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Some notes on the morphology and anatomy of seeds of two similar heathers, *Erica carnea* L. and *Erica erigena* R. Ross

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Abstract: This paper presents the results of comparative studies on seed morphology and anatomy of two species: *Erica carnea* and *E. erigena*. SEM and LM micrographs are presented. The seeds differ in size and shape of epidermal cells of the seed coat, but they represent the same structural type, which is clearly dissimilar from that of the other European species of this genus.

Additional key words: SEM micrographs, seed sculpture, species identification

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Introduction

Erica carnea L. (winter heath) and *Erica erigena* R. Ross (Irish heath) are remarkably similar in their appearance and morphology (see Ross 1967). This close resemblance has been reflected in very confused nomenclature. Bentham (1839) regarded the Irish heath as a mere variety of *E. carnea* (*E. carnea â occidentalis* Benth.), while others have considered it as a subspecies [*E. carnea* subsp. *occidentalis* (Benth.) Lainz (Greuter et al. 1986)]. Most contemporary taxonomists consider them distinct species (Webb & Rix 1972, Bayer 1993, Stace 1997). However, following investigation of DNA sequences, McGuire & Kron (2005) have stated that *E. carnea* and *E. erigena* are not closely allied: "...there is very low support (55% bootstrap) for the *Erica carnea-erigena* clade of European taxa" (McGuire & Kron 2005).

Erica carnea (syn. *E. herbacea* L.) is a dwarf shrub with ascending shoots. In cultivation in western Europe, this species flowers in winter or early spring. Its flower buds start to develop as early as 9 months before flowering (Hansen 1950). The natural range of *E. carnea* includes mountains of central and southern Europe. In vertical zonation, it reaches up to the alpine zone (maximum altitude 2600–2650 m). It is associated mostly with calcareous sites. In contrast, *E. erigena* [(syn. *E. mediterranea* auct. non L., *E. hibernica* (Hooker & Arnott) Syme] is an erect shrub that can reach over 2 m in height. Like *E. carnea* it blooms in winter an early spring. The Irish heath occurs naturally in the western Europe, in widely scattered localities in western Ireland, south-western France and Spain (see: Foss & Doyle 1988), mostly in moist habitats.

The genus *Erica* is an unusually large and varied taxon containing approximately 850 species (Oliver 2000), of which only about 20 occur in Europe. The seeds show great diversity, although several distinct morphological types can be distinguished (Oliver 1991, Szkudlarz 2006). Thus, morphological and anatomical investigations of seeds may provide valuable data of taxonomic significance that may assist in determining whether these two species are closely al-

lied, if not actually conspecific, or whether they are not closely related (as suggested by McGuire & Kron's work on DNA) despite their remarkably similar appearances.

The morphology of the seeds of *Erica carnea* and *E. erigena* has been described in detail by Fagundez & Izco (2003); clear differences between the taxa were indicated. Hall (2006) and Nelson (2006) summarized published data of dimensions of seeds of European *Erica* species. In the present study, additional anatomical data were obtained.

Material and methods

The material was obtained from the Carrowmore, Co. Mayo, Ireland and from Botanical Garden and Herbarium Adam Mickiewicz University of Poznań (Table 1). Each sample consisted of 30 ripe seeds. For the anatomical analysis, dry seeds were soaked in 75% alcohol for one day and transverse sections of the central part of the seed were made by hand. The sections were mounted on glass slides and observed under a light microscope (LM). The morphological structure was analysed on the basis of observations of dry seeds, with the use of a stereomicroscope and a scanning electron microscope (SEM). The samples for SEM observations were sputtered with gold. All measurements, both of anatomical and morphological structures, were made by using software for digital analysis of LM and SEM images (Lucia Screen Measurement, Nikon UK Ltd.). The analysis involved the morphological features recognized as taxonomically important, such as: length and width of seeds, shape of seed coat, microsculputre, character of cell boundaries in seed coat (Huckerby et al. 1972, Barthlott 1981,) and additionally, the anatomical ones: thickness of inner periclinal walls, height of anticlinal walls and shape of cells (in the transverse section).

Table 1. Data of studied populations (BG – Botanical Garden of A. Mickiewicz University, POZ – Herbarium of A. Mickiewicz University)

Species	Locality	Collector
Erica carnea (1)	BG Poland	
Erica carnea (2)	Alpen, near Aldino, Italy	M. Schenk, POZ Poland
Erica erigena (3)	Carrowmore, Ireland	Ch. Nelson, 7.2004

Results

Erica carnea – seed ellipsoid to ovoid, length 1.12 mm (1.0–1.3 mm), width 0.6 mm (0.53–0.72 mm) (Table 2); hilum on the seed tip; sculpture reticulate (or alveolar-reticulate) (Figs. 1, 9). Because of curvature of outer periclinal walls, the cell outline is oval (Fig. 2), but in fact, considering the position of anticlinal walls, the cells are polyhedral (penta- to heptagonal in surface view) (Fig. 6), in the central part isodiametric or slightly elongated (up to 2 times longer than wide), only along the funiculus more elongated, isodiametric near the ends of the seed (Fig. 1). Anticlinal walls straight. Cell boundaries channelled (furrow-like). Periclinal walls elevated at the junctions with anticlinal walls, with a sunken central part (Fig. 5). Microsculpture of periclinal walls smooth (Fig. 2).

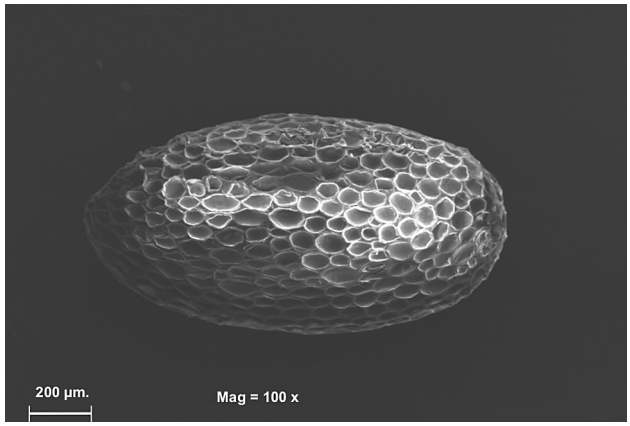

Fig. 1. *Erica carnea*, seed (SEM)

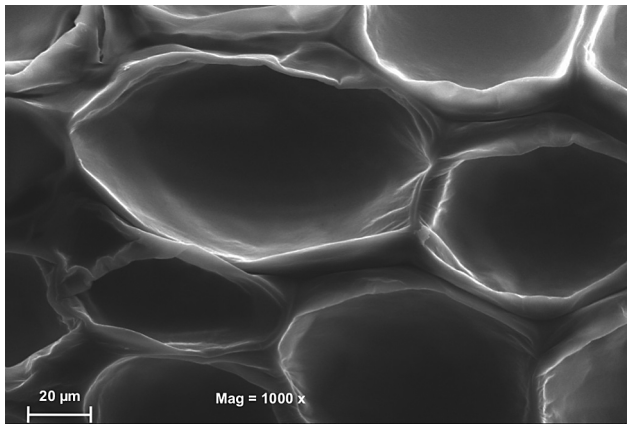

Fig. 2. *Erica carnea*, surface of seed coat (SEM)

Table 2. The main statistics of the studied samples: range of seed length and width (min-max), arithmetic means (x), standard deviations (SD) and variability coefficient (V)

	Lenght (mm)				Width (mm)			
	min–max	x	SD	V%	min–max	x	SD	V%
E. carnea (1)	1.01–1.31	1.149	0.0592	5.15	0.53–0.67	0.596	0.0461	7.74
E. carnea (2)	0.98–1.13	1.06	0.0550	5.18	0.58–0.73	0.67	0.0518	7.93
E. erigena (3)	0.81–1.09	0.93	0.0615	6.65	0.47–0.64	0.54	0.0337	6.22

Cells of the seed coat are U-shaped in cross section, as their inner periclinal and anticlinal walls are evenly, strongly thickened, up to 12–15 μm thick; the walls have numerous pores, anticlinal walls ca. 40 μm high (Fig. 5)

Erica erigena – seeds ellipsoid in outline but with blunt ends, length 0.93 mm (0.81–1.09 mm), width 0.54 mm (0.47–0.64 mm) (Table 2); hilum on the seed tip; sculpture reticulate (or alveolar-reticulate) (Figs. 3, 10). Cells of the seed coat polyhedral (penta- to heptagonal in surface view) (Fig. 8), elongated (1.5 to 3 times longer than wide), isodiametric at the chalazal end (Fig. 3). Anticlinal walls straight. Cell boundaries channelled (furrow-like). Periclinal walls elevated at the junctions with anticlinal walls, with a

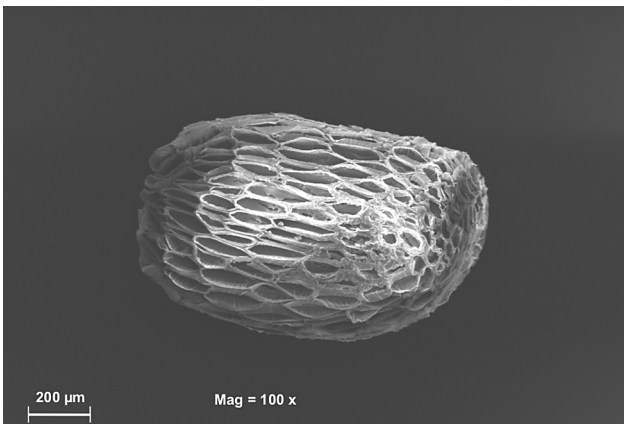

Fig. 3. *Erica erigena*, seed (SEM)

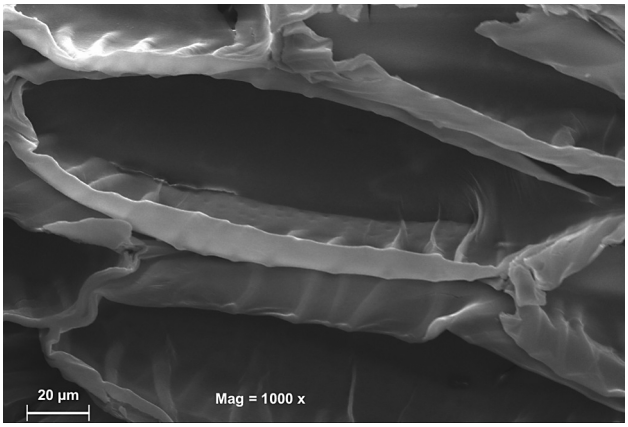

Fig. 4. *Erica erigena*, surface of seed coat (SEM)

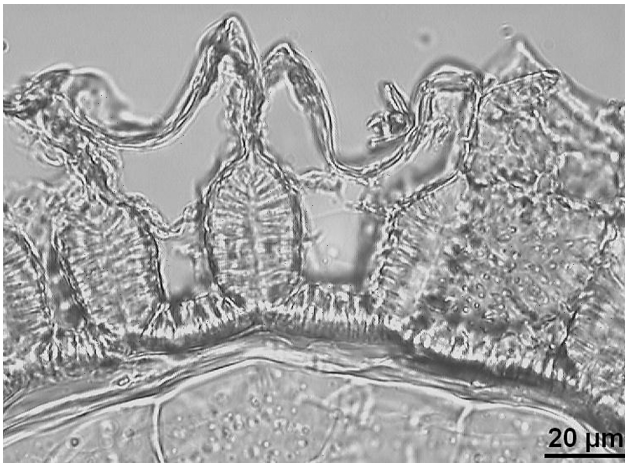

Fig. 5. *Erica carnea*, seed coat cross section (LM), scale bar 20 μm

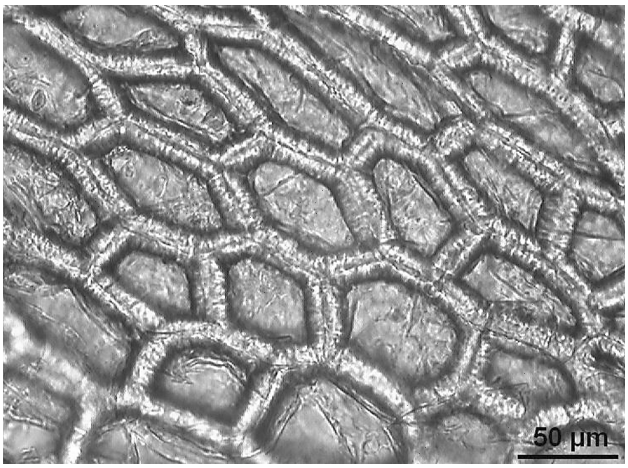

Fig. 6. *Erica carnea*, seed coat surface view (LM), scale bar 50 μm

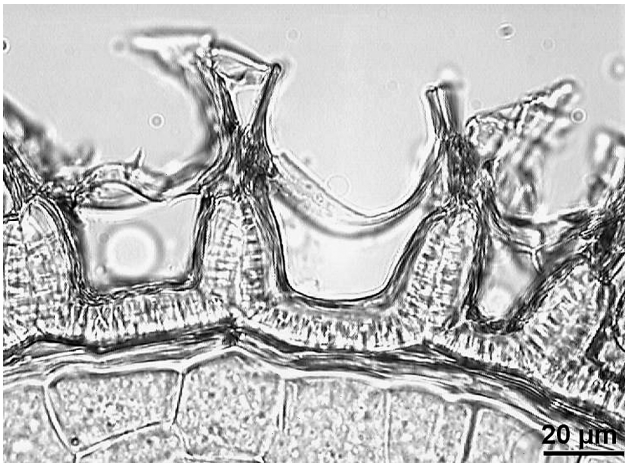

Fig. 7. *Erica erigena*, seed coat cross section (LM), scale bar 20 μm

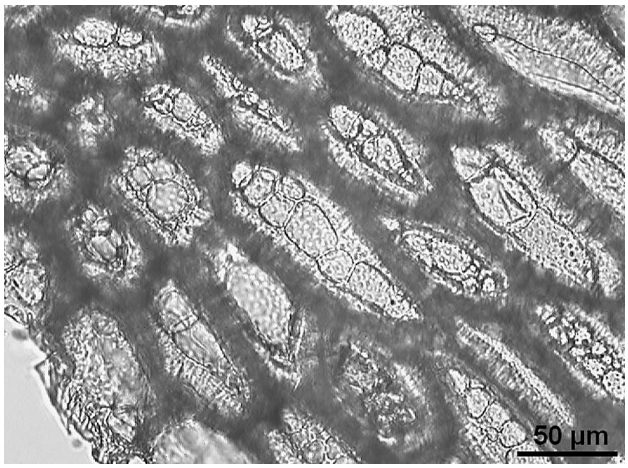

Fig. 8. *Erica erigena*, seed coat surface view (LM), scale bar 20 μm

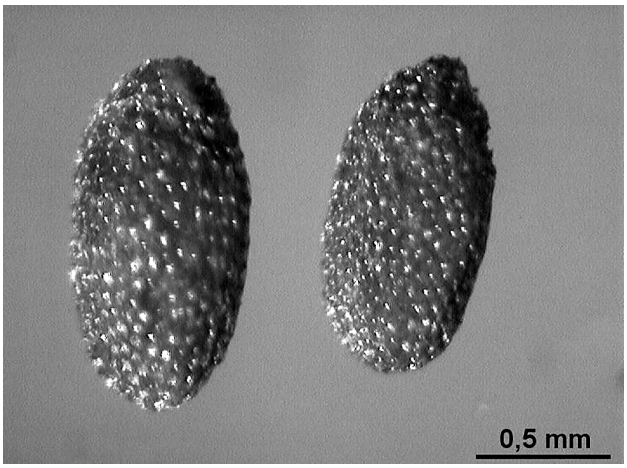

Fig. 9. *Erica carnea*, seeds (LM), scale bar 0.5 mm

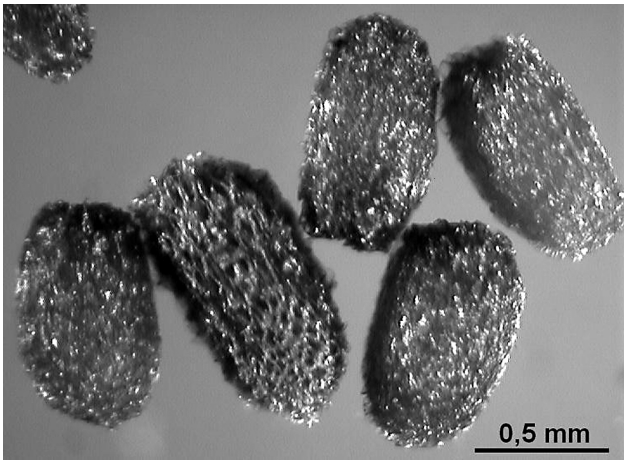

Fig. 10. *Erica erigena*, seeds (LM), scale bar 0.5 mm

sunken central part (Fig. 7). Microsculpture of periclinal walls smooth, with single, irregularly distributed folds. They are visible on the sunken periclinal walls, running from the upper cell edge downwards (Fig. 4). These folds are ridge-like thickenings of epidermal cell walls (Fig. 8). They are clearly visible under a light microscope as rings within a cell. Cells of the seed coat are U-shaped in cross section, as their inner periclinal and anticlinal walls are evenly thickened. Inner periclinal walls 6–7 μm thick, both these and anticlinal walls have numerous pores, anticlinal walls ca. 40 μm high.

Discussion

Seeds of *Erica carnea* and *E. erigena* differ slightly one from each other in their size (length) and shape (cf Nelson 2006) and in the shape of epidermal cells of the testa. Anatomical observations provide further differences regarding the characteristic thickening of the outer epidermal walls of testa in *E. erigena*. In SEM picture they are visible as folds or ribs and in LM picture as rings within a cell. These observations are consistent with earlier opinions (Fagundez & Izco 2003) that seeds of those two species can be distinguished morphologically. The morphological differences were confirmed by differences in anatomical structure. Despite the differences, these species have a similar morphological seed type, and their seeds differ from the other European taxa. These differences concern various elements of sculpture. *Erica carnea* and *E. erigena* have an alveolar-reticulated seeds, while in others species are reticulated, delicately reticulated with caruncle or pitted-reticulated (Fraga 1984, Fagundez & Izco 2003, Fagundez & Izco 2004a, Fagundez & Izco 2004b). However, the results of the studies on these two species, or even the comparative analysis of the selected European taxons are not a sufficient base for giving opinion on infrageneric taxa (sections and subgenera), considering the size of the genus.

Taking into account a high morphological similarity between *E. carnea* and *E. erigena*, as well as of their particular organs, including seeds, the picture of the taxonomical relationship between them revealed by the DNA analysis (McGuire & Kron 2005) seems very interesting but, at the same time, unexpected. The results of molecular studies show that both taxons are relatively distant, more closely related to other European species than one to each other. This outcome is surprising and difficult to accept. To address it fully would require conducting further morphological analysis of the lager group of species.

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