

ECOLOGY OF GAP PHASE REGENERATION IN A
SUBTROPICAL BROADLEAVED CLIMAX
FOREST OF MEGHALAYA

ABSTRACT

By

PRATHIMA RAO

THESIS SUBMITTED IN FULFILMENT OF THE DEGREE OF
DOCTOR OF PHILOSOPHY IN BOTANY



NORTH-EASTERN HILL UNIVERSITY

SHILLONG, INDIA

1992



The present study of gap phase regeneration, conducted in a broadleaved subtropical forest at Mawphlang, 30 km south-west of Shillong, Meghalaya, deals with the community characteristics, physical features of treefall gaps and their influence on microenvironment and species diversity of the forest. It also examines the growth and population behaviour of naturally recruited seedlings of dominant tree species in treefall gaps within the forest.

The forest stand at Mawphlang representing the relict climax vegetation of the area, is dense and evergreen with trees not exceeding 20 m in height. The canopy layer is mainly composed of Quercus dealbata L., Quercus griffithii Hk., Quercus glauca Thunb., Schima khasiana Dyer, Myrica esculenta Buch.Ham, and Manglietia insignis (Wall)Bl. The sub-canopy layer (3-10 m height) shows abundance of Exbucklandia populnea (Griff) Br., Prunus undulata Buch.Ham. and Rhododendron arboreum Sm. The shrub layer is dominated

by Daphne shillong Banerjee and Baliospermum micrantha Muell Arg. The ground vegetation is mainly composed of herbaceous species and some pteridophytes. The seedlings and saplings of Q. dealbata, Q. griffithii and S. khasiana are abundantly found on the forest floor. In terms of species richness, the forest is relatively poor than other humid tropical forests, but it is comparable to the subtropical or warm temperate forests of the Far East.

The tree density was high in lower dbh (10-20 cm; 20-30 cm) classes and low in higher dbh (40-50 cm; 50-60 cm) classes and the tree population of the forest showed an overall straight line relationship between density and diameter. Density-diameter curves of individual species showed a marked variation in shape, ranging from sigmoid to bimodal and reverse J-shaped.

All treefall gaps larger than 20 m² were identified in an experimental area of about 50 ha. Shape, size and various other physical characteristics related to topography and post treefall debris were studied in each of the twelve identified gap. Dumbbell shaped gaps were most common followed by elliptical and quadrangular gaps. The size of the gaps varied between 34 m² to 950 m².

Photon flux density, relative humidity, air temperature, soil moisture, soil temperature and litter depth were

monitored at monthly intervals for two years in gaps and understorey. Photon flux density was higher (about 70%) and relative humidity was lower (15%) in gaps than in the surrounding understorey. Litter layer was relatively thin in the gaps throughout the year. Seasonal as well as among gap variations were significant only for photon flux density, relative humidity and soil moisture content. Photon flux density was maximum during winter and minimum during rainy season and it increased with increase in gap area. Relative humidity and soil moisture content, however, decreased along the increasing gap size gradient. Both of them showed peak during rainy season and minimum value during winter season. The technique of Principal Component Analysis was applied to the six microenvironmental variables and PC I and PC II were obtained. They together accounted for 92% (PC I 80%; PC II 12%) of the total variation in the microenvironmental factors. PC I of microenvironment was positively correlated with gap area.

The number of tree species (seedlings) in the gap increased with an increase in its size. Likewise equatibility of dominance among the species also increased from the smaller to larger gaps. Tree seedling density and total species diversity in the gaps was negatively correlated to the Principal Component I of microenvironmental variables. Gaps were ordinated into groups on the basis of Principal

Component Analysis of the shade tolerant and shade intolerant tree species. The smaller gaps (gap nos. 1 to 9) with higher density of shade tolerant species formed one cluster and the large gaps (gap nos. 10 and 12) having a comparatively higher density of shade intolerant species constituted another cluster. Gap no. 11 with more or less equal proportion of shade tolerant and shade intolerant species formed a distinct group of its own.

α -diversity, the mean number of species per gap, for tree seedlings was higher in the gaps than in the understorey. β -diversity which shows the mean similarity among the gaps was lower for tree seedlings than for herbs and shrubs. α -diversity for tree seedlings, shrubs and herbs and β -diversity for tree seedlings increased between August, 1988 and August, 1990 suggesting that the gaps became more similar after a period of two years in their species composition.

Seed production per tree in four dominant tree species, Q. dealbata, Q. glauca, Q. griffithii and S. khasiana ranged between 3662 in Q. dealbata and 42,856 in Q. griffithii. Recruitment of naturally emerged seedlings of these species as well as M. esculenta and T. tomentosa was low in this forest. In the understorey Q. dealbata seedlings were most abundant followed by Q. glauca, Q. griffithii,

S. khasiana and T. tomentosa in descending order. Q. dealbata seedlings were also abundant in the small gaps, while in the medium and large gaps S. khasiana was more abundant. Total tree seedling recruitment (plants ha⁻¹) sharply declined from 1430 in the small gaps to 510 in the medium gaps. Further increase in gap area did not influence the density of recruited seedlings.

Survival and growth of the seedlings recruited in the gaps and understorey were monitored from August, 1988 to August, 1990. Seedlings of S. khasiana, T. tomentosa and M. esculenta registered high mortality during winter due mainly to low temperature and high soil moisture stress created by low rainfall and high evapo-transpiration losses. Mortality was negligible in the oak species.

S. khasiana and M. esculenta showed higher shoot growth rate in the large gaps, while the three oak species performed better in the understorey. T. tomentosa showed best growth in the small and medium sized gaps. Peak seedling growth during rainy season in all the species is attributed to the favourable temperature and edaphic conditions of the forest floor.

Seed and seedling predation influenced the performance of the tree seedlings in this forest. High seed predation both at the pre- and post-dispersal stages in the three

oak species could be one of the reasons for their poor germination and low seedling recruitment in the forest. Total seed loss to predation ranged from 91% in Q. dealbata to 98% in Q. griffithii and Q. glauca.

Seedlings of all the six tree species showed maximum leaf area damage (85-95%) during autumn. The proportion of damaged leaf area per seedling also increased along the gap size gradient. The shade tolerant oak species were more susceptible to leaf damage than the shade intolerant species.

Thus it may be concluded that the creation of treefall gaps in the oak forest at Mawphlang brings about a marked change in the forest microenvironment by significantly increasing the solar radiation which triggers off a series of changes in atmospheric and edaphic conditions in the gaps. Size of the gap also plays an important role in influencing its microenvironment. Species with different regeneration guilds tend to occupy the newly created niches causing a change in species diversity between gaps and understorey as well as along the increasing gap size gradient. Recruitment of tree seedlings of oak species is adversely affected by pre- and post-dispersal predation of seeds by insects and rodents. Growth and population behaviour of infinitively small proportion (0.03-0.5% of total seed production) of naturally recruited seedlings in

gaps and understorey is further regulated by sharp seasonal variation in certain climatic variables and the activity of insect herbivores which damage as high as 71% of the recruited seedlings in the population.

LEHU LIBRARY
Acc. No. 102766
Acc by [Signature]
Date 2/16/95
Class [unclear]
Sub [unclear]
Enter [unclear]
Trunc [unclear]