Phylogenetics of *Swertia* L. (Gentianaceae-Swertiinae) and Molecular Differentiation of *Swertia* Species in Nepalese Medicinal Herbs

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**Phylogenetics of Swertia L.**

- **Background**
  - *Swertia* L. (Gentianaceae) is a morphologically diverse genus especially in floral morphology and pistil gland shape and form (see photos).
  - **Diversity:** 150 species worldwide. 30 species in Nepal with one endemic. S. marmai (see Fig. 1).
  - **Distribution:** Cosmopolitan with its center of species diversity in the Sino-Himalayan region. *Swertia* species predominantly occur in the mountainous regions of the 54 districts in Nepal.

- **Materials and Methods**
  - 92 samples representing the major sections of *Swertia* and closely related genera were included in the study.
  - Nepalese species were collected from both wild habitats and local herbal markets.
  - Standard molecular techniques (PCR and DNA Sequencing) were used to obtain data from both nuclear ribosomal internal transcribed spacer (ITS) and chloroplast (trnL-F) regions.
  - Additional ITS and trnL-F sequence data was obtained from Genbank.
  - Distance, parsimony, and Bayesian analyses were used to reconstruct phylogenetic trees in PAUP* or MrBayes.

- **Results**

  - Molecular Differentiation
    - *Swertia* species in the Nepalese herbal market
  - Infragenetic sections
    - Ophalia
    - Heteranthus
    - Pterygocalyx
    - Obolaria
  - Swertiinae
    - Clade 1
      - *Megacodon stylophorus* Obolaria virginica
    - Clade 2
      - *Halenia brevicornis*
    - Clade 3
      - *S. macrospora* Obolaria virginica
    - Clade 4
      - *S. angustifolia*
    - Clade 5
      - *Ophelia*

- **Phylogeny**
  - Results from DNA ITS (Fig. 3a) are generally congruent with those of the chloroplast trnL-F sequence (Fig. 3b).
  - *Obolaria* and *Gentianella* are the closest genera to *Swertia,* which is paraphyletic including *Halenia, Ophelia, Gentianella,* and *Conopogon.* There are a few well-supported clades (Fig. 3b):
    - Clade 1.1: *Megacodon, Obolaria,* and *S. brevicornis.*
    - Clade 2.1: *Halenia,* *S. angustifolia,* and *S. calycina.*
    - Clade 3.1: *S. macrospora.*
    - Clade 4.1: *Obolaria,* *Gentianella,* and *S. angustifolia.*
    - Clade 5.1: *Ophelia*
  - Linear newArray

- **Fig. 1.** Geographical distribution of *Swertia* in Nepal

- **Fig. 2.** Sites in color showing species-specific nucleotides

- **Discussion**
  - *Swertia* species are the most important among Nepalese medicinal herbs.
  - The evolutionary relationships among the species within the genus has been debated (Chassot, 2000; Gilg,1895; Ho & Liu, 1990; Ho et al, 1994; Shah,1990, 1992; Strauss et al, 2002; von Hagen and Kadezek, 2001; Yuan and Kaplan, 1995).

- **Objectives**
  - To study the morphological variation and distribution pattern of the species within *Swertia* species in Nepal.
  - To test the monophyly of *Swertia* species and its sections.
  - To use DNA barcoding to identify the *Swertia* species used in Nepalese traditional medicine.

**References**


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