

AN UNEXPECTED NEW TAXON OF *SALSOLA* (*CHENOPODIACEAE*) FROM TURKEY

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Salsola cyrenaica subsp. *antalyensis* (*Chenopodiaceae*) from the S Anatolian coast near Finike is illustrated and described as a new subspecies. Its anatomy, relationships, ecology and phytogeography are discussed. The new subspecies differs from subsp. *cyrenaica* by the reduced number of flowers per leaf axil, very dense axillary hairs, the smaller size of most floral organs, mostly 3 instead of 2 stigmas and 5 not 3 wings on the fruit. The new taxon grows in a narrow coastal strip of c.2km only, in open dwarf-shrub communities on limestone rocks from sea level to c.40m. It is the first representative of the *S. longifolia* group, sect. *Coccosalsola*, from Turkey and from the northern shores of the Mediterranean.

Keywords. *Chenopodiaceae*, coastal halophytes, new subspecies, *Salsola longifolia* group, *Salsola* sect. *Coccosalsola*.

INTRODUCTION

This paper describes a new subspecies of *Salsola* L. (*Chenopodiaceae*), which represents an unexpected addition to the Turkish flora. The new taxon was discovered in the vegetative stage by the second author during an expedition in summer 1998, about 100km SSW of Antalya near Finike. As the attempts failed to identify the plants by use of the *Flora of Turkey* 2 (Aellen, 1967) and 10 (Kit Tan, 1988), it was forwarded to the first author. Because of the hardening pulvinus at the leaf base and other vegetative characters, it was recognized as a member of *Salsola* sect. *Coccosalsola* Fenzl (= *Darniella* (Maire & Weiller) Brullo), until then not known from Turkey. Further identification had to wait until the first author returned in winter 1998 from a second visit to the locality, with flowering and fruiting material and data on the species' habitat and ecology. By recourse to own experiences with E Mediterranean species of the group from Egypt (Freitag, 1989), and consulting the treatments of Maire (1962) and Brullo (1984), it became clear that, rather surprisingly, the closest relative was *Salsola cyrenaica*, a narrow ranging endemic from Libyan Cyrenaica.

DESCRIPTION

***Salsola cyrenaica* (Maire & Weiller) Brullo subsp. *antalyensis* Freitag & Duman, subsp. nov. Figs 1–3.**

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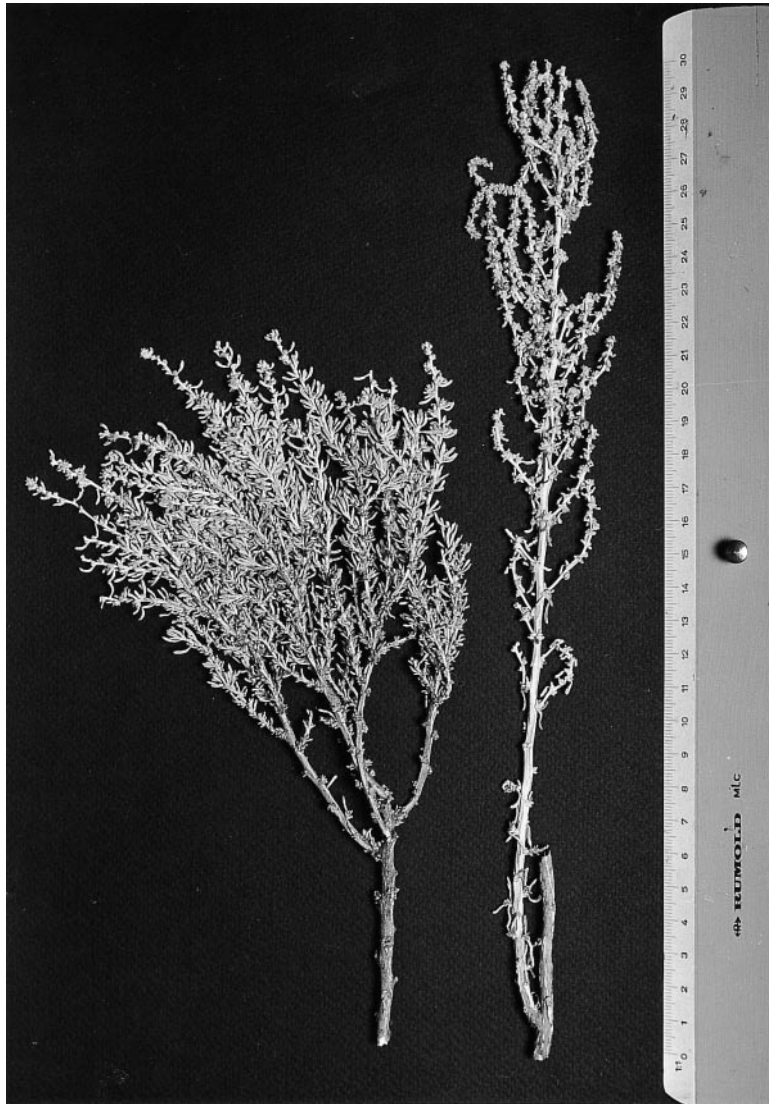


FIG. 1. *Salsola cyrenaica* subsp. *antalyensis*: left, condensed form (isotype, *Duman* 6866) from typical dry habitats; right, form with elongated shoots (*Duman* 6866a) from more mesic habitats.

A subspecie *cyrenaica* floribus axillaribus 1–3(–5), pilis axillaribus densissimis, bracteis bracteolis floribusque parvioribus, stigmatibus brevioribus saepe 3, stylo crassiore, perianthio in statu fructifero alis 5 bene differt.

Type: Turkey, Antalya, 18km E Demre at road to Finike, on limestone cliff, 10 xii 1998, *H. Duman* 6866 (holo. KAS; iso. GAZI).



FIG. 2. *Salsola cyrenaica* subsp. *antalyensis*; dense mat-like bush c.1.5m diam. on steep rocky slope.

Dwarf shrub, 20–60 (–80) × 30–100 (–150)cm, very dense, greyish green, in dry condition colour fading, young organs delicately papillose, otherwise glabrous except for dense axillary tufts of c.1mm long curled white hairs, most prominent in bract axils before full development of floral clusters and after fruit-shedding. *Stems* arising from a dark grey, gnarled, flattened tap root up to 8cm in diam.; densely branched from base, annual shoots very numerous, 7–30 (–40)cm long, erect or ascending, sparsely branched, each producing a spike in its upper $\frac{1}{3}$ – $\frac{1}{2}$; cortex bright grey to white, striate with longitudinal furrows associated pair-wise with the leaf bases; internodes 2–10mm long; each leaf axil with brachyblast carrying 4–6 rosulate leaves; stem surface after leaf-shedding rough by persistent leaf bases, with age longitudinally fissured, turning light and finally darkish grey, step-wise changing to a more horizontal position. *Leaves* (3–)8–10 (–12) × 0.8–1.4mm, semiterete, obtusely 3-edged or almost terete, succulent, linear to clavate in outline, obtusely apiculate, sessile, the lowermost 0.7–1mm slightly widened and soon turning to a white, woody and persistent pulvinus. *Bracts* leaf-like, upwards gradually shorter to 2mm and more distinctly



FIG. 3. Typical habitat of *S. cyrenaica* subsp. *antalyensis* near Finike; S-exposed limestone cliffs with a phrygana community dominated by *Pistacia lentiscus*, *Quercus aucheri*, *Genista acanthoclada* etc.

clavate. *Floral clusters* with 1–3(–5) flowers, each subtended by a bract of 2nd order and 2 fleshy bracteoles immersed in dense wool; bracts of 2nd order 1.5–2(–2.5) × 0.8–1.2mm, oblong, subapiculate, in lower $\frac{1}{3}$ – $\frac{1}{2}$ sheathing with wide hyaline margins; bracteoles (1.1–)1.3–1.5mm long, with narrow hyaline margins, cucullate. *Flowers* globular to ovoid, 0.8–1mm diam. *Tepals* (0.6–)0.8–1.1(–1.3) × 0.7–1mm, ± obovate, at apex rounded, obtusely crenulate or shortly lacinate, cucullate, hyaline throughout, 1-veined up to the transverse line at $\frac{1}{2}$. *Anthers* 5, 0.6–0.75mm long including the minute obtusely triangular appendage, 0.35–0.45mm wide, divided to $\frac{1}{2}$; filaments band-shaped, 0.9–1.3 × 0.075–0.1mm, 0.5–0.7mm exerted; interstaminal disc lobes 0.4 × 0.5mm, apex truncate to convex and densely glandular-papillose, fused at base. *Ovary* globose to ovoid; style 0.3–0.4mm long, 0.2–0.25mm thick; stigmas (2–)3, 0.2–0.3mm long, 0.15–0.2mm wide, dark brown, suberect to spreading, scarcely surpassing the perianth. *Fruiting perianth* (4–)5–6(–7)mm diam., tepals not significantly hardened, horizontally spreading from the small basal plate with 5 flat circular pits surrounding the hilum, lower part of tepals protruding into 5 hyaline wings arranged in the same plane, wings often unequal, ± circular, not or little overlapping, upper part of tepals erect or slightly incurved, leaving the fruit almost free. *Fruit* horizontal, disc- to plate-shaped, 1.3–1.7mm diam., 0.5–0.7mm thick, with a membranous pericarp and persistent style, olive-coloured to brownish; embryo coiled in one plane.

Flowering. October to December.

Fruiting. November to January.

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

Additional specimens examined. TURKEY. C3, Antalya: type locality, 8 viii 1998, *Duman* 6838 (GAZI, KAS); *ibid.*, 10 xii 1998, *Duman* 6866a (GAZI, KAS); *ibid.* 17.5km from Demre, rocks and roadsides near sea, 2 vi 1994 *Burton* An. 1036 (Burton, private collection, KAS).

As the descriptions of subsp. *cyrenaica* as given by Maire & Weiller (1939) and Brullo (1984) do not fully apply to the new subspecies, a complete description is given. The drawings of Brullo (1984, fig. 10, under *Darniella cyrenaica*) fit well, except for the style/stigma complex and the lobes of the hypogynous disc. A summary of the more important differences is given in Table 1, in which the information for subsp. *cyrenaica* is based on the lectotype (Maire & Weiller 1323, MPU, selected by Brullo, 1982) and on *Brullo & Furnari*, 16 ix 1974 (CAT).

Remarks

The individuals vary considerably in habit. In the typical dry habitats, the bushes are more condensed, more richly branched and rarely surpass 40cm in height. The annual shoots reach only a length of 7–15cm, have shorter internodes and slightly smaller leaves. In contrast, individuals on deeper soil or less exposed habitats (*Duman* 6866a) are taller and produce much longer annual shoots with longer, white internodes. Otherwise the population is homogeneous.

Anatomy

The leaf anatomy is of the salsoloid (Carolin *et al.*, 1975) or centric (Butnik, 1984) type indicating C₄ type of photosynthesis. The rather thin-walled epidermis is followed by a hypodermal layer rich in large compound crystals. The chlorenchyma

TABLE 1. Diagnostic characters of the two subspecies of *S. cyrenaica*

Characters	Subsp. <i>antalyensis</i>	Subsp. <i>cyrenaica</i>
Number of flowers in axillary clusters	1–3(–5)	1–10
Bracts (2nd order), length (mm)	1.5–1.75(–2)	(1.3–)2–2.5(–3)
Bracteoles, length (mm)	(1.1–)1.3–1.5	1.5–1.7(–2)
Flowers, diam. (mm)	0.8–1	1.25–1.5
Tepals, length (mm)	(0.6–)0.8–1.1(–1.3)	1.5–1.6
Filaments, length (mm)	0.9–1.2	1.3–1.5
Filaments, width (mm)	0.075–0.1	0.15–0.2
Lobes of hypogynous disc	Apex truncate to convex, fused at base only	Apex retuse, fused for 1/3–1/2
Stigmas, number	2–3	2
Stigmas, length (mm)	0.2–0.3	0.3–0.7
Style, upper diam. (mm)	0.2–0.25	0.3–0.35
Wings in fruiting perianth	(3)5	3

consists of an outer palisade and an inner Kranz layer with much thickened cell walls. The very voluminous aqueous tissue surrounds the large central bundle. It is made up by 4–5 transparent mesophyll layers, with large crystals occurring scattered along its periphery, alternating with numerous small peripheral vascular bundles attached to the Kranz layer. We found the same leaf type in the related Mediterranean species *S. longifolia*, *S. cyrenaica*, *S. melitensis* and the Macaronesian species *S. divaricata* Masson ex Link.

The cotyledons are biconvex, flattened, with 3 bundles arranged in one horizontal plane. The mesophyll consists of 3–5 rather uniform chloroplast-bearing cell layers as they are typical for C₃ plants.

Ecology

The new subspecies grows in a narrow coastal strip c.2km in length, 100m in width and 3–40m above sea level on limestone cliffs and slopes in fissures filled with terra rossa, preferably in SE exposure up to c.40m altitude (Fig. 3). With an annual mean of 986.5mm (Turkish State Meteorological Service, 1984), Finike receives comparatively high rainfall.

Salsola cyrenaica subsp. *antalyensis* is a locally frequent and abundant component of open phrygana vegetation with scattered dwarfed shrubby individuals of *Pistacia lentiscus* L., *Quercus aucheri* Jaub. & Spach and *Ceratonia siliqua* L., and a very open lower layer formed by *Genista acanthoclada* DC., *Sarcopoterium spinosum* (L.)Spach, *Capparis spinosa* L. var. *inermis* Turra, *Daphne gnidioides* Jaub. & Spach, *Echinops viscosus* DC. subsp. *viscosus*, *Onosma frutescens* Lam., *Phagnalon graecum* Boiss., *Polygonum equisetiforme* Siebth. & Sm. and *Inula heterolepis* Boiss. Seemingly, a slight influence of salt dust from the nearby sea is an important ecological factor. In addition, it could be stated that size and frequency of the *Salsola* bushes is particularly high on sites just beside the coastal road with some disturbance caused by road construction. Otherwise, the restriction of the species to that short coastal section remains inexplicable in ecological terms, as there are identical habitats to the west and east of the locality. During the first author's expedition in 1997 the species was not met with despite intensive searching for chenopods at comparable habitats west of the area between Kaş and Kalkan. But eventually the new taxon should be found at other localities of the hitherto unexplored rocky coast between Kaş and Demre or on the rocky islands situated in front of that coastal section.

DISCUSSION

Relationship of S. cyrenaica and subsp. antalyensis

The new taxon is classified as a subspecies of *S. cyrenaica* because of its strong similarities to the type subspecies and the weight ascribed to the differing characters by Freitag (1997). Both subspecies occur in Mediterranean areas with high precipi-

tation. In that respect, the new subspecies comes also close to *S. melitensis* Botsch. (see Table 2).

Because there is no agreement about the taxonomic position of *S. cyrenaica* and the related species of the area, a short discussion is justified. It was originally described as *Darniella cyrenaica* by Maire & Weiller (1939) from Derna (=Darnah) in coastal E Cyrenaica, but later reduced by Maire (1942, 1962) to a variety of *S. sieberi* C. Presl (= *S. longifolia* Forssk.). In the revision of section *Coccosalsola* Fenzl by Botschantzev (1976, 1989), it was considered a synonym of *S. schweinfurthii* Solms-Laub., and according to the *Flora of Libya* (Jafri & Rateeb, 1978) it belongs to the 'very polymorphic species' *S. longifolia*.

Only Brullo & Furnari (1979) recognized again the higher rank of the taxon as *S. sieberi* subsp. *cyrenaica*, and finally Brullo (1982, 1984) reinstated its specific status, first as *S. cyrenaica* and later as Maire's original name *Darniella cyrenaica*. In our opinion, specific rank is fully justified. This can be judged from Table 2, which gives the relevant data from the related E Mediterranean species and suggests closer links both to the semidesert species *S. schweinfurthii* Solms-Laub. and to the endemic *S. melitensis* Botsch. from coastal cliffs of Malta and Gozo. For the time being, the group is retained in sect. *Coccosalsola* subsect. *Coccosalsola* of *Salsola*, but Il'in (1954) gave good arguments for including it in *Seidlitzia* Bunge that would also embrace *Darniella*. Final decision awaits the results of molecular studies currently in progress.

All three species are distributed along or near the south-eastern coast of the Mediterranean and only *S. schweinfurthii* extends far beyond the border of the map through N Saudi Arabia to Oman. But due to their different ecological requirements they are not really sympatric. For details of their distribution see Fig. 4, and their different climatological requirements are included in Table 2.

Phytogeographical considerations (Fig. 4)

The discovery of the new taxon in S Anatolia was most unexpected. It is the first record of the *S. longifolia* group on the north side of the Mediterranean, in a semihu-

TABLE 2. Diagnostic characters of E Mediterranean species related to *S. cyrenaica*¹

	<i>S. cyrenaica</i>	<i>S. schweinfurthii</i>	<i>S. longifolia</i>	<i>S. melitensis</i>
Branching, foliage	Very dense	Loose	Loose	Dense
Leaf arrangement	Alternate	Alternate	Opposite	Alternate
Axillary flowers	(1-)3-5(-10)	(1-)3-5	1	1
Axillary hairs	Very dense	Loose	Loose	Loose
Green blotch on tepal back	Absent	Present	Present	Absent
Fruiting perianth, diam. (mm)	4-7	6-8	10-15	5-7
Climate	Med.	Sub-Saharan	S Med.	Med.
Precipitation (mm)	300 (subsp. <i>cyr.</i>) 1000 (subsp. <i>ant.</i>)	20-100	100-200	500-600

¹ *S. sinaica* Brullo is included in *S. schweinfurthii* (see Freitag, 1989).

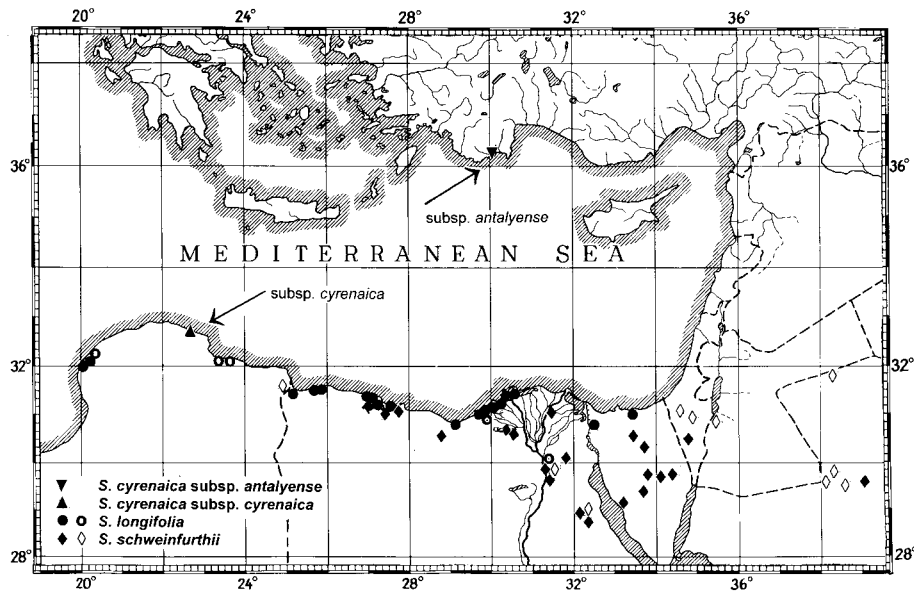


FIG. 4. Distribution of the species of the *S. longifolia* group in the eastern Mediterranean. Open symbols refer to literature records.

mid climate with a much higher precipitation than at the localities of all the other species. The members of the group are highly xerophytic, light-demanding and at least moderately salt-tolerant. They are distributed in the northern section of the Saharo-Sindian desert belt from the Canary Islands (*S. divaricata* Masson ex Link) to the upper Indus plain (*S. drummondii* Ulbrich). Ecologically, the presence of derivative taxa such as *S. cyrenaica*, and in particular subsp. *antalyensis* (also *S. melitensis* on Malta and Gozo) in more humid Mediterranean areas can be explained only by the very special local habitat conditions: the steep S-exposed slopes on limestone cliffs protect them from competition by typical Mediterranean plants, and the salty spray and dust from the rocky shore provide the needed ion balance.

When and how the ancestors reached the coast of SW Anatolia remains a matter of speculation. Though inconclusive by their very nature, several more obvious hypotheses might be shortly outlined and critically discussed:

1. The very limited and evidently 'unsaturated' distributional area suggests a recent introduction and a comparison with the well-known spread of other introduced halophytes and ruderals, e.g. species of *Puccinellia* along inland roads in Europe. But decades or even a few centuries certainly are much too short for the evolution leading to subspecies level in a shrubby species.

2. Dispersal by early maritime trade looks somewhat more likely. Both Derna in Cyrenaica and Finike in S Anatolia were harbours at least since early Greek times (7th century BC). Eventually, evolution of the particular characters of subsp. *antaly-*

ensis could have been speeded up by the small size of its population. But according to general experiences in evolutionary rates the time span is again too short.

3. As the sister taxon is restricted to the E Cyrenaica, the presence of subsp. *antalyensis* at the S Anatolian coast could be interpreted as the result of a long-distance dispersal event across the Mediterranean Sea. The wings of the persistent perianth provide an effective anemochorous device for the small, light fruits, and strong south-westerly winds do occur occasionally during the passage of cyclones at winter-time, when the fruits are mature. But why then the species has not reached to Crete, which is much closer, offers the same type of habitats and shares so many species with the Cyrenaica?

In our opinion, despite remaining doubts, the last hypothesis serves with the most logical explanation. The colonization by the parental population could have occurred at any time, probably already during the Tertiary. But doubts remain. It might add to the problems, that the area of the typical subspecies in Libya is even more restricted. Therefore one could speculate as well about the opposite migration route. However, this is much less likely for several reasons: storms from north-eastern direction are very rare; geographically the N African coast is the native area of the species group; physiologically (C_4 plant) and ecologically the species are basically adapted to semidesert conditions – consequently the taxon growing in the most humid area should be the derivative one.

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