Chapter-5

PHYTOGEOGRAPHY

Phytogeography is a Greek origin, made up of two words, phyto means plant and geography means distribution. Hence, Phytogeography is the one among the branches of plant science that deals the geographic distribution pattern of plant taxa and their effect on the earth's surface. While dealing the comprehensive account of evolution fern and phytogeography of Indian ferns, Bir (1988) highlighted the role of Himalaya in the distribution pattern of ferns in India, China and Japan.

The present study area (Northern India) occupies the western Himalayan region and one of the most fertile plain of the world i.e. Gangetic plains. Northern India has number of different ecosystem which forms the ecotones (junctional part of the two ecosystems) and Himalaya is the one of the hot spot of the world. Hence, Northern India shows the high degree endemism and rich in biodiversity. The boundary of Northern India is sharing the international boundaries with four countries viz., China, Nepal and Pakistan. That’s why study shows its Phytogeographical affinity with the neighbouring countries.

In the present study, the phytogeographical affinities of the genus Athyrium of Northern India, based on field observation, herbarium study, relevant literature consultation, revisionary work, flora of adjacent states, geographical regions and neighbouring countries, is being presented. The phytogeographical analysis of five geographical regions of India and nine Asian countries (Bhutan, China, Japan, Myanmar, Nepal, Pakistan, Sri Lanka, Thailand and Taiwan) was done on the basis of previous reports and publications, i.e. Jammu & Kashmir (Singh & Pande, 2002; Wani et al. 2012), Himachal Pradesh (Dixit, 1984; Chandra, 2000; Khullar, 2000), Uttarakhand (Dixit & Kumar 2002; Joshi et al., 2009; Pangtey et al., 2010), Central India (Tiwari, 1964; Khare, 1989; Bir & Vasudeva, 1972; Dixit, 1993; Dixit & Singh,
Taxonomic Studies on the Genus *Athyrium* Roth in Northern India

2005), Western India (Chandra, 2000) North-east India (Dixit, 1984; Chandra, 2000; Singh & Panigrahi, 2005), South India (Manickam & Idurayaraj 1992, Fraser-Jenkins, 1997, 2008), Bhutan (http://biodiversity.bt/species/list); China (Fraser-Jenkins, 2008; Wang et al., 2013; Fraser-Jenkins et al., 2015); Japan (Kramer & M. Kato, 1990; Adjie, 2008); Myanmar (Dickason 1946; Flora of Burma/Myanmar, Online Burma/Myanmar Library (http://www.burmalibrary.org/show.php?cat=3097); Nepal (Thapa 2002; Fraser-Jenkins et al., 2015); Pakistan (Stewart, 1972; Chandra, 2000; Khullar, 2000, Iltaf et al., 2012); Sri Lanka (Fraser-Jenkins & Zink, 2006); Thailand (Boonkerd et al., 2004; Ferns of Thailand, Laos and Cambodia (http://rbg-web2.rbge.org.uk/thaiferms/index.htm); Taiwan (Lu & Yang, 2005; Liu & Fraser-Jenkins, 2006).

**Analysis of data:**

The species of genus *Athyrium* reported from Northern India (Table-2 & Figure-2) shows maximum resemblance with North east India [s.i.-0.575] followed by South India (including Western Ghat) [s.i.-0.279], Central India [s.i.-0.277] and Western India [s.i.-0.270]. Among the Asian Countries the species of genus *Athyrium* (Table-3 & Figure-3) show maximum resemblance with Nepal [s.i.-0.666] followed by Bhutan [s.i.-0.530], Pakistan [s.i.-0.390], China [s.i.-0.248], Thailand [s.i.-0.222], Myanmar [s.i.-0.212], Sri Lanka [s.i.-0.157], Taiwan [s.i.-0.156] and Japan [s.i.-0.096].

**Table-2: Diversity of genus *Athyrium* from study area along with other phytogeographical regions of India—**

<table>
<thead>
<tr>
<th>Sl.no.</th>
<th>Phytogeographical regions</th>
<th>Species under the genus <em>Athyrium</em></th>
<th>Species common with N. India</th>
<th>Similarity index</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Central India</td>
<td>6</td>
<td>5</td>
<td>0.277</td>
</tr>
<tr>
<td>2.</td>
<td>North east India</td>
<td>50</td>
<td>23</td>
<td>0.575</td>
</tr>
<tr>
<td>3.</td>
<td>South India (including Western Ghat)</td>
<td>13</td>
<td>6</td>
<td>0.279</td>
</tr>
<tr>
<td>4.</td>
<td>Western India</td>
<td>7</td>
<td>5</td>
<td>0.270</td>
</tr>
<tr>
<td>5.</td>
<td>Northern India</td>
<td>30</td>
<td>--</td>
<td>--</td>
</tr>
</tbody>
</table>
Table-3: Diversity of genus *Athyrium* from study area along with Asian counties-

<table>
<thead>
<tr>
<th>Sl.no.</th>
<th>Asian Counties</th>
<th>Species under the genus <em>Athyrium</em></th>
<th>Species common with N. India</th>
<th>Similarity index</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Bhutan</td>
<td>19</td>
<td>13</td>
<td>0.530</td>
</tr>
<tr>
<td>2.</td>
<td>China</td>
<td>123</td>
<td>19</td>
<td>0.248</td>
</tr>
<tr>
<td>3.</td>
<td>Japan</td>
<td>53</td>
<td>4</td>
<td>0.096</td>
</tr>
<tr>
<td>4.</td>
<td>Myanmar</td>
<td>17</td>
<td>5</td>
<td>0.212</td>
</tr>
<tr>
<td>5.</td>
<td>Nepal</td>
<td>33</td>
<td>21</td>
<td>0.666</td>
</tr>
<tr>
<td>6.</td>
<td>Pakistan</td>
<td>11</td>
<td>8</td>
<td>0.390</td>
</tr>
<tr>
<td>7.</td>
<td>Sri Lanka</td>
<td>8</td>
<td>3</td>
<td>0.157</td>
</tr>
<tr>
<td>8.</td>
<td>Thailand</td>
<td>6</td>
<td>4</td>
<td>0.222</td>
</tr>
<tr>
<td>9.</td>
<td>Taiwan</td>
<td>21</td>
<td>4</td>
<td>0.156</td>
</tr>
<tr>
<td>10.</td>
<td>Northern India</td>
<td>30</td>
<td>--</td>
<td>--</td>
</tr>
</tbody>
</table>
Table 4: Distribution of the different taxa of genus *Athyrium* Roth in different regions in India and neighboring country

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Name of the taxa</th>
<th>INDIA</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Northern India</td>
<td>Central India</td>
<td>North-East India</td>
<td>South India (including W. Ghats</td>
<td>Western India</td>
<td>BHUTAN</td>
<td>CHINA</td>
</tr>
<tr>
<td>1.</td>
<td><em>Athyrium anisopterum</em> Christ</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td><em>A. atkinsonii</em> Bedd.</td>
<td>+</td>
<td>+</td>
<td></td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>3.</td>
<td><em>A. attenuatum</em> (Wall. ex C.B. Clarke) Tagawa</td>
<td>+</td>
<td></td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>4.</td>
<td><em>A. cuspidatum</em> (Bedd.) M. Kato</td>
<td>+</td>
<td>+</td>
<td></td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>5.</td>
<td><em>A. davidii</em> (Franch.) Christ</td>
<td>+</td>
<td>+</td>
<td></td>
<td></td>
<td>+</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td><em>A. drepanopterum</em> (Kunze) A. Braun ex Milde</td>
<td>+</td>
<td>+</td>
<td></td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>8.</td>
<td><em>A. falcatum</em> Bedd.</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td></td>
<td></td>
<td>+</td>
</tr>
<tr>
<td>9.</td>
<td><em>A. fimbriatum</em> (Hook.) T. Moore</td>
<td>+</td>
<td>+</td>
<td></td>
<td></td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>10.</td>
<td><em>A. flabellulatum</em> (C.B. Clarke) Tardieu</td>
<td>+</td>
<td>+</td>
<td></td>
<td>+</td>
<td></td>
<td></td>
<td>+</td>
</tr>
<tr>
<td>11.</td>
<td><em>A. foliolosum</em> T. Moore ex R. Sim</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td></td>
<td>Taxonomic Study Name</td>
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</tr>
<tr>
<td>12.</td>
<td><em>A. himalaicum</em> Ching ex Mehra &amp; Bir</td>
<td>+</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13.</td>
<td><em>A. hohenackerianum</em> (Kunze) T. Moore</td>
<td>+</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>14.</td>
<td><em>A. kumaonicum</em> Punetha</td>
<td>+</td>
<td></td>
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</tr>
<tr>
<td>15.</td>
<td><em>A. mackinnoniorum</em> (C. Hope) C. Chr.</td>
<td>+</td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>17.</td>
<td><em>A. nephrodioides</em> (Baker) Christ</td>
<td>+</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>19.</td>
<td><em>A. pectinatum</em> (Wall. ex Mett.) T. Moore</td>
<td>+</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>20.</td>
<td><em>A. rubricaule</em> (Edgew. ex C.B. Clarke) Bir</td>
<td>+</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>21.</td>
<td><em>A. rapicola</em> (Edgew. ex C. Hope) C. Chr.</td>
<td>+</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>23.</td>
<td><em>A. setiferum</em> C. Chr.</td>
<td>+</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>26.</td>
<td><em>A. wallichianum</em> Ching</td>
<td>+</td>
<td></td>
<td></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>29.</td>
<td><em>Athyrium × pangteyi</em> Fraser-Jenk.</td>
<td>+</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30.</td>
<td><em>Athyrium × pichisermollianum</em> Fraser-Jenk.</td>
<td>+</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

Taxonomic Studies on the Genus *Athyrium* Roth in Northern India
Table 5: Distribution of the different taxa of the genus *Athyrium* in different Indian states and Union Territories of India

<table>
<thead>
<tr>
<th>Sl. no.</th>
<th>Name of the taxa</th>
<th>States / Union territories of India</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sl. no.</td>
<td>Name of the taxa</td>
<td>States / Union territories of India</td>
</tr>
<tr>
<td>--------</td>
<td>-------------------------------------</td>
<td>-------------------------------------</td>
</tr>
<tr>
<td>11.</td>
<td><em>A. devolii</em> Ching</td>
<td>Jammu &amp; Kashmir</td>
</tr>
<tr>
<td>12.</td>
<td><em>A. dissitifolium</em> (Baker) C. Chr.</td>
<td>+</td>
</tr>
<tr>
<td>13.</td>
<td><em>A. distans</em> (D. Don) T. Moore</td>
<td>+</td>
</tr>
<tr>
<td>14.</td>
<td><em>A. drepanopterum</em> (Kunze) A. Braun ex. Milde</td>
<td>+</td>
</tr>
<tr>
<td>15.</td>
<td><em>A. dubium</em> Ching</td>
<td>+</td>
</tr>
<tr>
<td>17.</td>
<td><em>A. fangii</em> Ching</td>
<td>+</td>
</tr>
<tr>
<td>18.</td>
<td><em>A. fimbriatum</em> (Hook.) T. Moore</td>
<td>+</td>
</tr>
<tr>
<td>19.</td>
<td><em>A. flabellulatum</em> (C.B. Clarke) Tardieu</td>
<td>+</td>
</tr>
<tr>
<td>20.</td>
<td><em>A. foliolosum</em> T. Moore ex R. Sim</td>
<td>+</td>
</tr>
<tr>
<td>Sl. no.</td>
<td>Name of the taxa</td>
<td>States / Union territories of India</td>
</tr>
<tr>
<td>--------</td>
<td>-----------------</td>
<td>-----------------------------------</td>
</tr>
<tr>
<td>22.</td>
<td><em>A. himalaicum</em> Ching ex Mehra &amp; Bir</td>
<td>+ + + +</td>
</tr>
<tr>
<td>23.</td>
<td><em>A. hohenackerianum</em> (Kunze) T. Moore</td>
<td>+ + + + + + + +</td>
</tr>
<tr>
<td>25.</td>
<td><em>A. kumaonicum</em> Punetha</td>
<td>+</td>
</tr>
<tr>
<td>26.</td>
<td><em>A. mackinnoniorum</em> (C. Hope) C. Chr.</td>
<td>+ + +</td>
</tr>
<tr>
<td>27.</td>
<td><em>A. micropterum</em> Fraser-Jenk.</td>
<td>+ + + +</td>
</tr>
<tr>
<td>28.</td>
<td><em>A. nakanoi</em> Makino</td>
<td>+ + + +</td>
</tr>
<tr>
<td>29.</td>
<td><em>A. nephrodioides</em> (Baker) Christ</td>
<td>+ + +</td>
</tr>
<tr>
<td>30.</td>
<td><em>A. niponicum</em> (Mett.) Hance</td>
<td>+</td>
</tr>
<tr>
<td>Sl. no.</td>
<td>Name of the taxa</td>
<td>States / Union territories of India</td>
</tr>
<tr>
<td>--------</td>
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<td>-----------------------------------</td>
</tr>
<tr>
<td>34.</td>
<td>A. praetermissum sledge</td>
<td>Jammu &amp; Kashmir + Himachal Pradesh + Uttarakhand + Punjab + Haryana + Delhi + Uttar Pradesh + Bihar &amp; Jharkhand + West Bengal + Sikkim + Assam + Meghalaya + Manipur + Nagaland + Tripura + Mizoram + Arunachal Pradesh + Gojrat + Rajasthan + M.P. &amp; Chhattisgarh + Maharashtra + Odisha + Karnataka + A.P. &amp; Telangana + Kerala + Tamil Nadu + Goa + Daman &amp; Diu</td>
</tr>
<tr>
<td>Sl. no.</td>
<td>Name of the taxa</td>
<td>States / Union territories of India</td>
</tr>
<tr>
<td>--------</td>
<td>------------------------------------------------------</td>
<td>------------------------------------</td>
</tr>
<tr>
<td>41.</td>
<td><em>A. setiferum</em> C. Chr.</td>
<td>+</td>
</tr>
<tr>
<td>42.</td>
<td><em>A. silvicola</em> Tagawa</td>
<td>+</td>
</tr>
<tr>
<td>43.</td>
<td><em>A. solenopteris</em> (Kunze)  T. Moore</td>
<td>+</td>
</tr>
<tr>
<td>44.</td>
<td><em>Athyrium spinulosum</em> (Maxim.) Milde</td>
<td>+</td>
</tr>
<tr>
<td>45.</td>
<td><em>A. strigilosum</em> (T. Moore ex E. J. Love) Salomon</td>
<td>+</td>
</tr>
<tr>
<td>46.</td>
<td><em>A. vermae</em> Fraser-Jenk.</td>
<td>+</td>
</tr>
<tr>
<td>47.</td>
<td><em>A. vidalii</em> (Franch. &amp; Sav.) Nakai</td>
<td>+</td>
</tr>
<tr>
<td>48.</td>
<td><em>A. wallichianum</em> Ching</td>
<td>+</td>
</tr>
<tr>
<td>49.</td>
<td><em>A. woodsioides</em> Christ</td>
<td>+</td>
</tr>
<tr>
<td>50.</td>
<td><em>Athyrium × boreo-occidentaliindobharaticol a-biriyanum</em> Fraser.-Jenk.</td>
<td>+</td>
</tr>
<tr>
<td>51.</td>
<td><em>Athyrium × dixiti</em> Fraser.-Jenk.</td>
<td>+</td>
</tr>
<tr>
<td>Sl. no.</td>
<td>Name of the taxa</td>
<td>States / Union territories of India</td>
</tr>
<tr>
<td>-------</td>
<td>-----------------</td>
<td>-----------------------------------</td>
</tr>
<tr>
<td>52.</td>
<td><em>Athyrium × drepanopteroides</em> Fraser.-Jenk.</td>
<td>+</td>
</tr>
<tr>
<td>53.</td>
<td><em>Athyrium × kathmanduense</em> Fraser.-Jenk.</td>
<td>+</td>
</tr>
<tr>
<td>54.</td>
<td><em>Athyrium × lobulosoimpolitum</em> Fraser.-Jenk.</td>
<td>+</td>
</tr>
<tr>
<td>55.</td>
<td><em>Athyrium × manickamii</em> Fraser.-Jenk.</td>
<td>+</td>
</tr>
<tr>
<td>56.</td>
<td><em>Athyrium × nepalense</em> Fraser.-Jenk.</td>
<td>+</td>
</tr>
<tr>
<td>57.</td>
<td><em>Athyrium × pangteyi</em> Fraser.-Jenk.</td>
<td>+</td>
</tr>
<tr>
<td>58.</td>
<td><em>Athyrium × pichisermollianum</em> Fraser.-Jenk.</td>
<td>+</td>
</tr>
<tr>
<td>59.</td>
<td><em>Athyrium × sanjappae</em> Fraser.-Jenk.</td>
<td>+</td>
</tr>
</tbody>
</table>
Taxonomic Studies on the Genus *Athyrium* Roth in Northern India
FIGURE 2: Species diversity in numbers under the genus *Athyrium* from different Phytogeographical regions in India.

FIGURE 3: Species diversity in numbers under the genus *Athyrium* from Study area and different Asian Countries.