However, sample No.1 has 5% octaploidy ($2n=8x=72$), and its size is comparatively smaller than others. Centromere locations of all samples are alike. It was found that three pairs are metacentric, one pair submetacentric and five pairs acrocentric.

2-*S. aegyptiaca* (Hasseq.) Zoh.

Sample nos.: 6-11

Chromosome number: $2n=2x=18$

Chromosome size: 3.2-5.8 nm

Karyotypes: Figs. 1-d & 2-d

Chromosomes of six samples of *S. aegyptiaca* were studied. All the samples have $2n=2x=18$. We have not found its chromosome number in available literature. The occurrence of 10% aneuploidy with reduction of one chromosome in sample No. 6 and 22% aneuploidy with reduction of two chromosomes in sample No.8 are remarkable. Sample No.11 is the only sample with 100% of normal chromosome sets in all studied

materials. The size of the chromosomes of this sample is comparatively smaller than others. A satellite was observed in the long arm of the ninth pair of sample Nos. 7 and 8 and also on the short arm of the sixth pairs of other samples. In general, *S. aegyptiaca* contains six pairs of submetacentric, one pair of metacentric and two pairs of acrocentric chromosomes.

3-*S. altissima* (L.) Pall.

Sample nos.: 12 & 13

Chromosome number: $2n=2x=18$

Chromosome size: 3.43-5.14 nm

Karyotypes: Figs. 1-e & 2-c

The chromosome numbers of samples studied confirm the results reported by Hekmat-Shoar [5]. The percentage of every set, the centromere location, and chromosome length have no significant differences in both samples. Concerning the centromere location, two pairs are metacentric, two pairs submetacentric and five pairs are acrocentric.

4-*S. arcuata* Bunge

Sample no.: 14

Chromosome number: $2n=2x=18$

Chromosome size: 2.3-3.7 nm

Karyotype: Fig. 1-g

The chromosomes of *S. arcuata* have been studied from only one sample. They have also been studied by Zakharyeva [in Fedorov, 4]. Each chromosome set includes two pairs of metacentric, two pairs of submetacentric, three pairs of acrocentric and two pairs of telocentric chromosomes.

5-*S. baluchistanica* Akhani & Podl. (In press)

Sample no.: 15

Chromosome number: $2n=8x=72$

Chromosome sizes: 2-3.1 nm

Karyotypes: Figs. 1-1 & 2-b

S. baluchistanica is a new species that is closely related to *S. fruticosa*. Its chromosome number is $2n=72$. Fourteen percent of the cells were found in aneuploidy state with reduction of four chromosomes. Concerning the centromere arrangements, three pairs are submetacentric, five pairs metacentric, two pairs telocentric and the remaining twenty-six pairs are acrocentric.

6-*S. crassifolia* Pall.

Sample nos.: 16 & 17

Chromosome number: $2n=2x=18$

Chromosome size: 0.5-1.3 nm

Karyotype: Fig. 1-b

The chromosome number of this species is reported for the first time. In sample number 16 there are 19% of aneuploidy with reduction of four chromosomes and sample 17 has 12% aneuploidy with

Table 1. Localities and herbarium vouchers of the collected seeds from 19 samples of 10 species of the genus *Suaeda* in Iran for seed proteins electrophoresis analysis. Abbreviations: BEHESHTI UH=Shahid Beheshti University Herbarium; MMTT=Natural History Museum of Iran; TARI = Research Institute of Forests and Rangelands

Species and sample number	Locality and herbarium voucher
1. <i>S. acuminata</i> (C.A.Mey.) Moq.	Azərbayjan: 69 km from Kaleibar to Khodaafarin, near Safalu, 250 m, 5.10.1987, ASSADI & AKHANI, 61575 (TARI).
2."	Azərbayjan: N side of Uromieh Lake, Bandare-Sharafkhaneh, 1300m, 4.10.1987, ASSADI & AKHANI, 61505 (TARI).
3."	Tehran: Karaj, near Mardabad, c.1200m, 17.11.1987, AKHANI (TARI).
4."	Fars: Arsanjan, W shores of Tashk Lake, between the villages Gomban & Katak, 1700m, 27.11.1987, ASSADI & AKHANI, 61813 (TARI).
5."	Fars: 23 km W of Abadeh-Tashk, border of Tashk Lake, 1700m, 26.11.1987, ASSADI & AKHANI, 61792 (TARI).
6." <i>S. aegyptiaca</i> (Hasselq.) Zoh.	Yazd: Kavire-Marvast, near Rahmatabad, 1600m 25.11.1987, ASSADI & AKHANI, 61772 (TARI).
7."	Fars: c.30 km W of Jahrom, 7 km after Mobarakabad towards Harm villages, 700m, 28.11.1987, ASSADI & AKHANI, 61832 (TARI).
8."	Bushehr: On the road from Kaki to Khur-Mouj, after the river Mond, c.20m, 2.12.1987, ASSADI & AKHANI, 62029 (TARI).
9. <i>S. altissima</i> (L) Pall.	Azərbayjan: N of Uromieh Lake, Bandare-Sharafkhaneh, 1300m, 5.10.1987, ASSADI & AKHANI, 61504 (TARI).
10."	Azərbayjan: SE of Uromieh Lake, near Chopoghlu, 1350 m, 1.10.1987, ASSADI & AKHANI, 61321-a (TARI).
11. <i>S. crassifolia</i> Pall.	Azərbayjan: N. of Uromieh Lake, Bandare-Sharafkhaneh, 1300m, 4.10.1987, ASSADI & AKHANI, 61501 (TARI).
12. <i>S. fruticosa</i> J.F.Gmelin	Tehran: E. of Houze-Soltan Lake, 800m, 14.9.1987, AKHANI, 4822 (MMTT).
13."	Hormozgan: Between Bandare-Lengeh & Bandare-Charak, after Bandare-Shenas, c.10m, 30.11.1987, ASSADI & AKHANI (TARI).
14. <i>S. maritima</i> (L.) Pall	Arak: N. of Kavire-Meyghan, 8 km W. Davoodabad, AKHANI, 1037 (BEHESHTI UH).
15."	Tehran: Between Tehran & Qom, Rude-Shur, 1000m, 6.9.1987, AKHANI, 4795 (MMTT).

Table 1. Continued

Species and sample number	Locality and herbarium voucher
16 & 17. <i>S. microphylla</i> Pall.	Tehran: Karaj, c. 10 km WNW of Mardabad, c.1200 m, 17.11.1987, ASSADI & AKHANI, 61722 (TARI).
18. <i>S. microsperma</i> (C.A.Mey.) Fenzel	Semnan: Touran Protected Area, c.8 km NE. of Razeh, 30.10.1987, AKHANI, 4144 (MMTT).
19."	Semnan: Touran Protected Area, between Delbar & Ahmadabad, along Kal-Shur river, 30.10.1987, AKHANI, 4209 (MMTT).

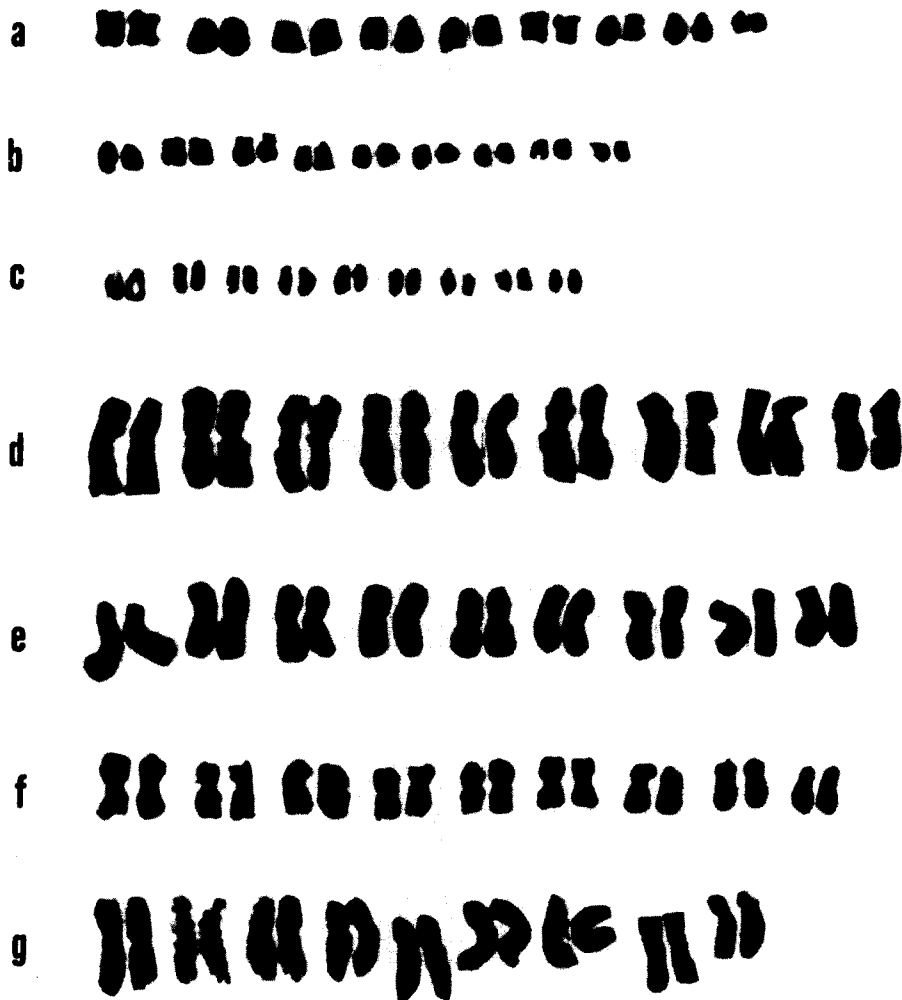


Figure 1. Selected caryotypes of different species of *Suaeda*: (a) *S. acuminata* (C.A.Mey.) Moq. (5); (b) *S. crassifolia* Pall. (17); (c) *S. microsperma* (C.A.Mey.) Fenzel (27); (d) *S. aegyptiaca* (Hasselq.) Zoh. (9); (e) *S. altissima* (L.) Pall. (13); (f) *S. microphylla* Pall. (25); (g) *S. arcuata* Bunge (14)

reduction of two chromosomes. The karyotype of this species consisted of one pair of submetacentric, four pairs of metacentric, two pairs of acrocentric and two pairs of telocentric chromosomes.

S. fruticosa J.F.Gmelin

Sample nos.: 18 & 19

Chromosome numbers: $2n=6x=54$ & $2n=8x=72$

Chromosome size: 2.3-3.7 μ m

Caryotype: Figs. 1-j & 2-a

Two different chromosome numbers were observed in the samples studied. The number of $2n=72$ has not been reported for this species, but $2n=54$ has been

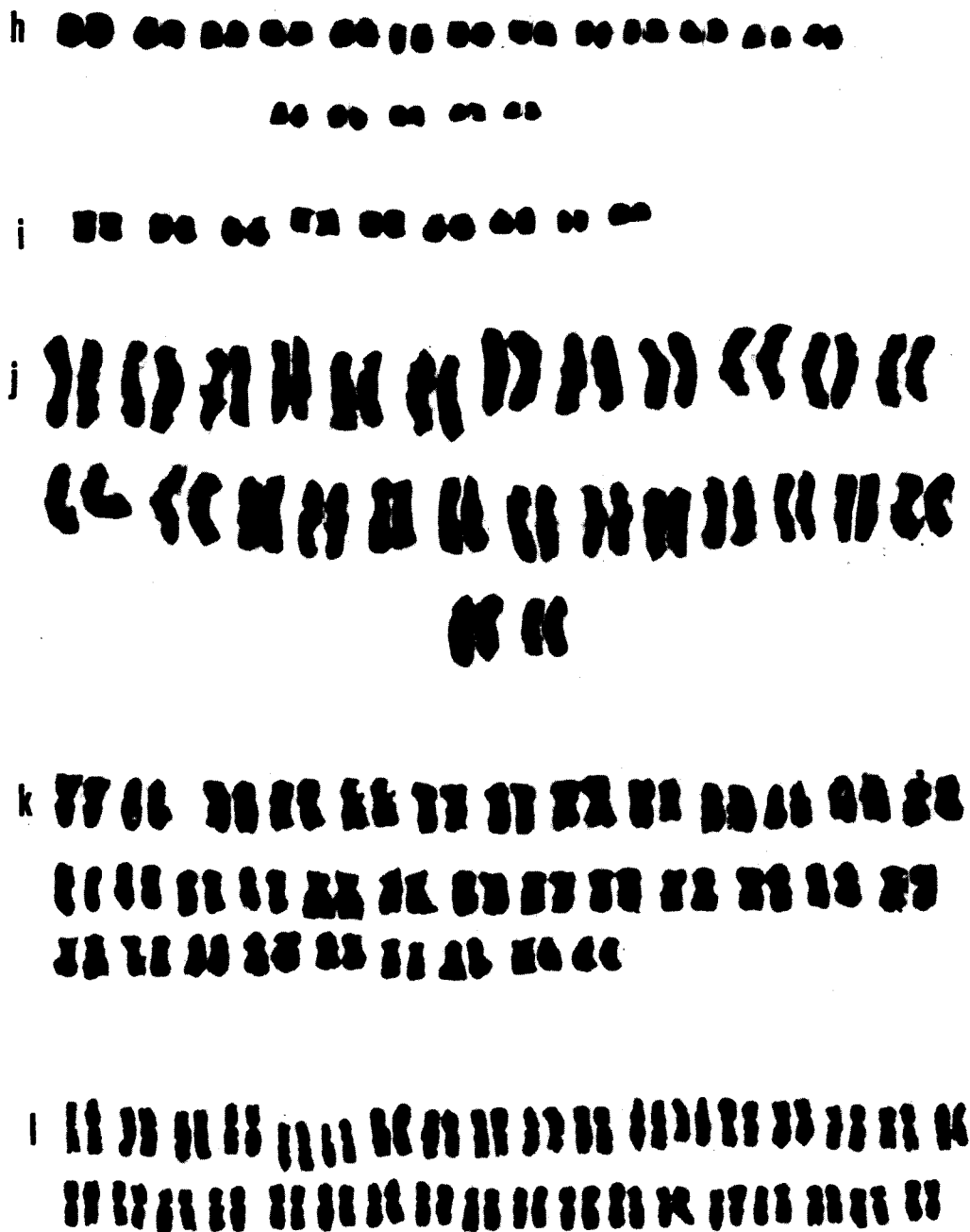


Figure 1. Continued

(h) *S. maritima* (L.) Dumort (23); (i) *S. maritima* (L.) Dumort (21); (j) *S. fruticosa* J.F.Gmelin (18); (k) *S. fruticosa* J.F.Gmelin (19); (l) *S. baluchistanica* Akhani & Podl. (15)

reported by Mehra and Malik [Kumar and Subramanian, 7]. The location of centromeres are similar in both samples and all the chromosomes are acrocentric. A satellite was observed on pair numbers 12 and 13.

8-*S. maritima* (L.) Dum.

Sample nos.: 20-23

Chromosome numbers: $2n=2x=18$ & $2n=4x=36$

Chromosome size: 0.7-1.6 nm

Caryotype: Figs. 2-i, j

Chromosomes of *S. maritima* were studied from four populations in the northwest, centre and south of

Iran. Two different chromosome numbers were distinguished. The samples of Azarbayjan (number 20) and Arak (number 21) are diploid and the samples of Tehran (number 22) and Bushehr (number 23) are tetraploid. Differences in chromosome numbers have also been reported by others: Kumar and Subramanian [7], Basset and Crampton [3], Hekmat-Shoar [5] and Pedrol and Castroviejo [8]. The chromosome size of four studied samples are almost similar. On the basis of centromere location, sample numbers 22 and 23 contain three pairs of submetacentric, ten pairs of acrocentric and five pairs of metacentric. On the other

Table 2. Chromosome numbers, percentage of each chromosome set and chromosome length from 27 samples of 10 species of the genus *Suaeda* from different parts of Iran

Species and sample number	Chromosome sets and their frequency in 100 countings										Chromosome lengths (nm)		
											Min.	Max.	Mean
1. <i>Suaeda acuminata</i> (C.A.Mey.) Moq.	18	90	5	5	.	.	.	.	.	.	0.9	2.00	1.43
2."	18	88	6	.	.	.	6	.	.	.	1.14	2.25	1.64
3."	18	90	5	.	.	.	5	.	.	.	1.14	2.30	1.68
4."	18	88	6	.	.	.	6	.	.	.	1.14	2.28	1.69
5."	18	90	5	.	.	.	5	.	.	.	1.14	2.28	1.68
6. <i>S. aegyptiaca</i> (Hasselq.) Zoh.	18	85	5	.	.	10	.	.	.	.	4.07	5.80	4.84
7."	18	89	4	.	.	.	7	.	.	.	4.20	6.00	4.90
8."	18	74	.	.	.	22	.	.	.	.	4.00	5.70	4.91
9."	18	92	.	.	.	.	4	4	.	.	3.90	5.60	4.74
10.	18	96	.	.	.	.	4	.	.	.	3.93	5.57	4.73
11.	18	100	.	.	.	.	.	.	.	.	3.20	4.00	3.65
12. <i>S. altissima</i> (L.) Pall.	18	90	5	.	.	.	5	.	.	.	3.43	5.02	4.00
13."	18	88	8	.	.	.	4	.	.	.	3.43	5.14	4.21
14. <i>S. arcuata</i> Bunge	18	98	.	.	2	.	.	.	.	.	2.30	3.70	3.01
15. <i>S. baluchistanica</i> Akhani & Podl. (in press)	72	.	.	86	.	.	.	.	14	.	2.00	3.10	2.52
16. <i>S. crassifolia</i> Pall.	18	75	6	.	.	.	.	19	.	.	0.50	1.25	1.02
17."	18	76	6	.	.	12	.	6	.	.	0.60	1.30	1.05
18. <i>S. fruticosa</i> J.F.Gmelin	54	.	2	96	.	.	.	.	.	2	2.45	3.70	3.04
19."	72	.	10	85	.	.	.	.	5	.	2.30	3.45	3.00
20. <i>S. maritima</i> (L.) Dum.	18	92	.	.	.	.	8	.	.	.	0.70	1.60	1.11
21."	18	94	.	.	.	.	6	.	.	.	0.75	1.60	1.11
22."	36	88	.	.	.	.	.	6	6	.	0.70	1.60	1.08
23."	36	92	.	.	.	.	.	8	.	.	0.70	1.60	1.12
24. <i>S. microphylla</i> Pall.	18	95	.	.	5	.	.	.	.	.	2.28	3.80	3.01
25."	18	90	5	.	.	5	.	.	.	.	2.28	4.02	3.21
26. <i>S. microsperma</i> (C.A.Mey.) Fenzel	18	82	6	.	.	12	.	.	.	.	0.84	1.80	1.43
27."	18	90	5	.	.	5	.	.	.	.	0.85	1.83	1.43

hand in sample numbers 20 and 21, one pair of submetacentric, three pairs of acrocentric, three pairs of metacentric and two pairs of telocentric were distinguished.

9-*S. microphylla* Pall.

Sample nos.: 24 & 25

Chromosome number: $2n=2x=18$

Chromosome size: 2.28-4.02 μ m

Caryotype: Fig. 1-f

Chromosomes of *S. microphylla* were studied from

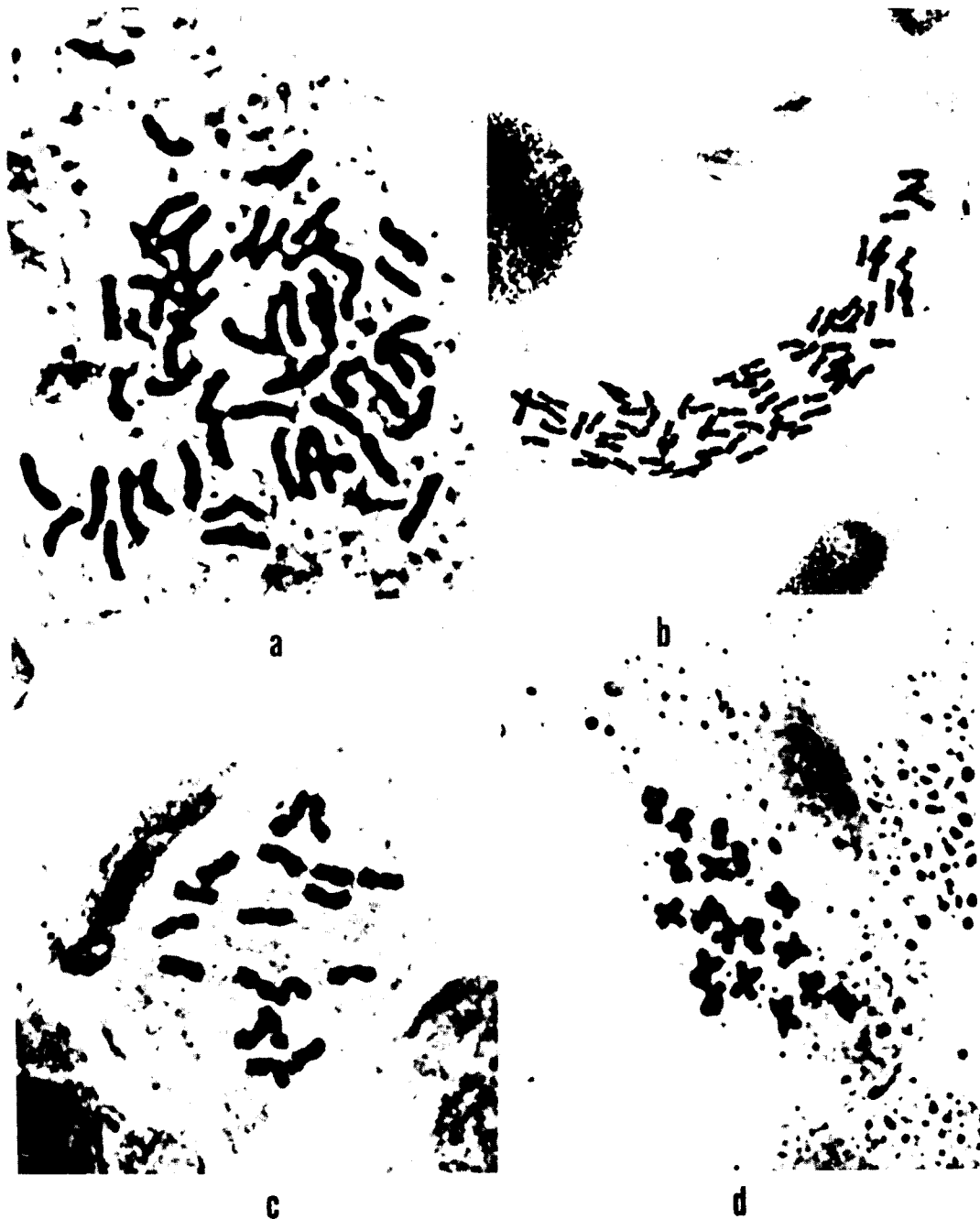


Figure 2. Chromosomes of (a) *S. fruticosa* J.F.Gmelin (18); (b) *S. baluchistanica* Akhani & Podl. (15); (c) *S. altissima* (L.) Pall. (13) and (d) *S. aegyptiaca* (Hasselq.) Zoh. (9).

two samples of the same population. The chromosome of the first pair have a constriction and those of the fifth pairs have a satellite. Caryotype consisted of two pairs of metacentric, two pairs of submetacentric and five pairs of acrocentric. The chromosome number of this species has also been reported by Hekmat-Shoar and Manafi [6].

10-*S. microsperma* (C. A. Mey.) Fenzel

Sample nos.: 26 & 27

Chromosome number: $2n=2x=18$

Chromosome size: 0.84-1.83 nm

Caryotype: Fig. 1-c

The chromosome number of this species is reported for the first time. Based on the caryotypes of both studied samples, four pairs of acrocentric, two pairs of telocentric and three pairs of metacentric were distinguished.

Conclusion

On the basis of this work and other works [3-10], the basic chromosome number of the genus *Suaeda* is $x=9$. Most of the species have diploid chromosome numbers except *S. maritima*, *S. baluchistanica* and *S. fruticosa*. *S. baluchistanica* is closely related to *S. fruticosa*. Nevertheless it can be separated by its vigorous and prostrate habit, large leaves, large seeds and its habitat on sandy shores. Its chromosomes are also smaller than *S. fruticosa* and centromere locations are also different. *S. maritima* is also a very polymorphic species widely distributed in Asia, N. Africa, Europe and N. America. Further cytogenetic and cytogeographic investigations from different populations are recommended for *S. maritima* and *S. fruticosa* groups.

According to chromosome lengths, the ten species studied could be divided into two groups: (a) species with small chromosomes (mean lengths 1-2 nm, incl. *S. acuminata*, *S. crassifolia*, *S. maritima* and *S. microsperma*) and (b) species with large chromosomes (mean lengths 2.5-5 nm, incl. *S. aegyptiaca*, *S. altissima*, *S. arcuata*, *S. baluchistanica*, *S. fruticosa* and *S. microphylla*). The chromosomes of the first groups are morphologically related to each other, but the second group are more or less heterogeneous.

The occurrence of abnormal chromosome sets is more or less different in every species and even in different populations of the same species, although diploidy state and aneuploidy state with reduction of two chromosomes were found in most species.

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