POLLEN MORPHOLOGY OF THE GALAPAGOS ENDEMIC GENUS SCALESIA (ASTERACEAE)

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SUMMARY

Pollen grains from herbarium specimens of 22 taxa of the genus \textit{Scalesia} Arn. (Asteraceae, Heliantheae) were examined by scanning electron and light microscopy. \textit{Scalesia} present trizonocolporate, isopolar, radiosymmetric pollen grains, which are medium sized, oblate-spheroidal to prolate-spheroidal, circular in polar view and from circular to slightly elliptic in equatorial view. The exine is thick (c. 5–7 µm), with long, acute, conical echinae to 10 µm as supratectal elements.

RESUMEN

Morfología del polen de \textit{Scalesia} (Asteraceae), género endémico de Galápagos. Se examinaron granos de polen tomados de muestras de herbario de 22 taxa pertenecientes al género \textit{Scalesia} Arn. (Asteraceae, Heliantheae), con el microcopio óptico y el microscopio electrónico de barrido. \textit{Scalesia} presenta granos de polen trizonocolporados, isopolares y radiosimétricos. Son de tamaño medio, de oblado-esferoidales a prolado-esferoidales, de contorno circular en vista polar y de circular a ligeramente elípticos en vista ecuatorial. La exina es gruesa (c. 5–7 µm), presentando espinas cónicas y agudas de hasta 10 µm de largo como elementos supratectales.

INTRODUCTION

Galapagos is a large and complex archipelago of volcanic islands located on the equator, c. 800–1000 km west of the S American coast of Ecuador. They include over 120 islands, islets and rocks that bear terrestrial vegetation. There are about 500 native plant species in the islands, with c. 260 endemic taxa (including infraspecies). In the Asteraceae there are 20 autochthonous genera in Galapagos (Eliasson 1974), four of them, \textit{Darwiniothamnus}, \textit{Lecocarpus}, \textit{Macraea} and \textit{Scalesia}, endemic to the islands (Wiggins & Porter 1971, Eliasson 1974, 1984, Adsersen 1980, Lawesson & Adsersen 1987).

\textit{Scalesia} Arn. (Heliantheae, subtribe Verbesininae) is the largest and most diverse of the four and is present on most of the larger islands where the different species show allopatric distributions (Wiggins & Porter 1971) (Fig. 1). The genus comprises 15 species and 20 taxa including subspecies and varieties (Eliasson 1974), twelve of which are shrubs and three are trees. Some are rare and endangered (Tye 2000 and in press). In general, the habit of the genus is heliophilous and pioneer, growing at all altitudes from sea level to 1700 m, from the lowest semi-arid to the highest humid zones of the islands.

MATERIAL AND METHODS

We used pollen obtained from plant specimens deposited in the Charles Darwin Research Station Herbarium (CDS), Galapagos, Ecuador. The pollen grains were acetylated following the method of Erdtman (1960) and Kearns & Inouye (1993), mounted in glycerine jelly for light microscopy (LM). For scanning electron microscopy (SEM) the pollen after being acetylated was mounted on cover slips previously attached to aluminium stubs with silver paint, then coated with evaporated gold by ion sputtering and examined with a JEOL JSM 840 microscope. Measurements were made with the light microscope on a minimum of 25 pollen grains per sample (see Appendix for list of samples). The light-microscope slides (four duplicates) were de-posited in the pollen collection at CDS and the Department of Plant Biology of the University of Malaga, Spain (MGC). The terminology used for descriptions follows Punt \textit{et al}. (1994).

\textit{Scalesiapeddunculata var. parvisflora} was excluded because the taxon is of dubious value and the sample was poor with few pollen grains in equatorial view; nevertheless, the measurements obtained were included with those of var. \textit{pedunculata}.

RESULTS

\textit{Scalesia} is a stenopalynous genus (Fig. 2) with little variation between species, these differences being mainly in size.

Pollen type is trizonocolporate, isopolar and radiosymmetric. Shape is more or less circular in polar view, with the colpi slightly intruding, from circular to slightly elliptical in equatorial view. Polar axis (P) = 21–32 µm; equatorial axis (E) = 21.5–32 µm, excluding echinae. P/E
Figure 1. Distribution of the different species of Scalesia.

**DISCUSSION**

*Scalesia* is not well studied from a palynological point of view; in fact there are few such studies of the subtribe Verbesininae. The only study of *Scalesia* pollen morphology is that by Takahashi (1990), in which two species, *S. affinis* and *S. baurii* were studied. The present paper is the first in which all the species and infraspecific taxa of this genus are studied.

Heliantheae is a stenopalynous taxon whose pollen grains present a characteristic exine morphology called “helianthoid type” by Stix (1960). The structural pattern consisting of caveate exine with internal foramina was called “helianthoid pattern” by Skvarla & Turner (1966). These characteristics are shared with other tribes of Asteraceae such as Eupatorieae, Astereae, Helenieae, Calenduleae, Inuleae and Senecioneae and less so in Anthemideae (Skvarla et al. 1977).

The pollen morphology of *Scalesia* does not differ from that described for other genera of the tribe, and few differences can be observed between the species of *Scalesia* regarding pollen size, spine length and density, and the foramina situated at the spine bases. These features can vary within a species, such that the measurements of the different taxa overlap (Fig. 3) and pollen morphology is not useful for the taxonomy of the group. Nevertheless, some differences can be observed. The pollen grains of *S. microcephala* ssp. *microcephala* together with those of *S. helleri* ssp. *helleri* and *S. cordata* were smaller, and the grains of *S. incisa*, *S. atractyloides* var. *darwinii*, *S. aspera* and *S. divisa* bigger. Spine length is variable, the shortest being those of *S.
villosa (2.5–3.5 µm) and the longest in S. affinis, S. atractyloides var. darwinii, and S. incisa, with length up to 7.5 µm. Exine thickness is also variable, from 2.5 to 5.5 µm, the last value reached by S. gordilloi. We found little difference in number and arrangement of spine base foramina using SEM, but these can vary from grain to grain even in the same sample. Transmission electron microscopy might reveal further differences.

Table 1. Morphometrical analysis of Scalesia taxa pollen. P = polar axis. E = equatorial axis. All values in µm.

<table>
<thead>
<tr>
<th>Taxon</th>
<th>P</th>
<th>E</th>
<th>P/E</th>
<th>Spines</th>
<th>Exine</th>
</tr>
</thead>
<tbody>
<tr>
<td>S. affinis Hook. f.</td>
<td>25.5–27.5</td>
<td>24.5–27.5</td>
<td>1–1.03</td>
<td>5.5–7.5</td>
<td>3–4</td>
</tr>
<tr>
<td>S. aspera Andersson</td>
<td>28–32</td>
<td>27–32</td>
<td>1–1.03</td>
<td>4–6.5</td>
<td>3.5–4.5</td>
</tr>
<tr>
<td>S. atractyloides atractyloides Arn.</td>
<td>22.5–26.5</td>
<td>23–26.5</td>
<td>0.93–1</td>
<td>4.5–5.5</td>
<td>2.5–4</td>
</tr>
<tr>
<td>S. atractyloides darwinii (Hook. f.) Eliasson</td>
<td>28–31</td>
<td>28–31</td>
<td>1–1.03</td>
<td>5.5–7.5</td>
<td>3–3.5</td>
</tr>
<tr>
<td>S. bauri bauri B.L. Rob. &amp; Greenm.</td>
<td>25–26.5</td>
<td>24–25.5</td>
<td>0.98–1.03</td>
<td>4.5–6.5</td>
<td>2.5–3</td>
</tr>
<tr>
<td>S. bauri hopkinsii (B.L. Rob.) Eliasson</td>
<td>24–31.5</td>
<td>23–29.5</td>
<td>1.01–1.12</td>
<td>4.5–5</td>
<td>2.5–3</td>
</tr>
<tr>
<td>S. cordata A. Stewart</td>
<td>22.5–25</td>
<td>21.5–24.5</td>
<td>0.95–1.04</td>
<td>4.5–5.5</td>
<td>2.5–3</td>
</tr>
<tr>
<td>S. crockeri Howell</td>
<td>24–28</td>
<td>24–26.5</td>
<td>1–1.09</td>
<td>3–6</td>
<td>3–4</td>
</tr>
<tr>
<td>S. divisa Andersson</td>
<td>28.5–30.5</td>
<td>28.5–30.5</td>
<td>0.96–1.03</td>
<td>5–6.5</td>
<td>4–5</td>
</tr>
<tr>
<td>S. divisa/incisa hybrids</td>
<td>24.5–26.5</td>
<td>24.5–28</td>
<td>0.94–1</td>
<td>4–5</td>
<td>3–4</td>
</tr>
<tr>
<td>S. gordilloi O.J. Hamann &amp; Wium-And.</td>
<td>25.5–28</td>
<td>25.5–28.8</td>
<td>0.94–1</td>
<td>4</td>
<td>4.5–5.5</td>
</tr>
<tr>
<td>S. helleri helleri B.L. Rob.</td>
<td>21.5–23.5</td>
<td>23–25</td>
<td>0.90–0.96</td>
<td>4.5–5.5</td>
<td>3–3.5</td>
</tr>
<tr>
<td>S. helleri santacruziana Harling</td>
<td>23–28</td>
<td>24.5–27.5</td>
<td>0.95–1.06</td>
<td>4.5–6.5</td>
<td>2.5–3.5</td>
</tr>
<tr>
<td>S. incisa Hook. f.</td>
<td>27.5–29</td>
<td>29.5–31</td>
<td>0.92–0.97</td>
<td>5–6</td>
<td>4</td>
</tr>
<tr>
<td>S. microcephala microcephala B.L. Rob.</td>
<td>21–25.5</td>
<td>21.5–25.5</td>
<td>0.94–1</td>
<td>4–7.5</td>
<td>2–4</td>
</tr>
<tr>
<td>S. microcephala cordifolia Eliasson</td>
<td>23.5–25.5</td>
<td>23–26.5</td>
<td>0.97–1.05</td>
<td>5.5–6.5</td>
<td>3–3.5</td>
</tr>
<tr>
<td>S. pedunculata Hook. f.</td>
<td>23–28</td>
<td>24–28</td>
<td>0.94–1</td>
<td>4.5–5.5</td>
<td>2.5–4</td>
</tr>
<tr>
<td>S. retroflexa Hemsl.</td>
<td>22.5–26</td>
<td>21.5–26</td>
<td>0.97–1.04</td>
<td>5–6.5</td>
<td>3–3.5</td>
</tr>
<tr>
<td>S. steartii Riley</td>
<td>25–27.5</td>
<td>25.5–27</td>
<td>0.98–1.03</td>
<td>4.5–6</td>
<td>3–3.5</td>
</tr>
<tr>
<td>S. villosa A. Stewart</td>
<td>23–26</td>
<td>22.5–26</td>
<td>0.94–1.11</td>
<td>2.5–3.5</td>
<td>3</td>
</tr>
</tbody>
</table>

Figure 3. Measurements of the polar axis of Scalesia taxa (mean, with bars from minimum to maximum value) in order of minimum polar axis value.
Our results for *S. affinis* and *S. baurii* (sspp. bauri and hopkinsii) mostly coincide with those reported by Takahashi (1990) except that the size values given by this author for *S. affinis* from Floreana Island (P = 39 µm, E = 39–43 µm) are higher than those obtained by us for specimens from Fernandina and Isabela (P = 25.5–27.5 µm; E = 24.5–27.5 µm). These two populations have been separated as sspp. *affinis* and *gunnifera* respectively. Takahashi (1990) reported some bent spines in this species; bent spines are common in *Scalesia* pollen, even coexisting with straight spines in the same sample or in the same pollen grain.

**ACKNOWLEDGMENTS**

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**LITERATURE CITED**


**APPENDIX: SPECIMENS EXAMINED**

*S. affinis*. Isabela, Volcán Sierra Negra, Camino al Muro de las Lágrimas, Jaramillo & Guerereo, 21 Nov 1999 (CDS 9813); Fernandina, NE Cape Hammond, Adsersen, 17 Jun 1974 (CDS 1391).

*S. aspera*. Eden, Jaramillo & Coroneo, 9 Nov 1999 (CDS 9666); Eden, Huttel, 19 May 1992 (CDS 7483).

*S. atractyloides* atractyloides. Santiago, Cabo Nepean, Jaramillo & Ramírez, 4 Jan 2001 (CDS 11587).


*S. b. hopkinsii*. Pinta, McMullen, 2 Jul 1990 (CDS 7055); Wolf Island, Harris, 22 Feb 1971 (CDS 1031).


*S. crockeri*. Santa Cruz, Cerro Colorado, Adsersen, 17 Jan 1998 (CDS 8934); Santa Cruz, Cerro Barranco del Cano de Itabaca, Huttel, 29 Oct 1984 (CDS 4336).

*S. divisa*. San Cristóbal, west side of Sappho Cove, Jäger & Tye, 6 Jun 2002 (CDS 13913).

*S. divisa/incerisa* hybrids. San Cristóbal, entre Punto Pitt y Bahía Rosa Blanca, Tye & Jaramillo, 14 Apr 1999 (CDS 9474); San Cristóbal, entre Punta Pitt y Bahía Rosa Blanca, Tye & Jaramillo, 14 Apr 1999 (CDS 9472).

*S. gordonii*. San Cristóbal, La Loberia, Hagemann, 15 Mar 1994 (CDS 6252); San Cristóbal, Camino a las Negritas, Jaramillo, 1 Apr 2002 (CDS 13006).

*S. helleri helleri*. Santa Fe, Barranco, Adsersen, 17 Jan 1998 (CDS 8931); Santa Cruz, Bahía Las Palmitas, Arisniegas, 28 Apr 1995 (CDS 6789).

*S. h. sanctacraziana*. Santa Cruz, Cerro Gallina, Arisniegas, 7 Sep 2000 (CDS 6784).

*S. incisa*. San Cristóbal, Tye & Jaramillo, 12 Apr 1999 (CDS 9467); San Cristóbal, entre punta Pitt y Bahía Rosa Blanca, Simbaña, 1 Feb 2001 (CDS 11860).


*S. pedunculata*. Floreana, Cerro Pajas, Perry, 21 Nov 1966 (CDS 634); Floreana, Lawesson, 11 Feb 1986 (CDS 4824).

*S. p. pedunculata*. Santa Cruz, Los Gemelos, Jaramillo & Ramírez, 16 Apr 2001 (CDS 11731).


*S. retroflexa*. Santa Cruz, near Punta Núñez, Adsersen, 13 Jan 1998 (CDS 8968).
