Seed Morphology in New World
Antirrhineae (Scrophulariaceae): Systematic and Phylogenetic Implications

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Abstract: Seeds of 39 species representing all native genera and sections of New World Antirrhineae were examined with the Scanning Electron Microscope and Light Microscope. Based on seed shape and surface ornamentation, seven morphological categories are recognized: cristate, tetracostate, foveolate, tumid tuberculate/cristate, circumalate, medusiform, and a miscellaneous category. Most sections and/or generic categories can be characterized by a single morphological type, although Maurandya s.l. has several distinctive seed types included within present generic boundaries. The cristate seed type is believed to be the "primitive type" from which the medusiform and tumid tuberculate/cristate types have developed. The tumid tuberculate/cristate type presumably gave rise to the circumalate, tetracostate, and foveolate patterns. The miscellaneous category (represented by Linaria and Kickxia) may be phyletically remote from the other New World types. Seeds of the New World Antirrhineae mostly seem to be adapted for water dispersal although some adaptations for wind dispersal (e.g. wings, light weight) are evident. Free-hand sections and seed coat clearings indicate that circumalate seeds are of two different anatomical patterns; such structural diversity may be found in the other seed types.

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A renewed interest in the systematic importance of seeds has characterized the recent botanical literature. Studies of seed morphology with the Scanning Electron Microscope (SEM) have revealed such taxonomically useful micro-characters as testal cell length (ARDITTI & al. 1980), shape (CANNE 1979), and ornamentation (CROW 1979), as well as the protrusion and the patterns of the radial walls (CAROLIN 1980). This information has aided the delimitation of taxa at various levels (e.g. WHIFFIN & TOMB 1972, NEWELL & HYMOWITZ 1978) and permitted the construction of putative evolutionary relationships (HILL 1976, SEAVEY & al. 1977).

The Scrophulariaceae have a wide variety of seed shapes, sizes, and testal patterns that offer much systematic and evolutionary information (THIERET 1955). As with seed morphology, there are also major differences in seed coat anatomy, particularly the construction of exotestal cells and the hypodermis (CORNER 1976). The taxonomic utility of these data within the family is illustrated by the use of seed characters in the delimitation of specific (e.g. PENNELL 1935), generic (DON 1827, STRAW 1966); sectional (MUNZ 1926, VIANO 1979), tribal (YAMAZAKI 1957, THIERET 1967), and even familial boundaries (CAMPBELL 1930). Relatively few comparative studies of scrophulariaceous seed morphology/anatomy have been undertaken, however. At the light microscope (LM) level, members of the Veroniceae have been surveyed by THIERET (1955) and YAMAZAKI (1957). More recently, the SEM has been particularly useful in the analysis of seed coat microsculpturing in Cordylanthus (CHUANG & HECKARD 1972), Agalinis (CANNE 1979, 1980), Linaria (VIANO 1979, SUTTON 1980), and hemi- and holoparasitic Scrophulariaceae and Orobanchaceae (MUSSELMANN & MANN 1976). The investigated seeds of Veronica, Cordylanthus, and Agalinis have a reticulate seed coat; they differ primarily in shape and size as well as pattern and ornamentation of the epidermal cells making up the reticulations. The Linaria seeds, however, are much more diverse and are characterized by irregular crests, ridges, and tuberdes.

Within the Antirrhineae, several authors have noted the variously angled, ridged, tuberculate, and winged seeds in their discussions and subtribal classifications. For example, CHAVANNES (1833) divided the seeds of the tribe into two principal types: a discoid (i.e. alate) form and a more variable angular or prismatic type. GRAY (1868) characterized the sections of Maurandya using seed characters and MUNZ (1926) used seed characters in his keys to species of Linaria, Antirrhinum, and Maurandya. Similarly, ROTHMALER (1943) separated Lophospermum and Epixiphium on the relative size of the seed wings.