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Taxonomic studies on the *Arenaria serpyllifolia* group (*Caryophyllaceae*)

Abstract

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Scanning electron microscopic investigation of seed and capsule morphology of *Arenaria serpyllifolia* L. and *A. leptoclados* Guss. In the *Caryophyllaceae* have been studied. Seed size in both species show consistency, but testa ornamentation (midzone) vary in shape even in the seeds from one capsule of *A. serpyllifolia*, while in *A. leptoclados* midzone cells are narrowly elongate in different populations and environments. The ripe capsule teeth ornamentation has a diagnostic character to separate *A. serpyllifolia* and *A. leptoclados*.

Introduction

The group *Arenaria serpyllifolia* (*Caryophyllaceae*), includes some taxa, that in turn has often been considered at specific or subspecific rank. McNeil (1963) regarded seed size as the most satisfactory character separating the tetraploid *A. serpyllifolia* L. from the diploid *A. leptoclados*, both automatically self-pollinating species. Perring and Sell (1967) used seed characters but not those of the testa to separate the subspecies *leptoclados*, *serpyllifolia* and *macrocarpa* (Lloyd) Perring & Sell. In the first edition of Flora Europaea *A. serpyllifolia* and *A. leptoclados* are treated as species (Charter & Halliday 1964) but in the second they are regarded as subspecies (Charter & Halliday 1993). Greuter & al. (1984) recognised as species the following in the Mediterranean area: *A. argaea* Rech. f., *A. leptoclados* (Reichenb.) Guss., *A. marschlinsii* Koch, *A. minutiflora* Loscos [doubtful status], *A. peloponnesiaca* Rech. fil. and *A. serpyllifolia* L.. For Britain Stace (1991), accepts subspecific status: *serpyllifolia*, *leptoclados* (Reichenb.) Nyman and *Lloydii* (Jordan) Bonnier (*A. macrophylla*). For Lybia Abdul Ghafoor (1977) lists only *A. serpyllifolia* without any discussion of infraspecific taxa. Soon after SEM was available Godeau (1973) published photographs of seeds of Breton origin. On the basis of seemingly only three specimens he discussed testa features, including some to be seen easily only at $\times 10,000$ and $\times 30,000$; these few observations were scarcely enough to reveal the full range of variation. In his paper on *Arenaria* from the USA Wofford (1981) published an SEM of *A. serpyllifolia* but did not indicate which precise taxon.

Material and methods

The plant material used in this study was entirely dried specimens obtained from many herbaria. (BM, E, GL, ULT, T). The localities of collection and the names of the collectors are given in (Table 3). 44 sheets labelled of *Arenaria serpyllifolia* and 18 of *A. leptoclados* from North Africa, Tenerife and Britain were studied thoroughly. 36 specimens were measured for sepal length, capsule width and feature and seed diameter by a scale lupe 10× (Table 1, Table 2).

In obtaining material from herbarium specimens great care was taken to select only fully ripe, undamaged seeds from mature capsules. Leo Microscopy Stereoscan 360 and Emscope sputter coater with a gold target were used. The heated stubs were evenly rubbed with wax sticks to leave a smooth, thin layer which hardened after a few seconds. Using a dissecting microscope, the seeds or capsules were carefully placed on the wax layer. Material was then kept in a dry and dust-free place to avoid dust contamination and no stop hydration. Measurements of the seed size were made using a micrometer eyepiece.

Results and discussions

The results show consistency of seed size in these different populations and environments in both species. The work on Britain, North African and Tenerife material shows that the mid zone cells vary in shape from more or less isodiametric to very elongate; such variation can be found even in the seeds from

one capsule of *A. serpyllifolia* s. s..

However, in most populations of *A. leptoclados* examined most mid zone cells are narrowly elongate. The sepal length, capsule width and seed diameter are three of

Table 1. Measurements of British in (GL) and North African specimens of *Arenaria serpyllifolia*.

Sepal size mm	Seed size mm	Capsule size mm	Capsule feature
± 3.0	0.3 x 0.4	2.5 x 1.2	*
± 2.5	0.3 x 0.4	3.0 x 2.0	*
± 3.0	~	3.0 x 1.9	*
± 3.0	0.4 x 0.4	3.0 x 2.0	*
± 3.0	0.4 x 0.4	3.5 x 2.0	*
± 3.5	0.3 x 0.4	3.0 x 1.7	*
± 3.5	0.3 x 0.4	3.0 x 1.7	*
± 3.0	0.4 x 0.4	3.0 x 1.8	*
± 3.5	0.3 x 0.4	2.5 x 1.1	*
± 3.0	0.3 x 0.4	3.0 x 1.4	*
± 2.5	0.3 x 0.4	3.0 x 2.0	*
± 3.0	0.3 x 0.4	3.0 x 2.0	*
± 3.0	0.3 x 0.4	3.0 x 2.0	*
± 4.0	0.4 x 0.5	3.0 x 2.0	*
± 3.5	0.5 x 0.6	3.5 x 2.5	*
± 3.5	0.5 x 0.6	3.5 x 2.0	*
± 4.0	0.5 x 0.6	3.5 x 2.0	*
± 3.5	~	3.5 x 2.5	*
± 3.0	~	3.5 x 2.5	*
± 3.0	0.5 x 0.6	3.0 x 2.0	*
± 4.0	0.5 x 0.6	4.0 x 2.5	*
± 4.0	0.5 x 0.6	3.5 x 2.5	*

Table 2. Measurements of British in (GL) and Mediterranean specimens of *Arenaria leptoclados*.

Sepal size mm	Seed size mm	Capsule size mm	Capsule feature
± 3.0	0.3 x 0.4	2.5 x 1.2	*
± 2.5	0.3 x 0.4	3.0 x 2.0	*
± 3.0	~	0.3 x 1.9	*
± 3.0	0.3 x 0.4	0.3 x 2.0	*
± 3.0	0.4 x 0.4	3.5 x 1.5	*
± 2.5	0.3 x 0.4	2.5 x 1.0	*
± 3.5	0.3 x 0.4	3.0 x 1.7	*
± 3.0	0.4 x 0.4	3.0 x 1.8	*
± 3.5	0.3 x 0.4	2.5 x 1.1	*
± 3.0	0.3 x 0.4	3.0 x 1.4	*
± 2.5	0.3 x 0.4	3.0 x 2.0	*
± 3.0	0.3 x 0.4	3.0 x 2.0	*
± 3.0	0.3 x 0.4	3.0 x 2.0	*
± 4	0.4 x 0.5	3.0 x 2.0	*

* = Capsule covered with distinct papillae except the teeth. ~ = No seeds present.

Table 3: Details of the seed and fruit capsule samples studied; Herbaria abbreviations were taken from Patricia (1981). Material collected from Libya is written in **bold**.

Taxon	Locality	Date	Collector	No.	Herbarium
<i>A. leptoclados</i>	Greece	1896	J. Dorfner	196	(E)
<i>A. leptoclados</i>	Serbia	1897	s.c.	15025	(E)
<i>A. leptoclados</i>	Crete	1940	Davis	1338	(E)
<i>A. leptoclados</i>	Morocco	1969	Davis	48969	(E)
<i>A. leptoclados</i>	Morocco	1969	Davis	48969	(E)
<i>A. leptoclados</i>	Lybia	1970	Davis	50344	(E)
<i>A. leptoclados</i>	Algeria	1971	Davis	52652	(E)
<i>A. leptoclados</i>	Algeria	1975	Davis	58386	(E)
<i>A. leptoclados</i>	Tunisia	1975	Davis	57561	(E)
<i>A. leptoclados</i>	Britain	1889	J. Andrew	245	(GL)
<i>A. leptoclados</i>	Britain	1890	R. Withie	240	(GL)
<i>A. leptoclados</i>	Britain	1897	R. Kidston	234	(GL)
<i>A. leptoclados</i>	Britain	1908	D. Patton	155	(GL)
<i>A. leptoclados</i>	Britain	1932	T. Wise	s.n.	(GL)
<i>A. leptoclados</i>	Britain	1944	T. Megrouther	5137	(GL)
<i>A. leptoclados</i>	Britain	1949	E. R. Wise	s.n.	(GL)
<i>A. leptoclados</i>	Britain	1984	C. Rodiguaz	s.n.	(GL)
<i>A. serpyllifolia</i>	Morocco	1924	E. Jahandiez	615	(E)
<i>A. serpyllifolia</i>	Morocco	1932	A. Faure	s.n.	(E)
<i>A. serpyllifolia</i>	Morocco	1951	D. H. Spence	5239	(E)
<i>A. serpyllifolia</i>	Libya	1970	Davis	50344	(E)
<i>A. serpyllifolia</i>	Libya	1976	S. M. Jafri	6424	(ULT)
<i>A. serpyllifolia</i>	Algeria	1971	Davis	52537	(E)
<i>A. serpyllifolia</i>	Morocco	1973	Davis	55434	(E)
<i>A. serpyllifolia</i>	Algeria	1975	Davis	59389	(E)
<i>A. serpyllifolia</i>	Algeria	1971	Davis	53105	(E)
<i>A. serpyllifolia</i>	Algeria	1971	Davis	53105	(E)
<i>A. serpyllifolia</i>	Tunisia	1975	Davis & Lamond	57537	(E)
<i>A. serpyllifolia</i>	Algeria	1975	Davis	59262	(E)
<i>A. serpyllifolia</i>	Algeria	1975	Davis	59074	(E)
<i>A. serpyllifolia</i>	Algeria	1975	Davis	59466	(E)
<i>A. serpyllifolia</i>	Morocco	1981	Davis	67628	(E)
<i>A. serpyllifolia</i>	Britain	1889	J. Andrew	s.n.	(GL)
<i>A. serpyllifolia</i>	Britain	1882	W. Gourlie	s.n.	(GL)
<i>A. serpyllifolia</i>	Britain	1883	J. Wglie	s.n.	(GL)
<i>A. serpyllifolia</i>	Britain	1892	Ahorllywood	234	(GL)
<i>A. serpyllifolia</i>	Britain	1902	s.c.	s.n.	(GL)
<i>A. serpyllifolia</i>	Britain	1905	Horwards	245	(GL)
<i>A. serpyllifolia</i>	Britain	s.d.	P. Ewing	243	(GL)
<i>A. serpyllifolia</i>	Britain	1912	P. Ewing	391	(GL)
<i>A. serpyllifolia</i>	Britain	1912	P. Ewing	392	(GL)
<i>A. serpyllifolia</i>	Britain	1948	K. W. Praid	s.n.	(GL)
<i>A. serpyllifolia</i>	Britain	1980	J. Dickson	42	(GL)
<i>A. serpyllifolia</i>	Britain	1985	J. Dickson	s.n.	(GL)
<i>A. serpyllifolia</i>	Britain	1985	H. J. Noltie	s.n.	(GL)
<i>A. serpyllifolia</i>	Britain	1987	s.c.	s.c.	(GL)

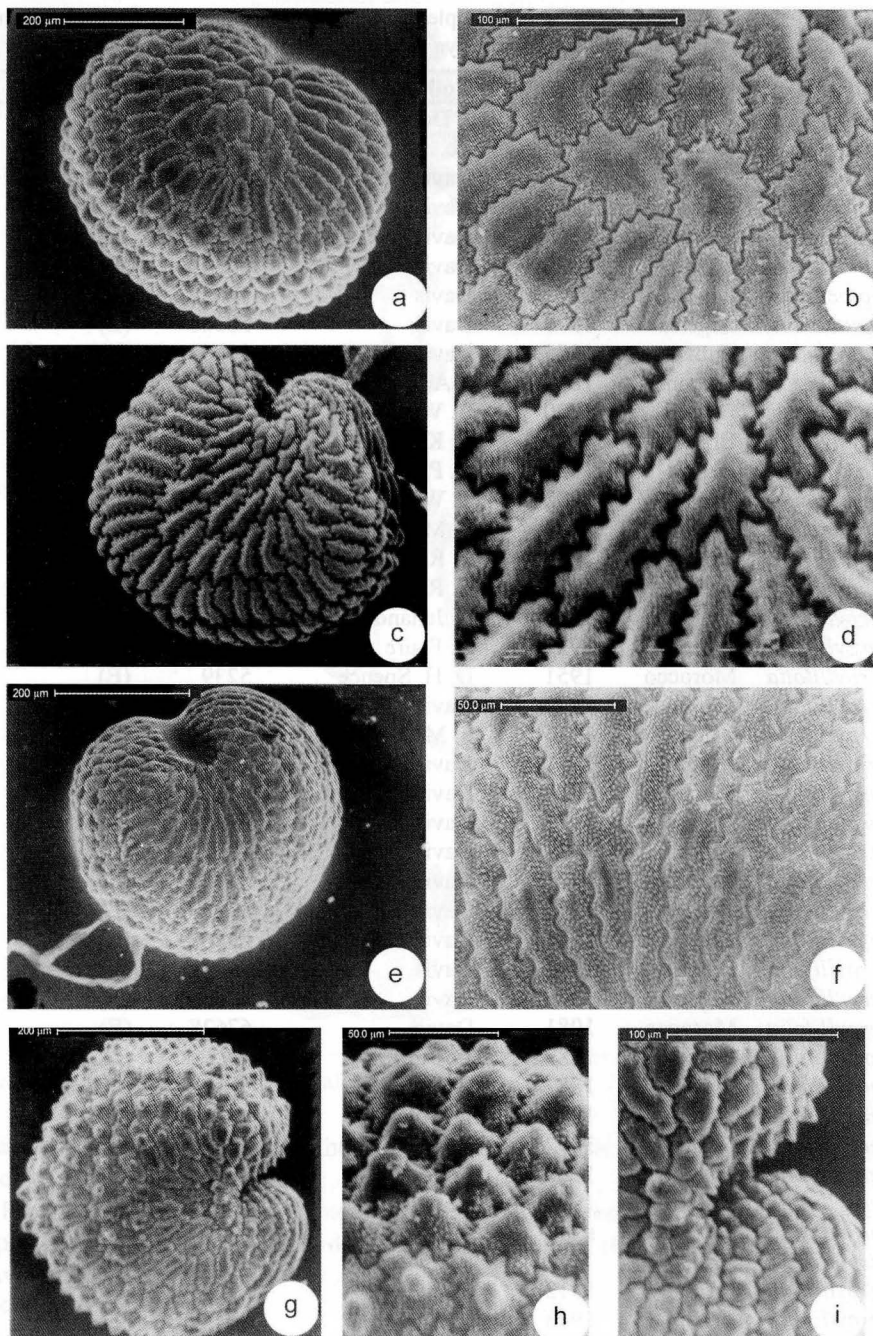


Fig. 1. Ornamentation of the testa and shape of the seeds in *Arenaria* (a, b) *A. serpyllifolia* s. s. whole seed, and lateral face (midzone); (c, d): *A. serpyllifolia* whole seed. $\times 300$, and lateral face (mid zone) $\times 1200$; (e, f): *A. leptocladus* whole seed and lateral face (mid zone); (g, h, i): *A. leptocladus*. (Davis 50334) whole seed, lateral face (mid zone), and near the hilum.

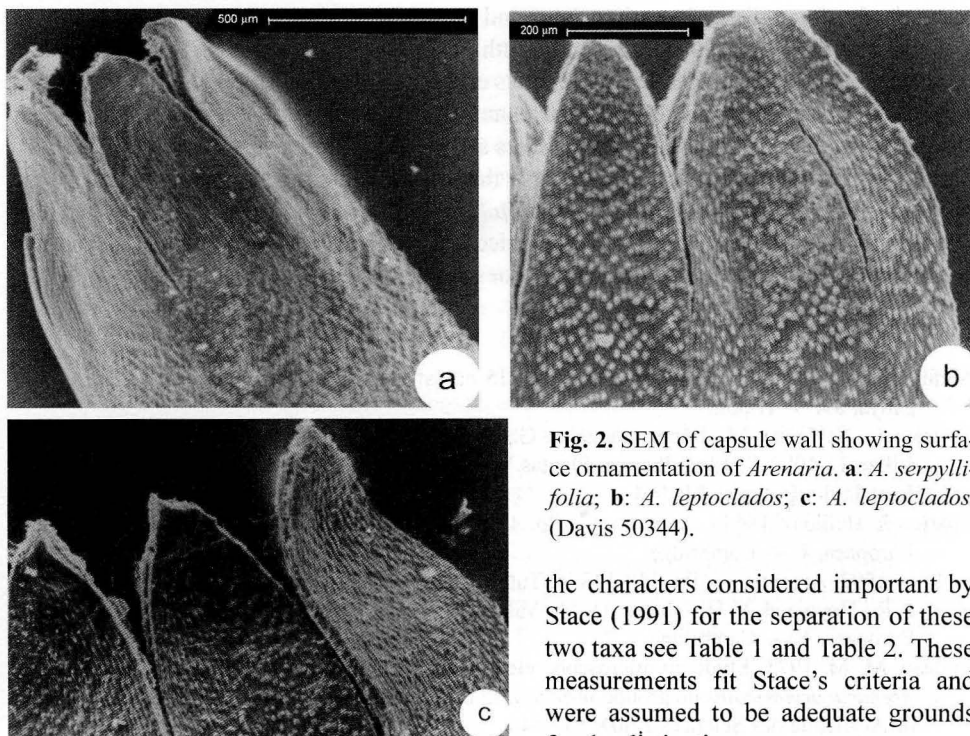


Fig. 2. SEM of capsule wall showing surface ornamentation of *Arenaria*. **a:** *A. serpyllifolia*; **b:** *A. leptoclados*; **c:** *A. leptoclados*. (Davis 50344).

the characters considered important by Stace (1991) for the separation of these two taxa see Table 1 and Table 2. These measurements fit Stace's criteria and were assumed to be adequate grounds for the distinction.

The specimen collected by Davis (50344) from Wadi Derna in Cyrenaica (Libya) is very noteworthy. The specimen is well into the fruiting condition and no petals can be seen. However, it has conspicuously glandular hairiness on the stems of the small leaves and sepals which are c. 3.5 mm long and narrowly acuminate. These are some of the diagnostic features of *A. minutiflora* Loscos, described from northeastern Spain; see map in Jalas and Suominen (1983). Loscos (1877) in his description of the taxon made no mention of seed characteristics; Lindberg (1932) made *A. minutiflora* a subspecies of *A. serpyllifolia* and Monserrat (1981) considered it a subspecies of *leptoclados*. Jahandiez and Maire (1934) listed it from Morocco, Ozenda (1977) from Algeria and Maire (1962) gave all of these countries and added Libya. Maire treated *A. serpyllifolia* having 3 subspecies. These are *typica* (with two varieties), *leptoclados* (also with two varieties) and *minutiflora*. Like Greuter & al. (1983) he listed Algeria, Libya, Morocco and Tunisia but the *multiflora* species is qualified by a question mark. In Flora Iberica Castroviejo & al. (1990) lumped *A. minutiflora* with *leptoclados* subspecies which is also the treatment in the second edition of Flora Europaea (Charter & Halliday 1993).

As made clear in (Fig. 1) the seeds of Davis (50344) are highly distinctive in their marked papillae. In the absence of examination of Spanish material and in particular Loscos' type specimen it is not known if the seeds are papillate. Should such seeds prove to be papillate the case for recognition of *minutiflora* as a distinct taxon would be strengthened.

Distinct papillae had been noticed on the capsules but the papillae were not uniformly distributed over the capsules in the two taxa. There appears to be a total separation: *A. serpyllifolia* s. s. has the distinct papillae on the capsule body but not on the teeth whereas *A. leptoclados* has the papillae on both the body and the teeth. These characteristics can be

recognised using a dissecting microscope and be seen very clearly in capsule impressions and using SEM (Fig. 2). Furthermore the teeth of *serpyllifolia* are glossier and blunter than those of *leptoclados*. All these characteristics of the capsule teeth, unremarked by previous authors, were found in all the material examined, whatever the geographical origin. It should be emphasized that fully ripe capsules are necessary for clear observation. The finding of capsular characteristics, most notably the distribution of papillae, adds weight to the recognition of specific status for *A. serpyllifolia* and *A. leptoclados*. The capsular teeth of Davies (50344) are papillate right to the apices and this is a further confirmation that the specimen is a *leptoclados* subspecies if it does not prove to be a distinct taxon.

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