

MORPHOLOGY OF POLLEN GRAINS AND SEEDS OF THE BALTIC SEA COAST  
ENDEMIC SPECIES *LINARIA LOESELII* SCHWEIGG.

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**ABSTRACT.** *Linaria loeselii* Schweigg. is an endemic species of the Baltic Sea coast which occurrence is restricted to its south-eastern part. The aim of the presented work was to investigate its pollen morphology as well as ultrastructural traits of its seed-coat. Pollen grains of this species are small, spheroidal or prolate spheroidal, 3-zono-colporate, with microreticulate to foveolate ornamentation. The seeds are winged, concolourous, black to golden brown, metallic shiny. The seed-coat ornamentation of *L. loeselii* are of verruculate to rugulate type.

**KEY WORDS:** *Linaria loeselii*, the Baltic Sea coast endemic species, pollen, seeds, SEM

## INTRODUCTION

The genus *Linaria* Mill. comprises 150 species distributed throughout the northern hemisphere. Its main centre of distribution is located in the Mediterranean basin. *Linaria* together with few other genera traditionally placed in family Scrophulariaceae was recently added to the expanded Plantaginaceae (APG II 2003, ALBACH et AL. 2004).

The seed characters have proved to be useful in many morphological studies of the *Linaria*. For instance SUTTON (1988) divided the genus into five sections (*Linaria*, *Supinae*, *Pelisseriannae*, *Versicolores* and *Diffusae*) on the base of seed morphology. The SEM studies of seeds were carried out in the identification of the most species of *Linaria* from south-western Iberian Peninsula (e.g. JUAN et AL. 1999, SEGARRA and MATEU 2001 a, b, SÁEZ and CRESPO 2005). An interesting contribution to the taxonomy of Plantaginaceae sensu lato based on ultrastructure of seed coat was recently given by SHEHATA and LOUTFY (2006).

VIANO (1978) indicated the potential significance of pollen morphology in the systematics of the genus *Linaria*. Author ascertained important range of variations between the grains of 33 species, originated from the different regions of the Mediterranean basin. Pollen grains of some other species of the genus were also described in the works of OLSON (1974), ELISENS (1986) and HALBRITTER (2000).

From among 53 species of *Linaria* growing in Europe almost 60% are endemic to the continent. *Linaria loeselii* is an endemic species of the Baltic Sea coast which occurrence is restricted to its south-eastern part

(PANKHURST 2006). In Poland it grows only on coastal dunes between the village Unieście in the west and Vistula Bar in the east. At present the most numerous populations exist in the Słowiński National Park (PIOTROWSKA et AL. 1997, PRZYRODA... 1997). The species is listed in Bern Convention on the Conservation of European Wildlife and Natural Habitats and it is protected by law in Poland. *Linaria loeselii* is also considered to be vulnerable within Polish vascular flora (KAŹMIERCZAKOWA and ZARZYCKI 2001, FREY 2004, ZARZYCKI and SZELAĞ 2006).

*Linaria loeselii* is sometimes treated as subspecies of *L. odora* [*L. odora* (M. Bieb.) Fisch. subsp. *loeselii* (Schweigg.) Hartl] or even, both mentioned names of species are used as synonyms (STASIAK 1988, KAŹMIERCZAKOWA and ZARZYCKI 2001, MIREK et AL. 2002, PANKHURST 2006).

The aim of the presented work was to investigate the pollen morphology and the ultrastructural traits of seed-coat of this interesting, rare species.

## MATERIAL AND METHODS

In 2006 the flowers and the seeds of *L. loeselii* were collected from one rich population on the Łeba Sandbar in the Słowiński National Park (E 20°19', N 49°26'). The sample of pollen grains (ripe anthers were taken only) was acetolysed according to ERDTMAN'S method (1952), with some insignificant modifications (TOMLIK-WYREMBLEWSKA 1995). The sample of 30 well developed and ripe seeds was not prepared, but only cleaned. The using of scanning electron microscopes (JEOL JSM

6300 and LEO 435 VP) allowed to investigate the details of exine sculpture and the seed ultrastructure. Light microscopy (BIOLAR 2308) was mainly applied to study the exine structure and quantitative characters of pollen grains. In all 30 pollen grains were observed. The pollen terminology follows PUNT *et al.* (2007). With regard to the seed surface, mainly terminology of BARTHLOTT (1981) was applied.

## RESULTS

### Pollen morphology (Fig. 1)

Pollen grains of *L. loeselii* are small in size; length of polar axis (P) is 17.3  $\mu\text{m}$  (with the whole range 13.3-20.0  $\mu\text{m}$ ) and equatorial axis (E) 16.1  $\mu\text{m}$  (with the

whole range 11.5-20.0  $\mu\text{m}$ ). P/E value oscillates from 1.00 to 1.16, with the mean value 1.09. They are most often spheroidal or prolate-spheroidal, with circular equatorial outline. Pollen grains are three-zono-colporate. Ectocolpi are narrowly oblong, with parallel margins and rounded or truncate ends, about  $\frac{3}{4}$  length of polar axis. The colpus membranes are without perforations, covered sparsely by minute granules. They are raised and connected with each other in the equatorial region, forming a bridge over the ectoaperture. The endopori are equatorial. The ornamentation of exine is microreticulate to foveolate. Lumina or perforations of variable outline and size; circular to prolate and irregular; diameter (or length) 0.1-0.6  $\mu\text{m}$ . Muri with smooth and obtuse ridges. The ornamentation of apocolpi and mesocolpi is similar, or depressions of the polar area

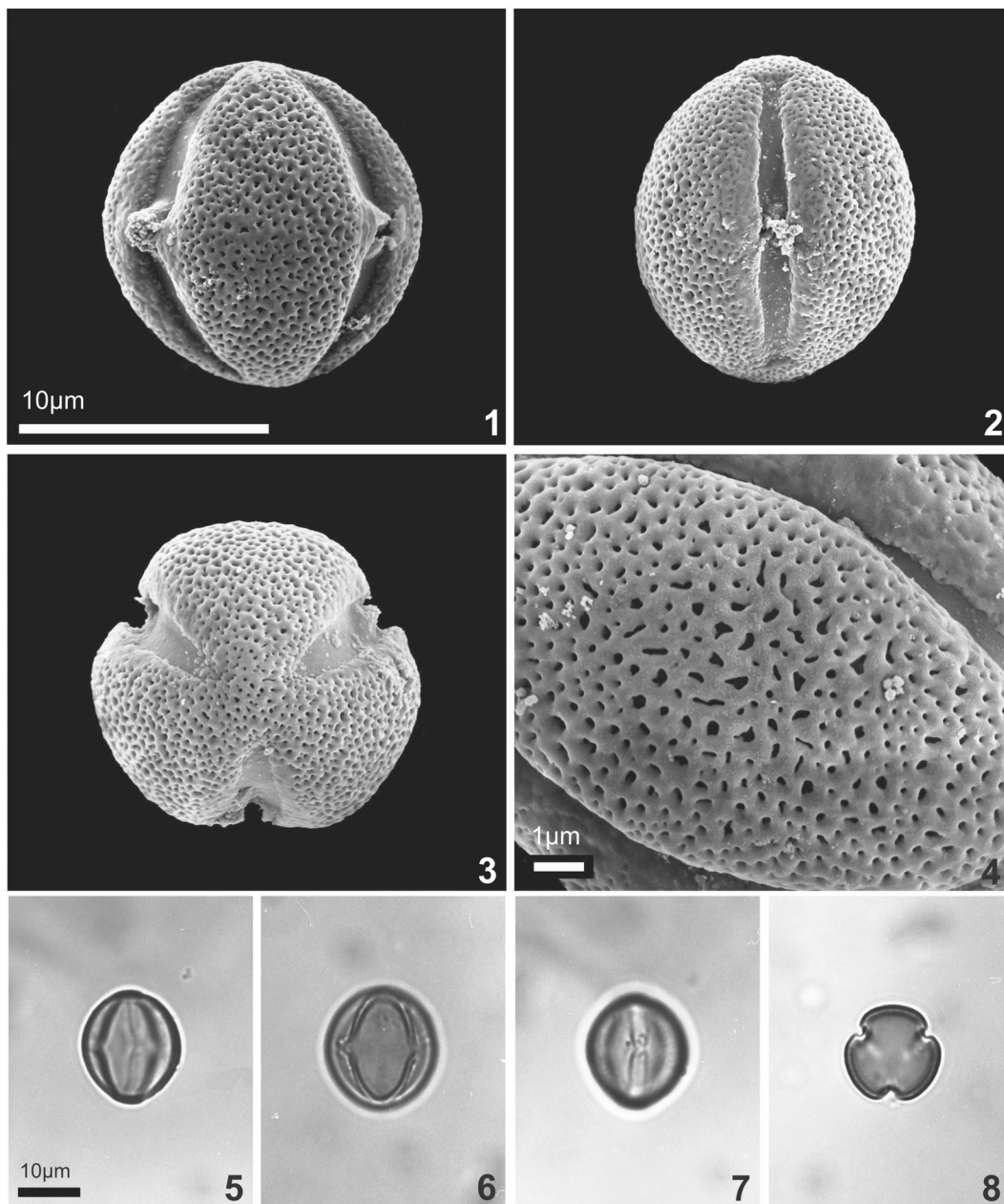


FIG. 1. Pollen morphology of *Linaria loeselii* in SEM (1-4) and LM (5-8): 1-2 – equatorial view, colpi and microreticulate ornamentation of mesocolpi visible, 3 – outline in polar view, microreticulate ornamentation of apocolpus visible, 4 – details of reticulate ornamentation, 5-7 – outline in equatorial view, 8 – outline in polar view, exine structure visible

are slightly smaller than of the ones of equatorial areas. Exine 1-2  $\mu\text{m}$  thick, remaining the same thickness from mesocolpia to poles; endoexine of the same thickness as endoexine.

#### Seed morphology (Fig. 2)

The seeds of *L. loeselii* are winged, consisting of two parts: disc (seed body) and wing. Seeds are concolourous (seed body and wing are similar in colour, disc a little bit darker), black to golden brown, metallic shiny. The examined seeds are 2.7-3.4 mm long and 1.7-2.5 mm wide. Wing is broad, 0.5-0.8 mm wide, usually flat or concave-convex, membranous. The seed-coat surface is smooth and formed by irregularly polygonal cells. They are more or less isodiametric on disc (15-25  $\mu\text{m}$  in diameter), and prosenchymatic-elongated on wing (35-70  $\mu\text{m}$  long) orientated  $\pm$  longitudinally to seed radial. The cells of seed-coat have shallow or obscure, concave anticlinal walls and raised, verruculate to rugulate, and convex periclinal walls.

### DISCUSSION

VIANO (1978) determined the ranges of variation of pollen size between the different species of *Linaria* and at the same time he observed the relationship between pollen size and sections of the genus. ELISENS (1986) stated that pollen dimension was mainly correlated with the length of flower style within the tribe *Antirrhineae*. Unfortunately both cited authors did not investigated the species from section *Linaria* (to which belongs *L. loeselii*). We noticed, that pollen morphology of *L. loeselii* was generally typical also for the other species of genus,

that had been investigated so far (OLSON 1974, VIANO 1978, ELISENS 1986, HALBRITTER 2000, HAMDI and AS-SADI 2005). However, observed some differences were in exine ornamentation of *L. loeselii* pollen. According to the authors, cited above, the grains of the genus are microreticulate. It means network-like pattern, consisting of lumina smaller than 1  $\mu\text{m}$ , delimited by significantly narrower muri (PANKHURST 2006). The pollen grains of *L. loeselii* was observed with the lumina wider than muri, forming microreticulate ornamentation, as well as shorter than the distance between adjacent depressions, forming foveolate ornamentation. Besides, both types of sculpture occurred nearly always together, forming a system of lumina and foveolae, being mixed with each other.

The seed features of *Linaria* species have been traditionally used in its intrageneric classification, but there is lack of detailed information of the most species of the *Linaria* section. On the other hand SEGARRA and MATEU (2001 a) stated the variability in seed micromorphology of the species of section *Supinae* required using of other plant features to identify particular taxa or to determine taxonomic relationships in this group.

As all species of the section *Linaria*, *L. loeselii* have the seeds with a marginal encircling wing (CHATER et AL. 1972, SUTTON 1988). Its seed-coat microsculpture is of verruculate to rugulate type. In this respect it resembles the seed-coat surface of *L. pedunculata* and of *L. tursica* (section *Supinae*), but both species have the seeds without wing. Besides, the anticlinal walls of seeds of *L. loeselii* are slightly concave, while till now only the raised anticlinal ones have been observed (for *Linaria* species of sections: *Supinae*, *Diffusae*, *Speciosae* and *Versicolores*; JUAN et AL. 1999, SEGARRA and MATEU

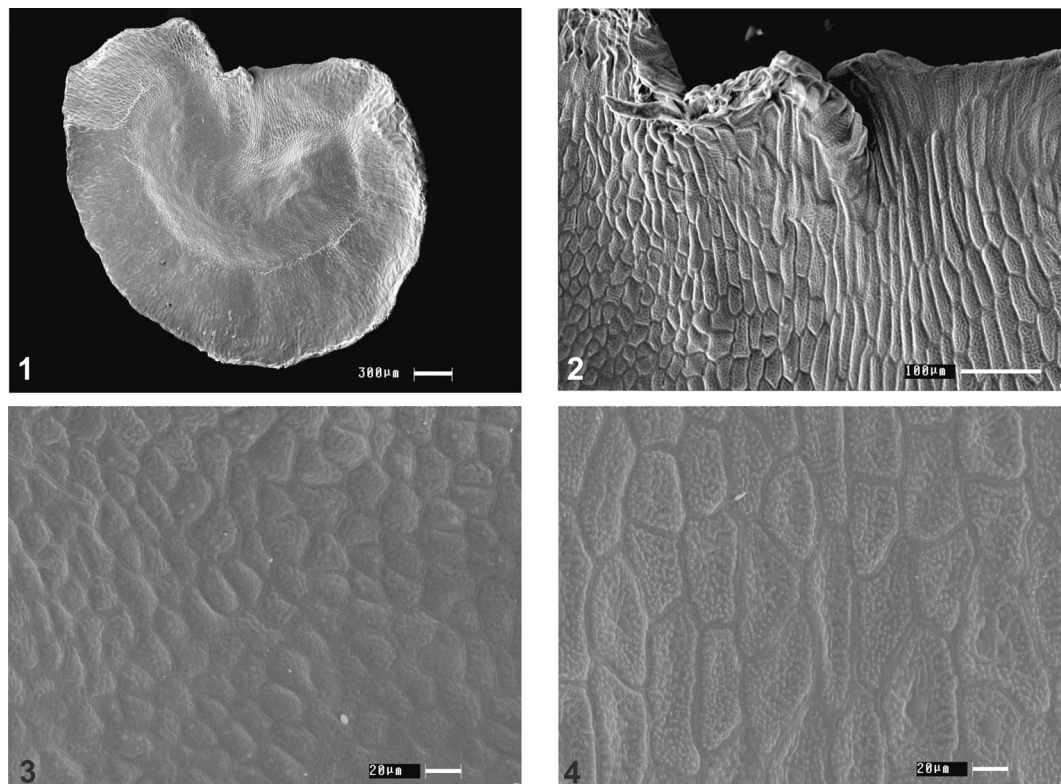


FIG. 2. Ultrastructure of seed of *Linaria loeselii*: 1 – outline of the whole seed, 2 – close up of seed wing, 3 – ornamentation of seed body (disc) coat, 4 – ornamentation of wing cells



2001 a, b, SÁEZ and CRESPO 2005, SHEHATA and LOUTFY 2006). It seems to be a rare feature of *Linaria* seeds or it may be a characteristic one for the seeds of *Linaria* sections.

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