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Seed morphology of the subfamily Helleboroideae (Ranunculaceae) and its systematic implication

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Running head: Seed morphology of Helleboroideae

Number of Table: 1

Number of figure: 12 (black and white, color only for online version)

Highlights

- Major seed surface types: striate, lineate, colliculate and irregularly wrinkled.
- The wall ornamentation was predominantly smooth.
- Mechanical layer of the seed coat was of the exotesta except in all *Eranthis*.
- A close relationship of*Caltha–Trollius–Megaleranthis*was convincingly supported.
- Another group supported strongly by this study was *Aconitum–Delphinium*.

A B S T R A C T

A comprehensive morphological and anatomical study was carried out on seeds of 28 species from three tribes and eight genera of subfamily Helleboroideae (*Aconitum, Actaea, Caltha, Cimicifuga, Delphinium, Eranthis, Megaleranthis* and *Trollius*) and two putatively related genera in Ranunculaceae (*Adonis* and *Ranunculus*) using scanning electron and light microscopy to evaluate seed characteristics for use in the examination of systematic relationships. Considerable differences were found in seed coat morphology and anatomy both among and within genera of the subfamily. There are four major types of seed coat surface: striate, lineate, colliculate and irregularly wrinkled. The shape of testal cells was either elongated rectangular, rectangular chiseled, irregular or polygonal to subpolygonal. The wall ornamentation was predominantly smooth and either without any ornamentation or having finely granulated or some ribbon like appendages. The mechanical layer of the seed coat was of the exotestal type except in all species of *Eranthis*, in which the seed coat mechanical layer was absent; such a seed coat was referred to as being an ‘undifferentiated seed-coat’. Maximum parsimony analysis of morphological features establishes three groupings within the studied genera: *Aconitum*/*Delphinium*, *Actaea*/*Cimicifuga*, and *Caltha*/*Eranthis/Trollius/Megaleranthis*. This study is congruent with the earlier groupings of the Helleboroideae based on morphology and also agrees in part with recent molecular studies. Our data convincingly support a close relationship between *Caltha – Trollius – Megaleranthis* and between *Actaea – Cimicifuga*. Another group supported strongly by the results of this study is *Aconitum – Delphinium*.

Keywords: Helleboroideae, Ranunculaceae, seed morphology, seed anatomy, systematics

Introduction