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SEED MORPHOLOGY OF *CALLUNA* SALISB. (ERICACEAE)

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ABSTRACT. *Seed morphology of Calluna Salisb. (Ericaceae).* Seed morphology of *Calluna vulgaris* (L.) Hull, the only species of *Calluna* Salisb. (*Ericaceae*), was studied. Seeds were collected and stored under cold and dry conditions. SEM pictures were taken for whole seeds and details. Measures were made for different quantitative characters. A complete description is given. Seeds are tiny (0.55-0.65 mm), ellipsoid and with a reticulated pattern for testa sculpture, with the hilum region transformed into a pore. This character clearly distinguish *Calluna* seeds from those of *Erica*.

Keywords. Testa sculpture, *Calluna vulgaris*, SEM pictures

RESUMEN. *Morfología de semillas de Calluna Salisb. (Ericaceae).* Se estudia la morfología de las semillas de *Calluna vulgaris* (L.) Hull, única especie de *Calluna* Salisb. (*Ericaceae*). Las semillas se recolectaron y almacenaron en condiciones de baja humedad y temperatura. Se realizaron fotos de microscopía electrónica de semillas completas y de detalle. Se realizaron medidas de diferentes caracteres cuantitativos . Se realiza una descripción completa. Las semillas son pequeñas (0.55-0.65 mm), elipsoidales y con una ornamentación de la testa reticulada. La región hilar se transforma en un poro, carácter que diferencia a *Calluna* del género próximo *Erica*.

Palabras clave: Ornamentación de la testa, *Calluna vulgaris*, fotografías de microscopía electrónica

INTRODUCTION

Calluna vulgaris (L.) Hull is a low shrub that occurs in different types of shrublands of holartic and western mediterranean Europe and NW Africa (fig. 1). It was originally described as part of *Erica* by Linnaeus (1753) (*E. vulgaris* L.) but many distinct characters led to its differentiation into a monospecific genus. *Calluna* has petaloid calyx exceeding the corolla and imbricate, decussated leaves.

Calluna is included in the subfamily *Ericoideae*, and was placed in a separated tribe, *Calluneae*, from the rest of the *Ericoideae* by Stevens (1971), based on leaves and calyx characters, but also on its distinct pitted areas on the anticlinal walls of the testa cells of the seed. Later, Anderberg (1993) and Kron *et al.* (2002) considered that *Calluna* should be included in the tribe *Ericeae* because it forms a monophyletic group with *Erica* and the other genus of this tribe.

Seed morphology has not been commonly used in systematics in the *Ericaceae*, except for some works in *Vaccinium* (Vander Kloet, 1983), *Monotropa* (Olson, 1980), subfamily *Pyroloideae* (Takahashi, 1993) or *Erica* (Fraga, 1984). In

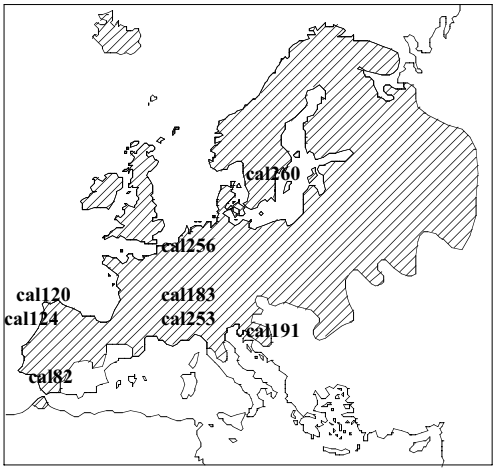

Figure 1. Distribution of *Calluna vulgaris* (L.) Hull. Location of populations studied**.** *Distribución de Calluna vulgaris (L.) Hull. Localización de las poblaciones estudiadas.*

other cases, some seed characters have been included in general systematic studies (Stevens, 1971; Anderberg, 1993; Judd & Kron, 1993; Oliver, 2000; Kron, *et al.,* 2002). Peltrisot (1904a, 1904b, 1904c) studied the anatomy and development of the seeds of *Ericaceae*, and Huckerby *et al.* (1972) and Wilson *et al.* (1973) studied seeds of *Erica*, *Calluna* and *Bruckenthalia* for fossil material identification.

Calluna was included in many of these works, and seeds have been used in many other studies mostly germination (Pons, 1989) or regeneration of heathlands (Granström, 1987; Barclay-Estrup & Gimingham, 1994).

Recently, seed morphology has been used to solve some systematic problems in genus *Erica* (Fagúndez & Izco, 2003a, 2003b). Seed characters have proved to be of a high systematic importance, and should be considered in any general study.

The aim of this study is to give a complete description of the seeds of *Calluna* including infraspecific variation, and consider the main differences with related genus, mostly *Erica*.

MATERIALS AND METHODS

Seeds were either collected in the field or sent from different seedbanks (tab. 1). 8 populations were studied, covering the whole geographical range of the species (fig. 1). Varieties or forms were not contemplated. Collected seeds were stored under cold and dry conditions following the procedures of the University of Santiago de Compostela Seedbank (Fagúndez, 2001).

Population	***Locality***	***From***
cal82	SPAIN: Huelva, Andévalo	J. Fagœndez & D. Reyes, 8-99
cal120	SPAIN: Coruña, Carnota	J. Fagœndez & R. Iglesias, 11-99
cal124	SPAIN: Coruña, Teo	J. Fagœndez & A. Aguilar, 9-98
cal183	GERMANY	Botanischer Garten Univ. Göttingen
cal191	SLOVENIA	Hortus botanicus univ. Ljubljana
cal253	GERMANY: Tirol	L. Donaire, 8-00
cal256	BELGIUM: Namur	B. Pías, 9-01
cal260	SWEEDEN: Uppland, Nibble	G. Berggren 10-64 (A-L Anderberg, Sweedish museum of N. History)

Table 1. Data of studied populations. *Poblaciones estudiadas.*

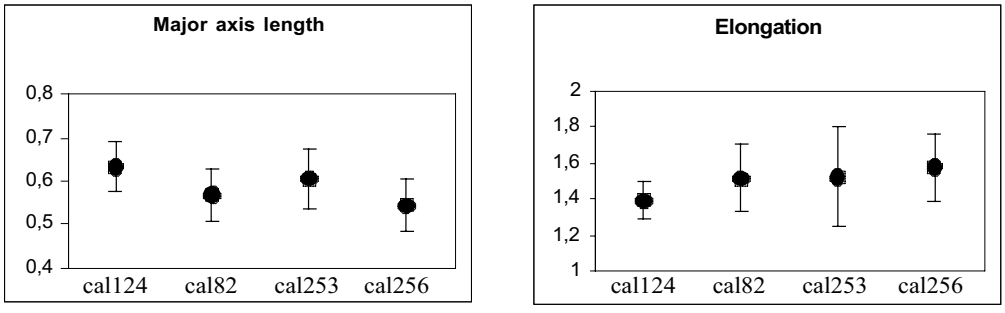

Figure 2. Representation of mean ± standard deviation of major axis length (mm) and elongation of seeds for the studied populations. *Media ± desviación típica de eje mayor (mm) y elongación de las semillas de las poblaciones estudiadas.*

Seeds of 4 populations were measured using a video-camera connected to a binocular scope. Images were treated by means of UTHSCSA Image tool software (San Antonio, Texas 1997). Area (a), perimeter (p), major axis length, minor axis length, elongation (Main axis/minor axis) and sinuosity (4π ¿a / p^2) were measured for each seed, mean and standard deviation were calculated for each population.

Seed weight was calculated for 100 seeds. A Munsell colour chart was used for colour determination.

For SEM pictures, 5-10 dry seeds from 2 populations were mounted on metal stubs using double-stick tape and gold-coated. Pictures of whole seed and detail were taken from three seeds of each population.

Nomenclature used for description purposes is that of Berggren (1981) and Barthlott (1981, 1984).

RESULTS

Seed description

Calluna vulgaris (L.) Hull. Seeds yellowish red. Weight around 0.025 mg. Seeds mostly ellipsoid or broadly ellipsoid in outline, sometimes oblong, oval or circular. Circular or slightly elliptic in shape. 0.55-0.65 mm long, 0.35-0.45 mm wide. Axis ratio 3:2. Without appendages. Terminal hilum, constituted by a pore of diameter 0.1-0.3 mm with a deep cavity surrounded by the seed coat and a fleshy irregular tissue at the bottom. Seed surface alveolated-reticulated, with 6-7 cells in main axis.

population	*N*	*Area*	*Perimeter*	*Major axis*	*Minor axis*	*Elongation*	*Sinuosity*
cal124	12	0,22 ± 0,05	2,48 ± 0,28	0,63 ± 0,06	0,46 ± 0,05	1,39 ± 0,10	0,44 ± 0,03
cal82	26	0,16 ± 0,03	1,79 ± 0,21	0,56 ± 0,06	0,38 ± 0,04	1,50 ± 0,19	0,65 ± 0,07
cal253	15	0,19 ± 0,04	2,01 ± 0,18	0,60 ± 0,07	0,41 ± 0,06	1,51 ± 0,27	0,57 ± 0,04
cal256	29	0,15 ± 0,03	1,79 ± 0,17	0,54 ± 0,06	0,35 ± 0,04	1,57 ± 0,19	0,57 ± 0,04

Table 2. Mean ± standard deviation of seed characters. All values in mm except for area (mm^2), elongation and sinuosity. *Media ± desviación típica de los caracteres seminales. Todos los valores en mm excepto area (mm^2), elogación y sinuosidad.*

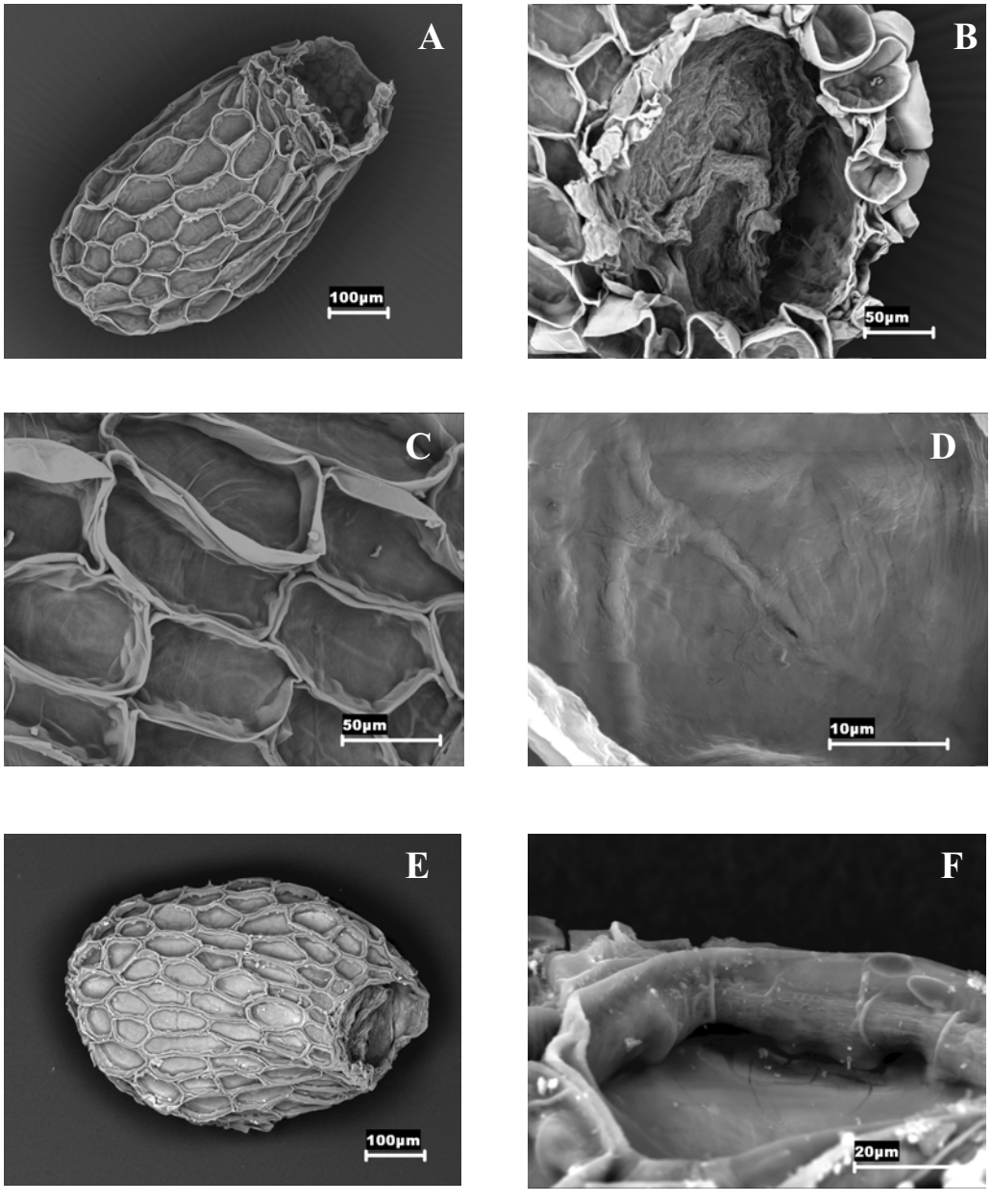

Figure 3. A: cal120. Whole seed; B: cal120. Pore of the hilum region, with a fleshy structure surrounded by the testa; C: cal120. Surface cells of the seed; D: cal120. Outer periclinal wall; E: cal124. Whole seed; F: cal124. Outer anticlinal wall.

Surface cells irregularly polygonal, mostly hexagonal, with straight borders, in contact with (5) - 6 - (7) surrounding cells. Cells of 0.1-0.05 x 0.05, isodiametric or elongated with axis ratio up to 2:1. Outer anticlinal walls thin, 0.02 mm high, sometimes bending over the inside of the cell. Outer periclinal smooth or with an irregularly branched secondary ornamentation. Cell boundaries always channelled.

Variation at population level

Seed characters, in terms of size (major axis length) and shape (elongation), are similar for the studied populations (tab. 2, fig. 2). Numerical values overlap for most variables (fig. 2). No differences were also observed for shape of testa cells, testa sculpture, hilum structure or boundaries of testa cells. No relation is stablished between populations in terms of geographical distribution.

DISCUSSION

The presence of a pore interrupting the seed coat is exclusive of

Calluna within the *Ericoideae*. This comes from the micropilar cavity, where the endosperm forms the micropilar haustoria observed in many other *Ericaceae* (Peltrisot, 1904a; Stevens, 1971; Olson, 1980; Anderberg, 1993; Judd & Kron, 1993), but only in *Calluna* stands out of the seed and separates from the seed in later stages of maturity, leaving this pore (Peltrisot, 1904b). *Erica* seeds present a terminal or subterminal hilum that is a scar from the funiculum.

As for testa sculpture, ornamentation of *Calluna* is similar to some species of *Erica* like *E. erigena* R. Ross (Fagúndez & Izco, 2003a) that has thin outer anticlinal walls, and irisated shades that might be due to the presence of epicuticular waxes (Barthlott, 1981).

Peltrisot (1904b) and Stevens (1971) mention pitted areas in anticlinal and outer periclinal walls, that we have not observed (see SEM pictures D, F).

Our data mostly agree with those of Fraga (1983), Huckerby *et al.* (1972) and Villar (1993), with similar values for size and shape of seeds and ornamentation description.

Brisson & Peterson (1977) and Wyatt (1984) claim for a cautious approach in the employ of SEM in the study of seed morphology. They point out that a good infraspecific representation is needed for taking conclusions, mostly if a taxonomic innovation is presented. In this case, no significant differences are found among studied populations and the description presented contemplates the whole infraspecific variation.

In our opinion seed characters have systematic importance and should be considered in general studies in this family. *Calluna* seeds have differences from other *Ericoideae* in seed morphology result of a distinct seed development, the most important is the presence of a pore in the hilum region which clearly distinguish *Calluna* from *Erica*.

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