Summary and Conclusions

CHAPTER - VII

The present investigation highlights 's***ystematics and molecular studies on the diversity of pteridophyte and gymnosperm of Gujarat***'.

Botanical snakes of the plants, the pteridophytes or vascular cryptogams are the early land-dwellers of the plant kingdom are known to adapt successfully on the land during the mid-Palaeozoic era in the Late Silurian and Devonian periods *i.e.*, *ca*. 438 million years ago (Chaloner & Sheerin 1979; Kenrick & Crane 1997). They succeeded so well in past and dominated the Earth's vegetation *ca*. 280 to 230 million years ago. Gymnosperms are the first seed plants to have evolved *ca*. about 382.7 million to 358.9 million years ago with enormous ecological and socio-economic value. Both the groups are cosmopolitan in distribution throughout the world in the tropical and temperate forest area of the northern and southern hemisphere (Fragniere *et al*. 2015).

Studies on pteridophytes and gymnosperms diversity in Gujarat state are completely neglected for the last four decades. The purpose of the present study was to explore the pteridophytes and gymnosperms diversity in Gujarat and to provide authentic data for the determination of taxonomical evaluation as well as their molecular identification using DNA barcoding techniques. Since 2013, comprehensive and extensive fieldwork was carried out for the collection of pteridophytes and gymnosperms flora to document the diversity and species richness in different areas of the Gujarat state. The present study concluded in collection and identification of 47 taxa (6 lycophytes and 41 ferns) belonging to the broader category in the pteridophytes, 21 genera under 13 families in the wild from the state. There are 15 species under 10 genera belonging to 9 families of pteridophytes are under cultivation in botanical garden and arboretum. Hence, a total of 62 taxa belonging to 28 genera under 18 families which includes wild and ornamental species of pteridophytes in the state were documented. On the other side, two species of gymnosperms belonging to one genus and one family were documented in the wild from the state, whereas 11 species of gymnosperms under 8 genera belonging to 6 families were documented as ornamental or exotic species in the botanical gardens and arboretum of the state. Hence, a total of 13 taxa belonging to 9 genera under 7 families which include wild and ornamental species of gymnosperms in the state are documented.

The key for genera and species and its brief description were provided for easy identification of the species. For each taxon, its phenology, distribution in the state along with its map, ecology, IUCN category and DNA barcodes were provided. Voucher

specimens were submitted at BARO (Department of Botany, The M. S. University of Baroda, Vadodara, Gujarat), BSJO (BSI, Arid and Semi-arid regional centre, Jodhpur, Rajasthan), BSI (BSI, Western Regional Centre, Pune, Maharashtra), BLAT (Blatter's Herbarium, Mumbai, Maharashtra), CAL (Central National Herbarium, Kolkata, West Bengal).

Pteridophyte flora of the state displays, Polypodiales is the most species-rich order in the state covering 6 families under 13 genera and 20 species, followed by Ophioglossales with single-family and single genus with 12 species. Isoetales and Equisetales possess only one family belonging from one genus and one species. Pteridaceae is the most specious family which comprises 13 species within 7 genera, followed by Ophioglossaceae with 12 taxa under a single genus. Thereafter, Athyriaceae is represented with 5 taxa and Selaginellaceae by 4 species under a single genus. The Salviniaceae, Polypodiaceae encircle 2 species under 2 genera. The richest genus in the term of a number of species is *Ophioglossum* (12 taxa) and the least species *i.e*. single taxa per each genus *viz*., *Equisetum*, *Lygodium*, *Azolla*, *Salvinia*, *Marsilea*, *Ceratopteris*, *Actiniopteris*, *Anogramma*, *Pteris*, *Cheilanthes*, *Hypodematium*, *Tectaria*, *Lepisorus* and *Microsorum.* Two species of gymnosperms were reported from the Kachchh, Saurashtra and North Gujarat regions.

Gujarat is divided into six bio-geographical zones *viz*., Dessert, Semi-Arid, Western Ghats (Malabar Plains and Western Mountains), Deccan Peninsula and Coasts. The most pteridophytic species-rich bio-geographical zone of the state is Semi-Arid region which represents a total of 41 taxa under 20 genera from 13 families, followed by Western Ghats (Malabar Plains) of the state encompassing 30 taxa belonging to 15 genera under 11 families and the Western Ghats (Western Mountains) encompassing 26 species under 13 genera with 9 families. From the desert region of the state, a total of 10 taxa belonging to 7 genera under 5 families were reported. The Ranges of Deccan Peninsula and the coastal areas in Gujarat show 2 taxa representing 2 genera belonging to 2 families.

Pteridophytes are a habitat-specific group of plants with unique niche preferences within their range of distribution. In the state, the distribution of pteridophytes is characterized under four major categories. The highest species diversity was reported in the terrestrial habitat with 40 taxa. Followed by, 22 taxa as lithophytic, 6 taxa as hydrophytes and 2 taxa are documented as epiphytes.

In the present study, the morphologically complex taxon was analysed for molecular identification, and a total of 37 DNA barcodes of 18 taxa were generated and submitted to BOLD Systems and/or NCBI. The phylogenetic tree was constructed by using MEGA.

The IUCN status of each taxon was evaluated. Analysis reveals that a total of 47 taxa of pteridophytes occurring in the state, 28 taxon falls under Least Concern, whereas, 19 taxa categorised under Data Deficient.

7.1 Important Findings of Present Investigation:

During the course of time, certain taxa were added new to the world, nation and for the state. A new species *i.e*., *Ophioglossum gujaratense* SM Patil, RN Kachhiyapatel, R Patel & KS Rajput and *Ephedra karumanchiana* SK Patel, SM Patil, RS Patel, RN Kachhiyapatel & KS Rajput, are described from the Jambughoda Wild-life sanctuary and, Ramsan, Banaskantha district of Gujarat state respectively. *Anogramma reichsteinii* Fraser-Jenk. is documented for the first time as an extension of its known range, in western Peninsular India and the northern Western Ghats from the hills of Mahardar, Dangs district, Gujarat. The species *viz*., *Selaginella ciliaris* (Retz.) Spring, *S. delicatula* (Desv. ex Poir.) Alston, *S. repanda* (Desv. ex Poir.) Spring, *Ophioglossum parvifolium* Grev. & Hook, *O. thermale* Kom., *Lygodium flexuosum* (L.) Sw., *Salvinia molesta* D.S. Mitch., *Actiniopteris radiata* (Sw.) Link, *Pteris vittata* L., *Adiantum capillus-veneris* L., *A. incisum* Forssk., *Aleuritopteris anceps* (Blanf.) Panigrahi, *A. bicolor* (Roxb.) Fraser-Jenk., *A. formosana* (Hayata) Tagawa, *Athyrium falcatum* Bedd., *A. hohenackerianum* T. Moore, *A. parasnathense* (C.B. Clarke) Ching ex Mehra & Bir, *Thelypteris dentata* (Forssk.) E.P. St. John, *T. prolifera* (Retz.) C.F. Reed, *Hypodematium crenatum* (Forssk.) Kuhn. subsp. *crenatum*, *Tectaria coadunata* (J. Sm.) C. Chr., *Lepisorus nudus* (Hook.) Ching and *Microsorum membranaceum* (D. Don) Ching., are added as a new record for the state. *Ophioglossum gramineum* Willd was relocated from the forest area of the Jambughoda wildlife sanctuary, Gujarat. Lecto-typification of *Ophioglossum parvifolium* was done from the state. From the earlier reported pteridophytes, *Isoetes coromandeliana* and *Ceratopteris thalictroides* lost their natural habitat from Vadodara and Savli. However, this species was collected from the new locations of different wetlands and forest areas of the state. Earlier, *Equisetum debile* was reported from Savli taluka. However, the present study showed total habitat loss of this species due to

infrastructure development in and around the Savali. In the same line, this species was additionally collected from Maya Devi temple, Dang district, Gujarat.