Shola Grasslands of Western Ghats – Conservation Status and Management Needs

G.S. Rawat, P.V. Karunakaran and V.K. Uniyal

Introduction

The Western Ghats represent one of the oldest hill ranges in India stretching parallel to the west coast for about 1500 kms from river Tapi in the north to Kanyakumari in the south. These ranges fall within tropical climate and are well known for their rich evergreen and deciduous forests towards lower elevation (<1500 m above sea level; asl) and extensive grasslands dotted with pockets of stunted *shola* forests at higher (>1600 m asl) altitudes. These grasslands are unique in terms of species composition, physiognomy, and ecology. Characterised by juxtaposition of grasslands with shola forests (hence known as shola-grasslands or montane scrub-savannah), these formations give an unique appearance to the hill tops of Western Ghats especially in the Nilgiris, Annamalai and Pulni hills.

The Shola-grassland ecosystem not only harbour a rich biodiversity but also exhibit the ecological conditions that have led to evolution and coexistence of grassland-forest mosaic which pose interesting ecological questions (Gupta *et al*. 1967, Singh and Yadava 1977). These formations form the upper catchments of majority of perennial streams below. Besides, the area is home to many rare, endemic and threatened species, foremost of them being the Nilgiri tahr *Hemitragus hylocrius* (Rice 1982). Owing to extensive anthropogenic influences and subsequent varied land uses, large natural patches of the grasslands were converted into commercial plantations in the past resulting in

1997). Most of the montane grasslands have been converted into plantations of tea, coffee, eucalyptus and wattle, adversely affecting the native flora, fauna and the ecosystem. Other threats to this ecosystem emanate from frequent fires during summer. It is believed that the fires prior to 1990 were quite extensive which caused virtual devastation of the shola forests (Jose *et al*. 1994). Though the fire has helped in the maintenance of grasslands in their present form, repeated fires encourage growth of non-palatable species like *Pteridium aquilinum* and *Eupatorium* spp. in the grasslands reducing forage availability to the native herbivores and change the species composition. The other potential threat to this ecosystem is exotic wattle (*Acacia* spp.). It has been noticed in Kodai hills and Nilgiris that wattles have naturalised in the montane grasslands making the native species quite vulnerable. This article deals with the brief ecological review of shoal-grasslands, conservation issues and management needs.

Ecological Review of the Shola-Grasslands

The juxtaposition and apparent stability of shola-grassland complex has been a subject of interest among many scientists. While studying the ecological status of this complex, Ranganathan (1938) asserted that both sholas and grasslands represent climax communities. Sholas are more common on shady and moist western slopes. The frost bitten grasses regenerate well owing to their perennial root-stock. Bor

are the relicts of evergreen forest climax which have been pushed back to their last strong hold by fire and livestock grazing. Meher-Homji (1965, 1969) described the hill top vegetation as shola, scrub zone and scrub-savannah. While accepting the adverse effect of fire on the distribution of sholas, Meher-Homji (1969) opined that fire coupled with destruction of sholas would have led to scrub-savannah which on further degradation would have given rise to grasslands and ultimately barren rocks. Dabadghao and Sankaranarayanan (1973) justified that grasslands rarely occur as climatic climax in India and generally represent secondary seral stages. According to them *Andropogon polyptychus* is the grass climax at high altitudes in the Nilgiris and *Chryzopogon zeylanicus,* a sub-climax stabilized by factors such as fire, grazing, frost and erosion. This is considered to be the montane phase of broad *Sehima-Dichanthium* type. Puri *et al.* (1989) also believe that seedlings of the forest species germinate within the grasslands are eliminated because of low humidity and frequent fire. According to Jose *et al.* (1994) shola-grassland vegetation is an expression of complex environmental interactions. Edaphic factors could be of primary importance in the delimitation of plant communities. Further they added that *Arundinella vaginata* contributes more to the grassland productivity than any other species in Annamalais. It has been established that the ligneous elements within the shola forests are of tropical origin and the elements outside the shola complex, in the rolling knolls, are of extra tropical origin (Puri *et.al*. 1989). Many investigators have examined the palaeoecology of montane grasslands in Nilgiris to find out the history of vegetation in these landscapes, (Mittre and Gupta 1970, Menon 1967, Meher-homji 1969). From the analysis of pollen grains collected from underneath the peat bogs, it has been concluded that the formation of shola forests commenced about 35,000 years ago through gradual invasion of grasslands under a regime of low precipitation, absence of frost and high speed winds (Mittre and Gupta 1970). Human migration, shifting cultivation, grazing and repeated fires gradually reduced the tree cover to almost non-existent scrub-land. Being located at high altitude, the landscape was exposed to strong wind and frost resulting in gradual elimination of tropical ligneous stock. These temperate factors continue to operate in the montane ecosystem and prohibit in the grasslands the regeneration of tropical elements, which survive in the sheltered pockets of the landscape in the form of shola forests. The severe cold in winter and frequent fires in summers restrict the ligneous tropical elements within the shola and keep the knolls under grass cover. The shola forests therefore, are relicts of the ancient time and are repositories of impoverished biota of the high altitude of the Western Ghats.

Based on palynological studies of peat bogs from the parts of Nilgiris, Menon (1967) concluded that the dominant vegetation during late Quaternary period in the Western Ghats was Graminaceous. This period gradually gave way to the arboreal species when the temperature increased. When the climate became humid again the forest vegetation degraded and grasslands took over the plateau. The formation of shola forest commenced about 35000 years ago through gradual invasion of grassland under a regime of low precipitation, absence of frost and high wind. Blasco and Thanikaimoni (1971)

opined that discontinuous distribution of species common to south Indian hill tops and Himalayas (whether it is due to recent migration of species or due to the Quaternary glaciation or is the result of polytopism) remains to be settled unequivocally. While comparing the pollen samples of Kakathope and Rees Corner, Ootacamund, Vishnu-mittre and Gupta (1970) concluded that the grasslands are pioneer groups in Nilgiri plateau. The prevalence of open vegetation during early stage decidedly indicates the pioneer status of grasslands. The formation of shola forest commenced in seral stage from few shrubs and *Rhododendron* in grasslands to a dense vegetation characteristic of shola forest. It is probable that frost and soil factors have been the important determinants in maintaining and stabilizing the moist upland savannah. Grazing and periodic burning appear to have been much less significant. Karunakaran *et al*. (1998) carried out a detailed ecological study on the grasslands of Eravikulam National Park in Kerala and analysed patterns of plant species diversity and community composition across various landscape units giving several recommendations for the proper management of high range grasslands. They found that in the high ranges there are as many as 10 different grassland communities with varying range of diversity, richness and evenness (Table 1).

Table 1: Diversity, Richness and Evenness of different vegetation associations in the High Range grasslands of Eravikulam National Park, Kerala (Source: Karunakaran *et al*., 1998).

Associations	*Diversity (H')*	*Richness ±SD*	*Evenness*
Arundinella tuberculata-Heteropogon contortus-Chrysopogon zeylanicus	1.94	2.29 ± 0.24	0.61
Ar. tuberculata-Phlebophyllum kunthianum-Ch.zeylanicus	2.02	2.13 ± 0.21	0.64
Acacia mearnsii-Tripogon bromoides-Themeda ciliata	1.99	1.72 ± 0.14	0.64
Anaphalis pulneyensis- Ac.mearnsii- Ar.ciliata	1.86	2.03 ± 0.24	0.58
Pouzolzia wightii- Ac. mearnsii - Ch.zeylanicus	1.96	2.65 ± 0.16	0.56
Gentiana quadrifaria - Ch. zeylanicus - Ac. mearnsii	1.94	2.67 ± 0.36	0.55
Carex filicinea - Ageratina adenophora	2.26	1.97 ± 0.77	0.75
Conyza bonarensis-Hedyotis corymbosa	2.42	2.86 ± 0.88	0.73
Themeda cymbaria-Cymbopogon flexuosus	2.20	2.04 ± 0.36	0.70
Psychotria congesta - Triumfeta rhomboidea- Ac .mearnsii	2.40	2.01 ± 0.38	0.76

SD-Standard Deviation

Conservation Issues

Major issues of conservation in the Shola-Grasslands include degradation and loss of wildlife habitat, changes in the species composition, loss of species diversity and local extinction of threatened floral and faunal species. Principal factors leading to above changes include frequent fire, plantation of exotic trees, invasion by exotic species and conversion of grasslands for various other purposes.

Fire

Though, role of fire in maintaining the grassland vegetation of Western Ghats has been recognized by several authors (Bor 1938, Ranganathan 1938, Meher-Homji 1969), uncontrolled and excess of fire is known to damage the shola forests leading to rapid shrinkage of sholas, invasion of weeds and changes in the species composition in the grasslands (Karunakaran *et al*. 1998). Complete prevention of fire in the fire prone area, on the other hand, leads to increase in fire hazards due to increase fuel load i.e., accumulated dry biomass. Thus, lack of proper fire management plans and resultant stochastic fire events are the causes of concern in the area (Kunhikrishnan 1991). Based on a three year experimental study in the grasslands of Eravikulam National Park, Kerala, Karunakaran *et al*. (1998) found that:

i. Burning induced flowering of *Sehima nervosum* and *Andropogon lividus*.
ii. Nilgiri tahr used burnt areas intensively soon after burning to utilize fresh sprout which means some extent of controlled burning during cool season might be useful for the grassland species. However, frequent burning might lead to less preponderance of *Chrysopogon zeylanicus* community which is preferred more than *Sehima* community by Nilgiri tahr.
iii. Early (cool season) and late (warm season) burning had different effects on the plant communities and species diversity.
iv. Species such as bracken *Pteridium aquilinum* increased in all the intensively burnt areas. Similarly, regeneration of Neelakurinji (*Phlebophyllum kunthianum*) was affected by both early and late burning. In the early burnt area there were very few seedlings of this species compared to late burnt areas.

Plantation of exotic species

The commercial forestry operations by private enterprises and conversion of natural grasslands under plantation of exotic species have persistently threatened the shola-grassland complex in the region (Nair 1994). For example, the establishment of monoculture plantations in the High Ranges of Kerala gradually reduced forest cover about 50% by the start of the century. Of this, 82% loss was contributed by monoculture of teak, wattle (*Acacia mearnsii, A. auriculiformis, A. dealbata)* and eucalyptus *(Eucalyptus globulus, E. terticornis)* (Nair 1994, Karunakaran 1997). Thus both agro- and industrial forestry flourished by cutting natural vegetation in the high elevation areas completely ignoring conservation forestry. Of all the exotics, black wattle (*Acacia mearnsii*) is considered most obnoxious as it spreads very quickly in burnt areas, depletes natural

vegetation and habitat of many plants and animals. Karnuakaran *et al*. (1998) compared the species diversity and habitat use by wild ungulates in different age wattle plantations along the fringes of Eravikulam NP. These authors found that the grasslands free from wattle plantations had maximum percentage (33 %) of endemic species and areas with ca. 10 years of wattle plantation had only 6 % endemic species, even though the older wattle plantation sites had higher species diversity (Table 2). The high amount of tannin present in the bark and leaves of black wattle is known to retard litter decomposition making insufficient improvement of the soil (Noble 1967) for the regeneration of native species and regeneration of invasive species such as *Chromalina odorata* and *Wendlandia thyrsoides*. Khan (1978) reported remarkably low bird diversity in the eucalyptus and black wattle plantation of Nilgiris when compared to shola-grassland vegetation.

Livestock grazing

Livestock grazing in the grasslands of Western Ghats is not as severe as it is in the Himalayan region. Nevertheless tea estates and other habitations do have a considerable number of cattle which are grazed in and around the natural grasslands. As such, grazing is not considered as threat to wild ungulates (Karunakaran *et al*. 1998) but it may pose a problem if communicable diseases such as Foot and Mouth and worms start spreading to the wild. Other causes of grassland degradation include excessive pressure on the land by tourists and ill planned developmental activities.

Management Needs

As has been discussed in the foregoing sections, the shoal-grassland ecosystems are quite vulnerable to fragmentation, degradation, change in species composition and local extinction of rare and threatened species. For the long-term management of this ecosystem, a holistic plan will have to be evolved keeping various landscape features, endangered species and rationalisation of human use in mind. A few suggestions pertaining to the management of this ecosystem are given below:

i. *Identification and monitoring of ecologically sensitive sites:* A series of ecologically sensitive sites all along the crest of Western Ghats need to be identified which would represent typical associations and endangered species of flora and fauna. Such sites, both within and outside the present PA network need to be monitored regularly so as to detect the changes in the ecosystem properties. Under this program, rare and endemic plant taxa need to be flagged for regular population studies.

ii. *Management of semi-natural areas*: Several sites have been taken for the fodder and grassland development by the forest / wildlife departments of various states in the recent past. One of the fodder species, viz., Congo signal grass *(Brachiaria ruziziensis*) has been propagated in and around tea and coffee estates all along Nilgiris and Annaimalais. Similarly, in some PAs, especially, Eravikulam NP, several sites were scraped for introduction of fodder grasses. However, introduction of exotic species has

not proved to be successful. Based on a detailed study, Karunakaran *et al*. (1998) have suggested that scraping the existing vegetation and reintroduction of new species should be strictly prohibited. Other suggestions include eradication of weed (*Ageratina adenophora*) by cutting or uprooting before flowering, maintenance of 5-10 m wide fire lines away from the shola edges which would need maintenance by burning during December. Management of semi-natural areas for more fodder production and proper vaccination of livestock so as to avoid transmission of communicable diseases is strongly recommended.

iii. ***Control of black wattle:*** At present only a few PAs in the Western Ghats represent undisturbed Shola-Grassland ecosystems free from black wattle. Other PAs viz., Mukuruti NP, Annamalai WLS, and Eravikulam NP are quite vulnerable to invasion by black wattle. It is suggested that all the sites under black wattle should be brought back to grassland or shola vegetation cutting (and not allowing to flower), removal of seedlings and replacement by native species.

iv. ***Protection and monitoring of Shola forests*****:** The shola forests are known to play an important role in controlling the local climate apart from acting as a biological repository. Every shola is provided with a stream, or *vice versa* thus maintaining the water table and constant release of water through perennial streams. It is also known that this endangered ecosystem is rapidly vanishing from the upper reaches of Western Ghats. Main threats to shola appear to be fire and collection of fuel wood. These need to be controlled and monitored so as to maintain the health of both the ecosystems.

v. ***Developing Fire management plans:*** A detailed fire management plan for the Shola-Grasslands needs to be evolved. Based on the study conducted by Karunakaran *et al*. (1998) major recommendations related to fire management are as follows:(i) Controlled burning should be practised during December-January, (ii) the grassland communities frequently used by Nilgiri tahr should be selected for occasional burning, (iii) controlled burning should be practised near fire prone areas such as boundary of tea estates, settlements, and road sides on priority basis, (iv) Burning the grasslands should be totally avoided during the year of Neelakurinji (*Phlebophyllum kunthianum*) flowering.

vi. ***Status surveys:*** Status surveys of shola–grasslands (both within the PAs and outside) need to be carried out frequently throughout the Western Ghats so as to identify landuse changes and immediate threats. Use of modern tools such as remote sensing could be of much use for this purpose.

vii. ***Management of Tourism:*** Nilgiris and Annamalais attract a large number of tourists every year because of their picturesque landscape and serenity. Unmanaged and excess of tourism, however, leads to degradation of area, pressure on the shola forests for camping and collection of fuel wood. Proper management of tourism, preferably on the lines of eco-tourism would

be desired for the long term conservation of these grasslands.

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Literature Cited

Blasco, F. and. Thankaimoni., G, 1971. Late Quarternary Vegetational History of southern region. The Palaeobotanist. 632-643.

Bor,N.L., 1938. The vegetation of Nilgiris, Indian Forester 64, 600-609.

Dabadgho, P.M. and Sankaranarayan, K.A., 1973. The Grass Cover of India, ICAR, New Delhi.

Gupta, S.C. S.Chinnamani and Rege, N.D., 1967. Ecological Relationship between High Altitude Grasslands in the Nilgiris. Indian Forester 93, 164-168.

Jose, S., A. Sreepathy, B. Mohankumar and Venugopal, V.K., 1994. Structural, florisitc and edaphic attributes of the grassland-Shola forests of Eravikulam in Peninsular India**.** Forest Ecology and Management 65, 279-291.

Karunakaran, P.V., 1997. Ecological studies on the grasslands of Eravikulam National Park, Kerala. Ph. D. Thesis. Saurashtra University, Rajkot.

Karunakaran, P.V., Rawat, G.S. and Uniyal, V.K., 1998. Ecology and Conservation of Grasslands of Eravikulam National Park, Kerala. Wildlife Institute of India, Dehra Dun.

Khan, M. A. R., 1978. A comparative account of the avifauna of the shola and neibouring plantations in the Nilgiris*.* Journal of Bombay Natural History Society 75, 1028-1037.

Kunhikrishnan, E., 1991. The endangered flora of the high altitude shola-grasslands in the Western Ghats. In Proceedings of the symposium on rare, endangered and endemic plants of the Western Ghats. Kerala Forest Department. Thiruvananthapuram.

Meher-Homji, V.M., 1965**.** Ecological status of the Montane Grasslands of South Indian Hills-a Phytogeographic Re-assessment. Indian Forester 91, 210-215.

Meher-Homji, V.M., 1969. Some Consideration on the Succession of Vegetation around Kodaikanal. Journal of Indian Botanical Society 48, 42-51.

Menon, V.K., 1967. Pollen Analysis of the Post Glacial Deposits from Pykara,

Ootacamund, Indian Journal of Palynology 1-2, 1-9.

Nair, S.C., 1994. The High Ranges. INTACH. New Delhi, 81**.**

Noble, W. A., 1967. The shifting balance of grassland, shola forests and planted trees in the upper Nilgiris, South India. Indian Forester 93 (10), 691-693.

Puri, G.S, Meher-homji, Gupta, R.K. and Puri, S.K., 1989. Forest Ecology. Vol I,II. Oxford and IBH Publishing Company, New Delhi.

Ranganathan, C.R., 1938. Studies in the Ecology of the Shola Grassland Vegetation of Nilgiri Plateau. Indian Forester 54, 523-541.

Rice, C.G., 1982. The behaviour of and Ecology of Nilgiri Tahr. Ph.D. Thesis. M.S. Colorado University.

Singh, J.S. and Yadav, R.S., 1977. Grassland Vegetations, Its Structure, Function, Utilization and Mangement. Progress in Ecology, Vol. II. Today and Tomorrow Printers and Publishers, New Delhi.

Vishnu-Mittre and Gupta, H.P., 1970. The Origin of Shola Forest in the Nilgiris, South India. The Paleobotanist 19, 110-114.