# Ploidy levels in some European representatives of the *Suaeda maritima* group

**Stupně ploidie některých evropských zástupců skupiny *Suaeda maritima***

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Krahulcová A. et Tomšovic P. (1997): Ploidy levels in some European representatives of *Suaeda maritima* group. – Preslia, Praha, 69: 327–332.

Chromosome numbers are given for three species of the *Suaeda maritima* group, differentiated into three ploidy levels: diploid *Suaeda prostrata* Pallas (2n = 2x = 18), tetraploid *Suaeda maritima* (L.) Dumort. (2n = 4x = 36) and octoploid *Suaeda pannonica* (Beck) Graebn. (2n = 8x = 72). The plants studied were collected in the Pannonian region of Europe; in addition, *S. maritima* s. str. also originated from three other European localities. Octoploidy, revealed in *S. pannonica* for the first time, is the highest ploidy level found in the genus in Europe. The genus *Suaeda*, comprised predominantly of annuals, displays a wide variation in ploidy levels (up to 10x), as is illustrated here by literature data. The importance of polyploidy in evolution of annual taxa is briefly discussed.

Keywords: Chromosome numbers, *Suaeda*, polyploidy, annuals, Pannonian region

## Introduction

The euploid series of chromosome numbers in the genus *Suaeda (Chenopodiaceae)* is based on x = 9, ranging from diploids to decaploids (see in Table 1). The highest chromosome number in the genus (2n = 10x = 90) was found in two species outside Europe: *S. rolandii* Bassett et Crompton in Canada (Bassett et Crompton 1978) and *S. corniculata* (C. A. Mey.) Bunge subsp. *erecta* (Bunge) Lomonosova in Russia, SW Siberia (Lomonosova et Krasnikov 1993). With respect to the fifteen species recently recognized in Flora Europaea (Ball et Akeroyd 1993), the karyology in eight of them has been studied so far. As can be seen from Table 1, only diploid and tetraploid taxa are known so far from localities in Europe.

The aggregate species *Suaeda maritima* (L.) Dumort. occurs on most of the European coast, but also in inland saline areas of Russia, Central Europe, East Asia and India (Chapman 1947). The whole taxonomy and distribution of this group was recently studied by Freitag et al. (1996) in participation with the authors of this communication. In the study cited, several of our karyological data were used (in the form of personal communications). Our present paper includes the localities of plants studied (not mentioned in Freitag et al. 1996) and, in particular, a more detailed comparison between our original karyological data and the literature references concerning the whole genus. In addition, the correction of one of our chromosome counts in *Suaeda maritima* s. str., erroneously published by Freitag et al. (1996), is given. The taxonomic interpretation of the species studied corresponds to that of Freitag et al. (1996). The names of taxa, whose chromosome numbers were previously given in the literature (Table 1), are cited according to the authors of appropriate references and to Flora Europaea (Ball et Akeroyd 1993).

Table 1. – Ploidy levels hitherto known in European representatives of the genus *Suaeda* Scop. (information about life form is given in parentheses according to Ball et Akeroyd 1993). Nine references based on plants originating outside of Europe are also included (marked by asterisk).

| Ploidy level | Taxon (life form) | Reference | Origin of plants |
|---|---|---|---|
| Diploids (2n = 2x = 18) | *S. altissima* (L.) Pallas (annual) | Kozuharov et Kuzmanov 1969 | Bulgaria |
| | | * Hekmat-Shoar et Manafi 1982 | Iran |
| | *S. linifolia* Pallas (annual) | * Lomonosova et Krasnikov 1993 | Russia, Altai region |
| | *S. prostrata* Pallas (annual) | Měsíček et Jarolímová 1992 | Czech Republic |
| | | * Goldblatt 1981 | Turkey, Tajikistan |
| | *S. salsa* (L.) Pallas (annual) | * Hekmat-Shoar et Manafi 1982 | Iran |
| | *S. splendens* (Pourret) Gren. et Godron (annual) | Queirós 1975 | Portugal |
| | | Goldblatt 1981 | Spain |
| | *S. vera* J. F. Gmel. (small shrub) | Pastor et al. 1990 | Spain |
| | | Goldblatt et Johnson 1990 | Spain |
| | | Lago Canzobre 1988 | Spain |
| | *S. vermiculata* Forsk. ex J. F. Gmel. (small shrub) | Goldblatt et Johnson 1990 | Spain |
| Tetraploids (2n = 4x =36) | *S. corniculata* (C. A. Mey.) Bunge subsp. *corniculata* (annual) | * Lomonosova et Krasnikov 1993 | Russia, Novosibirsk region |
| | *S. corniculata* (C. A. Mey.) Bunge var. *prostrata* (Bunge) Krylov | * Freitag et al. 1996 | Kazakhstan |
| | *S. maritima* (L.) Dumort. s.l. (annual) | Lago Canzobre 1988 | Spain |
| | | Queirós 1975 | Portugal |
| | *S. maritima* (L.) Dumort. subsp. *maritima* | Moore 1982 | Germany |
| | | Goldblatt 1981 | France |
| | | Löve et Löve 1974 | Romania, Great Britain, Netherlands, Sweden, Norway |
| | *S. maritima* var. *prostrata* sensu Focke | Metzing et al. 1996 | Germany |
| | *S. maritima* var. *flexilis* sensu Focke | Metzing et al. 1996 | Germany |
| | *S. maritima* (L.) Dumort. subsp. *salsa* (L.) Soó | Moore 1982 | Hungary |
| | *S. splendens* (Pourret) Gren. et Godron (annual) | Goldblatt 1981 | France |
| | *S. vera* J. F. Gmel. (small shrub) | Dempsey et al. 1994 | England |
| | | Goldblatt 1981 | France |
| | | Lago Canzobre 1988 | Spain |
| Hexaploid (2n = 6x = 54) | *S. prostrata* Pallas (annual) | * Lomonosova et Krasnikov 1993 | Russia, Novosibirsk region |
| Octoploid (2n = 8x = 72) | *S. kossinskyi* Iljin (annual) | * Lomonosova et Krasnikov 1993 | Russia, Tuvin region |
| Decaploid (2n = 10x = 90) | *S. corniculata* (C. A. Mey.) Bunge subsp. *erecta* (Bunge) Lomonosova (annual) | * Lomonosova et Krasnikov 1993 | Russia, Novosibirsk region, Altai region |

Three ploidy levels have been published up to now within the complex species *S. maritima* (L.) Dumort., divided in Europe into three subspecies (Ball et Akeroyd 1993). The tetraploid number is reported in *S. maritima* s. str. from several localities in Europe (Table 1). Diploids (some of them originating from localities in Asia) are known in *S. prostrata* Pallas, included by Ball et Akeroyd (1993) also in subsp. *maritima* (Table 1). In addition, one reference to hexaploid *S. prostrata* is cited from Siberia (Table 1). The second taxon, *S. salsa* (L.) Pallas [syn. *S. maritima* (L.) Dumort. subsp. *salsa* (L.) Soó], is represented by diploids and tetraploids (Table 1). The chromosome number of the third subspecies, *S. maritima* subsp. *pannonica* (G. Beck) Soó ex P. W. Ball, was unknown up to now.

However, some of the chromosome numbers published in the literature might be erroneously assigned to other taxonomic units, with regard to previously unclear taxonomic interpretation within this complex species. Having available the seed collections of the *S. maritima* group originating predominantly from several European localities, we attempted to extend the knowledge about the ploidy variation in this group and to assign the cytotypes to appropriate taxa.

## Material and methods

Seeds for germination collected in the wild were used as material for chromosome study (for localities see Table 2). The root-tips were pretreated by a saturated solution of paradichlorbenzene or 1-bromonaphthalene for about 3 hours at room temperature, fixed in a cold mixture of ethanol-acetic acid (3:1) and stored in cold conditions overnight. Maceration was carried out either in a mixture of 37 % HCl – 96 % ethanol (1:1) at room temperature for 1 min, or in 1N HCl at 60° C for 5 min. After rinsing in water, the meristems were cut off and squashed in a drop of lacto-propionic orcein (Dyer 1963).

Plants cultivated from remaining seeds in each collection were used for taxonomic determination. The voucher specimens are deposited in PR.

## Results and discussion

With respect to ploidy levels, the plants belonging to the *Suaeda maritima* group studied by the present authors can be characterized as follows (see in Table 2): a) diploid *S. prostrata* Pallas, b) tetraploid *S. maritima* s. str. and c) octoploid *S. pannonica* (Beck) Graebn. in Aschers. et Graebn. The new octoploid chromosome number $2n = 8x = 72$ in *S. pannonica* is the highest ploidy level found up to now in the genus *Suaeda* in Europe. This species corresponds to *S. maritima* subsp. *pannonica* (Beck) Soó ex P. W. Ball in Flora Europaea (Ball et Akeroyd 1993).

One of our chromosome counts is presented erroneously in Freitag et al. (1996) and needs a correction: in the paragraph concerning "*salinaria* Schur" (p. 364), the correct chromosome number should be $2n = 36$, not 28. This count is given in the present paper in the Table 2 and it belongs to *S. maritima* (L.) Dumort. obtained from two localities in Hungary. This is the only tetraploid chromosome number from the group found in the Pannonian region.

Polyploidy is usually not associated with the perennial life form in the polyploid *Suaeda* (Ball et Akeroyd 1993, Bassett et Crompton 1978, Table 1, 2). On the contrary, the species

Table 2. – Chromosome numbers found by the present authors among representatives of *Suaeda maritima* group (all plants were annuals)

| Taxon | Chromosome number (2n) | Origin of plants studied |
|---|---|---|
| *S. prostrata* Pallas | 18 | Austria: "Neusiedler See" lake, coll. J. Köllner 1981 |
| | 18 | Austria: Podersdorf village E of the "Neusiedler See" lake, coll. P. Tomšovic 1988 |
| *S. maritima* (L.) Dumort. | 36 | Hungary: two collections from the vicinity of Hortobágy town, coll. J. Hašková 1988 and BG Hortobágy 1985 |
| | 36 | Norway: in the vicinity of Oslo, BG Oslo 1985 |
| | 36 | Germany: Jadebusen, BG Oldenburg 1985. |
| | 36 | Iran: Tehran, Karaj-Mardabak, BG Tehran 1988 |
| | 36 | France: Pas-de Calais, Etaples, BG Liége 1988 |
| *S. pannonica* (Beck) Graebn. | 72 | Hungary: "Velencii tó" lake, coll. P. Tomšovic 1984 |
| | 72 | Hungary, Kiskunság, BG Vácrátót 1991 |
| | 72 | Austria: "Neusiedler See" lake, coll. J. Köllner 1981 |
| | 72 | Austria: Podersdorf village E of the "Neusiedler See" lake, coll. P. Tomšovic 1988 |
| | 72 | Austria: "Neusiedler See" lake, Illmitz, coll. P. Tomšovic 1988 |

with high ploidy levels (i.e. from 6x to 10x) are annuals: one diploid perennial *S. moquinii* (Torrey) Greene occurs among the Canadian representatives of the genus, while the remaining polyploids (including the decaploid *S. rolandii* Bassett et Crompton) are annuals (Bassett et Crompton 1978). The association of polyploidy with the perennial life form, although not absolute, has often been emphasized in the literature (e.g. Grant 1971, Stebbins 1971). Among annuals, however, the high proportion of self-fertilization usually prevails in diploid ancestors as well as in their polyploid derivatives, although some of them proved to be of hybrid origin (Stebbins 1971).

The literature data concerning the floral biology and the breeding system in the genus *Suaeda* are not entirely consistent: as in the whole family *Chenopodiaceae*, the genus is anemogamous (Aellen 1979, Tomšovic 1990). The flowers are considered by some authors as homogamous or feebly protandrous, making spontaneous selfing easily possible (Chapman 1947, Aellen 1979). According to Tomšovic (1990), protogyny is developed in *Suaeda*. It seems that at least in *S. maritima* outcrossing is occasionally possible (Smith 1985). Although the exact proportion between selfing and outcrossing has not been proved experimentally, selfing is probably of great importance in the reproduction of *S. maritima*, as was established from observations on cultivated plants (Metzing et al. 1996). This mode of reproduction might be responsible for the establishment of homozygous lines, i.e. of special morphotypes occurring in particular populations, isolated among each other by different flowering periods (Metzing et al. 1996).

Following especially from the study by Smith (1985), the genus *Suaeda* probably does not belong to obligatory selfers, although selfing seems to be its prevailing mode of reproduction. With respect to extensive variations in ploidy levels, this genus can serve as a good example of the important part played by polyploidy in the evolution of annuals with a high proportion of self-fertilization.

## Acknowledgements

We are grateful to Dr. J. Köllner, Illmitz, and to Ing. J. Nováková-Hašková for collecting some of the material under study. We also thank our colleague V. Jarolímová who did two of the chromosome counts in *Suaeda* presented in this paper, and Dr. John R. Cross for the language revision of this paper.

## Souhrn

Práce uvádí originální chromozómové počty tří druhů skupiny *Suaeda maritima*, stanovené převážně na rostlinách pocházejících z panonské oblasti. Druh *S. maritima* (L.) Dumort. byl mimo to karyologicky studován na materiálu z dalších tří evropských lokalit. Podle stupňů ploidie lze rozlišit následující taxony: diploidní *S. prostrata* Pallas (2n = 2x = 18), tetraploidní *S. maritima* s. str. (2n = 4x = 36) a oktoploidní *S. pannonica* (Beck) Graebn. (2n = 8x = 72). Taxonomické zařazení uvedených druhů odpovídá pojetí Freitaga, Waltera a Wucherera v jejich práci z r. 1996. Oktoploidní *S. pannonica* představuje zatím nejvyšší ploidní stupeň známý v rodu *Suaeda* z Evropy.

Excerpce literárních údajů ukazuje na značnou variabilitu ploidních úrovní v celém rodu (i mimo Evropu), přitom se zde setkáváme s vysoce polyploidními a zároveň jednoletými druhy. Podle dosavadních znalostí převládá v tomto rodu autogamický způsob rozmnožování. Rod *Suaeda* je dobrým příkladem významného vlivu polyploidie při vývoji jednoletých taxonů s převažující samosprašností.

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Received 3 September 1997
Accepted 6 November 1997