

Cataloguing phylogenetic diversity of *Selaginella* bioresources in India

Selaginella P. Beauv., a prehistoric plant, exists on the earth since 440 mya or the early Carboniferous period without significant morphological changes. It successfully continues to exist through natural selection and grows in all biome types (mostly humid and warm climatic regions), except Antarctica. Many of the *Selaginella* species are considered potent medicinal plants. It contains several phenolic compounds (flavonoids), alkaloids as well as terpenoids. Bi-flavonoids, the main bioactive compounds of *Selaginella*, have several medicinal properties, especially antioxidant, anti-cancer and anti-inflammatory^{1,2}. *Selaginella bryopteris*, commonly known as Sanjiwani, is a widely used herbal medicine in India³. Moreover, the plants possess certain unique characteristics to discourage herbivores, pests and pathogens as well as to optimize growth by efficiently capturing sunlight. *Selaginella* can grow in the most extreme habitats such as in the cold tundra and alpine, or in the desert; however most of the species grow in the tropical rainforest^{1,4}. The genus *Selaginella* includes more than 700 species worldwide, among which the Indian subcontinent consists of more than 60 species in wide habitat ranges from the Himalaya to the Western Ghats³.

The single genus *Selaginella* is subdivided into seven subgenera: *Selaginella*, *Rupestrae*, *Lepidophyllae*, *Gymnogynum*, *Exaltatae*, *Ericetorum* and *Stachygyndrum*⁴. From an evolutionary viewpoint, Zhou *et al.*⁵ reported six deep-level clades and 20 major evolutionary lineages of the genus *Selaginella* which differ from one another in eco-geographical distribution and molecular, and morphological features. The monophyly of *Selaginella* subgenus *Stachygyndrum* (with highest species diversity occurring in both the Old and New World, consists of about 600 species) is often debated and considered to be four major well-supported clades⁵. *Selaginella* subgenus *Stachygyndrum* is typically characterized by anisophyllous microphylls and is recently reported to possess highest chloroplast diversity⁶. Liu *et al.*⁶ delineated this group with several categories of chloroplast diversity, i.e. monoplastidy, oligoplastidy, multiplastidy and a special type of chloroplast structure called biozonoplast which adds potential value to their deep shade adaptation.

Since most of *Selaginella* naturally grows in humid and cool areas, which are more prone to natural degradation and global warming, it is necessary to examine the existing status of the species in different biodiversity zones of our continent in order to formulate conservation strategies for these biological resources. A series of extensive field surveys has been conducted by Indian researchers that pioneered the systematics of Indian *Selaginella*⁷. Among the Indian species of *Selaginella*, about 30 are reported to occur in Eastern Himalaya³. Historically, the Himalayan region is predated by the initial collision of the Indian plate (part of Gondwana) and the Eurasian plate (part of Laurasia) (approximate 55 mya)⁸, and therefore, mixing of floras between them is likely to have deep roots⁹. Moreover, climate change issues in recent years have significantly affected plant dispersal, speciation and extinction in the Himalaya¹⁰. The Western Ghats, another biodiversity hotspot rich in *Selaginella*, harbours almost 18 species as described in earlier reports^{11,12}.

Phylogenetic diversity is a promising measure of biodiversity sciences, leading to preserving the diversity with natural history¹³. Availability of marker loci sequences from the reported species aids the phylogenetic reconstruction process¹⁴. Phylogeny studies from wide sampling will facilitate obtaining detailed biodiversity information at the local scale and considering the transition across timescales. So, collective information of existing species focusing on their phylogenetic position in the era of combinatorial morpho-molecular approach is essential for enriching the Pteridophyte flora of India. With the advent of molecular markers, effective documentation and authentication of species from natural habitats is possible. With regard to existing *Selaginella* bioresources in India, this integrated framework would serve as an up-to-date biodiversity knowledge base with the following possible outcomes:

(i) Collective analyses with phenotypic, molecular, ecological and biogeographic data together will highlight the present diversity and phylogenetic history of *Selaginella* from their native range in tropical to sub-temperate forests.

- (ii) Documentation of regions with rich biodiversity along with their ecological circumference would lead to exploitation and conservation strategies of this potential bioresource.
- (iii) To meet the global agenda regarding biodiversity, conservation of phylogenetic diversity will contribute towards more efficient preservation of our evolutionary heritage.

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