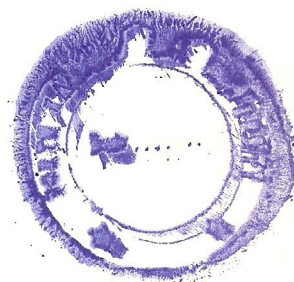


ECOLOGY OF TREE REGENERATION ALONG A
DISTURBANCE GRADIENT IN SUBTROPICAL
WET HILL FOREST OF MEGHALAYA

By

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THESIS SUBMITTED IN FULFILMENT OF THE DEGREE OF
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I certify that the thesis entitled "Ecology of tree regeneration along a disturbance gradient in subtropical wet hill forest of Meghalaya" submitted by Shri Saroj Kanta Barik, for the degree of Doctor of Philosophy of the North-Eastern Hill University, Shillong, embodies the record of original investigation carried out by him under my supervision. He has been duly registered and the thesis presented is worthy of being considered for the award of the Ph. D. Degree. The work has not been submitted for any degree of any other University.

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The 21st December, 1992.

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CHAPTER 1

GENERAL INTRODUCTION

Forests form the natural vegetation in most of the humid and subhumid parts of the tropical and subtropical world. They are important in many ways for the very existence of the human civilization. Forests have considerable impact on the local climate. They reduce soil erosion, regulate streamflow, increase precipitation and provide shelter to the wide variety of flora and fauna. Besides these environmental aspects, they have an important role in meeting man's need for food, fuel, shelter and other things of economic and sociocultural values. In many countries such as Sweden, Canada and Australia, wise and rational use of these forest resources through scientific management has been the basis of their economic development. This has also been helpful in maintaining the quality of environment in these countries. It is desirable to collect as much information as possible on the quality and availability of terrestrial biological resources, and site-specific land-use options and management practices. However, in many countries, a scientific land-use system has not been adopted as yet in order to attain an enhanced productivity on a sustained yield basis due to various ecological and social constraints (Anonymous 1978). The unscientific land-use practices have caused irreparable loss to the land resources of the earth in general, and forest wealth in

particular. Therefore, forests of the world continue to be depleted both quantitatively and qualitatively, at ever-increasing rates.

Like other developing countries, over-exploitation and unscientific management of forests in India have caused enormous reduction in the forested land which is only 64.01 million ha, accounting for mere (19.47%) of the total geographical area of the country (FSI 1989). Though the National Forest Policy of India (1952) aims at maintaining one third of its land under forest, the actual progress made in this direction is rather disappointing. As per the 1989 forest cover assessment of the country, the annual rate of loss of forest cover works out at 47,500 ha (FSI 1989).

The edapho-climatic conditions of North-Eastern India favour luxuriant growth of vegetation and the climax formation represented by the oak forests also exist in the region in a scattered manner. However, the present status of forest cover in North-Eastern India, is equally alarming. In Meghalaya, the age-old practice of shifting cultivation, massive tree felling and other developmental activities have caused a loss of 4.97% of forest area during the period 1983-1987 (FSI 1989). The rate of deforestation far exceeds the rate of replenishment of forest cover either through natural or artificial regeneration. The problem of inadequate natural regeneration in these forests needs to be addressed to by the ecologists and foresters alike. A detailed understanding of the dynamics of the forest ecosystem structure and function is a pre-requisite for silvicultural

management of forest crops.

A study of tree regeneration, whether natural or artificial, is very important for a clear understanding of the dynamics of forest ecosystem in time and space. Despite increasing importance of man-made forests, the natural regeneration continues to play a significant role in the maintenance of forest across the world, because a very large tract of forest is still managed through natural regeneration. An understanding of natural regeneration of trees is not only an essential prerequisite for the adoption of correct silvicultural practices for different types of forest crops, but it also serves to elucidate many problems connected with such interesting and important ecological questions as invasion of species, wood land succession, niche partitioning among species, maintenance of species diversity and gregariousness.

The natural regeneration of trees covers a wide range of ecological aspects related to forest biology. It takes place largely through seedling recruitment and sprout emergence. The regeneration ecology encompasses the study of soil seed bank, germination behaviour, reproductive allocation and fecundity, survival and growth of seedlings and sprouts as well as various factors affecting these parameters such as seed dispersal, predation, microenvironmental variables and microsite heterogeneity etc. Microsite heterogeneity affects species diversity, community structure and regeneration of constituent trees. Seed production and mode of dispersal determine the chance of colonization by a species and competitive interaction

decides whether a species can successfully occupy a given ecological niche. The interspecific variation in moisture, light, nutrient and other resource requirement for successful germination and establishment of tree species explains the spatial and temporal variation in forest community organisation.

Usually, the undisturbed forest ecosystem is self-maintaining and can be recognised as a biological entity. Therefore, it has often been referred as a stable community. It has capacity to exercise control over its hydrology and biogeochemistry, and can regulate the flow and use of solar energy. Regulation lies in internal ecosystem processes such as transpiration, nutrient uptake, decomposition, mineralisation and nitrification (Shugart, 1984). Any alteration in these stable ecosystems results in marked change in internal ecosystem processes and can lead to a progressive alteration of the dynamic balance (Anonymous 1978). The pattern of change is extremely complex, because it is brought about by many different processes, which operate at different scales. Disruption of forest structure by natural and man-induced disturbance is one of such processes and is an important determinant of the forest dynamics. The structure of plant and animal communities in many natural ecosystems has been reported to be affected by disturbance (White 1979, Vogl 1980, Armesto & Pickett 1985). The size of disturbance ranges from very small gaps created by the death of an individual tree or breakage of a tree limb to very large disturbances created by massive tree felling, fire, wind storms, land slides and earthquakes. Animal activities also create

disturbances of different sizes ranging from hoof marks to intensive browsing and grazing by mammals. Disturbance by defoliating insects may be of localised type, affecting a very small portion of the forest or it may spread over large forest areas. In recent years, however, anthropogenic disturbances have been increasing in size and intensity. The similarities between these man-made disturbances and natural disturbances have been recognized by many ecologists and therefore, it has been argued that the distinctions between natural and anthropogenic disturbances are less important than studying the nature and consequences of disturbances and subsequently, the response of species populations to these disturbances over a period of time (Bazzaz 1983). Several population attributes such as density and dispersal, ^{survival} survivorship and age structure, competitive interaction and niche breadth etc., are influenced by size and intensity of disturbance. Variation in intensity of disturbance in particular, differentially affects various population attributes including certain important life-history adaptations such as seedling establishment and sprouting behaviour (Bazzaz 1983, Johansson 1987).

Positive effect of disturbance on seedling survival has been demonstrated by several workers (Goldberg & Werner 1983, Klinkhamer & De Jong 1988). The impact of disturbance upon tropical forests has long been appreciated (Kramer 1933, Aubreville 1938, Jones 1950, 1956, Van Steenis 1956, Sousa 1984, Whitmore 1974, 1984, 1991) and many fast-growing shade-intolerant pioneer tree species have been reported to be adapted to

disturbance (Van Steenis 1956, Schulz 1960, Baur 1968, Lawton & Putz 1988). Ricklefs (1977), Denslow (1980), Orians (1982) and Brokaw (1985) have explicitly theorised that specialised gap-phase regeneration requirements contribute to the diversity of tropical forests. There is now much evidence that disturbance interferes with the exclusion of species by competition and is therefore, necessary for the maintenance of species diversity in many plant communities (Grubb 1977, Connell 1978). Disturbance significantly influences regeneration process like any other ecosystem processes. Disturbances of varying intensities make the forest floor spatially heterogeneous, providing a variety of microsites for seed germination and seedling establishment. The microenvironment of forest understorey is also altered drastically following a disturbance. By altering the physical environment and species composition of a community, disturbance disrupts succession and influences the regeneration of constituent species in the community. The pattern of interaction of different trees with the changed microenvironment following disturbance during regeneration phase is largely responsible for species coexistence in the community.

Species living in the same area ^{have} devise different adaptational as well as reproductive strategies for their coexistence. Regeneration through sprouts may prove to be an efficient strategy of slow growing species to compete with fast growing early colonizers. They could delay the occupancy of site by early colonizers after disturbance by sprouting profusely and by showing faster growth rate than seedlings at least during

early years of growth. An understanding of various aspects of sprout regeneration including factors that influence their emergence, survival and growth may provide vital clues for discerning the successional development of the forest community especially during post-disturbance period.

Some of the aspects concerning tree regeneration in the subtropical humid broad-leaved forest of Meghalaya have been studied by Khan & Tripathi (1986, 1987, 1989, 1991). Yet, there is a paucity of time series data on various regeneration aspects. Moreover, the regeneration response of tree populations to the varying degree of disturbance has not been investigated. The exact causes of forest decline in this part of the country are not yet clearly known. Keeping these in view, the present study aims at analysing the effect of disturbance on regeneration of forest trees, which may be helpful in taking ecologically viable silvicultural management decisions. The specific objectives of the study are :

- To assess the impact of disturbances on community characteristics and tree population structure.
- To predict successional trends in the community on the basis of information collected on the population and community level changes in the forest ecosystem following disturbance. Information on the present birth and death schedules can also provide a clue to the future forest composition.
- To study the pattern of environmental shift following disturbance in the forest community.

- To understand the occupancy of ecological niches by different species in time and space. The study may also address some of the central questions pertaining to the community ecology, such as, whether disturbance leads to diversification of niches, thereby encouraging species specialisation or it favours the survival of a few dominant species and extinction of others. The answer to this question in turn may help in understanding the complex relationship between species diversity and prevailing disturbance.
- To explain the failure of regeneration in the forests of Meghalaya by identifying microenvironmental constraints that cause seedling mortality and retard the growth of saplings.
- To analyse the causes underlying poor seedling recruitment despite the production of a large number of seeds produced by a single parent tree.
- To study the effect of disturbance on coppice regeneration, the sprouting behaviour of different tree species and growth of sprouts.