Pteridophytic diversity in human-inhabited buffer zone of Murlen National Park, Mizoram, India

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Abstract: A taxonomic inventorization of pteridophytes occurring in a human inhabited buffer zone of Murlen National Park, India, was conducted in 2012 and 2013. This survey revealed 35 species belonging to 27 genera and 15 families. Polypodiaceae was recorded as dominant family, represented by six genera and eight species, followed by Pteridaceae (three genera and six species) and Lycopodiaceae (three genera and four species). Of the recorded species, 23 species were terrestrial, 11 (epiphytic) and two (lithophytic) in their habit forms. The species richness was highest in Tualpui village, with 11 species, followed by Rabung (7) and Ngur (6). The site preference of species among the villages is discussed. These data will provide baseline for future research and monitoring of pteridophytic vegetation in this protected area, as well as in similar habitats in the adjacent areas.

Key words: Indo-Burma biodiversity hotspot; Jhum cultivation; Pteridophytes

INTRODUCTION

Pteridophytes are the second largest group of vascular plants with about 13,600 species (MORAN 2008) distributed throughout the world except in Arctic, Antarctic zones and oceans. They are an important seral stage in the biological successional process of the earth. The majority of pteridophyte species are concentrated in tropical rain forests and, in general, their richness decreases poleward from the equator (MORAN 2008). However, in the Himalaya and southeastern China this rule of latitudinal fern diversity gradient deviates (KHOLIA 2011a). Gigantic tree-like pteridophytes were the dominant vegetation during the Mesozoic era. In the Holocene, flowering plants replaced pteridophytes, but the latter are still the major vegetation in many forests where their diversity is manifold higher than the other group of plants. In other forests, they forms understory vegetation (KHOLIA 2010a). They are sometimes considered to be indicators of forest health (KHOLIA 2014). Generally, it is believed that modern ferns and their allies are much older than flowering plants, and often considered as living fossils, but except for a few families, most of the modern ferns evolved and flourished under the shadow of angiosperms (SMITH et al. 2006). In India, pteridophytes are mainly distributed in Himalayan region, as well as North-Eastern and Southern India, where climates are humid and more conducive for growth. Approximately 1,267 species of pteridophytes (ca. 9% of global species) are recorded from the country (SINGH & DASH 2014). The highest number (ca. 700 species) of pteridophytes occurs in the Eastern Himalaya and adjoining states, making this region a biodiversity hotspot for pteridophytes (DIXIT 2000).

The North-Eastern Region of India, which is comprised of seven sister states, is part of the Indo-Burma biodiversity hot spot (MEYERS 2000; CONSERVATION INTERNATIONAL 2011). Well known for its rich biological diversity, the region has been extensively explored in terms of pteridophytic flora by several workers. BAISHYA & RAO (1982) recorded 256 species of fern and fern allies in Meghalaya; JAMIR & RAO (1988) reported 280 species from Nagaland; BORTHAKUR et al. (2000) confirmed the presence of 221 species in Assam; and KHOLIA (2010a, 2011b, 2014) reported 480 species from Sikkim.

Mizoram, a hilly state having an area of ca. 21,000 km² and part of the North-East Region, is within the biogeographic province 9B (RODGERS et al. 2000). Jhum cultivation, also known as shifting cultivation, is the main system of agriculture in Mizoram, covering an area of ca. 300 km². Due its biogeography, physiognomy, climate, and vegetation, this state has ideal habitats for both mesophytic and epiphytic pteridophytes. However, pteridophytic diversity is poorly explored in the state, except with few efforts (BARBHUIYA & SINGH 2014; BENNIAMIN 2012; SHARMA et al. 2013; VANLALPEKA & LAHA 2014, 2015; VERMA et al. 2013, 2014.

Situated in Mizoram, adjacent to the Indo-Myanmar...
border, Murlen National Park (MNP) is significant for its proximity to the Chin Hills (Myanmar). It is an important area for floristic diversity, but has not had adequate attention by researchers. Apart from habitat degradation by *Jhum* cultivation, cane extraction, and occasional tree cutting, the hunting of larger vertebrates and birds are threats to this park (Kaul et al. 1996). A preliminary list of pteridophytes of MNP by Benniamin (2012) was based on a single visit and did not include human-inhabited areas. Despite the efforts to study the pteridophytic diversity in the region, few studies included the equally important peripheral and buffer areas having high human interference. Therefore, this study focuses on documenting the pteridophytes in and around human inhabitations within the buffer zone of Murlen National Park, Mizoram, India.

**MATERIALS AND METHODS**

**Study site**

Located in Champhai district, Mizoram (21°57’N to 24°30’N, 092°15’E to 093°29’E), MNP is characterized by dense tropical to subtropical evergreen mixed forests (Figure 1). Spreading over an area of ca. 200 km² with an elevation range between 600–1,800 m, the park has several small seasonal and perennial streams. Physiographically, the park is characterized by undulating topography and rugged mountains. It receives an annual rainfall of 2,000–2,500 mm. The temperature ranges between 5°C winter to 35°C in summer.

In this study six villages within the buffer area of MNP were surveyed: Rabung, Tualpui, Ngur, Vapar, North Khawbung, and Murlen. The trail which connects these villages to the surrounding park makes vegetation vulnerable due to anthropogenic disturbances. These villages harbour deciduous or evergreen mixed secondary forest with enormous human pressure. Most of the forests in these villages are under *Jhum* cultivation (slash and burn). This practice has affected the structure and function of natural vegetation in these villages as well as in the National Park.

**Data collection**

A systematic survey of pteridophytes was made in 2012 and 2013 by traversing on foot all the pteridophytic habitats in and around peripheral village forests, nearby *Jhum* fields, water channels, ridges and various habitats in and around the forests. The inventory was also carried out along existing trails near human habitations.

To facilitate identification, elevation and important taxonomic characters, including life form and habitat of the species, were also gathered. Identifications of specimens were based on field characters with the aid of existing literature (Baishya & Rao 1982; Jamir & Rao 1988; Kholia 2010a, 2014; Benniamin 2012; Table 1) and checked against authentic specimens housed in the herbarium of Botanical Survey of India, Eastern Regional Centre, Siliguri (ASSAM). Voucher specimens were dried, pressed, and mounted on herbarium sheets following Jain & Rao (1976) and deposited in the ASSAM herbarium.

**Data analysis**

The taxonomy of recorded species follows Fraser-Jenkins (2009). Species are listed in Table 1, along with spore producing period (fertile period), voucher specimens, and general distribution. Species richness was determined as the total number of species in an area. The general distributions of species is based on Dixit (1984) and Kholia (2010a, 2014).

**RESULTS**

In this survey, 35 species belonging to 27 genera and 15 families were found (Table 1). Polypodiaceae was found to be the dominant family, represented by six genera and eight species, followed by Pteridaceae (3 genera and 6 species) and Lycopodiaceae (3 genera and 4 species; Figure 2). The dominant genus was *Pteris* L. with four species (*Pteris biaurita* L. (Linnaeus 1753: 1076), *Pteris cretica* L. (Linnaeus 1767: 130), *Pteris pellucida* C.Presl (Presl 1825: 55), and *Pteris vittata* L. (Linnaeus 1753: 1074) followed by *Huperzia* Bernh., *Microsorum* Link, *Pyrrosia* Mirb., *Lygodium* Sw., and *Tectaria* Cav. with two species each. Of the recorded species, 23 species were terrestrial, 11 epiphytes, and two lithophytes, viz., *Microsorum membranaceum* (D.Don) Ching (DON 1825: 2; CHING 1933: 309)
Table 1. Pteridophytes of Murlen National Park, Mizoram, northeast India with their family, habit form, fertile time, village of collection, exsiccate and nativity.

| Family and species | Life form | Fertile time | Village of collection | Voucher specimen (with date) | General distribution | Identification reference |
|--------------------|-----------|--------------|-----------------------|-------------------------------|----------------------|-------------------------|
| **Lycodiaceae**    |           |              |                       |                               |                      |                         |
| Huperzia serrata (Thunb.) Trevis. | Terrestrial | Nov.–July | Murlen | Sachin Sharma; 128150; 25.01.2013 | Southeast Asia; Tropical America | BAISHYA & RAO 1982 |
| Huperzia squarrosa (G.Forst.) Trevis. | Epiphytic | June–Sep. | Tualpui | Sachin Sharma; 127274; 25.09.2012 | Southeast Asia; French Polynesia | KHOlia 2010a |
| **Lycopodiaceae**  |           |              |                       |                               |                      |                         |
| Lycopodiella cernua (L.) Pic.Serm. | Terrestrial | Sept.–Nov. | Rabung | Sachin Sharma; 128807; 21.09.2012 | Tropical-subtropical world | KHOlia 2010a |
| Lycopodium japonicum Thunb. | Terrestrial | Sept.–Feb. | Vapar | Sachin Sharma; 128500; 15.04.2013 | Indo-China; Japan | KHOlia 2010a |
| **Marattiaceae**   |           |              |                       |                               |                      |                         |
| Anigozanthus indica Desv. | Terrestrial | July–Nov. | Tualpui | Sachin Sharma; 129862; 25.09.2014 | Indo-China; Polynesia | KHOlia 2010a |
| **Equisetaceae**   |           |              |                       |                               |                      |                         |
| Equisetum arvense subsp. debl (Roxb. ex Vaucher) Hauke | Terrestrial | Sept.–Nov. | Ngur | Sachin Sharma; 128244; 19.01.2013 | Southeast Asia | KHOlia 2014 |
| **Selaginellaceae**|           |              |                       |                               |                      |                         |
| Selaginella pentagona Spring | Terrestrial | Sept.–Nov. | Tualpui | Sachin Sharma; 129225; 20.09.2012 | Indo-China | BAISHYA & RAO 1982 |
| **Gleicheniaceae** |           |              |                       |                               |                      |                         |
| Dicranopteris lanigera (D.Don) Fraser-Jenk. | Terrestrial | Oct.–Feb. | Vapar | Sachin Sharma; 129825; 06.03.2014 | Tropical Asia; Africa; Madagascar | KHOlia 2010a |
| **Polypodiaceae**  |           |              |                       |                               |                      |                         |
| Drynaria propinqua (Wall. ex Mett.) S.Sm. | Epiphyte | May–Oct. | Rabung | Sachin Sharma; 127249; 21.09.2012 | Southeast Asia | KHOlia 2010a |
| Lepisorus nudus Ching | Lithophyte | Oct.–Feb. | Rabung | Sachin Sharma; 127235; 21.09.2012 | Southeast Asia; Central and Southern Africa; Madagascar | BAISHYA & RAO 1982 |
| Leptochilus pteropus (Blume) Fraser-Jenk. | Terrestrial | Dec.–Feb. | Murlen | Sachin Sharma; 128136; 15.01.2013 | Tropical Asia | KHOlia 2014 |
| Microsorum membranaceum (D.Don) Ching | Lithophyte | Sept.–Feb. | Vapar | Sachin Sharma; 127375; 26.09.2012 | Indo-China; Sri Lanka | KHOlia 2010a |
| Microsorum punctatum (L.) Copel. | Epiphyte | Nov.–Feb. | Ngur | Sachin Sharma; 128046; 13.01.2013 | Tropical Asia; Africa | KHOlia 2010a |
| Pseudodrynaria coronans (Wall. ex Mett.) J.Sm. | Epiphyte | July–Feb. | Tualpui | Sachin Sharma; 127222; 20.09.2012 | Southeast Asia; Formosa | KHOlia 2010a |
| Pyrosia flocculosa (D.Don) Ching | Epiphyte | Feb.–Apr. | Vapar | Sachin Sharma; 129956; 28.02.2014 | Southeast Asia | KHOlia 2010a |
| Pyrosia mannii (Giesenh.) Ching | Epiphyte | May–July | Murlen | Sachin Sharma; 128151; 15.01.2013 | Southeast Asia | KHOlia 2010a |
| **Lygodiaceae**    |           |              |                       |                               |                      |                         |
| Lygodium flexuosum (L.) Sw. | Terrestrial | May–Oct. | Ngur | Sachin Sharma; 129816; 05.03.2014 | Southeast Asia; Australia; Pacific islands | KHOlia 2010a |
| Lygodium japonicum (Thunb.) Sw. | Terrestrial | May–Oct. | Tualpui | Sachin Sharma; 129820; 25.09.2014 | Southeast Asia; Japan; Tropical/subtropical America | KHOlia 2010a |
| **Pteridaceae**    |           |              |                       |                               |                      |                         |
| Adiantum philippense L. | Terrestrial | July–Oct. | Rabung | Sachin Sharma; 127233; 21.09.2013 | Pan-tropical | KHOlia 2010a |
| Onychium siliculosum (Desv.) C.Chr. | Terrestrial | May–Oct. | Ngur | Sachin Sharma; 129975; 04.03.2014 | Southeast Asia; Polynesia | KHOlia 2010a |
| Pteris biunata L. | Terrestrial | May–Oct. | Tualpui | Sachin Sharma; 128807; 21.09.2014 | Tropical/subtropical world | KHOlia 2010a |
| Pteris cretica L. | Terrestrial | May–Oct. | Tualpui | Sachin Sharma; 128160; 15.01.2013 | Tropical/temperate world | KHOlia 2010a |
| Pteris pellucida C.Presl | Terrestrial | July–Oct. | Vapar | Sachin Sharma; 129953; 28.02.2014 | India; Burma; Malay island | JAMIR & RAO 1988 |
| Pteris vittata L. | Terrestrial | July–Oct. | Murlen | Sachin Sharma; 127429; 27.09.2012 | Tropical/subtropical world | KHOlia 2010a |
| **Dennstaedtiaceae** | Microlepia puberula Alderw. | Terrestrial | Oct.–Dec. | Tualpui | Sachin Sharma; 129838; 07.03.2014 | Indo-China; Java | BAISHYA & RAO 1982 |
| Pteridium aquilinum (L.) Kuhn | Terrestrial | July–Nov. | Rabung | Sachin Sharma; 127243; 21.09.2013 | Tropical/subtropical world | KHOlia 2010a |
| Sphenomeris chinensis (L.) Maxon | Terrestrial | July–Dec. | Rabung | Sachin Sharma; 129823; 06.03.2014 | Southeast Asia, East Africa | KHOlia 2010a |
| **Thelypteridaceae** | Thelypteris xylodes (Kunze) Ching | Terrestrial | July–Dec. | Rabung | Sachin Sharma; 127244; 21.09.2013 | Southeast Asia | KHOlia 2014 |
and *Lepisorus nudus* Ching (Ching 1933: 83; Figure 3). The species richness was highest in Tualpui village (11 species) followed by Rabung village (7 species) and Ngur village (6 species). *Lycopodiella cernua* (L.) Pic. Serm. (Linnaeus 1753: 1103; Pichi Sermolli 1968: 166), *Dicranopteris lani­gera* (D.Don) Fraser-Jenk. (Don 1825: 17; Fraser-Jenkins 2008: 35), *Lepisorus nudus*, *Pseudodrynaria coronans* (Wall. ex Mett.) Ching (Mettenius 1856: 121; Ching 1940: 262), *Pyrrosia flocculosa* (D.Don) Ching (Don 1825: 1−2; Ching 1935: 66), *Lygodium flexuosum* (L.) Sw. (Linnaeus 1753: 1063; Swartz 1801: 106), *Onychium siliculosum* (Desv.) C.Chr. (Desvaux 1811: 324; Christensen 1905: 469), *Pte­ris biurita, Pteris vittata*, and *Pteridium aquilinum* (L.) Kuhn (Linnaeus 1753: 1075; Kuhn 1879: 11) occurred in xeric, open places. *Diplazium esculentum* (Retz.) Sw. (Retzius 1791: 38; Swartz 1803: 312) was used by local inhabitants as a vegetable. An overview of the study area with some species and specific habitats are shown in Figures 4 and 5.

**DISCUSSION**

In general, most of ferns and fern allies prefer shady, humid places because prolonged water availability is necessary for reproduction and growth. The relatively high species richness in Tualpui and Rabung villages is likely attributed to position of these villages along rivers. In contrast, Ngur and Vapar villages are on hill tops with exposed conditions where strong winds affect atmospheric humidity and conditions remain relatively dry. Moreover, spores would be washed downstream and bare slopes under *Jhum* cultivation have little water holding capacity. Hence, the spore germination is expected to be poor in these villages.

Most of the species found were fertile during May to October, as ferns need moisture for germination of their spores and to grow. However, *Brainea insignis* (Hook.) J.Sm. (Hooker 1853: 237–238; Smith 1856: 5) is fertile from November to March. This pre-monsoon fertility may be an adaptation to avoid competition. This species gets water from north-east monsoon (winter rains) or stored moisture in its caudex. Also, *Vittaria elongata* Sw. (Swartz 1806: 109, 302) is fertile from February to December, which includes a few pre-monsoon months.

Species such as *Lycopodiella cernua, Dicranopteris lani­gera, Drynaria propinqua* (Wall. ex Mett.) J.Sm. ex Bedd. (Mettienius 1856: 120; Beddome 1866: 160), *Pyroso
Figure 4. A. Shifting cultivation in study area. B. Invasion of obnoxious weedy fern *Pteridium aquilinum* in old Jhum fields. C. *Tectaria polymorpha* growing in open grass fields along road cuttings. D. *Dicranopteris lanigera* growing in disturbed land. E. *Lygodium flexuosum* climbing in bushes in old Jhum area. F. *Tectaria fuscipes* growing on slopes near stream.
floculosa, Lygodium japonicum (Thunb.) Sw. (Thunberg 1784: 926; Swartz 1801: 106), Adiantum philippense L. (Linnaeus 1753: 1094), Pteris biaurita, and Pteris vittata were common along roadsides and paths in the villages. Huperzia serrata (Thunb.) Trevis. (Thunberg 1784: 944; Trevisan de Saint-Léon 1874: 248), Angiopteris indica Desv. (Desvaux 1811: 307), Equisetum ramosissimum subsp. debile (Roxb. ex Vaucher) Hauke (Vaucher 1822: 387; Hauke 1962: 33), Microsorum membranaceum, Tectaria fuscipes (Wall. ex Bedd.) C.Chr. (Beddome 1876: 15; Christensen 1931: 290) and Tectaria polymorpha (Wall. ex Hook.) Copel. (Hooker 1862: 54–55; Copeland 1907: 413) were observed along the water channels, while Diplazium esculentum, Brainea insignis, and Asplenium phyllitidis D.Don (DON 1825: 7) were reported in and around kitchen gardens. Angiopteris indica, Equisetum ramosissimum subsp.
deble, Selaginella pentagona Spring (Spring 1850: 150), Leptochilus pteropus (Blume) Fraser-Jenk. (Blume 1828: 125; Fraser-Jenkins 2008: 62), Pteris pellucida, Microlepia puberula Alderw. (Alderw. et van Rosenburgh 1913: 17), Thelypteris xyloides (Kunze) Ching (Kunze 1851: 281; Ching 1936: 296–298), Asplenium phyllitidis, Tectaria fuscipes, T. polymorpha, Blechnum orientale L. (Linnaeus 1753: 1077), and Diplazium esculentum were found growing in moist, humid places.

Due to these specific habits and characteristic habitats, ferns and their allied plants are often considered as indicator species for climate change. Additionally, anthropological pressures, especially shifting cultivation, burning, frequent pruning, grazing, and tree cutting could lead to the depletion of pteridophytic diversity in MNP. Therefore, management authorities should take steps to protect the pteridophytic wealth of the park. The information presented here can serve as a baseline for the future research and monitoring of pteridophytes in MNP as well as in similar habitats in the adjoining areas.

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