

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 uses 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 gigentea*, *Dicranopteris lanigera*, *D. splendens*, *Thelypteris lakhimpurensis* 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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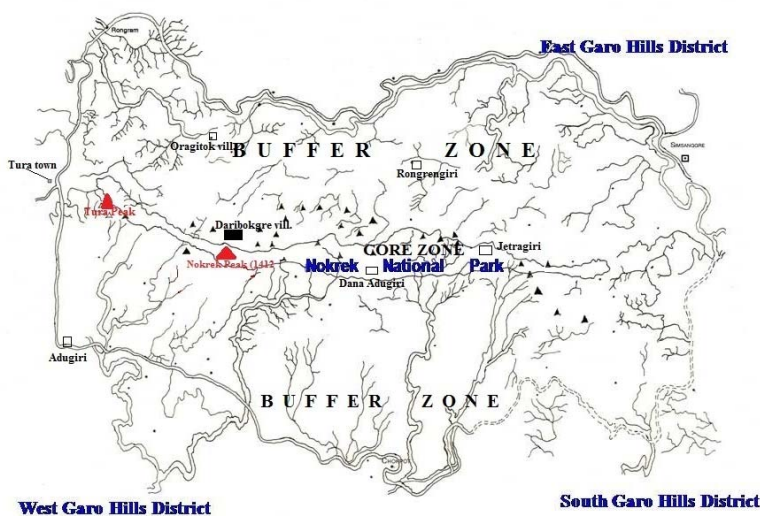


Fig. 1. Map of the Nokrek Biosphere Reserve

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

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.

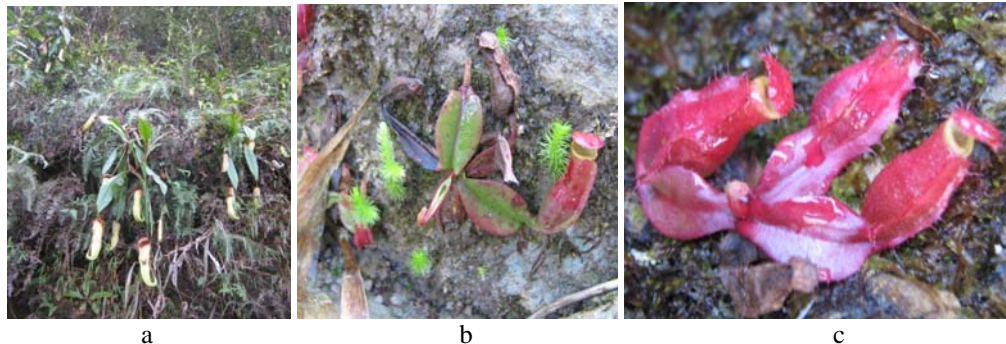


Fig. 2. *Nepenthes khasiana* in the Nokrek Biosphere Reserve: a – wild habitat, b and c – growing seedling

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

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



Fig. 5. Shale Fossils

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 to Williamnagar side while recording the disturbances of the Nokrek Biosphere Reserve.



Fig. 6. Stone quarrying factory in the Nokrek Biosphere Reserve

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.



Fig. 7. Slashed & burned forest land for Jhum cultivation

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 denticulate* (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.



Fig. 8. Secondary growth of *Macaranga denticulata*

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.



Fig. 9. Invasive *Eupatorium* & *Mikania* species

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 agalocha*) 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).



Fig. 10. Bamboo extraction in the southern side

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 (map) 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. *Kanggimin 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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