



Morphology and anatomy of the exine in *Saxifraga* (Saxifragaceae)

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Abstract

Details of exine morphology (SEM studies of 132 species) and anatomy (TEM studies of 25 species) of *Saxifraga* are reported. The variation observed was compared with that found in an earlier survey. We suggest modifications to known types and subtypes and the addition of new ones, making a total of nine exine types and subtypes in *Saxifraga*. Taxonomic conclusions include the following. A novel exine type (Type 2.3), in which the single tectum has numerous microchannels, is a putative synapomorphy for sects. *Heterisia* and *Irregulares*. At least three species from sect. *Ciliatae*, viz., *S. lychnitis*, *S. oresbia* from ser. *Lychnitidae*, and *S. nigroglandulifera* from ser. *Nutantes*, have a novel type with a perforate-reticulate or perforate-rugulate tectum. Species from the rest of the section are uniformly finely striate. Section *Saxifraga* has Type 2.1, with a single tectum, Type 4.3, with a double tectum, and Type 2.2, which is intermediate to various extents. The origin of Types 2.1 and 2.2 from Type 4.3 is suggested. Within sect. *Saxifraga* subsect. *Triplinervium*, *S. wahlenbergii* is unique in possessing pollen with a secondary tectum (Type 4.3), resembling the exine of *S. androsaeca* in subsect. *Holophyllae*. On this and other grounds, we support the transference of *S. wahlenbergii* to the latter subsection. Himalayan species with opposite rather than alternate leaves that were formerly assigned to sect. *Porphyron* subsect. *Oppositifoliae*, have exines with supracteal ornamentation similar to that in subsect. *Kabschia*; in this respect they are unlike the European species with opposite leaves, which lack this ornamentation. Among the species with chalk-glands, exines lacking supracteal ornamentation are restricted to European species, viz. those in sect. *Porphyron* subsects. *Engleria* and *Oppositifoliae*, and *S. florulenta*, offering morphological support for the transfer of the latter species to sect. *Porphyron*. *Saxifragella* is recognised as a new section of the genus.

Key words: Exine, palynology, systematics, SEM, TEM, *Saxifragella*

Introduction

Saxifraga Linnaeus (1753: 398) is the largest genus (about 470 species in 15 sections) in the family Saxifragaceae sensu stricto, where it appears to be sister to the other ca. 30 genera, including *Micranthes* Haworth (1812: 320), a former section of *Saxifraga* (Soltis *et al.* 1996 2001). *Saxifraga* is distributed chiefly in the mountains of Europe and Asia, with a few species occupying a circum-polar distribution and some extending southwards in the Americas down the Rocky Mt-Andean cordillera to Tierra del Fuego.

Early studies of pollen morphology focused on Scandinavian taxa and revealed variation between species (Erdtman 1952, Faegri & Iverson 1964). A number of studies have examined very limited numbers of *Saxifraga* species as part of much wider taxonomic surveys of the Saxifragaceae sensu lato (Agababayan 1961, Pastre & Pons 1973, Wakabayashi 1970), but they came to no important conclusions about the infra-generic classification of *Saxifraga* itself. Moore (1969) used pollen morphology to support the separation of the genera *Saxifraga*, *Saxifragella* Engler (1891: 61) and *Saxifragodes* D.M. Moore (1969: 323).

The first systematic palynological survey of the genus was conducted by Ferguson & Webb (1970) who reported the results of an extensive study of 105 species, with an emphasis on European taxa and including 17 that are now placed in *Micranthes*. They recognised four main pollen types and a number of subtypes based chiefly on the morphology (particularly surface pattern) and anatomy of the exine, but also in part on grain shape and size. They concluded that, in most cases, the types and subtypes supported the infra-generic classification of Engler & Irmischer (1916/1919). Later,