ANNEXURE II

LIST OF RESEARCH PUBLICATIONS AND OTHERS

A. Published paper(s): 09


B. Accepted paper(s) in press: 01


C. Communicated paper(s): 02


D. Workshops/Training programmes attended

2. Workshop on 'Preventing Extinction and improving conservation status of threatened plants through application of biotechnological tools'. North Eastern Hill University, Shillong (17-18 March 2011).

E. National/International seminar(s) attended


2. International seminar held in the Department of Environmental Science, North Eastern Hill University, Shillong.
RECOLLECTION OF HEMIORCHIS PANTLINGII KING
AFTER A CENTURY FROM MEGHALAYA

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Abstract: The paper deals with taxonomy of Hemiorchis pantlingii King (Zingiberaceae) collected from Nokrek Biosphere Reserve (NBR), Meghalaya. The species is a new record for Garo Hills District and is rediscovered after a gap of about 123 years from Meghalaya. The photographs of H. pantlingii King provided for easy identification.

INTRODUCTION

Hemiorchis Kurz. (Zingiberaceae), one of the early spring flowering zinger of angiosperms, flowers before leaf growth and resembles like that of a terrestrial orchid. Individual flowers last about 3 to 5 days only. Peduncles grow about 8-20 cm long bearing a head of buds covered with bracts which opens one by one in a period of 2 to 3 weeks. Leaves die in late autumn and rhizome remain underground in winter season.

The Genus Hemiorchis Kurz is represented by 3 species in the world (Schumann, 1904) and all are reported from India (Ghosal and Srivastava, 2006). Rao and Verma (1972) reported occurrence of two species, viz. Hemiorchis rhodorrhachis K. Schum. and Hemiorchis pantlingii King in Meghalaya without citation of any specimens. However, while scrutiny of herbarium specimens at ASSAM, authors came across only two herbarium sheets of G. Mann with Acc. No. 29751 and 29752 collected in March 1886 from Terriaghat, Southern base of Khasi Hills of Meghalaya under the name H. burmanica Kurz. These specimens were determined by D.M. Verma on 7th October 1966 as H. pantlingii King. After the collection of G. Mann, the species was not collected for a long time due to its rare occurrence in natural habitat. Luckson (2001) also reported the species from Sikkim.

While studying the Floristic Diversity of Nokrek Biosphere Reserve (NBR), Meghalaya, a project funded by MoEF, New Delhi, authors came across a single population of ca 20-25 plants growing near Sumsang river in Sumsanggre at altitude of 280m msl under shade of a large tree Artocarpus heterophylla Lam. in sandy loam soil, appearing-like ground orchids. But after critical observation of herbarium specimens at ASSAM and published literature, the collected specimens along with photographs identified as Hemiorchis pantlingii King which is recollected from Meghalaya after a gap of 123 years. The plant is collected for the first time from Nokrek Biosphere Reserve in March 2008 and is a new record for Garo Hills district of the state. The voucher specimens are processed and housed in the ASSAM herbarium at Botanical Survey of India, Eastern Regional Centre, Shillong, Meghalaya. The present paper deals with taxonomy of Hemiorchis pantlingii King along with photographs for easy identification.


Terrestrial annual herbs, 12-20 cm high, succulent, puberulous. Rhizomes stout, cylindrical, 0.2-0.4 cm thick, whitish, branched. Stem erect, 7-8 cm high, covered with 2-3 cm long creamish-purple stem-clasping sheathing leaves. Leaves 3-5, produced after flowering; petioles tightly clasped giving the impression of a short stem; lamina oblong-lanceolate, 15-40 \times 3-6 cm, acute at apex, dark green above, membranous, entire along margin, upper nerves ciliolate. Inflorescence radical, spike; peduncles clothed with 4-6 sheaths, 0.6-2.0 cm long; racemes 3-7 cm long with 2-5 sessile flowers; sheaths oblong,

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Fig. 1. Growing stages of *Hemiorchis pantlingii* King. (Zingiberaceae) A. Habit, B. Flower, C. Capsule, D. Seed in capsule.

Hairy, ca 3 cm long. Flowers spirally arranged, ebracteate, pale yellow, 1.5-2 cm across, 1 or rarely 2 flowers open at a time; bract ca 0.1 cm long. Calyx (3) tubular, 0.6-1.0 cm, apically trifid, pubescent, deciduous. Corolla tubes exceeding calyx by ca 0.3 cm, hispidulous outside, limbs divided above into 3 dissimilar lobes; lobes ca 1.0 cm long. Lateral petals oblong-ovate, 1.2-1.5 × 0.4-0.5 cm, membranous, entire margin, hispidulous, obtuse at apex, 3-nerved, mucronate at tip fleshy. Staminoides slightly leathery obovate-oblong, 0.8-1.2 × 0.6-0.7 cm, yellow or orange, entire margins, obtuse at apex, slightly clawed; claws ca 0.3 cm. Lip broadly obovate or orbicular when opened, ca 1.0 cm long and equally broad, yellow with purplish median line, deep orange at tip; spotted with red-purple dots, deep orange midrib like appearance which is protruding out in beak shape structure, entire margin. Stamens 0.5-0.8 cm long, curved; filament ca 0.5 cm long; anther oblong, 0.3-0.4 cm long, right angles, connective narrow, not produced. Style slender, 1.8-2.2 cm long, translucent white, glabrous, passing through connective of anthers. Stigma small, rounded, pubescent, protruding out of anther. Ovary oblong, 0.2-0.3 cm long, pubescent, ribbed, 1-celled with many ovules, parietal placentaion. Capsules 3-valved, 2.6-3.1 × 2.4-2.8 cm long, puberulous, 8-10 costate. Seeds pinkish, glabrous, slightly white at aperture.

Fl. & Fr.: March-April.

*Habitat:* Grows in tropical forest in sandy soil near Simsang rivers in moist condition; extremely rare in NBR.

*Distribution:* INDIA: (Meghalaya, Sikkim); NEPAL.

*Specimens examined:* Meghalaya: Garo Hills, NBR, near Simsang river in Simsanggre, 280m, 29.03.2008, VN Singh and B. Singh 116851 (ASSAM).

*Note:* The two species - *Hemiorchis rhodorrachis* K. Schum and *H. pantlingii* King of India looks similar, but differs from each other in few points. *H. rhodorrachis* K. Schum have rachis purplish red, corolla tube is orange and capsules are globose. On the other hand, the collected *H. pantlingii* King from Nokrek Biosphere Reserve have both rachis and corolla pale yellow and capsules fusiform.

**ACKNOWLEDGEMENTS**

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**REFERENCES**


CONSERVATION STRATEGIES FOR 
NEPENTHES KHASIANA IN THE NOKREK BIOSPHERE 
RESERVE OF GARO HILLS, NORTHEAST, INDIA

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Abstract
The present paper focuses on the various disturbance agents such as coal mining, limestone extraction, stone quarrying, jhum cultivation, fire, grazing, over-exploitation of resources, road constructions etc., affecting the natural growth of Nepenthes khasiana in the Nokrek Biosphere Reserve of India. N. khasiana is the prominent insectivorous scandent shrubs species of this biosphere reserve and is an important source of medicine and basic ornamental use for the local garo tribal people of north-east India. The inevitable pressure due to commercialization of the N. khasiana is leading to severe destruction of the species and may create the scarcity of that species in the near future. Therefore, joint efforts need to be implemented by the local garo villagers with governmental and non-governmental agencies for conservation and sustainable use of N. khasiana. The government may also take initiative by allotting demarcated forests areas to the villagers as village forest, thus motivating the villagers to take special care for its protection and rehabilitation and for a sustainable output.

Keywords: N. khasiana, Nokrek Biosphere Reserve; disturbance, conservation; sustainable use

Introduction

Nepenthes khasiana Hook. f. is one of the endemic plant species of India [1], belongs to a family of Nepenthaceae, which comprises app. 70 species in the world [1] and is used for medicine. Nepenthes khasiana is a scandent insectivorous shrub of the tropical and subtropical climatic regions; it is endemic to the Meghalaya state [2-7] and grows in the eastern Himalayan tract up to an altitude of 1,100 m in north-east India. It grows in association with Licuala peltata, Calamus erectus, Lithocarpus dealbata and fern species like Alsophila gigantea, Dicranopteris langera, D. splendens, Thelypteris lakhipurenensis and other species. In the Nokrek Biosphere Reserve of Meghalaya (Fig. 1), N. khasiana is intensively exploited by the garo tribal inhabitants for their medicinal use and as a source of income for their daily basic needs. They collect them from the nearby area and sell them to nearby markets for a cheap price, app. Rs. 20-30 per seedling plant. The powder of the roots and pitcher is applied in skin diseases, juice from unopened pitchers is used as eye-drops against eye diseases and the pitcher with the juice and crushed insects and administered to cholera patients [8]. A few years ago N. khasiana was naturally growing abundantly in the valley of Nokrek Biosphere Reserve [9].

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It still is abundant and it has a good a regeneration rate in the wild habitat of garo hills. Its ruthless exploitation for medicine and commercialization has reduced surrounding forests and forced the local inhabitants to travel several kilometers away from their villages for fuel, fodder and timber. Thus it is important to advise the villagers immediately to rehabilitate the existing forests of Nokrek Biosphere Reserve and to warn them of the possible scarcity of this species in the near future.

The few studies of *N. khasiana* which were carried out in the forests of Meghalaya show the dominance of *N. khasiana*. The anthropogenic disturbance was also reported to affect *N. khasiana*, [10-12]. In the tropical region the forests were rated according to the magnitude of anthropogenic disturbances (i.e., undisturbed, mildly disturbed and highly disturbed) and it was observed that highly disturbed forest were the ones where *N. khasiana* was intensively exploited for fodder, fuel and other necessary requirement by village garo people of Nokrek Biosphere Reserve. Taking into consideration the importance of *Nepenthes khasiana* as medicine and for other daily needs in the Nokrek Biosphere Reserve of the garo hills of eastern Himalaya and the present disturbance situation caused by human activities in its primary forest, the present research study was carried out in order to analyse the effect of human disturbance on *Nepenthes khasiana* in Nokrek Biosphere Reserve of the Meghalaya state.

**Methodology**

The paper reports the information on *Nepenthes khasiana* (Fig. 2) in the Nokrek Biosphere Reserve of the Meghalaya state, located in the garo hill district (25°15' to 25°29' North Latitude and 90°13' to 90°30' East Longitude) of eastern Himalaya. The temperature of the study area varies from 9.5 to 37.3°C, with March-May being the hottest and December-February being the coolest periods. Both the Southwest and the Northeast monsoon bring rain to the area ranging from 3900 to 6800 mm/year. The soil is mainly red loamy [13-14], and the area is drained by several perennial streams, which converge to form the one major river system viz., Brahmaputra. The great diversity in ecological features and the high range of altitude variation were responsible for the very rich and diverse vegetation of the area. It belongs to the Indo-malaya eco-region [15] with major vegetation types, namely, tropical forests (200-900 m) and subtropical forests (900-1412 m). The different disturbance factors in the forests of Nokrek
CONSERVATION STRATEGIES FOR NEPENTHES KHASIANA IN THE NOKREK BIOSPHERE RESERVE

Biosphere Reserve and adjacent areas (coal mining, limestone extraction, stone quarrying, jhum cultivation, fire, over-exploitation of *N. khasiana*, grazing and browsing, loss of agroforestry resources, pollution, invasion of new species, road and building constructions) of the garo hills of eastern Himalaya were visually observed, while studying the floral disturbances in the Nokrek Biosphere Reserve. The disturbance factors are mostly induced by human activities. *Nepenthes khasiana* is only growing in undisturbed forest patches in the Nokrek valley and its adjacent areas, which is an important source of traditional medicine and income for the villagers.

![Fig. 2. Nepenthes khasiana in the Nokrek Biosphere Reserve: a – wild habitat, b and c – growing seedling](image1)

**Results and Discussions** (Disturbance causes for *N. khasiana*)

The personally observed disturbances of *N. khasiana* in the Nokrek Biosphere Reserve and other parts of the Meghalaya state are mainly of the following types:

**a. Coal mining**

Extensive and unscientific coal mining activities (Fig. 3.) in the buffer areas of the Nokrek Biosphere Reserve have led to the increase in patchiness in the existing forest vegetation and to the creation of a landscape dotted with mine spoils [16]. Coal mining is performed in villages from the southern parts of the Nokrek Biosphere Reserve, which is very close to the core area of the BR. This is causing degradation and loss of vegetation cover, which ultimately results in loss of valuable plant species like *Nepenthes khasiana*, *Goniothalamus sesquipedalis*, *Citrus indica* and specific Cane and rattan species of Nokrek Biosphere Reserve.

![Fig. 3. Coal mining on the way to the Chokpot area in the Nokrek Biosphere Reserve](image2)
b. Limestone mining

Limestone mining activities (Fig. 4) are carried out in the southern range of the Nokrek Biosphere Reserve in the garo hills. Few limestone quarries are located near the boundary of the buffer zone of this BR. Chisingre and the way to the Chokpot area are sites rich in limestone. Many fossils like Shale, Starfish and primitive plant species are recorded during field tours to the buffer area of the Nokrek Biosphere Reserve (Fig. 5).

![Fig. 4. Limestone mining near the Chisingre area](image1)

![Fig. 5. Shale Fossils](image2)

c. Stone quarrying

Stone quarrying (Fig. 6) is one occupation of the tribal communities (garo, khasi & jaintia tribes) of the Meghalaya state of northeast India. Few stone grinding factories are seen near the Bandagre village and on the way the to Williamnagar side while recording the disturbances of the Nokrek Biosphere Reserve.

![Fig. 6. Stone quarrying factory in the Nokrek Biosphere Reserve](image3)

d. Shifting/Jhum cultivation

Shifting cultivation, locally called ‘Jhum’, is the primary occupation of the garo tribes living in and around the buffer area of the Nokrek Biosphere Reserve. They apply slash-and-burn methods for clearing forest patches. Extensive cutting and burning activities (Fig. 7) during Jhuming are the major biotic interference in the reserve area [17]. Those activities directly or indirectly affect the rich plant diversity and cause forest land degradation, habitat destruction and slowly deplete the biodiversity of the Nokrek Biosphere Reserve.
e. Forest fires
In the last few years, fire was recorded as one of the major causes with a severe impact on forest growth and regeneration in the Nokrek Biosphere Reserve. The repeated controlled fires in jhum fields and other forest floors may help regeneration by removing unwanted materials, but the intensity of uncontrolled fires damage whole trees/shrubs/herbs species of the reserve area. The effect of fire on *Nepenthes khasiana* were also recorded and it was noticed that sometime the controlled forest fires damage the primary habitat of this species along with others.

f. Over-exploitation of *N. khasiana*
The local garo tribes of the Nokrek Biosphere Reserve are not aware of the percent of floral diversity affected by lopping and other needs, and the suitability of growth thereof in the coming year without affecting its physiological needs. Thus, villagers remove whole crowns of the trees and shrubs for timber, fuel, fodder and other purposes, which in the following year never grow again and that will stop any further growth of the forests, especially when they do Jhum cultivation, and shorting of the Jhum cycle (3-5 years). When trees in the forest are beyond the reach of the villagers they remove saplings and poles for fuel and fodder, which causes permanent damage to the plant species. This affects the natural growth of the *Nepenthes khasiana* in the wild.

The garo tribes of the Nokrek Biosphere Reserve collect a large amount of *N. khasiana* from the wild habitat in the form of seedling and they sell it to the nearby town areas for their bread and butter. The regular extraction of *N. khasiana*, Orchids and other important medicinal plants from the wild habitat combined with Jhum cultivation are putting a lot of pressure on this biosphere reserve and a time may come when such species will disappear completely from this biodiversity rich area. Some studies undertaken to this biosphere reserve already suggested that the growing stock of *Nepenthes khasiana* with other important timber species has decreased due to their relentless exploitation. Topography, changes in soil properties and extensive human disturbance (like cutting, quarrying, and grazing) are considered the major factors influencing the vegetation composition of the Nokrek Biosphere Reserve. Phytosociological attributes showed that currently *Macaranga denticulata* (Fig. 8), *Saurauia punduana, Phoebe attenuata, Eurya acuminata, Schima wallichii*, etc. are some dominant plant species while, earlier the area was dominated by *Nepenthes khasiana, Calamus erectus, Citrus indica, Cinnamomum tamala* and many rare orchids.
g. Grazing and Browsing

Grazing and browsing of animals also plays an important role in reducing further growth of *N. khasiana*. Cows, goat, pigs, horses and many other animals are domesticated by garo tribes inhabiting the buffer area of the Nokrek Biosphere Reserve. Grazing animals remove newly grown saplings, affecting the regeneration process. The browsing animals mainly affect the growth of seedling/sapling by browsing over them and in time the plants stop growing.

h. Loss of agro-forestry resources

Many development activities of road constructions and footpath creation have changed the land pattern [18], which overburden with materials causing most of the agro-forestry trees form the area to die. The remaining trees cannot be used as fodder by villagers, due to the dust covering their leaves. Another disturbing aspect is that the grazing land gets converted to dumping sites and agro forestry land is also threatened. Therefore, the threat to the *N. khasiana* forest increases day by day.

i. Pollution

The air pollution, mainly dust, caused by running vehicles in border area of the buffer zone and the wind also affected the surrounding forest vegetation and human habitation areas, and slowly the growth of adjacent forest decreased, due to changes in the physiological activities of plants. Air pollution generally played a key role in changing the distribution of plant species and the ecology of susceptible plant communities in polluted regions. Air pollution also affects the biodiversity of the region. The local tribes and *Nokmas* of this reserve area believe that increasing pollution in Tura town is decreasing the natural growth of *Nepenthes khasiana*.

j. New invasive species

The changes in the area caused by developmental activities regularly affect the growth of native forests, the vegetation near human habitation areas and areas of agriculture/agro forestry. The invasive species such as *Lantana camara*, *Eupatorium odoratum*, *E. adenophorum*, *Mikania micrantha* (Fig. 9.), *Euphorbia hirta*, *Parthenium* sp., *Clerodendrum* sp. and many others are slowly and slowly colonizing the buffer area of the Nokrek Biosphere Reserve. Nevertheless, that invasion of new species may affect the growth of existing species in the future. Such invasive species may create demographic instability among the tree/shrub species and reduce tree/shrub diversity and can even change the structure of the forest of the Nokrek Biosphere Reserve in the near future. The presence of *Lantana camara* shrub as dense understorey perturbs the seedling recruitment of native tree species in the forest and that will lead to differential depletion of native trees.
k. Collection of Non-Timber Forest Products (NTFPs)

There is excessive collection of NTFP from the forest areas within the biosphere reserve. This causes depletion of local plant diversity in the area. Even today the garo villagers residing within the BR depend on their traditional medicinal practices for their well-being. Most of the medicinal plants are harvested from the wild. This causes a serious impact of the rare and threatened plant and animal species of the Nokrek Biosphere Reserve. The harvesting of Agar (*Aquilaria agallocha*) from the forests is a regular practice in the southern parts of the Nokrek Biosphere Reserve. This is causing a population decrease of this particular species from the area.

Lots of orchids are illegally smuggled out of the biosphere reserve and sold in nearby markets by the local garo villagers. This is really causing a degradation of this species. Most of the orchids are under the RET category and the destruction of the orchid species from their natural habitat causes the extinction of that particular species from the Nokrek Biosphere Reserve.

Bamboo is the secondary form of vegetation. In many places, especially in the southern range of the biosphere reserve, illegal cutting of bamboo species was reported while surveying the Nokrek Biosphere Reserve area (Fig. 10).

The Zingiberaceae family is abundant in the Nokrek Biosphere Reserve. Lots of Zingibers are under threat, due to unlimited extraction thereof from its natural habitat. People cut it for animal fodder, while flowers and fruits are used for cooking and also as spices.
The Nokrek Biosphere Reserve of the Meghalaya state in India has undisturbed forest areas which abode in endemic plant species like *Nepenthes khasiana*, *Citrus indica*, *Citrus latipes* and other vegetation. The disturbances in the Nokrek Biosphere Reserve will cause severe scarcity of *N. khasiana* and other species in the coming years. The tribal garo people inhabiting the villages in and around those hills depend on the forest for their daily needs. In India, the plant is used in treatment of urinary troubles when administered orally, and for redness and itching of the eye, cataract and night blindness if used as eye drops, and for treating stomach troubles, diabetes and cholera patients [19]. In many other parts of the region it was noted that the forests are managed by the villagers as 'Sacred Groves', locally called *Kanggimin Bol-Waarangni Biap* by the indigenous garo tribes. Those forests are relic patches of ancient forest, conserved by the tribal communities [20]. They believed that the spirits of the dead rest in peace in the forests and, therefore, they are considered sacred and left undisturbed. Those forests have a higher density of floral components, compare to the non-managed forests areas, and that because of the proper care in the managed area, provided by the garo villagers. Thus, considering the factors of disturbance for *N. khasiana*, the following conservation strategies could be helpful to minimize the losses of *N. khasiana* and of other valuable species in the future.

**Conservation strategies**

- Mining of coal and limestone should be completely stopped in transition zones of the reserve area. In buffer areas it could be done in proper scientific ways, so as to put less pressure on the forest areas where wild *N. khasiana* is growing.
- Awareness programmes for the villagers, about the importance of *N. khasiana*, need to be implemented. Literacy rate is very low in the Nokrek Biosphere Reserve, therefore, people should be made educated, which would help a lot in the conservation of the biological resources in that area.
- The garo village committee and other panchayat committees should implement some common rules in collaboration with the forest departments and with non-governmental organizations, for the protection and amelioration of the *N. khasiana* patches of the Nokrek Biosphere Reserve.
- The forest can be spread by plantation of valuable indigenous plant species, especially in coal mining and other degraded/wasteland areas.
- Special attention is needed for the protection of existing plant species, especially of seed bearing ones, for further regeneration.
- The forest resources should be used in a sustainable manner, for the sake of local the garo tribal people and of the national economy. There should be proper utilization of wild NTFPs from the reserve area, especially of wild medicinal and other economically important plants.
- A major initiative should be taken by the government by allotting demarcated forests areas to the villagers as village forest, thus motivating the garos to take special care for the protection and rehabilitation thereof and for sustainable resources. The forest department should help the tribal communities in preserving the ancient forest patches like sacred groves, so as to maintain the natural biological diversity of such forests.
- The wildlife authorities should pay special attention to the compensatory afforestation programme for the benefit of local garo tribes and should restore the lost forest areas to compensate the local affected people for their loss.
- The traditional Jhum cultivation practices should be done, but the Jhum cycle should be increased to 10-12 years, as this will help the soil to regain its lost fertility.
Conclusions

We conclude that the disturbance factors, as observed in the Nokrek Biosphere Reserve of the Meghalaya state, Northeast India, are constantly reducing the wild population of *N. khasiana* and if the necessary conservation strategies are not implemented immediately, those factors will wipe out the entire species from those hills in the near future, which would be a great loss for the Nokrek Biosphere Reserve.

Abbreviations

NBR = Nokrek Biosphere Reserve; NTFPs = Non Timber Forest Products; RET = Rare, Endangered and Threatened category. Kanggimm Bol-Waarangni Biap = garo tribal word meaning forefather spirit resides in the forest patches or sacred groves which help the local tribals from the natural calamities like flood, epidemic, etc.

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HARPULLIA ARBOREA (BLANCO) RADLK.-
A NEW RECORD TO MEGHALAYA

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Abstract: Harpullia arborea (Blanco) Radlk., is collected for the first time from Nokrek Biosphere Reserve, Meghalaya and is reported as a new record for the state.

INTRODUCTION

The genus Harpullia Roxb. (Sapindaceae) comprises of ca 37 species (Daniel, 2005), widely distributed from Indo-Malayan, Tropical Australia and New Caledonia. Only 2 species, viz., Harpullia arborea Blanco Radlk. and Harpullia cupanoides Roxb., are reported from India (Singh et al., 2000). A perusal of literatures viz., Kanjilal et al. (1934-40), Joseph (1968), Balakrishnan (1981-83) and Haridasan and Rao (1985-87), followed by herbarium studies revealed it as a new record for the state of Meghalaya.

A detailed taxonomic account of the species along with photographs, illustration (Fig. 1) and the distinction between the allied species i.e. H. cupanoides Roxb. have been provided to facilitate easy identification of the species in the field. The specimens are housed at ASSAM, Shillong.


Large canopy tree, evergreen, 15-20 m high; bole straight, cylindric, 40-60 cm in diam., straight, slightly buttressed; young parts densely tomentose; bark greyish, postular, aromatic; blaze one layer, yellowish white, fibrous in nature. Leaves compound, alternate and spiral, paripinnate or imparipinnate (Singh et al. 2000), exstipulate, up to 45 cm long, single at node, without a terminal leaflet; leaflets opposite or subopposite, sometimes alternate, 2-6 pairs, elliptic or oblong-lanceolate, broadest at middle, 8-16 x 2-6 cm, acute to rounded at apex, sometimes abruptly acuminate, base equal on both sides to oblique, entire along margin; midrib flat above, secondary veins prominent, oblique, widely parallel, tertiary veins reticulate, both surfaces glossy, sparsely hairy on nerves beneath; petioles 5-12 cm long. Inflorescence axillary, sometimes pseudo-terminal racemes or panicles, 14-18 cm long. Flowers on unbranched axis, unisexual, greenish; sepals 4 or 5, oblong-ovate to oblong-lanceolate, free; petals 5, distinctly clawed, spatulate, free, margin ciliate; stamens 5 or 7, dull pale green; ovary superior, 2 locular; style free, pale brown to pinkish. Capsules dehiscent, ellipsoid, obovoid or globular, inflated, 5-5.3 x 2.8-3.5 cm, coriaceous, fleshy, orange to red, loculicidally 2-valved. Seeds 2, black, enclosed at the base with deeply lobed small orange annular aril.

Flowers & Fruits: February-August.

Habitat: Rare in or on the margins of tropical evergreen forests in the Nokrek Biosphere Reserve.

Distrib: INDIA (Andaman Islands, Assam, Maharashtra, Meghalaya, Karnataka, Kerala and Tamil Nadu), AUSTRALIA, BANGLADESH, CHINA, JAVA, LAOS, MALESIA, MYANMAR, SRI LANKA, THAILAND AND VIETNAM.


Uses: Garos of Nokrek use young bark for fish poisoning. Watery exudate from bark and fruit is used

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to keep away leeches (Daniel, 2005). Oil extracted from seeds is antirheumatic (Singh et al., 2000).

Notes: Harpullia arborea (Blanco) Radlk. is often confused with *H. cupanoides* Roxb. due to their similar habit and leaf characters. However, *H. arborea* (Blanco) Radlk. may be distinguished by hairy sepals; petals distinctly clawed and auricled and seeds with small annular aril. *H. cupanoides* Roxb. has glabrous sepals; petals thin fleshy, neither clawed nor auricled like the former ones and seeds almost enveloped by the aril.

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The authors are thankful to the Director, Botanical Survey of India, Kolkata for encouragement and facilities. Authors are also thankful to the Ministry of Environment and Forests, New Delhi for financial assistance.

REFERENCES


The paper deals with wild edible plants of Nokrek Biosphere Reserve, Meghalaya used by the Garo tribes. It comprises of 71 species under 61 genera and 42 families. Of which 38 species are used as vegetable and 33 species edible as raw or cooked. All plants are arranged alphabetically in the tabular form, followed by families, vernacular name(s), plant part(s) used and methodology.

**Keywords:** Wild edible plants, Nokrek Biosphere Reserve, Garo tribes, Meghalaya

**IPC Int. Cl.** A61K 36/00, A01G 1/00, A01G 17/00, A47G 19/00, A23L 1/06, A23L 2/02

The Meghalaya state, approximately 22,429 km² in area, lies between the latitudes of 25°47'N to 26°10'N and the longitudes of 89°45'E to 92°45'E, with an altitude ranging from 100-1,965 m above sea level. It is one of the wettest place on earth, with a total forest area of ca 16,839 km² (forest cover 75.08%), and has an estimated population of about 23,57,510 with a density of 104 person per sq km². Ninety percent of the total area of the state is owned by the tribal communities. The Khasi, Garo and Jaintia are the three principal tribes reside in the state. Garo tribes are the main inhabitant of the Garo districts, believed to be member of Tibet-Burman family. They have two divisions, one inhabits the hilly mountains, and others live in the plain areas. There are 12 main divisions of the hill Garos and 6 of the plain Garos. Their divisions are made according to certain task assigned to them which distinguished their names such as, the Abengs were told to pick cotton, the Kochus to prepare dried fish, the Chiksaks to collect edible bamboo-shoots and so on. Local tribes within the reserve maintain their terrestrial jurisdiction among the clan Akhing. There are all together 26 clans in Garo districts. They are Christian by faith, and their society is matrilineal, inheritance is through the mother. Besides this tribe, Koches, Rabhas, Hajjongs and Banars are also residing in the Garo district.

Nokrek Biosphere Reserve (NBR) was established on 13th September, 1988 under the UNESCO’s Man and Biosphere (MAB) program, lies between 25°15' N to 25°29' N latitudes and 90°13' E to 90°30' E longitudes, is located in the western parts of the Meghalaya. It comprises of total 820 sq km of which 47.48 sq km is central core zone surrounded by a buffer zone of 772.52 sq km. It is one of the rich hot spot biodiversity area surrounded by Khasi hills (Meghalaya) in the East, Assam in North and West, and Bangladesh in the South.

The extensive ethnobotanical work have been done on various tribes such as Khasi, War Jaintia, Adis, Karbi, Pnar, Mikir, Apatanis, Nyshis, Monpas, Hill Miris, Yobins and Khampits Hill Miris, Yobins and Khampits of North-east India, there are very few published records on ethnobotany of Garo tribes. However, a lot of floristic assessment works have been done in Meghalaya. Floristic work in NBR has been carried out by the authors at Botanical Survey of India, Eastern Regional Circle, Shillong, and collected, processed of 1500 different plant samples as per Jain & Rao herbarium technique, and housed at ASSAM herbarium. In this context an attempt has been made to give the information regarding wild food plants used by the Garos which is gathered during our survey work.
Methodology

General basic informations on Garo tribes collected from the State Forests Department, Shillong and from forest officials of the Nokrek Biosphere Reserve. For the ethno-botanical record, discussions were held at Daribokgre, Chokpot, Nabokgre, Chandigre and Williamnagar with the headman’s (Nokma’s) of surrounding villages, medicine man (Priest, Kobiras) and head of the family (Nokni Skotong). During the meetings, information on wild edible plants, their local names, plant parts used, and methodology were recorded. Nine field trips in different seasons (2007-2010) were undertaken for collection of plant samples along with the photographs and GPS data. Herbarium sheets were prepared following standard methods. The authors of scientific names and abbreviations followed for authors of plant names. The voucher specimens deposited in ASSAM herbarium, Shillong.

Results and discussion

The result deals with 71 wild edible plant species under 61 genera and 42 families being taken by Garo tribes as food. Of which they consumes rhizomes, corms and tubers of 8 species; barks of 1 species; stem piths, tender shoots and fronds of 9 species; leaves and twigs of 21 species; flowers/flower-buds and inflorescence of 2 species; fruits/pods of 25 species; seeds, nuts, skin, kernels of 3 plant species; whole parts of 2 plant species. The all edible plants are arranged alphabetically in the tabular form, followed by families, vernacular name(s) and used the plant part(s), and methodology used by the local inhabitants (Table 1) (Figs. 1-12).

Table 1—Wild edible plants used by Garo tribes of Nokrek Biosphere Reserve in Meghalaya, India

<table>
<thead>
<tr>
<th>Plant name (Family)</th>
<th>Garo name</th>
<th>Parts utilize</th>
<th>Mode of uses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alpinia malaccensis (Zingiberaceae)</td>
<td>Gong</td>
<td>Rhizomes</td>
<td>Cooked as vegetable.</td>
</tr>
<tr>
<td>Amblyanthus glandulosus A.D.C. (Myrsinaceae)</td>
<td>-</td>
<td>Twigs</td>
<td>Cooked as vegetable.</td>
</tr>
<tr>
<td>Amorphophallus bulbifera (Roxb) Blume (Araceae)</td>
<td>Taa</td>
<td>Corms</td>
<td>Cooked as vegetable.</td>
</tr>
<tr>
<td>Aporusa octandra (Buch.-Ham. ex D.Don)</td>
<td>Chhambolji</td>
<td>Fruits</td>
<td>Ripe yellow fruits are eaten raw.</td>
</tr>
<tr>
<td>A.R.Vickery (Euphorbiaceae)</td>
<td>-</td>
<td>Fruits</td>
<td>Ripe fruits eaten raw.</td>
</tr>
<tr>
<td>Ardisia solanacea Roxb. (Myrsinaceae)</td>
<td>Nagri</td>
<td>-</td>
<td>Cooked as vegetable.</td>
</tr>
<tr>
<td>Artemisia indica Wild. (Asteraceae)</td>
<td>Phraphrakkhurbijk</td>
<td>Tender shoots</td>
<td>Fried in oil and taken as vegetable.</td>
</tr>
<tr>
<td>Asparagus racemosus Willd (Liliaceae)</td>
<td>Kizhangu</td>
<td>Tubers</td>
<td>Eaten raw as fruits.</td>
</tr>
<tr>
<td>Baccaurea ramiflora Lour. (Euphorbiaceae)</td>
<td>Kojuka</td>
<td>Fruits</td>
<td>Fruit eaten with salt, prickle prepared.</td>
</tr>
<tr>
<td>Bauhinia purpurea L. (Caesalpinaceae)</td>
<td>Bol-Megong</td>
<td>Twigs</td>
<td>Cooked as vegetable.</td>
</tr>
<tr>
<td>Begonia roxburghii (Miq.) A.D.C. (Begoniaceae)</td>
<td>Kamchahal</td>
<td>Leaves/petioles</td>
<td>Cooked as vegetable, petioles eaten raw by peeling off outer skin.</td>
</tr>
<tr>
<td>Briedelia retusa (L.) A.Juss. (Euphorbiaceae)</td>
<td>Mangritchok</td>
<td>Fruits</td>
<td>Ripe fruits eaten raw.</td>
</tr>
<tr>
<td>Buddleja asiatica Lour. (Buddlejaceae)</td>
<td>Sonme-bat</td>
<td>Barks</td>
<td>Chewed.</td>
</tr>
<tr>
<td>Calamus erectus Roxb. (Arecaceae)</td>
<td>Soknil</td>
<td>Fruits</td>
<td>Ripe fruits eaten raw.</td>
</tr>
<tr>
<td>Canthium dicoccum (Gaertn.) Tejsh. &amp; Binn. (Rubiaceae)</td>
<td>Teckieh-king</td>
<td>Fruits</td>
<td>Ripe fruits eaten raw.</td>
</tr>
<tr>
<td>Canthium parvifolium Roxb. (Rubiaceae)</td>
<td>Bol-thing</td>
<td>Fruits</td>
<td>Ripe fruits eaten raw.</td>
</tr>
<tr>
<td>Caryota urea L. (Arecaceae)</td>
<td>Chowa gach</td>
<td>Stem pith</td>
<td>Boiled, mixed with rice and cooked.</td>
</tr>
<tr>
<td>Chlorophytum arundinaceum Baker (Liliaceae)</td>
<td>Bol kyian</td>
<td>Twigs</td>
<td>Cooked as vegetable.</td>
</tr>
<tr>
<td>Chlorophytum khasianum Hook.f. (Liliaceae)</td>
<td>Bol chankso</td>
<td>Twigs</td>
<td>Cooked as vegetable.</td>
</tr>
<tr>
<td>Citrus indica Tanaka (Rutaceae)</td>
<td>Minang-Narang</td>
<td>Fruits</td>
<td>Ripe fruits are sour, eaten raw with salt.</td>
</tr>
<tr>
<td>Clausena excavata Burm.f. (Rutaceae)</td>
<td>Sam-sweng</td>
<td>Leaves</td>
<td>Cooked as vegetable in curries.</td>
</tr>
<tr>
<td>Clerodendrum wallichii Merr. (Verbenaceae)</td>
<td>Medongdi</td>
<td>Leaves</td>
<td>Cooked as vegetable.</td>
</tr>
<tr>
<td>Commelina benghalensis (L.) Schott (Commelinaceae)</td>
<td>-</td>
<td>Leaves</td>
<td>Cooked as vegetable.</td>
</tr>
<tr>
<td>Debregeasia retusa Roxb. (Urticaceae)</td>
<td>Bol-tysim</td>
<td>Fruits</td>
<td>Ripe fruits eaten raw.</td>
</tr>
<tr>
<td>Dendrocalamus hamiltonii Nees &amp; Arn. ex Munro (Poaceae)</td>
<td>Wanok</td>
<td>Tender shoots</td>
<td>Local food Me‘A prepared, also cooked as vegetable with dry fish.</td>
</tr>
<tr>
<td>Dioscorea oppositifolia L. (Dioscoreaceae)</td>
<td>Thabisa</td>
<td>Tubers</td>
<td>Cooked as vegetable.</td>
</tr>
<tr>
<td>Plant name (Family)</td>
<td>Garo name</td>
<td>Parts utilize</td>
<td>Mode of uses</td>
</tr>
<tr>
<td>--------------------</td>
<td>-----------</td>
<td>---------------</td>
<td>--------------</td>
</tr>
<tr>
<td>Dioscorea pentaphylla L. (Dioscoreaceae)</td>
<td>Stenz</td>
<td>Tubers</td>
<td>Cooked as vegetable.</td>
</tr>
<tr>
<td>Dracaena spicata Roxb. (Agavaceae)</td>
<td>-</td>
<td>Tubers</td>
<td>Cooked as vegetable.</td>
</tr>
<tr>
<td>Drymaria cordata (L.) Wild. ex Roem. &amp; Schult. (Caryophyllaceae)</td>
<td>Samisthalap</td>
<td>Whole plant</td>
<td>Eaten raw.</td>
</tr>
<tr>
<td>Elaeagnus conferta Roxb. (Elaeagnaceae)</td>
<td>Sukhwa</td>
<td>Fruits</td>
<td>Ripe ones eaten raw, used in making prickles, sold in local market.</td>
</tr>
<tr>
<td>Elastostema dissectum Wedd. (Urticaceae)</td>
<td>Khlow</td>
<td>Leaves</td>
<td>Cooked as vegetable.</td>
</tr>
<tr>
<td>Entada theedei Spreng. (Fabaceae)</td>
<td>Bolchhak chhan</td>
<td>Seeds</td>
<td>Boiled, sliced and mixed with gram and eaten as vegetable.</td>
</tr>
<tr>
<td>Eurya acuminata DC. (Theaceae)</td>
<td>Murrura</td>
<td>Tender shoots</td>
<td>Cooked in oil and eaten as vegetable.</td>
</tr>
<tr>
<td>Fagopyrum dibotrys (D.Don) Hara. (Polygonaceae)</td>
<td>Sambodom bong</td>
<td>Shoots</td>
<td>Tender ones are cooked as vegetable.</td>
</tr>
<tr>
<td>Ficus auriculata Lour. (Moraceae)</td>
<td>Kakbal-takakasing</td>
<td>Fruits</td>
<td>Eaten raw.</td>
</tr>
<tr>
<td>Ficus hispida L.f. (Moraceae)</td>
<td>Thwek, Sakhap</td>
<td>Leaves</td>
<td>Cooked as vegetable.</td>
</tr>
<tr>
<td>Ficus religiosa Miq. (Moraceae)</td>
<td>Prap</td>
<td>Fruits</td>
<td>Ripe ones eaten raw.</td>
</tr>
<tr>
<td>Ficus subinscia Buch.-Ham. ex J.E. Sm. (Moraceae)</td>
<td>Bol matap</td>
<td>Leaves</td>
<td>Cooked as vegetable.</td>
</tr>
<tr>
<td>Flemingia vestita Baker (Fabaceae)</td>
<td>Bol phiang</td>
<td>Tubers</td>
<td>Eaten raw.</td>
</tr>
<tr>
<td>Garcinia kydia Roxb. (Chusiaeae)</td>
<td>Tekra, Denga dati</td>
<td>Fruits</td>
<td>Eaten raw.</td>
</tr>
<tr>
<td>Gmelina arborea Roxb. (Verbenaceae)</td>
<td>Bol-lophiang</td>
<td>Flowers</td>
<td>Cooked as vegetable.</td>
</tr>
<tr>
<td>Grewia nervosa (Lour.) Panigr. (Tiliaceae)</td>
<td>Gansari, Prolmango</td>
<td>Fruits</td>
<td>Ripe ones eaten raw.</td>
</tr>
<tr>
<td>Hodgsonia macrocarpa (Blume) Cogn. (Cucurbitaceae)</td>
<td>Kagoab, Thibe</td>
<td>Seeds</td>
<td>Cooked and eaten as vegetable.</td>
</tr>
<tr>
<td>Homalium cordata Thunb. (Saururaceae)</td>
<td>Jamyndoh</td>
<td>Leaves</td>
<td>Eaten raw, also cooked as vegetable.</td>
</tr>
<tr>
<td>Medinilla erythrophylla Lindl. (Melastomaceae)</td>
<td>Megong aphas</td>
<td>Leaves</td>
<td>Cooked as vegetable.</td>
</tr>
<tr>
<td>Melastoma malabathricum L. (Melastomataceae)</td>
<td>Bol-Kakkha</td>
<td>Fruits</td>
<td>Ripe fruits eaten raw.</td>
</tr>
<tr>
<td>Melodinus monogynus Roxb. (Apocynaceae)</td>
<td>Bakwe</td>
<td>Fruits</td>
<td>Orange coloured ones are eaten.</td>
</tr>
<tr>
<td>Meyna spinosa Roxb ex Link (Rubiaeae)</td>
<td>Theksine</td>
<td>Fruits</td>
<td>Ripe fruits eaten raw.</td>
</tr>
<tr>
<td>Mucuna bracteata Roxb.</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Mucuna pruriens DC. ex Kurz (Fabaceae)</td>
<td>Wakmu</td>
<td>Seeds</td>
<td>Cooked and eaten as vegetable.</td>
</tr>
<tr>
<td>Murraya koinigi (L.) Spreng. (Rutaceae)</td>
<td>Nolsing, Sam-khasi</td>
<td>Leaves</td>
<td>Cooked as vegetable.</td>
</tr>
<tr>
<td>Mussaenda roxburghii Hook.f. (Rubiaeae)</td>
<td>Gardek</td>
<td>Twigs</td>
<td>Young twigs cooked as vegetable.</td>
</tr>
<tr>
<td>Myrica esculenta Buch.-Ham. ex D.Don (Myricaceae)</td>
<td>Bol-sohila</td>
<td>Fruits</td>
<td>Red to pink ones are sour, eaten with salt, sold in local market.</td>
</tr>
<tr>
<td>Neocinnamomum caudatum (Wall. ex Nees) Merr. (Lauraceae)</td>
<td>Makbil Teangk, Sami-jang</td>
<td>Fruits</td>
<td>Red fruits are eaten raw.</td>
</tr>
<tr>
<td>Neohyperolea cordifolia (L.) C.Presl (Nepplorpidiaceae)</td>
<td>Shusni shak</td>
<td>Tubers</td>
<td>Matured tubers eaten raw.</td>
</tr>
<tr>
<td>Oxalis corniculata L. (Oxalidaceae)</td>
<td>Khiahka</td>
<td>Whole plants</td>
<td>Eaten raw, also cooked as vegetable.</td>
</tr>
<tr>
<td>Phlogacanthus thyrsiflorus (Roxb.) Buch.-Ham. ex D.Don (Polygonaceae)</td>
<td>Elliot</td>
<td>Inflorescence</td>
<td>Cooked as vegetable.</td>
</tr>
<tr>
<td>Polygonum capitatum Buch.-Ham. ex D.Don (Polygonaceae)</td>
<td>Sambodom-bong</td>
<td>Twigs</td>
<td>Cooked with potato as vegetable.</td>
</tr>
<tr>
<td>Polygonum nepalense Meisn. (Polygonaceae)</td>
<td>Acharak</td>
<td>Tender shoots</td>
<td>Cooked as vegetable.</td>
</tr>
<tr>
<td>Pteridium aquilinum (L.) Kuhn (Pteridaceae)</td>
<td>Shatri</td>
<td>Tender fronds</td>
<td>Cooked in oil, sold in local markets.</td>
</tr>
<tr>
<td>Rubus acelofolia Poir. (Rosaceae)</td>
<td>Tikisambak</td>
<td>Fruits</td>
<td>Ripe fruits eaten raw.</td>
</tr>
<tr>
<td>Rubus rugosus Sm. (Rosaceae)</td>
<td>Thekhi-sambak</td>
<td>Fruits</td>
<td>Ripe fruits eaten raw.</td>
</tr>
<tr>
<td>Sarcochlamys pulcherrima (Roxb.) Gaud. (Urticaceae)</td>
<td>Mechaki</td>
<td>Tender shoots</td>
<td>Cooked with pork meat as vegetable.</td>
</tr>
<tr>
<td>Sauraula nepaulensis DC. (Actinidiaceae)</td>
<td>Gungsning</td>
<td>Fruits</td>
<td>Ripe fruits eaten raw.</td>
</tr>
<tr>
<td>Sonchus aspera (L.) Hill (Asteraceae)</td>
<td>Thamhui</td>
<td>Leaves</td>
<td>Cooked as vegetable.</td>
</tr>
<tr>
<td>Sonchus vulgaris DC. (Asteraceae)</td>
<td>Thamhui</td>
<td>Leaves</td>
<td>Young leaves eaten raw.</td>
</tr>
<tr>
<td>Sisus suaveolens (Roxb.) Pierre (Capparaceae)</td>
<td>Narungchi</td>
<td>Fruits</td>
<td>Ripe fruits eaten raw.</td>
</tr>
<tr>
<td>Syzygium dioxyphyllum (Wall. ex Duthe) S.N.Mitra (Myrtaceae)</td>
<td>Panchmal</td>
<td>Skins</td>
<td>Skin parts of matured fruits are peeled and eaten.</td>
</tr>
<tr>
<td>Syzygium praeocum (Roxb.) Rathakr. &amp; N.C. Nair (Myrtaceae)</td>
<td>Jongchhatchathbudu</td>
<td>Fruits</td>
<td>Ripe fruits eaten raw.</td>
</tr>
<tr>
<td>Thunbergia grandiflora Roxb. (Thunbergiaceae)</td>
<td>Khakhhu</td>
<td>Leaves</td>
<td>Cooked as vegetable.</td>
</tr>
<tr>
<td>Zanthoxylum rhetsa (Roxb.) DC. (Rutaceae)</td>
<td>Shumeccheng</td>
<td>Leaves</td>
<td>Cooked as vegetable.</td>
</tr>
</tbody>
</table>
For vegetable purpose they are using 38 species, viz. Alpinia malaccensis, Amblyanthus glandulosus, Amorphophallus bulbifer, Artemisia indica, Baliospermum micranthum, Bauhinia purpurea, Begonia roxburghii, Chlorophytum arundinaceum, Chlorophytum khasianum, Clausena excavata, Clerodendrum wallichii, Commelina benghalensis, Dendrocalamus hamiltonii, Dioscorea oppositifolia, Dioscorea pentaphylla, Dracaena spicata, Elastostema dissectum, Entada rheedei, Eurya acuminata, Fagopyrum dubotrys, Ficus hispida, Ficus subincisa, Gmelina arborea, Hodgsonia macrocarpa, Houttuynia cordata, Medinilla erythrophylla, Mucuna bracteata, Murraya koenigi, Mussaenda roxburghii, Oxalis corniculata, Phlogacanthus thyrsiflorus, Polygonum capitatum, Polygonum nepalense, Begonia roxburghii, Chlorophytum arundinaceum, Drymaria cordata, Elaeagnus conferta, Ficus auriculata, Ficus oligodon, Flemingia vestita, Garcinia kydia, Grewia nervosa, Melastoma malabathricum, Melodinus monogynus, Meyna spinosa, Myrca esculenta, Neocinnamomum caudatum, Nephrolepis cordifolia, Piper thomsonii, Rubus alcefolius, Rubus rugosus, Saurauia nepaulensis, Stixis suaveolens, Syzygium diospyrifolium and Syzygium praeox. Stem pith of 1 species viz. Caryota urens is cooked as food along with rice, whereas young leaves of 1 species, viz. Sonchus wightianus is eaten raw by Garo tribes.

Due to urbanization and fast developmental activities in this area, the traditional knowledge on the use of plants by Garo tribals is fast vanishing. Therefore it is an urgent need to document the traditional knowledge, or otherwise it will be lost forever. The conservation efforts of tribals in Garo hills need to be recognized and rewarded suitably. It is hoped that the study will lead to revitalization of the in-situ and ex-situ conservation of plant species of the study site.

Acknowledgement

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Contribution to the pteridophytic flora of India: Nokrek Biosphere Reserve, Meghalaya

Bikarma Singh1, V.N. Singh2, S.J. Phukan3, B.K. Sinha4 & S.K. Borthakur5

INTRODUCTION

Nokrek National Park or Nokrek Biosphere Reserve is a national park located approximately 40km from Tura town in West Garo Hills district of Meghalaya, India. UNESCO added this national park to its list of biosphere reserves in May 2009. The Nokrek range of hills situated at the eastern-most tip of the eastern Himalaya is notable for its very rich and diverse luxuriant vegetation, dotted with a high concentration of endemics as well as rare, endangered and threatened plants. It is considered to be a gene pool of Citrus species in the northeastern states of India, and the cultural meeting point of three Garo districts of Meghalaya State; rich in myths, folk traditional knowledge, biodiversity and associated cultural tribal practices. These Garo Hills form the major peaks (Nokrek Peak and Tura Peak), towards the tail end of Assam, before they abruptly fall into the low hills of Bangladesh. This is a compact range of hills with the main range descending equally steeply to all the three Garo Hills District of Meghalaya. The dense forests of these hills provide a home for many narrow endemics of phytogeographical significance, such as Vanda coerulaea Griff. ex Lindl., Nepenthes khutiana Hook.f. and Citrus indica Tanaka species. Considering the immense need for conservation, the area is protected as a biosphere reserve since 1988. The angiosperm flora of the area has largely been explored by the Botanical Survey of India, Eastern Circle, Shillong which recorded more than 1000 species, the herbarium specimens are housed in Assam. Of these more than 51 are endemics

MATERIALS AND METHODS

Study area

The Nokrek proper, with its northern and western slopes, forms a compact block of hilly ranges towards the northern and western end of the Garo Hills and belongs to the three Garo districts of Meghalaya State; the southern slope falls into the plains of Bangladesh. The area is believed to be the abode of the Garo tribal community, belonging to the Tibeto-Chinese family of the Tibeto-Burman subfamily of the Bodo group, who live in about 132 villages situated in and around Nokrek (Tripathi et al. 2008). The people have conserved some forest patches as ‘sacred groves’ and thus this hilly area is considered sacred, and a symbol of conservation with deep cultural imprints of traditional beliefs. Topographically, the area steeply descends from all sides of the highest peak the Nokrek Peak, with an altitude of 1412m. A major portion of the area belongs to the Nokrek National Park and Citrus Wildlife Sanctuary, and the rest is in the reserved forests of the Garo wildlife forest division. The IUCN has identified Nokrek and its environs to be one of the three centers of plant diversity within India, and focused on the need for immediate conservation (IUCN 1987). The Nokrek Biosphere Reserve was also internationally recognized within the framework of UNESCO’s Man and Biosphere (MAB) programme in 2009.

The temperature varies from 9.5–37.3 °C, typical of Assam, March–May being the hottest and December–February being the coolest months. Both south-west and northeastern monsoons bring rain to the area ranging from 3900 to 6800 mm/year. The soil is mainly red loamy and the area is drained by several perennial streams, which collect to form one major river system viz., Brahmaputra. The great diversity in ecological features and the high range of altitudinal variation are responsible for the very rich and diverse vegetation of the area. It belongs to the Indo-Malayan eco-region (Olson et al. 2001) with the major vegetation type: tropical forests (200–900 m) and subtropical forests (900–1412 m). The soil is very shallow and vegetation becomes active mainly after the monsoons and may dry up in the southern slopes during the dry season. There is a clear demarcation of vegetation types based on the altitudinal range. The Nokrek Biosphere Reserve, between 25°15′–25°29′N and 90°13′–90°30′E, was established on 13 September 1988 (vide Govt. of India, MoEF Order No. 27/59/81-C5 dt. 13 September 1988) with an area of about 8,20km², of which 47.48km² (vide Govt. of Meghalaya Notification No. FOR.23/86/316 dated 23.10.1997) is the core area (Fig. 1). The NBR straddles the border of Assam State and Bangladesh. It is composed of Citrus Gene Pool Sanctuary and Mahseer Hatchery Centre and their adjoining areas of Halladang, Dhalbubi, Darugiri and Rongrengiri ranges of Garo Hills Forest Divisions. It is the habitat of many varieties of medicinal plants, wild edible plants and plants of other economic importance (Images 1 & 2). The area is similarly rich in faunal elements also with a large number of birds, butterflies, amphibians and reptiles. The rare mammals of the area include the Hoolock Gibbon, Asian Elephant, Gaur, Leopard, Sambar, Barking Deer, Malayan Bear, Assamese Macaque, Rhesus Macaque, Giant Squirrel, Slow Loris, Himalayan Palm Squirrel, Hare, etc. The Nokrek is also notable for being the home of the Garos, one of the hilly tribes, who have a thorough knowledge of the local biodiversity, its utilization potentials and with many cultural practices unique to them. According to the Garos of Nokrek, there is also a mammal locally called Badamanu-big feet man, in the core area, but not evidenced.

The pteridophyte specimens were collected from 2006 to 2010 and deposited in Assam Herbarium at the Botanical Survey of India, Eastern Circle, Shillong. The families are arranged alphabetically. Each species is listed with author citation (Brummitt & Powell 1992) followed by the field observations on the habitat on which it was found growing in the study area, the locality, altitude, the collector’s name (acronyms: BS - Bikarma Singh; VNS - V.N. Singh; BKS - B.K. Sinha; DBD - D.B. Deb; RS = R. Shanpru; GP - G. Panigrahi; MKVR - M.K.V. Rao), collection number,
and comments on the distribution of the species.

RESULTS

Fern-allies

Equisetaceae

*Equisetum diffusum* D. Don. (Image 3): Terrestrial near the river in sandy loamy soil. Near river Didari from Daribogre (963m), VNS & BS 114552 (Assam). Although this species is very common in Nokrek, it is a new record for the Garo District. It is widely distributed in India (Arunachal Pradesh, Assam, Andaman Islands, Meghalaya, Kerala, Sikkim, Tamil Nadu), Bangladesh, China, Myanmar, Nepal and Sri Lanka.

*Equisetum ramosissimum* Desf. subsp. *debile* (Roxb. ex DC.) Hauke: Terrestrial near the river in sandy loamy soil. Rongsingiri (350m), VNS & BS 115886 (Assam). It is rare in Nokrek, and recorded only from Rongsingiri Village in this biosphere reserve. It is distributed in northeastern India (Arunachal Pradesh, Assam, Meghalaya), Bangladesh, China and Nepal.
Huperziaceae

*Huperzia hamillonii* (Sprang) Trev.: Epiphyte on rotten tree trunks in shady and wet places. Nokrek Peak (1150m), VNS & BS 114711 (Assam). Rare in high altitude areas of Nokrek. Widely distributed in India (Arunachal Pradesh, Sikkim, Assam, Andaman Islands, Meghalaya, Kerala, Tamil Nadu), Australia, China, Malaysia, Myanmar, New Zealand and Sri Lanka.

*Huperzia phlegmaria* (L.) Rothm. (Image 4): On moss deposits on tree trunks in wet places. Nokrek Peak (1312m), VNS & BS 118573 (Assam). This species is rare in Nokrek, and is also very rare in Meghalaya State (Baishya & Rao 1982). Chandra et al. (2008) considered this species under the rare category. This species is distributed in India (Andaman Islands, Arunachal Pradesh, Assam, Kerala, Meghalaya, Sikkim, West Bengal), Australia, Bhutan, Myanmar and New Zealand.

Lycopodiaceae

*Palhinhaea cernua* (L.) A. Franco. & Vasc.: Epiphytic on decaying tree trunks in moist places. Way to Khalakgre (1062m) VNS & BS 114765 (Assam). It is very common in Nokrek, and distributed widely in northeastern India (Arunachal Pradesh, Assam, Meghalaya, Sikkim), southern India (Kerala, Karnataka), Australia, China, Nepal, Myanmar, New Zealand and Sri Lanka.

Selaginellaceae

*Selaginella decipiens* Warb. (Image 5): Terrestrial in wet places. Way to Nokrek Peak (1200m), VNS & BS 114762 (Assam). Occasionally found growing in the dense forests of Nokrek, and recorded for the first time in Garo Hill District. It is distributed in northeastern India (Sikkim, Darjeeling, Meghalaya, Manipur), southern India (Tamil Nadu, Kerala), Nepal, Myanmar, Thailand and Vietnam.

*Selaginella delicatula* Alston.: Terrestrial in wet places. Way to Daribokgre (782m) BS & VNS 115837 (Assam). Very common in Nokrek. It is widely distributed in northeastern India (Assam, Arunachal Pradesh, Meghalaya), China, Nepal and Myanmar.

*Selaginella helferi* Warb.: Terrestrial in wet places in dense forests. Way to Chandigre (512m) VNS & BS s.n. (Assam 74674). Very common in Nokrek. This species is distributed in India (Assam, Kerala, Meghalaya, Sikkim, Tamil Nadu), Bangladesh, China, Nepal, Myanmar and Sri Lanka.

*Selaginella hookeri* Baker: Terrestrial in moist places. Daribokgre (809m) VNS & BS 114759A (Assam). The species is recorded only from Daribokgre and is a new record for the Garo District. It is widely distributed in northeastern India (Arunachal Pradesh, Assam, Meghalaya, Nagaland), Bangladesh, China and Nepal.

*Selaginella involvens* (Sw.) Spring. Terrestrial as
well as lithophytic in wet places. Niengamandalgre to Simsanggre (300–950 m) VNS & BS 116894 (Assam), Tura Peak (850m) DBD 28914 (Assam). It is recorded to be rare in Nokrek, and is a new record for Meghalaya, although it was collected by Deb as cited above and deposited in Assam herbarium, but remained unidentified. This species is distributed in India (Assam, Meghalaya), China, Myanmar and Sri Lanka.

**Selaginella monospora** Spring. (Image 6): Terrestrial in moist places. Nokrek Peak (500–1412 m) VNS & BS 114695 (Assam). Although this species is very common in all parts of Nokrek, no publications from the study site state so, hence it is a new record. It is widely distributed in northeastern India (Arunachal Pradesh, Assam, Manipur, Mizoram), southern India (Kerala, Tamil Nadu, Karnataka), Bangladesh, China, Nepal and Myanmar.

**Selaginella semicordata** (Wall. ex Hook. & Grev.) Spring.: Terrestrial as well as lithophytic on moss laden rocks in moist places. Along Simsang River (652m) VNS & BS 114659 (Assam). It is rare in Nokrek and reported for the first time from Meghalaya. The species is distributed in northeastern India, China and Nepal.

**Selaginella subdiaphana** Spring.: Terrestrial as well as epiphytic in dense forests. Tura Peak (750m) DBD 28965 (Assam). Although this species was collected by Deb and housed in Assam herbarium, no publication from Meghalaya includes it; hence a new record for the state. It is widely distributed in northeastern India, Bangladesh and Nepal.

**Selaginella tenuifolia** Spring.: Epiphytic in dense forests. Nokrek Peak (1378m) VNS & BS 118482B (Assam). It is rare in Nokrek, and recorded for the first time from Meghalaya. Chandra et al. (2008) considered this species rare and a threatened group pteridophyte. The species is distributed in northeastern India (Arunachal Pradesh, Meghalaya, Sikkim), eastern India (West Bengal, Darjeeling).

**Ferns**

**Adiantaceae**

**Adiantum philippense** L. (Image 7): On walls and on tree trunks in shady places. Tura forests (650m) VNS & BS 118314 (Assam). Common in Nokrek, and widely distributed in northeastern India (Arunachal Pradesh, Meghalaya), Bangladesh, Nepal and Taiwan.

**Aspleniaceae**

**Asplenium cheilosorum** Kunze ex Mett.: Terrestrial
as well as epiphytic in moist and shady damp places. Nokrek Peak (1214m) VNS & BS 114709 (Assam). The species is rare in Nokrek, and recorded for the first time from the Garo Hill District. It is widely distributed in south India (Kerala), northeastern India (Assam, Arunachal Pradesh, Meghalaya), Bhutan, China, Japan, Malaysia, Myanmar, Philippines, Sri Lanka, Taiwan and Vietnam.

*Asplenium ensiforme* Wall, ex Hook. & Grev.: Epiphytic on moss covered tree trunks in dense forest. Dribokgre toward east (800m) VNS & BS 114598 (Assam). It is rare in Nokrek and recorded only from the eastern part of NBR. A new record for the Garo Hill District, but widely distributed throughout hilly areas of India (Himalaya, Nilgiri Hills), Bhutan, China, Hong Kong, Japan, Myanmar, Nepal, Sri Lanka, Thailand and Vietnam.

*Asplenium finlaysonianum* Wall. ex Hook.: Epiphytic on decaying tree trunks. Ringrey (500m) VNS & BS 118391 (Assam). Occasionally in Nokrek, and recorded for the first time from the Garo District. Widely distributed in northeastern India (Assam, Arunachal Pradesh, Meghalaya, Nagaland), Bangladesh and Myanmar.

*Asplenium gueinzianum* Mett. ex Kuhn.: Epiphytic on moss covered tree trunks. Way to Tura Peak (900m) MKV Rao 64379 (Assam). This species is rare in Nokrek, and recorded only from Tura Peak during the field tours. It is a new record for Meghalaya, and distributed in northeastern India (Arunachal Pradesh, Meghalaya and Nagaland), Bhutan, Japan and Taiwan.

*Asplenium nidus* L. (Image 8): Epiphytic as well as lithophytic on moss covered tree trunks and on rocks. Near Khalakgre Nillage (990m) VNS & BS 114546 (Assam). Although this species is very common in Nokrek and a new record for the Garo District. Widely distributed throughout hilly regions of northern India (Punjab, Kashmir, Delhi), and throughout all the districts of northeastern India, Africa, Bhutan, Madagascar, Malaya, Nepal, Polynesia, Philippines, Sri Lanka and Taiwan.

*Asplenium normale* D. Don.: Terrestrial as well as epiphytic in damp and moist places inside dense forest. Nokrek Peak (1306m) VNS & BS 114672 (Assam). Very common in Nokrek and a new record for the Garo District. It is widely distributed in the hilly regions of southern India (Kerala, Tamil Nadu), northeastern India (Assam, Arunachal Pradesh, Meghalaya, Manipur), Africa, Bhutan, Hong Kong, Malaya, Nepal, Philippines, Polynesia, Sri Lanka and Taiwan.

*Asplenium perakense* Mattew & C. Chr.: Epiphytic on moss covered tree trunks in dense forests. Way to Tura Peak (850m) MKVR 59418 (Assam). Very rare in Nokrek, and recorded for the first time from Meghalaya. It is distributed in India (Nagaland, Meghalaya, Myanmar, China, Japan and Vietnam.

*Asplenium phyllitidis* D. Don. (Image 9): Epiphytic as well as lithophytic on moss covered tree trunks and on rocks. Way to Rongsingiri (400–500 m) BS & VNS 118294 (Assam). Common in the southern areas of Nokrek Reserve, but very rare in the eastern and western sides. Although this species is common in dense forests, it is a new record for the district. Widely distributed in India (Andaman Islands, Arunachal Pradesh, Meghalaya, Assam, Manipur), Myanmar,
Thailand, Malesia and Vietnam.

*Asplenium unilaterale* Lam.: Epiphytic on moss covered tree trunks near the sides of streams and river. Tura Peak (670m) GP 22463 (Assam). Very common in Nokrek, and widely distributed throughout Himalayan regions of India; Africa, China, Japan, Myanmar, Philippines, Polynesia, Sri Lanka and Taiwan.

**Blechnaceae**

*Blechnum orientale* L.: Terrestrial in open places. Bandari Falls (300m) VNS & BS 114980 (Assam). The species is common in Nokrek and a new record for the Garo District. It is widely distributed in temperate Asia (China, Japan, Taiwan), tropical Asia in the Indian subcontinent (India, Nepal, Sri Lanka), Indo-China (Cambodia, Laos, Myanmar, Thailand, Vietnam), Malesia (Indonesia, Malaysia, Philippines), Australia and Pacific Islands.

**Cryptogrammaceae**

*Onychium siliculosum* (Desv.) C.Chr. (Image 10): Terrestrial in open places. Niengmandalgre (350–700 m) VNS & BS 116840 (Assam). Very common in Nokrek, abundantly growing in lower elevation areas of Meghalaya. It is distributed in northeastern India (Assam, Arunachal Pradesh, Meghalaya), China, Japan and southern Malaya.

**Cyatheaceae**

*Alsophila gigantea* Wall. ex Hook. (Image 11): Terrestrial along river sides as well as in open places. Kalupara (500m) BS & VNS 118460 (Assam). It is common in the southern side of Nokrek, but extremely rare in the eastern and western regions. It is a new record for the Garo Hill districts. This species is widely distributed in the Himalayan regions of India, Bangladesh, China, Laos, Myanmar, Nepal, Sri Lanka, Thailand and Vietnam.

*Alsophila khasyana* T. Moore ex Kuhn. (Image 12): Terrestrial in moist and shady forests. Kalupara 6th Mile area (800m) VNS & BS 118460 (Assam). This species is extremely rare in Nokrek, and is a new record for the Garo Hill District. It is distributed in India (Western Ghats, eastern States of the Himalayas including Khasi Hills and Garo Hills of Meghalaya), Myanmar.

*Alsophila spinulosa* (Wall. ex Hook.) Tryon.: Terrestrial in moist and shady places along rivers and streams. Rongrengiri (350–600 m) VNS & BS 114924 (Assam). This species is extremely rare in Nokrek, but widely distributed throughout the hilly areas of east Khasi Hills and west Garo Hills and a new record for the entire three Garo Hill districts. It is distributed in northeastern India, Bhutan, China, Japan, Myanmar, Nepal, Thailand and Taiwan.

**Davalliaceae**

*Davallia griffithiana* Hook. (Image 13): Epiphytic on moss laden tree trunks in dense forests. Way to Rongsengiri (500m) BS & VNS 118293 (Assam). This is very rare in Nokrek, and recorded for the first time from Garo Hill District. This species is distributed in northeastern India (Arunachal Pradesh, Meghalaya, Nagaland), Bhutan, China, Myanmar and Taiwan.

*Davallia trichomanoides* Blume.: Epiphytic in dense forests. Rongsingiri (370m) VNS & BS 115892b (Assam). This species is common in Nokrek, (eastern
Khasti and southern Garo Hills) but a new record for the Garo District. It is widely distributed in northeastern India (Arunachal Pradesh, Meghalaya, Nagaland, Sikkim), Bhutan, Myanmar and Nepal.

**Dennstaedtiaceae**

*Dennstaedtia scabra* (Wall. ex Hook.) T. Moore.: Terrestrial in moist places in slopes in semi-shaded places. Rongsingiri (600m) VNS & BS 115892 (Assam). This species grows occasionally in Nokrek, and recorded for the first time from Garo Hill District. It is widely distributed in northern India (Kashmir, Punjab), northeastern India (Assam, Meghalaya, Arunachal Pradesh), Bhutan, Thailand, Indo-china, China, South Korea, Japan, Taiwan, Philippines, Malaya and Borneo.

*Microlepia rhomboidea* (Wall. ex Kunze) Prantl.: Terrestrial in moist places. Nokrek Peak (1150m) VNS & BS 116756 (Assam), Niengsanggre-Adugre (500m) in moist as well as in open places on wet ground, commonly along streams and rivers in semi-shady places. Tura ridge (720m) VNS & BS 114903 (Assam). Although this species is common in Nokrek, it is a new record for the Garo District. This species is widely distributed in Bangladesh, northeastern India, China, Thailand, Indo-china, Taiwan, and Philippines.

*Microlepia platyphylla* (D. Don) J. Sm.: Terrestrial in moist as well as in open places on wet ground, commonly along streams and rivers in semi-shady places. Tura ridge (720m) VNS & BS 114903 (Assam). Although this species is common in Nokrek, it is a new record for the Garo District. This species is widely distributed in Bangladesh, northeastern India, China, Thailand, Indo-china, Taiwan, and Philippines.
VNS & BS 118203 (Assam). This species is rare in Nokrek, and recorded for the first time from Meghalaya. It is recorded from the Himalayan regions.

Microlepia speluncae (L.) T. Moore.: Terrestrial in moist places on slope sides in open or semi-shaded places or on edges of forests at lower elevations. Tura ridge (800m) VNS & BS 114893 (Assam). It is common in Nokrek, and is a new record for the Garo Hill districts. This species is widely distributed in pantropical regions.

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Microlepia speluncae (L.) T. Moore.: Terrestrial in moist places on slope sides in open or semi-shaded places or on edges of forests at lower elevations. Tura ridge (800m) VNS & BS 114893 (Assam). It is common in Nokrek, and is a new record for the Garo Hill districts. This species is widely distributed in pantropical regions.
Pteridophytes of Nokrek

Lindsaeaceae

*Lindsaea odorata* Roxb. ex Griff. (Image 14): Epiphytic as well as terrestrial. Tura ridge (750m) VNS & BS 118318A. It is very common in Nokrek, and is a new record for Garo District. It is widely distributed in northeastern India (Assam, Arunachal Pradesh, Meghalaya), Andaman and Nicobar Islands, Philippines and Sri Lanka.

*Sphenomeris chinensis* (L.) Maxon.: Terrestrial along river sides. Tura Peak (1100m) VNS & BS 118318 (Assam). This species is rare in Nokrek, and is a new record for the Garo Hill districts. According to Baishya & Rao (1982), this species is common in Khasi and Jaintia districts of Meghalaya. It is mostly indigenous to Hawaii Islands, parts of Polynesia, and east Asia. It is commonly found in forest openings and other disturbed areas such as along trails or roads, or on landsides when there is adequate moisture.

Lomariopsidaceae

*Bolbitis sinensis* (Baker) K. Iwats.: Terrestrial in deep gullies in shady places. Along Simsang River from Daribokgre (755m) VNS & BS 114662 (Assam). This species is rare in Nokrek, and recorded for the first time from Meghalaya and is a new record for the state. It is distributed in the eastern Himalaya.

Loxogrammaceae

*Loxogramme chinensis* Ching.: Epiphytic as well as lithophytic in dense forests. Nokrek Peak (902m) BS 118578A (Assam). This species is occasionally found in Nokrek, and recorded for the first time from Meghalaya. It is widely distributed in northeastern India (Assam, Arunachal Pradesh, Meghalaya), Bhutan, China, Japan, Myanmar, Thailand and Taiwan.

*Loxogramme involuta* (D. Don) C. Presl.: Epiphytic as well as lithophytic in dense forests in shady areas. Near Daribokgre along Simsang River (850m) VNS & BS 116733 (Assam), on the way to Nokrek Peak from Tura Peak (1210m) MKV Rao 64378 (Assam). This species is occasionally recorded from Nokrek. It is distributed in northeastern India (Arunachal Pradesh, Meghalaya), Bhutan, China, Malesia, Nepal, Polynesia and Sri Lanka.

Lygodiaeeae

*Lygodium flexuosum* (L.) Sw. (Image 15): Climber along forest margins. Daribokgre along Simsang River (820m) VNS & BS 114658 (Assam). On way to Durabandagre (600 m) VNS & BS 115804 (Assam). This species is common in Nokrek and is a new record for the Garo District. It is widely distributed throughout India especially in the hilly areas of the eastern Himalayas, Africa, Australia, China, Malaysia and Sri Lanka.

*Lygodium japonicum* (Thunb.) Sw.: Climber in moist places. Khalakgre (800m) VNS & BS 118287 (Assam). This species is extremely rare in Nokrek, and is a new record for the Garo Hill districts. Distributed in the western Himalaya, southern India, northeastern India (Arunachal Pradesh, Assam, Meghalaya), Australia, China, Japan, Korea, Malesia, Philippines and Sri Lanka.

*Lygodium microphyllum* (Cav.) R.Br.: Climber in dense forests as well as in open areas. Very rare in Nokrek, and recorded for the first time from Meghalaya. It is distributed in northeastern India (Arunachal Pradesh, Meghalaya), southern India (Kerala, Tamil Nadu), Africa, Australia, Hong Kong, Malaysia and Sri Lanka.

Marattiacae

*Angiopteris helferiana* C. Presl. (Image 16): Arborescent ferns along forest margins and river sides. Along Simsang river from Daribokgre (780m) VNS & BS 114657 (Assam), Tura Peak (880m) VNS and Sri Lanka.
& BS 114894 (Assam). Rare in Nokrek, and widely reported from northeastern India, Australia, China, Japan, Madagascar, Malaysia, New Caledonia and Polynesia. It is known by the name of *Angiopteris evecta*, but according to Fraser-Jenkins (2008), there is no such species in India and neighbouring countries. The species which is found in the Indian subcontinent is *Angiopteris helferiana*.

*Nephrolepidaceae*

*Nephrolepis cordifolia* (L.) C. Presl.: Terrestrial in dense forests as well as in damp places on rocks. Common in Nokrek, and widely distributed throughout hilly areas of India.

*Polypodiaceae*

*Aglaoomorpha coronans* (Wall. ex Mett.) Cop.: On huge tree trunks in dense forests. Sisubibra (450m) BS & VNS 116711 (Assam). Very common in Nokrek, and widely distributed in northeastern India, Bangladesh, Bhutan, China, Hong Kong, Malaya, Nepal and Taiwan.

*Arthromeris lehmannii* (Meth.) Ching.: On big tree trunks in dense forests. Nokrek Peak (1270m) BS 118577A (Assam). Rare in Nokrek, and is a new record for the Garo District. According to Baishya & Rao (1982), this species is very rare in Meghalaya. Distributed in northeastern India, China, Myanmar, Thailand, Taiwan and Vietnam.

*Arthromeris wallichiana* (Spreng) Ching.: Epiphyte on tree trunks of *Quercus* (Tourn.) L. and *Castanopsis* Spach in dense forests. Nokrek Hills (700m) GP 3973 (Assam). Rare in Nokrek, and is a new record for the Garo districts, although the cited specimens are housed in Assam herbarium. This species is distributed in India (Meghalaya, Sikkim, Nagaland), Burma and China.

*Belvisia callifolia* (D.N. Christ) Cop.: Epiphyte on moss covered tree trunks in dense forests. Nokrek Peak (1300m), BS 118477A (Assam). Rare in Nokrek, also very rare in Meghalaya (Baishya & Rao 1982). It is widely distributed in northeastern India (Arunachal Pradesh, Meghalaya), Nepal.

*Belvisia henryi* (Hieron. ex C.Chr.) Raymond.: Epiphytic as well as lithophytic in forest understory. On way to Adugre (870m) BS & Party 114763A (Assam). It is rare in Nokrek, and a new record for the Garo District. It is distributed in northeastern India, but rare in Meghalaya (Baishya & Rao 1982). Widely occurs in China, Thailand and Vietnam.

*Belvisia mucronata* (Fée) Cop.: Epiphytic on tree trunks of *Citrus indica* Tanaka and *Artocarpus heterophylla* Lam. in moist and shady places. Way to Nokrek Peak (972m) BS 118562 (Assam). This species is rare in Nokrek, also reported very rare in Meghalaya (Baishya & Rao 1982). Widely distributed in India (Assam, Arunachal Pradesh, Meghalaya, Sikkim, Western Ghats), Bhutan, China, Malaysia, Philippines, Polynesia, Sri Lanka and Taiwan.

*Colysis decurrens* (Blume) Panigrahi.: Epiphytic as well as lithophytic along rivers and stream sides in dense forests. Nokrek Peak (850m) BS 118502 (Assam). Occasional in Nokrek, but widely distributed in northeastern India, China, Malaya, Myanmar, Nepal, Taiwan and Vietnam.

*Colysis hemionitidea* (Wall. ex Mett.) C. Presl.: Epiphytic as well as lithophytic along rivers and stream
sides in dense forests. Tura top Hills (860m) GP 22481 (Assam). It is rare in Nokrek. This species was also reported from Tura Peak at an elevation of 700m by Baishya & Rao (1982); widely distributed in southern India, northeastern India, Bangladesh, Bhutan, China, Malaya Islands, Japan, Myanmar, Nepal, Taiwan and Vietnam.

*Colysis pedunculata* (Hook. & Grev.) Ching.: Epiphytic on moss covered tree trunks, sometimes found at the base of tree trunks. Tura Peak (1190m) GP 22384 (Assam). Rarely occurs in Nokrek, and also reported by Baishya & Rao (1982) to be very rare in Meghalaya. Widely distributed in northeastern India, Bangladesh, Bhutan, China, Malaya, Myanmar and Nepal.

*Drynoglossum heterophyllum* (L.) Trimen.: Epiphytic on exposed tree trunks. Patalgiri (570m) VNS & BS 116880A (Assam). Very common in Nokrek, but widely distributed in southern India (Kerala, Tamil Nadu), northeastern India (Assam, Arunachal Pradesh, Meghalaya), central India, China, Japan, Java, New Guinea, Myanmar, Philippines and Sumatra.

*Lemmaphylhim carnosum* (Wall.) C. Presl.: Creeping on tree trunks laden with moss in moist places. Nabokgre to Patalgiri (500–1200 m) VNS & BS 116869 (Assam), Tura top (900m) GP 22482 (Assam). Occasional in Nokrek, and recorded for the first time from Garo Hill districts. Widely distributed in northeastern India (Arunachal Pradesh, Meghalaya), northern India, China, Nepal and Thailand.

*Lemmaphylhum microphyllum* C. Presl.: Epiphytic on moss laded tree trunks. Patalgiri to Simsangiri (700–1000 m) VNS & BS 116880B (Assam). Recorded for the first time from Meghalaya (east Garo Hills), hence is a new record for Meghalaya. Occasional in Nokrek, and recorded for the first time from Garo Hill districts. Widely distributed in northeastern India (Arunachal Pradesh, Meghalaya), northern India, China, Nepal and Thailand.

*Lemmaphylhim rostratum* (Bedd.) Tagawa.: Epiphytic on tree trunks in dense forests. Tura Peak (1320m) VNS & BS 114901 (Assam). Recorded for the first time from the state. Very rare in Nokrek, distributed in northeastern India (Arunachal Pradesh, Meghalaya (east Garo Hills), Nagaland), China, Myanmar, Taiwan and Vietnam.

*Leptochilus axillaris* (Cav.) Kaulf.: Epiphytic, creeping on tree trunks. Near Didari River (850m) BS & VNS 114563 (Assam). Very rare in Nokrek, and is a new record for the Garo Hill districts of Meghalaya. According to Baishya & Rao (1982), this species is very rare in Meghalaya. It is recorded from southern India (Kerala), northeastern India (Assam, Meghalaya, Arunachal Pradesh), Bangladesh, China, Malaya, Myanmar, Philippines, Polynesia and Thailand.

*Microsorum pteropus* (Blume) Cop.: Epiphytic as well as lithophytic in moist places along river and stream sides. Rare in Nokrek (Garo Hills), reported by Baishya & Rao (1982) from the study site. Widely distributed in southern India, northeastern India (Nagaland, Meghalaya, Sikkim), Bangladesh, Bhutan, Malaysia, Malaya, Myanmar, Nepal and Sri Lanka.

*Microsorum punctatum* (L.) Cop. (Image 17): Epiphytic on decaying tree trunks in shady places. Tura hills (850m) GP 22508 (Assam). Found occasionally in Nokrek, and widely distributed in India, Africa, Polynesia, China and Taiwan.

*Microsorum zippelii* (Blume) Ching.: Epiphytic on decaying tree trunks in shady places and cliffs along stream sides. Rare in Nokrek (Garo Hills), reported by Baishya & Rao (1982) from the study site. Widely distributed in southern India, northeastern India (Nagaland, Meghalaya, Sikkim), Bangladesh, Bhutan, Malaysia, Malaya, Myanmar, Nepal and Sri Lanka.

*Phymatosorus cuspidatus* (D. Don) Pic.-Serm. (Image 18): Epiphytic on humic tree trunks in shady places along river sides. On way to Patalgre (460m) BS & VNS 116836 (Assam). Recorded by Baishya & Rao (1982) from Rongrengiri area at an elevation of about 150m. Rare in Nokrek, also reported rare in Meghalaya by (Baishya & Rao (1982). Widely
Pteridophytes of Nokrek

Image 17. Microsorum punctatum

distributed in northeastern India (Arunachal Pradesh, Assam, Meghalaya, Nagaland), southern India (Western Ghats), China, Laos, Nepal and Vietnam.

Pleopeltis contorta (Christ) Alston & Bonner.: Epiphytic on tree trunks in damp places. Patalgiri to Simsanggiri (350–900 m) VNS & BS 116878 (Assam), Simsanggiri to 15km inside buffer zone (700m) VNS & BS 116792. Occasionally in Nokrek, and recorded for the first time from Garo District. It is reported from northeastern India (Arunachal Pradesh, Meghalaya, Nagaland, Sikkim), China and Tibet.

Pleopeltis macrosphaera (Baker) Panigrahi & Patnaik.: Epiphytic on tree trunks in dense forests. Nokrek Peak (850–1200 m) VNS & BS 114726 (Assam), Tura Peak (720m), MKVR 64381 (Assam). Rare in Nokrek, and recorded for the first time from Meghalaya. It is distributed in northeastern India (Arunachal Pradesh, Meghalaya), China.

Pleopeltis nuda Hook.: Epiphytic on moss tree trunks in damp places. Daribokgre to East Down Hills (862m) VNS & BS 114598 (Assam), Tura Peak (960m) DBD 28956 (Assam). Common in Nokrek, and recollected after 50 years from Garo districts. Distributed in northeastern India, Africa, China, Japan, Malaya and Sri Lanka.

Pyrrosia adnascens (Sw.) Ching. (Image 19): Epiphytic on tree trunks in open as well as dense forests. Daribokgre along Didari Chibima River (960m) VNS & BS 114562 (Assam), Tura Peak (750m) DBDeb 28843 (Assam). Common in Nokrek, widely distributed throughout northeastern India, China, Fiji, Malaya, Philippines, Polynesia, Sri Lanka, Taiwan and Vietnam.

Pyrrosia costata (Presl) Tagawa & K. Iwats.: Epiphytic on tree trunks along river sides. Tura Peak (950m) GP 224741 (Assam), on way to Tura Peak (600m) MKVR 64339 (Assam). Recorded from northeastern India (Assam, Arunachal Pradesh, Meghalaya), China, Myanmar and Thailand.

Pyrrosia floculosa (D. Don) Ching. (Image 20): Epiphytic as well as lithophytic in moist places. Nokrek Peak (1120m) VNS & BS 115997 (Assam), Tura Peak (800m) MKVR 59094 (Assam), Tura Peak (900m) DBD 28959 (Assam). Common in Nokrek (Garo Hills), and widely distributed in northeastern India (Assam, Meghalaya, Nagaland), Bhutan, China, Myanmar, Nepal and Vietnam.

Pyrrosia heterocis (Mett. ex Kuhn) Ching.: Epiphytic in moist places. Rongrengiri (295m) VNS & BS 114562A (Assam), MKVR 64339 (Assam), Tura Peak (670m) MKVR 59094 (Assam). Occasionally in Nokrek, and recorded for the first time from Garo Hill districts of Meghalaya. This species is distributed in northeastern India (Assam, Arunachal Pradesh, Meghalaya, Nagaland, Sikkim), Bhutan, China, Myanmar and Sri Lanka.

Pyrrosia lanceolata (L.) Farw.: Epiphytic in dense forests. Rongrengiri (295m) VNS & BS 116762b (Assam). Rare in Nokrek, and is a new record for Meghalaya. This species is very similar to Pyrrosia adnascens, but differs in certain characters. Widely distributed in southern India, northeastern India (Arunachal Pradesh, Meghalaya, Sikkim), Bhutan, China, Japan, Polynesia, Sri Lanka and Taiwan.

Pyrrosia longifolia (N.Burm.) F. Morton.: Epiphytic on tree trunks along roadsides. Daribokgre along Didari Chibima River (960m) VNS & BS 114559 (ASSAM), Nokrek Peak (1200m) BS & VNS...
s.n. (ASSAM 74702). Rare in Nokrek, and recorded for the first time in Meghalaya. Widely distributed in northeastern India (Arunachal Pradesh, Meghalaya), Australia, Malaya, Malaysia and Polynesia.

*Pyrrosia nudu* (Gies.) Ching.: Epiphytic on barky tree trunks. Rongrengiri (295m) VNS & BS 116762A (ASSAM). Rare in Nokrek, and recorded for the first time from Garo District. Widely reported from Himalayan regions of India, Nepal and China.

*Pyrrosia nummularifolia* (Sw.) Ching.: Epiphytic as well as lithophytic along river sides. Ningsangiri (650m) VNS & BS 118209 (Assam), along Sinsang river from Daribokgre, VNS & BS 114660 (Assam). Common in Nokrek, but a new record for the Garo District. Widely distributed throughout northeastern India, Bhutan, Bangladesh, China, Malaya, Malaysia, Philippines and Vietnam.

**Pteridaceae**

*Pteris biaurita* L. subsp. *fornicata* Fraser.-Jenk.: Terrestrial in moist places. Tura Peak (680m) VNS & BS 114896 (Assam). Occasionally in Nokrek, and is a new record for the Garo Hill districts of Meghalaya.

Although it is recorded from the Khasi and Jaintia Hill districts, it has not been identified up to subspecies level.

*Pteris biaurita* L. subsp. *walkeriana* Fraser.-Jenk. & Dominic Rajkumar: Terrestrial along river sides. Nabokgre to Patalgre (600–820 m) VNS & BS 116867 (Assam), Sinsanggiri to 15km inside core zone (900m) VNS & BS 116800 (Assam). Very rare in Nokrek, and recorded for the first time in Meghalaya.

*Pteris ensiformis* Burm. f.: Terrestrial in open as well as in moist places. Rongrenggiri (350m) VNS & BS 116774 (Assam). Although very common in Nokrek, and is a new record for the Garo District. Distributed in northeastern India, Nepal.

*Pteris grevilleana* Wall. ex T. Agardh.: Terrestrial as well as lithophytic in wet places. Rongrenggiri (350m) VNS & BS 116867 (Assam). Very rare in Nokrek, and recorded from east Garo Hills and is a new record for the state.

*Pteris longipes* D. Don.: Terrestrial in moist places. Nokrek Peak (1230m) VNS & BS 114690 (Assam). Growing occasionally in Nokrek, and according to Baishya & Rao (1982) is widely distributed in Garo
districts. Distributed in southern India, northeastern India, China and Sri Lanka.

*Pteris longipinmla* Wall.ex J.Agardh.: Terrestrial in wet places. Rongsingre (500m) VNS & BS 115891 (Assam). Extremely rare in Nokrek, and a new record for the Garo District.

*Pteris vittata* L.: Terrestrial along river sides. Niengmandalgre (600m) VNS & BS 116843 (Assam). Very common in Nokrek, and widely distributed throughout Himalaya including northeastern India, southern India, central India, China and Sri Lanka.

**Tectariaceae**

*Tectaria fuscipes* (Wall. ex Bedd.) C. Chr.: Terrestrial in moist places. Foot hills of Nokrek range (300–700m) VNS & BS 116843 (Assam), Rongrengre (150m) VNS & BS 118238 (Assam). Although very common in Nokrek, is a new record for the state. Widely distributed in eastern Himalaya, northeastern India (Nagaland, Meghalaya), Myanmar.

*Tectaria polymorpha* (Wall. ex Hook.) Cop.: Terrestrial along road sides. On way to Khalakgre (750m) VNS & BS 115989 (Assam). Common in Nokrek, but is a new record for the Garo District. Distributed in southern India, northeastern India, eastern Himalaya, Bangladesh, Indonesia, Malaysia, Myanmar, Philippines and Sri Lanka.

**Thelypteridaceae**

*Cyclosorus crinipes* (Hook.) Ching.: Terrestrial in moist places. Tura ridge (980m) VNS & BS 118312 (Assam). Rare in Nokrek, and widely distributed in the eastern Himalayan region. This is a new record for Meghalaya.

*Cyclosorus dentatus* (Forsk.) Ching.: Terrestrial in wet places near the river. Nokrek Peak (1230m) VNS & BS 116721A (Assam). Rare in Nokrek, and recorded for the first time from Garo Hill districts. Widely distributed in northeastern India, Taiwan, Fujian, Jiangxi, Guangdong, Guangxi, Yunnan, Guizhou, Vietnam, Thailand, Myanmar and Tropical America.

*Pseudocyclosorus falcilobus* (Hook.) Ching.: Terrestrial in wet places. Bansamgre (308m) VNS & BS 118255 (Assam). Rare in Nokrek, and recorded for the first time and in Meghalaya. Widely distributed in northeastern India, eastern and southern China, Japan, Indochina.

*Pronephrium lakkhipurense* (Ros.) Holtt.: Terrestrial along forest margins. Tura ridge (970m) VNS & BS 114895 (Assam). Very rare in Nokrek, and recorded for the first time from Garo District. Widely distributed in northeastern India (Assam, Arunachal Pradesh, Meghalaya), Sichuan, Yunnan and Thailand.

*Pronephrium nudatum* (Roxb. ex Griff.) Holtt.: Terrestrial along river sides. Ronsingiri (450m) VNS & BS 115861 (Assam). Rare in Nokrek, and is widely distributed in northeastern India (Assam, Arunachal Pradesh, Meghalaya), northern India (Uttaranchal), Bangladesh.

*Thelypteris clarkei* (Bedd.) C.F. Reed.: Terrestrial in moist places. Chokpot (312m) VNS & BS 115712 (Assam). Extremely rare in Nokrek, but widely distributed throughout the Himalayan regions including northeastern India (Arunachal Pradesh, Meghalaya), Nepal and China.

*Thelypteris procera* (Don) Fras.-Jenk.: Terrestrial along river sides. Beyond Susibibra (602m) VNS & BS 116715 (Assam). Occasionally found growing in Nokrek, and recollected after more than 50 years from the Garo Hill districts. It is distributed in the Indian subcontinent and other parts of tropical Asia.

*Trigonospora ciliata* (Wall. ex Benth.) Holtt.: Terrestrial in dense forests. Ningsangre (720m) VNS & BS 118202 (Assam). Extremely rare in Nokrek, and reported for the first time. Distributed in Sri Lanka, Nepal and northeastern India (Arunachal Pradesh, Meghalaya).

**Vittariaceae**

*Antrophyum obovatum* Baker.: Epiphytic in dense forests. Nokrek Peak (1300m) BS 114700A (Assam). Extremely rare in Nokrek, and recorded only from the above locality. According to Baishya & Rao (1982), the species is recorded only from Khasi Hills of Meghalaya. Widely distributed in India (Arunachal Pradesh, Darjeeling, Meghalaya, Sikkim), China and Nepal.

*Antrophyum plantaginum* (Cav.) Kaulf.: Epiphytic in dense forests. Nokrek Peak (1000m) BS 118600 (Assam). Rare in Nokrek. Baishya & Rao (1982) reported from southern Garo Hill (Baghmara). It is distributed in northeastern India (Assam, Arunachal Pradesh, Meghalaya), southern India (Tamil Nadu), Sri Lanka, Nepal, Polynesia and Australia.

*Antrophyum reticulatum* (G. Forst.) Kaulf.:
Epiphytic in dense forests along river sides. On way to Jetagiri (470m) BS 118594 (Assam), Tura Peak (960m) DBD 28957 (Assam), Way to Baghmara (350m) GP 22531 (Assam). Rare in Nokrek, but fairly common in Meghalaya. Distributed in India (Assam, Meghalaya, Sikkim, Tamil Nadu), Nepal.

Yxxtaria elongata Sw.: Epiphytic on moss covered tree trunks in shady places. Darugiri RF (350m) MKVR 64154 (Assam), on way to Baghmara (400-500 m) MKVR 64471 (Assam). Occasional in Nokrek, reported from northeastern India (Arunachal Pradesh, Meghalaya and Sikkim), Africa, Australia, Bangladesh, China, Loas, Malaysia, Philippines, Polynesia, Sri Lanka and Vietnam.

Woodsiaceae (Athyriaceae)

Athyrium drepanopterum (Kunze) A.Br. ex Milde.: Terrestrial along riverine areas. Chandigre (300-500 m) VNS & BS 114743 (Assam). Rare in Nokrek, and recorded for the first time from Garo district. Distributed in China, northeastern India (Arunachal Pradesh, Meghalaya), Nepal.

Diplazium apicisorum Panigrahi & S. Singh.: Terrestrial in moist places. Nokrek Peak (1100-1300 m) VNS & BS 114681 (Assam). It is a new record for Meghalaya. Widely recorded from only northeastern India especially in the Himalayan region.

CONCLUSION

A total of 113 taxa were found in the Nokrek Biosphere Reserve of Meghalaya, evidencing the pteridophyte richness of the area. They include 25 new distribution records for Meghalaya (Selaginella involvens, Selaginella semicordata, Selaginella subdiaphana, Selaginella tenifolia, Asplenium gueldenstamn, Asplenium perakanse, Microlepia hancel, Microlepia rhomboidea, Dicranopteris linearis, Coniogramme procera, Bolbitis sinensis, Loxogramme chinesis, Lygodium microphyllum, Lemmaphyllum microphyllum, Lemmaphyllum rostratum, Pleopeltis macrosphaera, Pyrrosia lanceolata, Pyrrosia longifolia, Pteris biaruita ssp. walkeriana, Pteris grevilleana, Tectaria fascipes, Cyclosorus crinipes, Pseudocyclosorus falciolus, Diplazium apicisorum and Diplazium pseudosetigerum) and another 43 species (Equisetum diffusum, Selaginella decipiens, Selaginella hookeri, Selaginella monospora, Asplenium cheilosorum, Asplenium ensiforme, Asplenium finlaysonianum, Asplenium nidus, Asplenium normale, Asplenium phylitis, Blechnum orientale, Alsophila gigantean, Alsophila khasiana, Alsophila spinulosa, Davallia griffithiana, Davallia trichomanoides, Demnaedictia scabra, Microlepia platyphylla, Microlepia speluncae, Drynaria propinqua, Arachinodes aristata, Dryopteris coechlata, Mecodium tenellum, Lindsaea odorata, Sphenomeris chinesis, Lygodium flexuosum, Lygodium japonicum, Arthromeris lehmanni, Arthromeris wallachiana, Belvisia henryi, Lemmaphyllum carnosum, Leptochilus axillaris, Pleopeltis contorta, Pyrrosia heteractis, Pyrrosia mammularisfolia, Pteris biaruita ssp. fornicate, Pteris ensiformis, Pteris longipinnula, Tectaria polymorpha, Cyclosorus dentatus, Pronephrium lakhimpurehse, Trigonospora ciliata and Athyrium drepanopterum) are new records for all the three Garo Hills districts of Meghalaya. Polypodiaceae stands the dominant family of the area with 31 species followed by Aspleniaceae and Selaginellaceae with 10 species each. Asplenium is the largest genus with a maximum number of nine species, which is followed by Pyrrosia with eight species and Pteris with seven species including two subspecies. The identity of some collection requires further studies.

REFERENCES


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