

# Phylogeny and biogeography of the plant family Calceolariaceae

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Akademisk avhandling för filosofie doktorsexamen i biologi med inriktning mot systematik och biodiversitet, som enligt naturvetenskapliga fakultetens beslut kommer att offentligt försvaras måndagen den 20:e december 2010, klockan 09.00 i Hörsalen, Institutionen för Växt- och Miljövetenskaper, Carl Skottbergs gata 22B, 413 19 Göteborg. Examinator: Mari Källersjö. Fakultetsopponent: Prof. Khidir Hilu, Virginia Polytechnic Institute and State University, Biological Sciences (MC 0406), 2125 Derring Hal, Blacksburg, VA 24061, USA.

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## Dissertation Abstract

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*Calceolaria* L., *Jovellana* Ruiz & Pav., and *Porodittia* G. Don (= *Stemotria* Wettst. & Harms) together constitute the family Calceolariaceae consisting of approximately 300 species distributed mainly in South America. The present thesis shows that using morphology as basis for sectional delimitations in the genus *Calceolaria* is not sufficient to define monophyletic groups. Comparing information from nuclear versus chloroplast sequence data reveal extensive topological discordance, neither of which can easily be related to morphological features. The putative sister relationship between *Calceolaria* and *Jovellana* is confirmed, while the phylogenetic position of *Porodittia* is revealed to be nested deep inside *Calceolaria*.

For *Jovellana*, a small genus present disjunctly across the Pacific Ocean in South America and New Zealand, a taxonomic revision suggest synonymisation of two previously recognised species in New Zealand with a larger circumscribed *J. sinclairii* while the distributional disjunction is revealed as a result of long distance dispersal of recent date.

This thesis also explores the presumed close relationship between the origin of the Andes and the evolutionary distribution history of *Calceolaria*. Biogeographic models for reconstruction of ancestral areas are used to estimate the origin of the family. By extending the model to simultaneous estimation of ancestral area in three dimensions based in specimen data a correlation between the uplift history of the Andes and the radiation events of *Calceolaria* can be established. By optimising morphological traits relating to growth habit and pollination of the genus in a phylogenetic framework, and relating these to the ancestral area reconstruction and the uplift history of the Andes, a suggested radiation pattern for *Calceolaria* can be established. This pattern follow a south to north trend with an origin in lowland Chile or low Andean slopes, with subsequent radiations to the north correlated with the Altiplano region and the Huancabamba deflection. The pattern also show a correlation between the uplift history of the Andes and the radiation of *Calceolaria*. This further suggests that the divergence patterns of a group of species cannot be understood without extensive information on not only the phylogeny, but also the preferred ecological niches and other mechanisms important for radiation success.

**Keywords:** Calceolariaceae, *Calceolaria*, *Jovellana*, biogeography, BEAST, chloroplast DNA, Bayesian inference, phylogeny, continuous and discrete models, phylogeography, Andes

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