CHAPTER II

Regeneration status, age structure and survival of tree seedlings and sprouts in disturbed forest at Upper Shillong and in 'Sacred Grove' at Mawphlang.
INTRODUCTION

Regeneration status of trees can be predicted by the age structure of their populations (Marks 1974, Vablen et al. 1979, Pritts & Hancock 1983, Saxena & Singh 1984, Saxena et al. 1984). Presence of sufficient number of seedlings, saplings and young trees in a given population, indicates a successful regeneration of the tree species (Saxena & Singh 1984). Regeneration of tree species is greatly influenced by the interaction of biotic and abiotic factors of the environment (Boring et al. 1981, Lange & Graham 1983, Aksamit & Irving 1984). These factors may affect the recruitment, survival and growth of tree seedlings and sprouts. Therefore, a study pertaining to age structure and survival of seedlings and sprouts was undertaken to assess the regeneration status of the tree species occurring in the two forest stands.

METHODS

The age structure of all tree species growing in a given forest was studied from June 1983 to February 1985 at four-monthly intervals. On each observation date, density of the trees belonging to four different age groups viz., seedlings (< 20 cm height), saplings (20-150 cm height and < 5 cm diameter), small trees (5 to 25 cm 'dbh') and big trees (>25 cm 'dbh') was recorded in twenty (20 m X 20 m) randomly laid permanent quadrats. Relative proportion (%) of each age group to the total density of tree species in a forest was calculated and the pyramid of age structure, keeping the seedling density as base, was drawn.

In a given forest, density of tree seedlings and stumps at the periphery and in the middle of the forest was separately studied in June,
1983. The two sites differed from each other in respect of light intensity and vegetation density. The light intensity (average for a day) at ground surface in the sparse forest stand at the periphery was 13,000-17,000 Lx and in the dense forest stand in the middle, it was 5,000-8,000 Lx. Density of the tree seedlings and stumps was determined in randomly laid 20 quadrats of 20 m X 20 m size in each of the two sites in a given forest.

For studying survival of the tree seedlings and sprouts, 35 - 50 seedlings and 10 stumps bearing 3 - 6 sprouts which were 10 - 20 leaved were tagged with labelled aluminium foil. Survival of the seedlings and sprouts was noted at two-monthly intervals in both the forests over one-year period. On each observation date, density of the ground vegetation was also determined in randomly laid twenty quadrats of 2 m X 2 m size.

The soil moisture content and thickness of the litter layer (organic matter above mineral soil) were estimated at bimonthly intervals at the periphery and at the centre of both the forests. On each sampling date, soil samples representing 0 - 10 cm depth were collected from 20 places and the soil moisture content was determined following the method outlined by Piper (1947). The litter depth was determined by line-intercept method as outlined by Mueller-Dombois & Ellenberg (1974).

RESULTS

Soil moisture content and litter accumulation:

The soil moisture content under the forest stands at the periphery and at the centre did not show wide variation in both forests. However,
a marked seasonal trend in soil moisture was observed in both the forests, the values being maximum in the month of June and minimum in December (Fig. 2.1). Litter accumulation as measured by its depth, invariably depicted higher values in the forest at Mawphlang. The litter accumulation was more in the centre than at the periphery. Maximum litter accumulation was observed during winter and minimum in rainy season in both the forests (Fig. 2.1).

**Ground vegetation:**

In general, density of ground vegetation in both the forests was higher at the periphery than in the centre. The density was also higher in the forest at Upper Shillong than in Mawphlang. Maximum density of ground vegetation was observed in the month of June and minimum in December both on the periphery and in the centre of the two forests (Fig. 2.2).

**Regeneration status and density of tree seedlings and stumps:**

Out of 10 tree species in the forest at Upper Shillong, five (Alnus nepalensis, Myrica esculenta, Quercus dealbata, Q. griffithii and Schima khasiana) regenerated by both seedlings and sprouts. Daphniphyllum himalayense, however, regenerated only through sprouts and *Pinus kesiya* only by seedlings. At Mawphlang forest out of 14 tree species, four viz., *Myrica esculenta, Quercus dealbata, Q. griffithii* and *Schima khasiana* regenerated by both seedlings and sprouts. Regeneration of *Rhododendron arboreum* was only by seedlings and of *Manglietia caveana* only through sprouts.

Number of seedlings and stumps per unit area differed in the
Fig. 2.1. Litter accumulation and soil moisture content in the two forest stands during the study period. Litter accumulation denoted by bars and soil moisture by curve. Filled symbols for dense stand at the centre and open symbols for sparse stand near the periphery of the forests.
two forests and also at the periphery and in the centre of a given forest. The number was greater in the forest at Upper Shillong than in Mawphlang. In general, the seedlings and stumps were more at the periphery of the forests than in the centre (Table 2.1). In the forest stand at the periphery of the 'Sacred grove' at Mawphlang, *S. khasiana* showed maximum seedling population and *Q. dealbata* had minimum number of seedlings, whereas in the centre, the maximum seedling density was shown by *Quercus griffithii* and minimum by *Q. dealbata*. In the forest at Upper Shillong, *Pinus kesiya* exhibited maximum and *Myrica esculenta* minimum number of seedlings. *Manglietia caveana* showed maximum number of stumps and *Myrica esculenta* minimum in the centre of the forest at Mawphlang, whereas at the periphery the corresponding values were observed in *Schima khasiana* and *Quercus griffithii* respectively. As for the number of stumps, *Schima khasiana* showed maximum and *Myrica esculenta* minimum values in the forest at Upper Shillong both at the periphery and in the centre (Table 2.1).

**Survival of seedlings and sprouts:**

Survival of the tree seedlings was lowest during winter months, while it was better during rainy season and in spring (Fig. 2.2). Further, survival of seedlings was poor in the dense forest stands. None of the seedlings of *Myrica esculenta*, *Quercus* spp. and *Schima khasiana* survived in dense stands, whereas at the periphery seedlings of *Quercus* spp. showed 35% survival and *Myrica esculenta* and *Schima khasiana* seedlings showed 10% survival. Seedling survival was better in *Quercus griffithii* than in *Q. dealbata* in both forests.
Table 2.1. Density (± S.E.) of the tree seedlings and sprout bearing stumps in the forests under study.

<table>
<thead>
<tr>
<th>Forest stand</th>
<th>Tree species</th>
<th>Density/hectare</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Seedlings</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Alnus nepalensis</td>
</tr>
<tr>
<td>Upper Shillong</td>
<td>Dephiniphyllum himalayense</td>
<td>0</td>
</tr>
<tr>
<td>Forest stand in the centre</td>
<td>Myrica esculenta</td>
<td>30±4.8</td>
</tr>
<tr>
<td></td>
<td>Pinus kesiya</td>
<td>290±16.3</td>
</tr>
<tr>
<td></td>
<td>Quercus dealbata</td>
<td>90±7.8</td>
</tr>
<tr>
<td></td>
<td>Quercus griffithii</td>
<td>45±4.2</td>
</tr>
<tr>
<td></td>
<td>Schima khasiana</td>
<td>70±3.8</td>
</tr>
<tr>
<td>Forest stand near the periphery</td>
<td>Alnus nepalensis</td>
<td>90±4.2</td>
</tr>
<tr>
<td></td>
<td>Myrica esculenta</td>
<td>43±6.3</td>
</tr>
<tr>
<td></td>
<td>Pinus kesiya</td>
<td>412±62.4</td>
</tr>
<tr>
<td></td>
<td>Quercus dealbata</td>
<td>100±21.0</td>
</tr>
<tr>
<td></td>
<td>Quercus griffithii</td>
<td>70±11.2</td>
</tr>
<tr>
<td></td>
<td>Schima khasiana</td>
<td>90±13.8</td>
</tr>
<tr>
<td>Mawphlang</td>
<td>Manglietia caveana</td>
<td>0</td>
</tr>
<tr>
<td>Forest stand in the centre</td>
<td>Myrica esculenta</td>
<td>28±3.5</td>
</tr>
<tr>
<td></td>
<td>Quercus dealbata</td>
<td>40±3.6</td>
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<tr>
<td></td>
<td>Quercus griffithii</td>
<td>44±4.0</td>
</tr>
<tr>
<td></td>
<td>Schima khasiana</td>
<td>42±2.8</td>
</tr>
<tr>
<td>Forest stand near the periphery</td>
<td>Quercus dealbata</td>
<td>64±6.3</td>
</tr>
<tr>
<td></td>
<td>Quercus griffithii</td>
<td>98±9.8</td>
</tr>
<tr>
<td></td>
<td>Rhododendron arboreum</td>
<td>90±10.0</td>
</tr>
<tr>
<td></td>
<td>Schima khasiana</td>
<td>102±12.2</td>
</tr>
</tbody>
</table>
Fig. 2. Survival of natural populations of the tree seedlings in dense stand in the centre and in sparse stand near the periphery of the forests at Upper Shillong and Mawphlang. Vertical bars represent density of ground vegetation.
Dense stand at the centre

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Sparse stand near the periphery

\[ \text{A.nepalensis, M. esculenta, P. kesiya, Q. dealbata, Q. griffithii, S. khasiana} \]

\[ \text{Survival (%) of ground vegetation} \]

\[ \text{Jun Aug 1983, Feb Apr 1984, Jun 1983, Jan 1984} \]

Fig. 2-2
The sprouts also exhibited similar survival trend as shown by the seedling population. However, mortality of the sprouts was less than that of the seedlings. The reduced light intensity in the dense forest stand resulted in greater mortality of the sprouts, especially in the forest at Mawphlang. In contrast to the seedling population, the sprout survival was better in *Quercus dealbata* than in *Q. griffithii* (Fig. 2.3).

**Age structures of the two forests:**

The distribution of the various age groups in the total population of all tree species differed markedly in the two forests. While the age structure was upright pyramidal in the forest at Upper Shillong, it was inverted in the forest at Mawphlang. Among the four age groups, seedlings contributed about 45% of the total density at Upper Shillong and only about 7% at Mawphlang. The seedling population decreased substantially in February in both the forests, the reduction being greater in Mawphlang (Fig. 2.4). The density of saplings was greater in the forest at Upper Shillong than in Mawphlang forest and it did not show marked seasonal variation. As compared to seedling and sapling populations, trees are more abundant in the forest at Mawphlang.

**DISCUSSION**

Greater number of seedlings and stumps in the forest stand at Upper Shillong is attributed to the creation of large number of microsites by tree felling and forest burning, which might help in germination/sprouting of large number of tree seeds/stumps. Removal of overstorey trees might
Fig. 2. 3. Survival of the tree sprouts in dense stand in the centre and in sparse stand near the periphery of the forests at Upper Shillong and Mawphlang.
Dense stand at the centre

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Sparse stand near the periphery

A. nepalensis, D. himalayanse, M. esculenta, Q. dealbata, Q. griffithii, S. khasiana

MAWPHLANG

M. caveane, M. esculenta, Q. dealbata, Q. griffithii, S. khasiana

Survival (%)


Fig. 2-3
Fig. 2. Age structure of the total population of all the tree species in the two forest stands. Percentages of the total density as seedlings ( ), saplings ( ), small trees ( ) and big trees ( ) are given. The density of trees in a stand is indicated above the corresponding pyramid.
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Feb, 1985
1103

Oct, 1984
1206

Jun, 1984
882

Feb, 1984
1086

Oct, 1983
1192

Jun, 1983

936

MAWPHLANG

1663

1909

1926

1859

1921

1935

Fig. 2.4
have also favoured germination and seedling establishment through increased solar radiation on the forest floor and consequent increase in surface temperature and reduced competition with trees of upper canopy (Koller 1972, Noble & Slatyer 1980, Oliver 1981). On the other hand, poor seedling population in the forest at Mawphlang may be due to the unavailability of the same favourable conditions. Besides, thick layer of litter also acts as a mechanical barrier for seedling emergence (Telfer 1972, Grime 1979).

The forest at Upper Shillong is characterised by an upright pyramid of age structure. Selective felling of older trees for timber and other purposes appears to be responsible for their decreased proportion in total population of trees. The climax forest at Mawphlang where tree felling and burning are completely prohibited due to belief of the local tribals, shows an inverted pyramid of age structure. Similar change in age structure of plant populations in forest communities due to various kinds of disturbances has also been reported by Heinselman (1973), Foster (1980) and Primack et al. (1985).

The tree seedlings/sprouts showed better survival in the stand near the periphery than in dense forest stands, which may be attributed to the lack of threshold light intensity available to the seedlings/sprouts for photosynthesis in the latter stand. This conforms with the observations of Whitmore (1975), Garwood (1979), Sasaki & Mori (1981), Abbott (1984), Augspurger (1984a, b, c), Langenheim et al. (1984) and Primack et al. (1985). Thick litter layer in the dense forest stands, especially in Mawphlang (Fig. 2.1) may also influence the survival of tree seedlings through production of allelo- chemics as reported by Blaschke (1979) and Tayler & Shaw (1983). The peak
mortality of tree seedlings during winter months may be due to prevailing low temperature and high soil moisture stress (Fig. 2.2). The detrimental effect of soil moisture stress on the survival of tree seedlings has also been reported by earlier workers (e.g. Pereira & Kozlowski 1977, McLeod & Murphy 1977, Mueller-Dombois et al. 1980, Schulte & Marshall 1983). Significance of undercanopy vegetation in determining the size of seedling population of trees through mortality has been emphasized by Eis (1981), Cross (1981), Maguire & Forman (1983), Burton & Mueller-Dombois (1984) and Connell et al. (1984). The undercanopy vegetation may also influence seedling survival of tree species through allelopathic effects, as has been reported by Rice (1974), Stewart (1975), Horsley (1977a, b), Willis (1980) and Ashton & William (1982). The decrease in population size of the tree seedlings during rainy season especially on the periphery of the forests is largely caused by the erosive action of the torrential rain on the hill slopes of Meghalaya.

Better regeneration of trees in the forest at Upper Shillong than in Mawphlang signifies the role of prevailing disturbances in the former. Harris & Farr (1974) and Boring et al. (1981) have also emphasized the positive role of mild disturbances in improving the regeneration of trees, though the role of severe disturbances has been regarded as deleterious to forest ecosystems (Levin 1976).