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HELMUT FREITAG, MECIT VURAL & NEZAKET ADIGÜZEL

# A remarkable new *Salsola* and some new records of *Chenopodiaceae* from Central Anatolia, Turkey

**Abstract**

Freitag, H., Vural, M. & Adıgüzel, N.: A remarkable new *Salsola* and some new records of *Chenopodiaceae* from Central Anatolia, Turkey. – Willdenowia 29: 123-139. 1999. – ISSN 0511-9618.

The chenopod flora of a badland area 120 km WNW of Ankara was studied with the following results: *Salsola grandis* is described as a species new to science and illustrated, the presence of two species, viz. *Anabasis aphylla* and *Atriplex aucheri,* not listed in 'Flora of Turkey' but earlier reported from E Anatolia by Russian authors, is confirmed, and four species, viz. *Atriplex laevis, Halanthium kulpianum, Petrosimonia nigdeensis* and *Salsola nitraria,* are newly recorded from NW Central Anatolia. *Salsola grandis* belongs to *S.* sect. *Salsola* s.str. and is distantly related to *S. soda.* From the number and frequency of halophytic and semi-desert chenopod species, particularly from the presence of both the rather isolated endemic *Salsola grandis* and the strongly disjunct *Anabasis aphylla,* the conclusion is drawn that the area SE of Nallıhan has a much drier climate than its surroundings. Very likely, the evolution of *S. grandis* has taken place there from Tertiary times onwards, and the other disjunct species might have invaded later during drier climatic phases of the Pleistocene or early Holocene.

## Introduction

From 20.9.-16.10.1997, members of the Botanical Institutes of the Kassel University and the Gazi University in Ankara, undertook a joint expedition to different parts of Turkey to study and collect halophytic *Chenopodiaceae*. We were well aware that the body of information on that family as documented in Flora of Turkey 2 (Aellen 1967b), 10 (Kit Tan 1988) and a few relevant additions (Freitag in Nydegger-Hügli 1992, 1995, Freitag & Huber-Morath in Nydegger-Hügli 1998) is still rather incomplete. Due to the late flowering and fruiting of most species, they are seriously under-represented in herbarium collections. Therefore, we expected to get a better knowledge of the distributions of the respective species. Furthermore, in the case of taxonomically difficult genera, it was intended to carry out studies on the populations of relevant species in the field and to collect seeds for subsequent cultivation experiments. The latter were carried out in 1998 in Kassel, and are still under evaluation. The results of the expedition and subsequent studies will be published soon by the first and the third author. The present contribution is pub-

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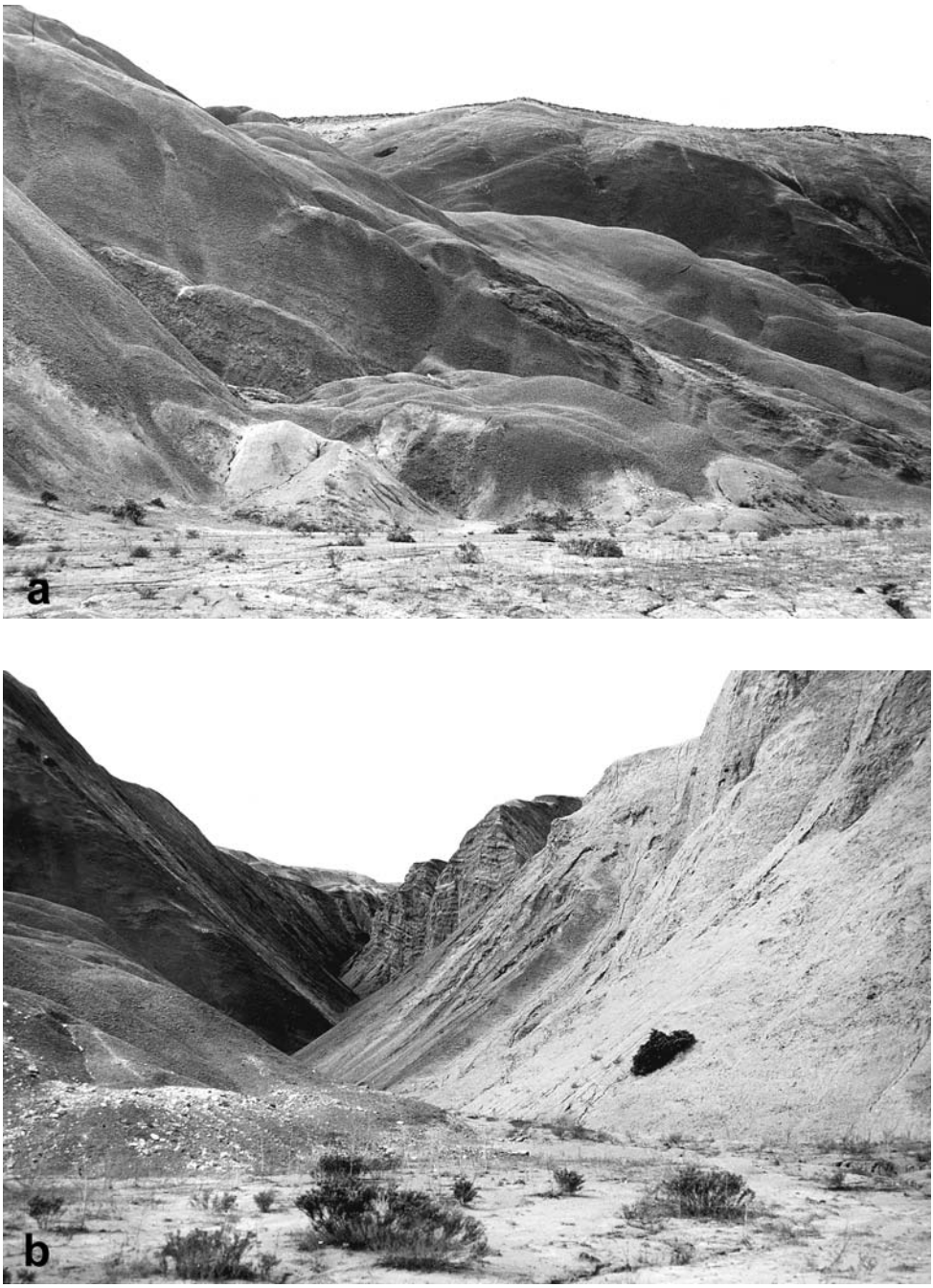



Fig. 1. The badland area 28 km ESE Nallıhan – a: from the foreland at 460 m above sea level; b: ravine with *Anabasis aphylla* L. on the widened bottom. – Photographs by H. Freitag.

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lished separately because it resulted from the only excursion undertaken together with the second author. After having finished the programme, just at the end of our stay in Ankara, M. Vural remembered a plant he collected together with N. Adıgüzel a few years ago in early summer near the very place. The herbarium specimens were collected in the first flowering stage but proved to belong to a hitherto unknown species. To get more information on this intriguing species, in a one-day trip from Ankara, we explored the site and found the species in marvellous fruiting stage, together with several other unexpected remarkable plants. The first set of plants is kept in KS, a second one in GAZI.

**The site and its ecological conditions**

The badland site is situated at 40°08'21"N, 3°28'20"E in the northwestern-most part of Ankara province, in a direct line about 120 km WNW from the centre of Ankara and 28 km ESE of Nallıhan, at the western bank of the dam opposite Davutoğlan just N of the road from Beypazarı to Nallıhan. Geologically, it belongs to the basin along the middle course of the Sakarya river, which is filled by Early Tertiary sediments. At the site, they consist of grey, very soft marl of the Akpınar and Kirmir series (Kavuşan 1993). They are subjected to heavy sheet and gully erosion and are deeply dissected by a regular system of runnels and ravines leading eastward to the valley of the Aladağ Çayı, a northern tributary of the Sakarya. The slopes, with an inclination of 20-80°, are for their most part completely barren. Scattered plants are present in the ravines, denser vegetation is restricted to the temporarily flooded bottom of larger ravines and the washes in the foreland between the marl hills and the shore of the artificial lake (Fig. 1-3).

The altitude ranges from about 460 m at the base of the marl hills to more than 500 m on the higher slopes. The more important climatic data from the stations closest to the site as taken from the State Meteorological Service (1974) are: Nallıhan (650 m above sea level, periods 1929-32, 1954-70): 428 mm (mean annual precipitation), 12.6 °C (mean annual temperature); Ankara

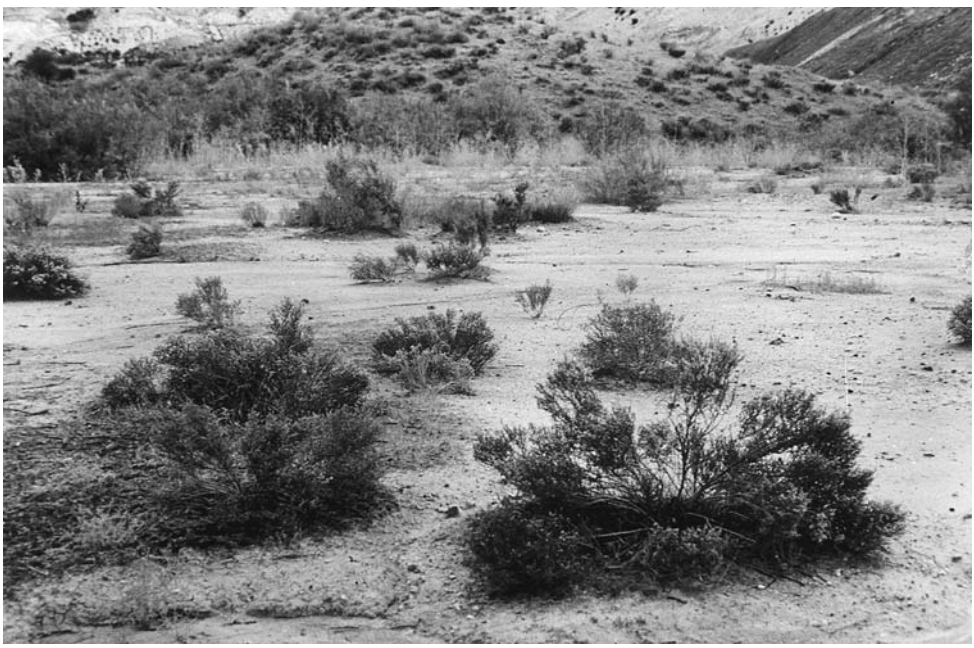


Fig. 2. *Anabasis aphylla*-dominated stand on the bottom of a ravine. – Photograph by H. Freitag.

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Fig. 3. Gully in a steep slope of weak gypsiferous Tertiary marly sediments with pure stand of *Salsola grandis* (locality of relevé no. 2). – Photograph by H. Freitag.

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(895 m above sea level, period 1926-70): 367 mm and 11.8 °C respectively. However, due to the significantly lower altitude and pronounced rain shadow from the mountain ridges towards the N, W and SW, the mean precipitation is certainly much lower and the summer temperature higher. Strongly indicative of a dry steppe or even semi-desert climate is, on one hand, the vegetation of nearby normal (non-marl) habitats with a dominance of *Noaea mucronata, Koeleria* sp. and *Genista sessilifolius* even on N exposed slopes, and, on the other hand, the lower timber line close to 850 m, as documented by a photograph in Louis (1939: Fig. 4).

**The vegetation**

We had no time for a thorough study of the vegetation, but a few relevés covering the gradient from the slopes to the ravines, valley bottoms and downward to the muddy shore of the lake could be made (Tab. 1).

Tab. 1. Relevés from the badland area ESE of Nallıhan, no. 1-4 by H. Freitag, no. 5 and 6 by M. Vural & N. Adıgüzel; chenopods in bold type.

Relevés: 1: small gully; 2: larger gully (see Fig. 4); 3: gentle slope, just above the bottom of a ravine; 4: bottom of a ravine; 5: wash, influenced by a piste; 6: wash, temporarily flooded by the dam.

| No. of relevé | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Max. height of plant cover [cm] | 30 | 50 | 30 | 80 | 200 | 50 |
| Total coverage [%] | 1 | 7 | 5 | 15 | 30 | 60 |
| Number of higher plant species | 1 | 1 | 4 | 9 | 19 | 5 |
| ***Salsola grandis*** | + | 2 | + | 1 | 1 | – |
| ***Halanthium kulpianum*** | – | – | 1 | 1 | 1 | – |
| ***Petrosimonia nigdeensis*** | – | – | 1 | 1 | – | – |
| ***Anabasis aphylla*** | – | – | 1 | 1 | 1 | – |
| ***Salsola nitraria*** | – | – | | 1 | 2 | – |
| ***Atriplex laevis*** | – | – | – | + | + | 4 |
| *Alhagi pseudalhagi* | – | – | – | 1 | 2 | – |
| *Lepidium graminifolium* | – | – | – | 1 | + | – |
| *Puccinellia koeieana* | – | – | – | 1 | + | – |
| *Xanthium strumarium* | – | – | – | + | 1 | |
| *Rumex pulcher* | – | – | – | – | + | + |
| *Tamarix parviflora* | – | – | – | – | 2 | – |
| *Phragmites australis* | – | – | – | – | + | – |
| *Torularia torulosa* | – | – | – | – | + | – |
| *Reaumuria alternifolia* | – | – | – | – | + | – |
| *Zygophyllum fabago* | – | – | – | – | + | – |
| *Centaurea coronopifolia* | – | – | – | – | + | – |
| *Caccinia macranthera* | – | – | – | – | + | – |
| ***Salsola tragus*** | – | – | – | – | + | – |
| ***Atriplex aucheri*** | – | – | – | – | + | – |
| ***Chenopodium chenopodioides*** | – | – | – | – | – | 1 |
| *Bolboschoenus maritimus* | – | – | – | – | – | + |

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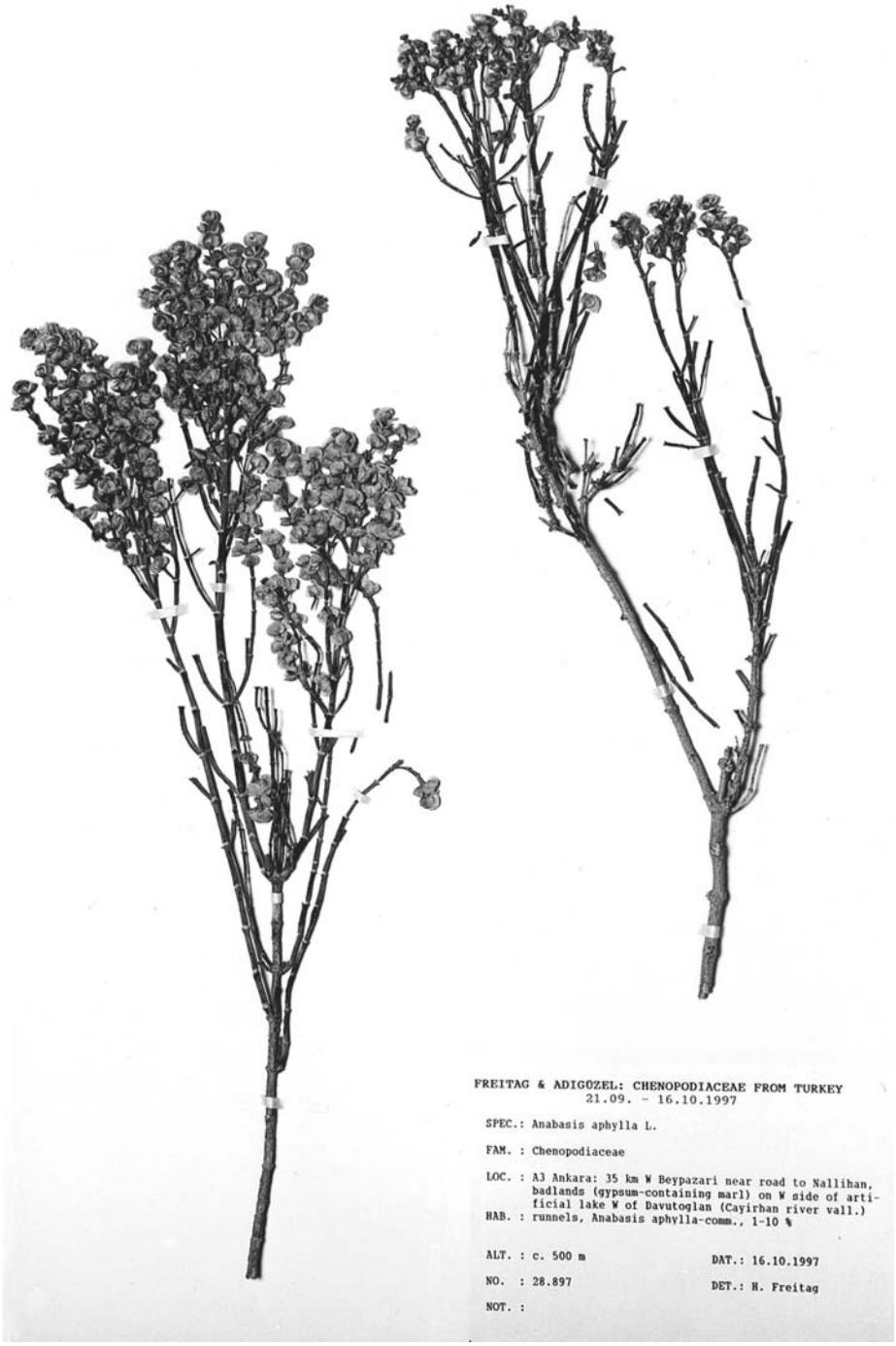



Fig. 4. *Anabasis aphylla* L. from the badland area ESE of Nallıhan *(Freitag, Vural & Adıgüzel 28 897).* – Photograph by H. Freitag.

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**Some remarkable species of *Chenopodiaceae* in the studied site**

***Anabasis aphylla*** L., Sp. Pl.: 223. 1753.
Not previously recorded in 'Flora of Turkey' – *Freitag, Vural & Adıgüzel 28 897*.

The species is locally common. It grows as a subshrub with numerous parallel, erect branches reaching a height of 0.6 m and a base diameter of 0.8 m (Fig. 2 & 4). The plants agree in all respect with specimens collected by the first author in former Soviet Azerbajdžan, in the N Caspian Lowlands and in adjacent semi-deserts of Central Asia. From neighbouring Nahičevan, Il'in (1937) described the subsp. *australis* on the basis of yellowish herbaceous branches and the whitish cortex of the woody parts, and from the Baku area the subsp. *rubra* with reddish stems. Both were already reduced to varietal rank by Grossgejm (1945). We did not investigate the types, but judging from the vast amount of material seen, the characters emphasized by Il'in are certainly very weak and probably do not justify any formal rank.

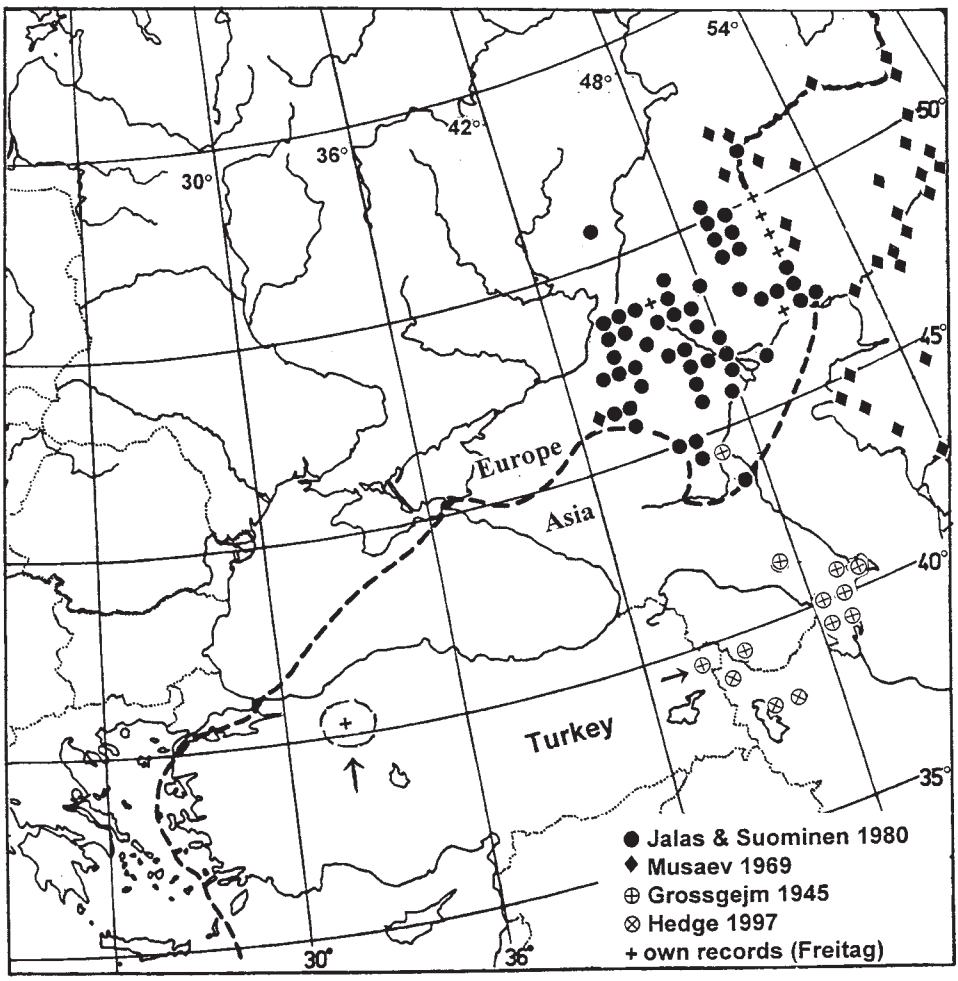



Fig. 5. Distribution of *Anabasis aphylla* L. in SW Asia and SE Europe.

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At first we thought this was a first record of that species for Turkey, but later studies revealed that it was already reported in the relevant Russian literature: Il'in (1937) stated its occurrence near Iğdır, probably based on a specimen collected when the area was occupied by Russia, and the distribution map 172 in Grossgejm (1945) shows a dot near Iğdır. Also Tahtadžjan (1956) cited the species as occurring in NE Turkey. There it would perfectly fit into the southwestern Transcaucasian range of *Anabasis aphylla,* which extends along the Aras valley from lower Nahičevan up to Armenia. Other localities are cited by Hedge (1997) from the area between Maku, Tabris and Orumiyeh in Iranian Azerbaijan (see Fig. 5). The species has not, however, been recollected in the province of Kars, and also we failed to find it in that or in any other area of Turkey.

Users of 'Flora iranica' (Hedge 1997) might be confused by t. 177. There, by error, the fine photograph of the specimen *Kukkonen 7656* is named *A. aphylla,* but actually represents *A. turkestanica* Iljin & Korov.

***Atriplex aucheri*** Moq., Chenopod. Monogr.: 51. 1840.
Syn.: *A. amblyostegia* Turcz. in Bull. Soc. Imp. Nat. Moscou 25(2): 416. 1852; *A. nitens* subsp. *desertorum* Iljin in Izv. Glavn. Bot. Sada SSSR 26: 414. 1927; *A. hortensis* subsp. *desertorum* (Sosn.) Aellen in Bot. Jahrb. Syst. 70: 29. 1939; *A. nitens* subsp. *aucheri* (Moq.) Takht. & A. A. Fedor., Fl. Erevana: 90. 1972.
Not previously recorded in 'Flora of Turkey' – *Freitag, Vural & Adıgüzel 28 901*.

The taxon belongs to the *Atriplex hortensis* group of *A.* sect. *Dichospermum* Dumort., which is characterized by dimorphic flowers and fruit valves free from the base, almost circular and entire-margined. Only *A. hortensis* L. and *A. sagittata* Borkh. (= *A. nitens* Schkuhr) of this group are listed in 'Flora of Turkey'. For convenience, the diagnostic characters of all three taxa are given in Tab. 2.

The occurrence of *A. aucheri* in Turkey is not surprising. It has been described from W Iran, where it is probably not rare (Hedge 1997), and has also been reported from Azerbajdžan (Karjagin 1952), Armenia (Tahtadžjan 1956), S Ukraine and SE European Russia (Il'in 1930, Jalas & Suominen 1980: map 517, Medvedeva 1996). The species was mentioned for Turkey by Il'in (1936) and Grossgejm (1945) under the synonym *A. amblyostegia* but has not been reported since. However, being very similar to the two other species of the *Atriplex hortensis* group, it might have been confused with them. This view is supported by the fact that the specimen *Balansa 1096* (in GOET) from Karahisar in Cappadocia, collected on 3.9.1856 was correctly labelled by the collector as *A. hortensis,* whereas the specimen *Balansa 393* from the same locality

Tab. 2. Diagnostic characters of the Anatolian taxa of the *Atriplex hortensis* group.

| Characters | *A. aucheri* | *A. sagittata* | *A. hortensis* |
|---|---|---|---|
| Upper leaves, shape | oblong to linear, entire | triangular, toothed | oblong to triangular, usually entire |
| Leaf surface | | | |
| upper side | grey, farinose | green, almost glabrous | green, glabrous |
| lower side | white, densely farinose | white, densely farinose | green, glabrous |
| Stem surface | whitish, farinose | green, glabrous | green, glabrous |
| Fruit valves (bracteoles), shape | obovate to ovate, slightly longer than wide | ovate, distinctly longer than wide | circular to ovate, as long as wide |
| Fruit valves, apex | rounded | acute | rounded |
| Fruit valves, base | ± cuneate to truncate | acute truncate | slightly cordate |

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is cited under *A. nitens* by Aellen (1939, 1967b). Probably the taxon has a wider distribution in the semi-arid parts of Turkey.

*Atriplex aucheri* is maintained here provisionally at species level although we agree with Aellen (1939) in treating all taxa of this group as subspecies of *A. hortensis*. But Aellen's view has not been accepted and he himself returned to the traditional view in later publications (Aellen 1966, 1967b).

***Atriplex laevis*** C. A. Mey.
*Freitag, Vural & Adıgüzel 28 900*.
As yet the species in Anatolia was known to occur westwards to Niğde and Konya only.

***Halanthium kulpianum*** (K. Koch) Bunge
*Freitag, Vural & Adıgüzel 28 896*.
Like the following species it was not hitherto known to occur west of the Tuz-Gölü area.

***Petrosimonia nigdeensis*** Aellen
*Freitag, Vural & Adıgüzel 28 895*.
With the rich populations on the bottom floor of larger ravines and washes in the study area, the distribution of this Central Anatolian endemic extends much further to NW Anatolia than previously known.

For some reasons we are forced to argue in favour of the name *P. nigdeensis* instead of *P. triandra* (Pall.) Simonk. The latter name was applied by Wagenitz (1959) to plants from the Tuz Gölü area, well before the description of *P. nigdeensis* by Aellen (1967a) from the same area. Recently, Hedge (1997) included *P. nigdeensis* in the synonymy of *P. triandra* (Pall.) Simonk. and for its illustration in 'Flora iranica' he chose just the specimen *Beug & Wagenitz 299* from near Tuz Gölü. We investigated many specimens from Turkey (including *Beug & Wagenitz 299*), S Russia and Kazahstan and found that, despite of the almost identical habit, the Anatolian populations differ constantly by significant differences in floral structure (see Tab. 3) that justify specific rank.

Until now we did not see any specimen of *P. triandra* from Turkey. This species is also absent from the Transcaucasian semi-desert areas except for the coastal parts of Azerbajdžan (Grossgejm 1945: map 170), but on the northern side of the Black Sea it extends westwards up to Romania (Jalas & Suominen 1980: map 617). *P. nigdeensis*, in contrast, is evidently restricted to Central Anatolia.

Tab. 3. Diagnostic characters of *Petrosimonia nigdeensis* Aellen and *P. triandra* (Pall.) Simonk.

| Characters | *P. nigdeensis* | *P. triandra* |
|---|---|---|
| Tepal length [mm] | 3.5-4 | 3-3.5 |
| Tepal apex | ciliate | glabrous |
| Anther number | 5 | 3 |
| Anther appendages | 3-lobed, with prominent middle lobe, rarely simple | 2-lobed, without prominent middle lobe |

***Salsola grandis*** Freitag, Vural & N. Adıgüzel, **sp. nova** – Fig. 6-9.

Holotypus: Turkey, NW part of Ankara prov., 28 km ESE Nallıhan, badlands in marl area near main road to Beypazarı at right bank of Aladağ Çayı, 16.10.1997, *Freitag, Vural & Adıgüzel 28 894* (KAS; isotypi: B, E, G, GAZI, GOET, LE).

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Species habitu *Halothamno* similis, sed stigmatibus filiformibus ubique papillosis, foliis basi vaginatis et axibus non viride-striatis ad *Salsolam* sect. *Salsolam* pertinens. *S. soda* affinis, sed tepalorum alis magnopere evolutis, spicis densis, antheris et stigmatibus longioribus et habitationibus aridis differt.

Description

*Annual*, (10)20-60(100) × 7-30(60) cm, erect, very rigid; (in living condition) greyish green, somewhat shining, glabrous, only the axils of bracteoles with short fascicles of curled multicellular hairs. *Stem* stout, at base up to 15 mm in diameter, regularly branched from any leaf axil, dominant, branches erect to ascending, slightly grooved longitudinally, pale green or purplish, only the basal branches with 2nd order axes; internodes in lower part of stem 2.5-3 cm, in middle part 1.5-2 cm, in upper part condensed. *Leaves* alternate except for the lowermost 3-4 pairs and sometimes the first pair of the side branches, stiff, succulent, ascending, ± horizontally spreading or ± recurved, the lower longer and almost linear, the upper decreasing in size and ± lanceolate, in cross section obtusely triangular, (2)3-5(7) cm long, at base 4-5 mm wide, sheathing by narrow hyaline margins and deeply hollowed on upper surface, towards the apex becoming plane or finally often convex, terminated by a 0.2-0.4 mm long weak mucro, longitudinally for c. 3/4 with 4 transparent lines, 3 along the edges and 1 following the groove on upper side of the leaf. *Inflorescences* usually many, terminating the axes as dense spikes. Lower bracts leaf-like, horizontally spreading, towards the spike apices gradually shorter to 1(0.4) cm, the uppermost ± ovate. *Bracteoles* 2, succulent, with keeled green back and finally recurved apices, slightly longer than flowers, 2.7-3.5 mm long, up to 1/2 with 0.55-0.7 mm wide sheathing hyaline margins, terminated by a c. 0.5 mm long weak mucro. *Flowers* solitary, almost globular, 2.5-3 mm long, 2-2.5 mm diam., with the stigmas 2.5-3.5 mm and the anthers 1-1.5 mm exserted. *Tepals* narrowly ovate, much hollowed, transverse line at 1/2, apex obtusely crenulate or emarginate, the outer broadly ovate to rhombic, 5-7-veined, with the large green blotch above the transverse line on one or both sides with an additional smaller blotch, the inner narrower, obovate or ligulate, 3(1)-veined, with a simple triangular blotch. *Anthers* 5, sagittate, divided for 2/5-1/2, 1.3-1.5 mm long including the obtusely triangular 0.2-0.25 mm long appendage; filaments 2.7-3 mm long, almost linear, at base 0.15 mm wide; interstaminal disc 0.15-0.2 mm high, made up of semi-circular lobes or an almost continuous ring with stoma-like secretory structures. *Ovary* broadly ovoid, 1.3-1.5 mm long, 1.1-1.2 mm wide; style 0.5-0.7 × 0.1 mm; stigmas 2-2.5 mm long, erect, towards the apices recurved, in the lower 0.5 mm flattened, otherwise thread-like and papillose all-round. *Fruiting perianth* (7)14-17 mm diam., wings straw-coloured, horizontally spreading, undulate, widely overlapping, the three outer wings up to 12 mm wide and 7 mm long, the inner much smaller, up to 7 × 7 mm, obovate to broadly spathulate; perianth tube in side view obtrapezoid, at the wings 3-4 mm and at base 1.5-1.8 mm diam., 2-3 mm high, ± hardened in lower part, basal plate with a narrow polygonal to circular peripheral rim and 5 deep circular pits separated by radially arranged thickened bulges emerging from the central hilum; tepals above the wings incurved, forming a flat, up to 1 mm high cap, the tepal apices with a persistent green blotch and broad hyaline margins leaving the fruit partly uncovered. *Nutlet* with a thin, membranous pericarp, olive-green, horizontal, 1.5-1.7 mm high, diameter at the top (2.2)2.5-3(3.5) mm, with bowl-like upper surface.

Flowering mid June to late July, fruiting September to November.

Conservation status: Very rare, but locally abundant; endangered.

Additional specimens examined

A3 Ankara: Type locality, 30.6.1995, *Vural & Adıgüzel 7369* (GAZI, KAS).

Remarks

Besides its size and shape, the species is unusually variable in the size and structure of the fruits. Most fruits are large-winged, but fruits have been found in the lower part of the infructescence of

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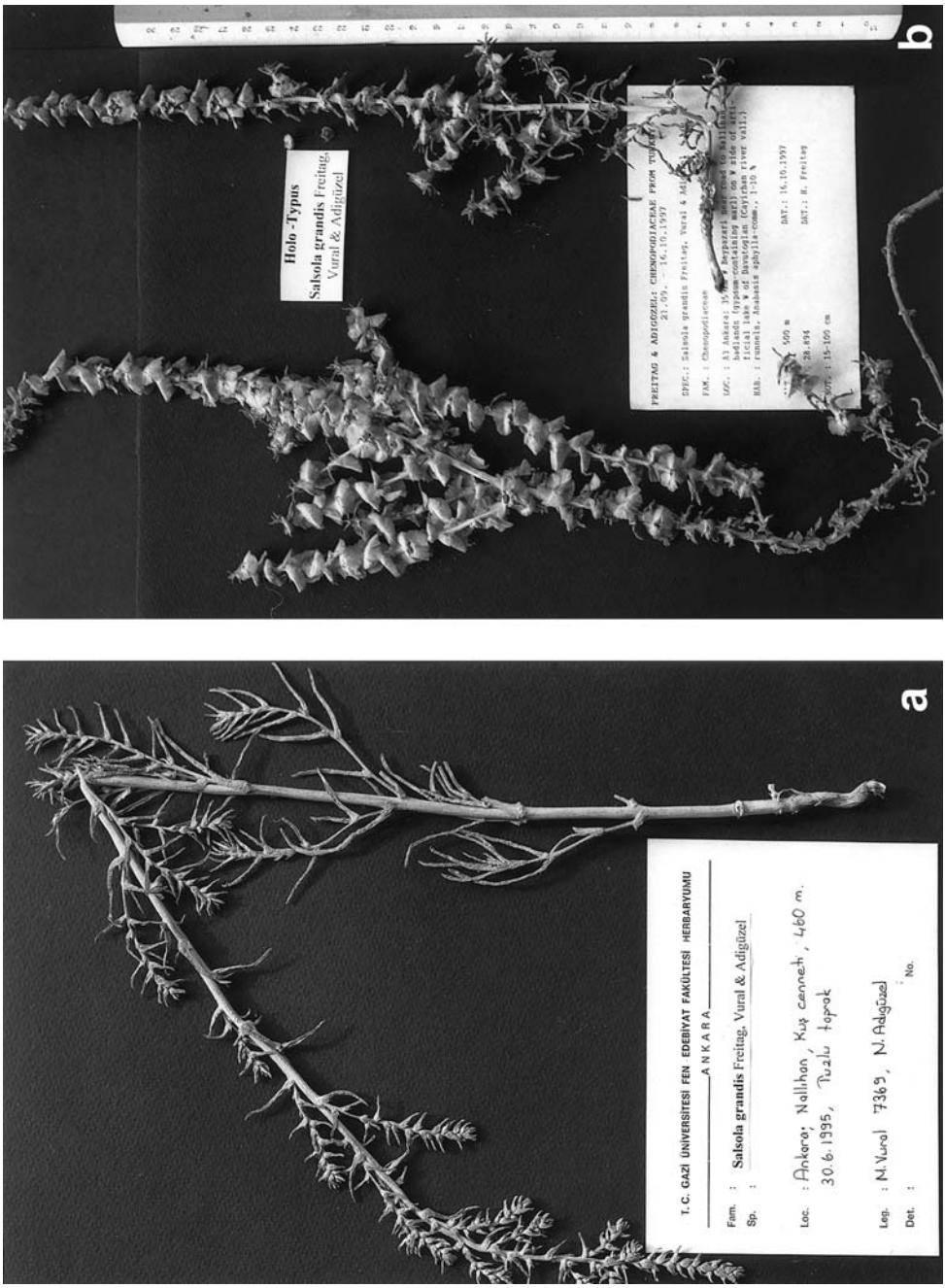



Fig. 6. *Salsola grandis* Freitag, Vural & N. Adıgüzel – a: flowering specimen *(Vural & Adıgüzel 7369)*; b: fruiting specimen (holotype). – Photographs by H. Freitag.

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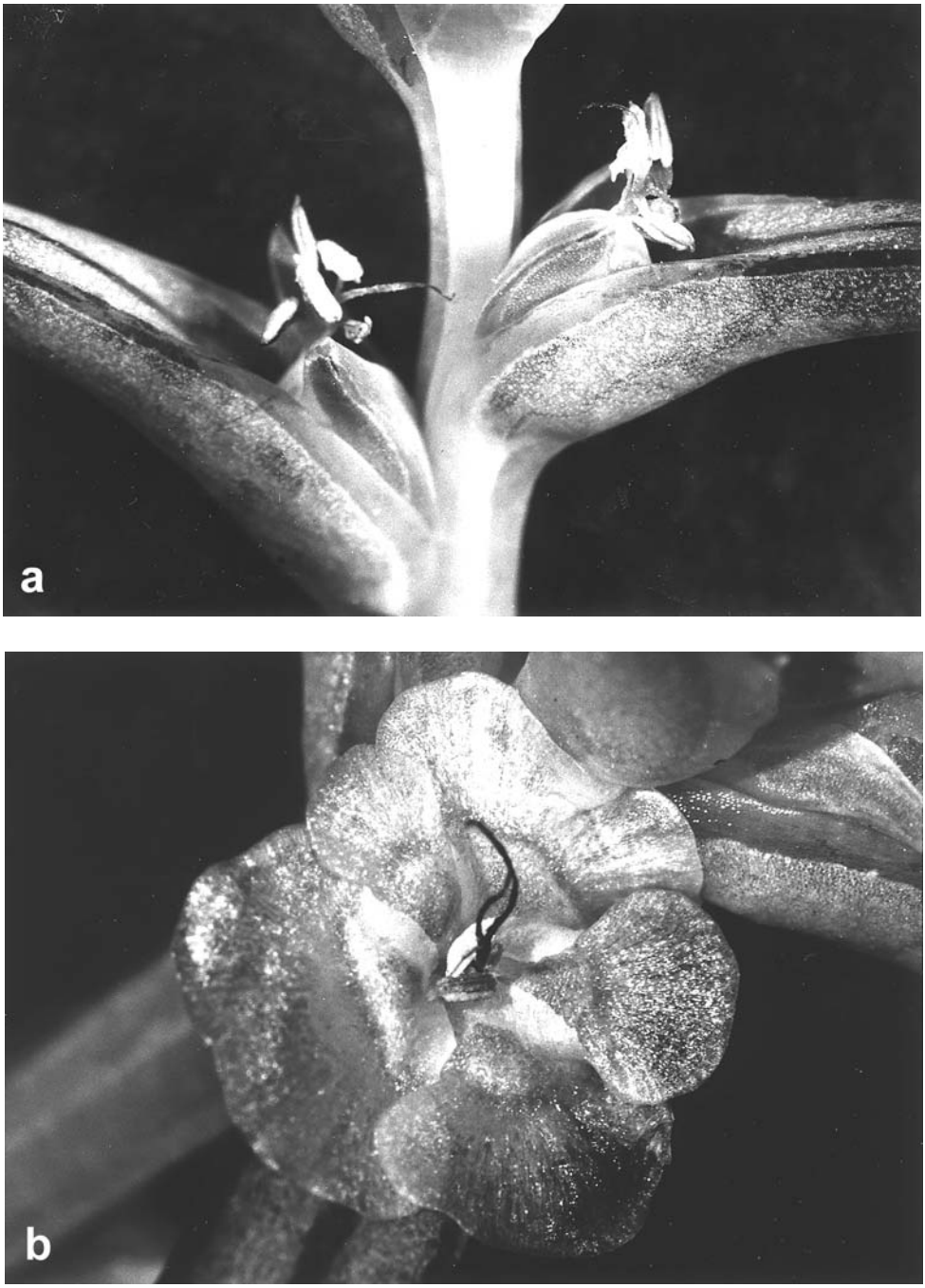



Fig. 7. *Salsola grandis* Freitag, Vural & N. Adıgüzel – a: detail of spike with 2 bracts and axillary flowers, each flower covered by 2 bracteoles; b: immature fruit with 2 smaller inner and 3 larger outer tepal wings, the 2 long stigmas are still present. – Photographs by H. Freitag from plants grown in Kassel from seeds of the type collection.

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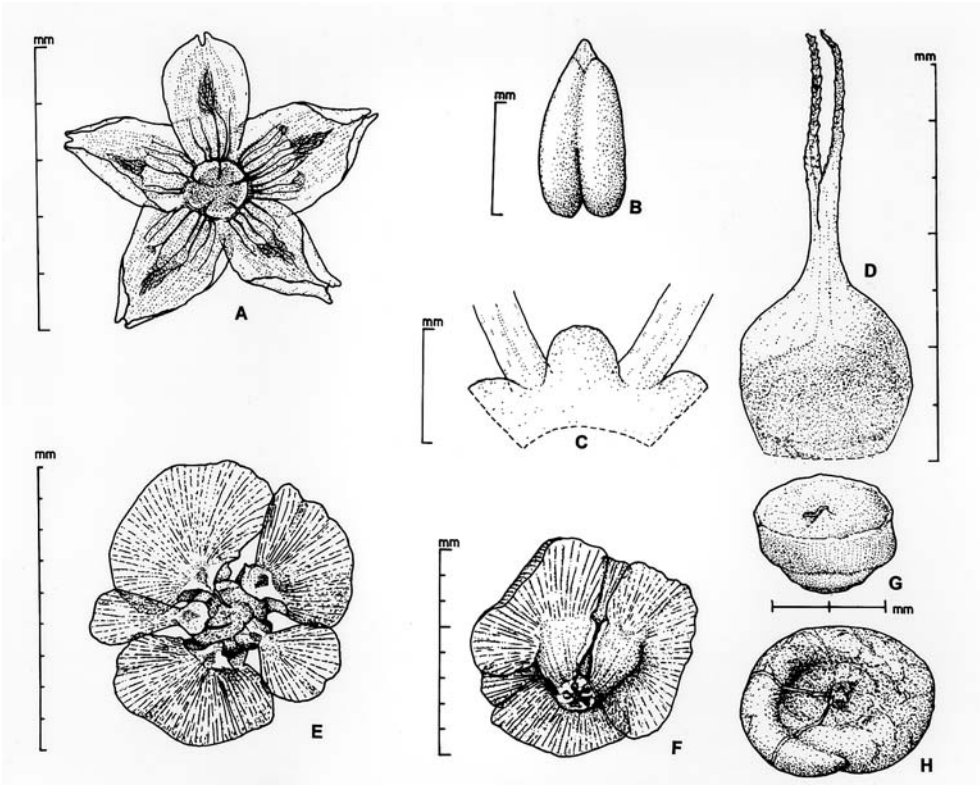



Fig. 8. *Salsola grandis* Freitag, Vural & N. Adıgüzel – A: perianth, from inside; B: anther; C: part of the hypogynous disc with bases of 2 filaments; D: pistil; E: mature fruit, from above; F: mature fruit, from below; G: nutlet of a small-winged fruit; H: nutlet of a large-winged fruit. – A-D from *Vural & Adıgüzel 7369*, E-G from type material; drawings by H. Thienenkamp.

several specimens that have much smaller wings and contain distinctly smaller nutlets (compare Fig. 8G and H). This is not, however, a typical case of heterocarpy, as all intermediates along the spike occur.

The description of most morphological and anatomical characters is based on live plants grown in the greenhouse in Kassel from offsprings of the type material.

## Ecology

The new species is particularly well adapted to and probably dependant on the ecological conditions of the site studied. It behaves like a typical xerohalophyte and is favoured by habitat disturbance as it occurs by heavy erosion (see Fig. 3) as well as by accumulation. Often it is the first pioneer on raw gypsum and salt-containing marly substrate. The seeds reach the respective barren habitats by their anemochorous devices or by flash floods and are held by the roughness of the soil surface.

## Relationship

The new species belongs to *Salsola* sect. *Salsola* as recently redefined by Rilke (1999), with glabrous, pale axes, sheathing leaf bases, filiform stigmas covered all-around by papillae and tepal tubes slightly hardened in fruit. With its large wings and comparatively flat fruiting tepal tubes, it has a somewhat isolated position. The differences from its closest relative, *Salsola soda*, are listed in Tab. 4.

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Tab. 4. Differential characters of *Salsola grandis* Freitag, Vural & Adıgüzel and *S. soda* L.

| Characters | *S. grandis* | *S. soda* |
|---|---|---|
| Spikes | dense | loose |
| Fruit diam. incl. wings [mm] | 14-17 | 3.5-6 |
| Wing length [mm] | 5-7 | 0.5-1 |
| Fruiting perianth tube | ob-trapezoid | barrel-shaped |
| Anther length [mm] | 1.3-1.5 | 0.9-1.2 |
| Stigma length [mm] | 2.0-2.5 | 0.9-1.7 |
| Ecology | xerohalophyte | hygrohalophyte |

Anatomy

Anatomical investigation of fresh material from plants grown in the greenhouse in Kassel has shown that the pale green colour of the axes, like in other species of the section, is the result of a continuous collenchyma ring underlying the epidermis and followed by a chloroplast-containing inner cortex layer. The leaf anatomy follows the salsoloid type (Carolin & al. 1975), which has also been described as the centric type (Butnik & al. 1991) of $C_4$-pattern known from most other species of *Salsola.* The cotyledons, however, differ strikingly in a $C_3$-anatomy with 3-4 layers of chlorenchyma palisade cells and the absence of both a hypodermis and the ring of peripheral bundles (Fig. 9).

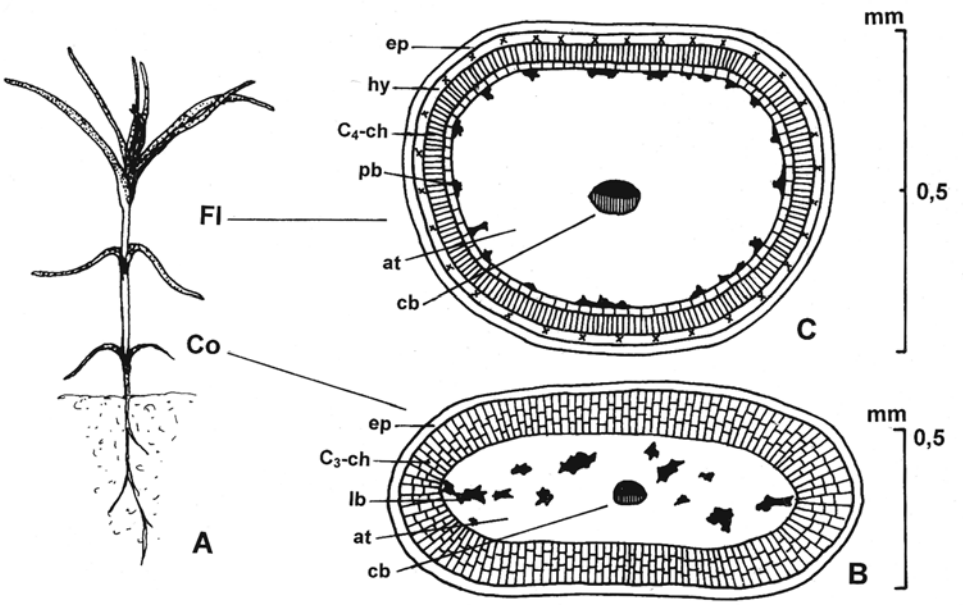



Fig. 9. *Salsola grandis* Freitag, Vural & N. Adıgüzel – A: seedling with cotyledons (Co) and first foliage leaves (Fl); B: anatomy of a cotyledon; C: anatomy of a foliage leaf. – Drawings by H. Thienenkamp from plants grown in Kassel from seeds of the type collection; ep = epidermis, hy = hypodermis, $C_3$-ch = $C_3$-chlorenchyma, $C_4$-ch = $C_4$-chlorenchyma, at = aqueous tissue, cb = central bundle, lb = lateral bundle, pb = peripheral bundle.

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***Salsola nitraria*** Pall. (= *S. macera* Litw.)
*Freitag, Vural & Adıgüzel 28 898.*
The previously known westernmost localities are around the Tuz Gölü. *Salsola macera* Litw. was maintained by Aellen (1967b), but the curvature of the small anther appendage emphasized by Aellen in contrast to the straight one in *S. nitraria* has no more significance than the other diagnostic characters mentioned by Litwinow in the protologue. For a full discussion see Freitag (1997).

## Phytogeographical considerations

The interesting chenopod flora of the area with an accumulation of halophytic species not yet known so far from NW Anatolia is challenging in phytogeographical terms. The present knowledge of distribution patterns of the species concerned suggests that the area contains a very remarkable and isolated outpost of Central Anatolian ecosystems. In climatological and biogeographical respects, the area is located just at the northwestern-most border of the Central Anatolian region. The deep furrows of the Sakarya and its tributaries connect the area with the dry W Anatolian plains. There, nearby Polatlı, we have also studied and collected some typical Central Anatolian halophytes such as *Petrosimonia nigdeensis* and *Suaeda cucullata.* Therefore some species might well have a continuous distribution downwards to the badlands SE of Nallıhan. Also the relevance of the record of *Atriplex aucheri* should not be overemphasized because it might have been confused with closely related species by earlier authors.

However, the surprising discovery of the spectacular new species *Salsola grandis* in the area, and at least the records of *Anabasis aphylla, Halanthium kulpianum* and *Salsola nitraria* require another explanation. *Salsola grandis* seems to be a narrow-ranging endemic because it is very difficult to imagine that the conspicuous plant has hitherto been overlooked in other parts of Central Anatolia. As it is fairly distant from its allies, it must have had a rather long time to evolve from common anchestors, probably since the Tertiary. As the large fruits represent very effective anemochorous diaspores, the limited range of the species indicates the absence of favourable conditions, probably both edaphic and climatic, in the surrounding areas, even along the drier corridor towards the western part of Central Anatolia.

A similar conclusion can be drawn from the occurrence of *Anabasis aphylla.* It is another most conspicuous species and certainly very rare in Turkey. The occurrence in the area poses the question how and when it might have arrived. Two alternative scenarios could be envisaged. At some time, by chance a long distance dispersal event could have happened and was followed by a limited local extension. Alternatively, the species is a relic of a more continuous distribution during a drier period in the past.

The first hypothesis seems promising at first glance, because the small nutlets of *Anabasis aphylla* remain surrounded by the winged perianth and are clearly anemochorous. However, the distance to the localities along the middle course of the Aras river and the westernmost part of the NW Caspian Lowland measures about 1300 km, which is far beyond the range of wind dispersal. Exceptional heavy and far reaching storms from E or NE directions – seed maturation is in late autumn – are extremely unusual. Even more unlikely seems a dispersal by birds.

The second hypothesis, which seems to explain quite well the isolated outposts of other chenopods in the western part of Anatolia (see the discussion about *Salsola canescens* subsp. *serpentinicola* in Freitag & Özhatay 1997), also offers problems, because of the absence of *Anabasis aphylla* from other localities in Central Anatolia. This, however, might be due to the specific ecological requirements of *Anabasis aphylla*. On one hand, it is strictly bound to slightly or moderately saline habitats and well adapted to a certain degree of natural or anthropogenic disturbance – conditions that are present in many semi-arid areas of Central and E Anatolia. On the other hand, its distribution around the Caspian Sea and in Transcaucasia (Fig. 5) clearly demonstrates that it grows only under semi-desert conditions with an annual mean precipitation below 300 mm and usually even below c. 250-200 mm. As the driest known parts of Central

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Anatolia receive significantly more than 300 mm, and only the Iğdır area in E Anatolia, where the species has been recorded by the Russian authors, receives 273 mm, the precipitation seems to delimit its distribution in Turkey. Consequently, the presence of *Anabasis aphylla* and *Salsola grandis* in the studied site could well indicate an extremely dry local climate, which is enhanced by the high salinity of the soil.

With respect to the remaining species, the disjunctions are not as large. However, their occurrence also underlines the island position of the area SE of Nallıhan and are best explained by an earlier invasion during a drier climatic phase.

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