GENERAL DISCUSSION
The data collected on regeneration behaviour of two selected forests reveal that regeneration is better in the disturbed forest at Upper Shillong than in undisturbed 'Sacred grove' forest at Mawphlang. The age structure of tree species in the disturbed forest was upright pyramidal, whereas in undisturbed forest it was inverted pyramidal. The regeneration of trees through seedlings and sprouts of stumps was greater in the disturbed forest. Survival of the seedlings and sprouts was also better in the disturbed forest. Variation in regeneration behaviour of the tree species in the two forest stands signifies the role of prevailing disturbances as also reported elsewhere (Heinselman 1973, Whitmore 1975, Foster 1980, Bazzaz 1983, Dunn et al. 1983, Saxena & Singh 1984, Primak et al. 1985, Oliver et al. 1985, White et al. 1985). The positive role of mild disturbances in improving the regeneration of trees has been emphasized by Kenoyer (1921), Harris & Farr (1974) and Boring et al. (1981). Greater seedling recruitment and sprouting of the stumps in the disturbed forest stand at Upper Shillong may be attributed to the availability of large number of microsites caused by tree felling and forest burning. Removal of overstorey trees may also favour germination and seedling establishment through increased solar radiation on the forest floor and consequent increase in surface temperature, and reduced competition from the trees of upper canopy (Koller 1972, Noble & Slatyer 1980, Oliver 1981). Conversely, poor seedling population in the undisturbed forest at Mawphlang may be due to the absence of the above mentioned favourable conditions.
Besides, the thick layer of litter in the undisturbed forest (Fig. 2.1) acts as a mechanical barrier for seedling emergence (Telfer 1972, Grime 1979). Poor emergence, survival and growth of Quercus dealbata and Q. griffithii seedlings (Chapter IV) in the plots from where litter was not removed confirmed the detrimental effect of forest litter on regeneration of forest trees.

The upright pyramid of age structure of the disturbed forest at Upper Shillong (Fig. 2.4) is attributed to the selective felling of older trees for timber and other purposes. On the other hand, in the undisturbed 'Sacred grove' forest at Mawphlang which does not experience such disturbances, the age structure is inverted pyramidal. Similar change in age structure of plant populations in forest communities caused by various kinds of disturbances has also been reported by Heinselman (1973), Foster (1980) and Primack et al. (1985).

The seedlings and sprouts showed better survival in the forest stands near periphery than in the dense forest stands (Chapter II). The results of the experiment concerning the effect of associated plant species on the transplanted seedlings also revealed better survival and growth in the sparse stand than in the dense one (Chapter VI), which may be attributed to the nonavailability of threshold light intensity for photosynthesis in the latter. This is in line with the findings of Whitmore (1975), Garwood (1979), Sasaki & Mori (1981), Abbott (1984), Laagenhein et al. (1984) and Primack et al. (1985). Studies conducted by Augspurger (1984a, b) on tropical trees and Nicholson (1960) and Sasaki & Mori (1981) on some dipterocarp seedlings also showed greater survival and growth in sun than in shade. Modifications
in the microclimate (air and soil temperature, evaporation, humidity etc.) through canopy opening as discussed by Koller (1972), Bazzaz & Pickett (1980) and Burton & Mueller-Dombois (1984) might have favoured the emergence, survival and growth of the seedlings under sparse canopy. The data on emergence, survival and growth of seedlings of Alnus nepalensis, Quercus griffithii and Schima khasiana in controlled conditions (Chapter V) also indicate that the performance of these tree species is favoured by the increased light intensity. Greater seedling emergence in lighted condition than in shade was also reported by McLemore (1971), Garwood (1979) and Campbell (1982). Seedlings of Heliocarpus appendiculatus and Dipteryx panamensis in controlled conditions showed greater height, survival and biomass in lighted condition (Fetcher et al. 1983). Attack by the pathogens could be one of the reasons for the greater seedling mortality in the dense stand (visual observation). Augspurger (1984b) also observed greater mortality of seedlings caused by pathogens in some tropical tree species under shaded condition.

Survival and growth of seedlings were poor in the plots from which ground vegetation was not removed (Chapter V & VI). This signifies the detrimental effect of ground vegetation on tree seedlings as emphasized by Eis (1981), Maguire & Forman (1983), Burton & Mueller-Dombois (1984) and Connell et al. (1984). Greater seedling mortality during the rainy season could also be related to the luxuriant growth of ground vegetation in this season. Poor natural regeneration in many logged forest stands has been attributed to dense growth of herbs (Hough 1937, Hough & Forbes 1943, Sulser 1971, Horsley 1977a, b). Resource competition offered by the ground
vegetation most likely causes seedling mortality in the uncleared plots as also suggested by Stone & Thorpe (1971), Maguire & Forman (1983). Besides, the ground vegetation may also influence seedling survival and/or growth through the production of allelochemics (Rice 1974, Stewart 1975, Horsley 1977a, b, Willis 1980, Ashton & William 1982, Rai & Tripathi 1984).

Peak seedling mortality observed during winter season (Fig. 2.2 & 6.2) may be attributed to the prevailing low temperature accompanied with high soil moisture stress (Fig. 6.2). Poor survival and growth of the seedlings at low soil moisture level was also observed in the controlled condition (Table 5.2, Fig. 5.3 & 5.4). The role of soil moisture in tree seedling establishment has been discussed by Noble & Alexander (1977), Schulte & Marshall (1983), Vance & Running (1985) and Wellington & Noble (1985).

Growth of sprouts and survival and growth of transplanted seedlings were greater in the burnt plots than in unburnt plots (Chapters III & VI). Harrington & Kelsey (1979), O'Dowd & Gill (1984) and Abbott & Loneragan (1984) have also observed better growth of tree seedlings in the burnt plots. Surface fire produces an immediate flush of readily available nutrients (Wells et al. 1979). Thus, burning might have favoured the growth of the seedlings and sprouts. Other possible roles of fire in relation to seedling/sprout survival and growth have been discussed in Chapters III & VI.

Seed germination is also regulated by various factors. Heavy seeds of Quercus dealbata and Q. griffithii germinated earlier than the light seeds and showed maximum germination (Table 4.2 & 4.3). Emergence of
seedlings of *Alnus nepalensis, Quercus griffithii* and *Schima khasiana* was greater at high soil moisture level and in lighted condition (Fig. 5.1). The observed maximum and earlier germination of heavy seeds of *Quercus dealbata* and *Q. griffithii* as also reported by Griffin (1972), Ghosh et al. (1976) and Dunlop & Barnett (1983) in other tree species may be ascribed to the greater storage of food reserves in heavier than in lighter seeds (Black 1956, Harper & Obeid 1967, Stanton 1984). Better growth of seedlings emerged from the heavy seeds than those from the light seeds may be attributed to the larger food reserve in the former compared to the latter (Dunlop & Barnett 1983, Zimmerman & Weis 1983). Greater seedling emergence at high moisture level and in lighted condition conforms with the observations of Satoo (1966), Larson & Sehabert (1969), McLemore (1971), Garwood (1979) and Campbell (1982).

Sprouting of tree stumps in the forest plays an important role in the regeneration process. Density of the tree stumps was greater in the disturbed forest at Upper Shillong than in the undisturbed forest at Mawphlang (Chapter II), which is attributed to the tree cutting operation in the former. Sprouting of the stumps and survival and growth of the sprouts differed with the species. Stumps of *Schima khasiana* exhibited maximum sprouting while that of *Quercus griffithii* showed minimum (Chapter III, Fig 3.2). However, the sprout growth was better in *Alnus nepalensis* (Chapter III, Section II). Further, sprouting and survival and growth of the sprouts are influenced by diameter and height of the stumps. The sprouts arising from the stumps of medium diameters (> 15-30 and > 30-45 cm) showed better
survival and growth than those resulting from the stumps of smaller and larger diameters. The number of sprouts emerging from the stumps of medium diameters was also larger than from the thinner and thicker stumps. The number and growth of the sprouts increased with the increase in height of the stumps. However, sprouts emerged from the stumps of medium height (25-30 and 45-50 cm) survived better than those emerged from the stumps of less or greater heights (Chapter III).

Less sprouting and poor survival and growth of sprouts that had emerged from the stumps of greater diameters may be attributed to the change in physiology of trees with age. The vegetative reproduction predominates in the juvenile phase and sexual reproduction in the adult phase (Hartmann & Kester 1975). This concept of phase change has been suggested as an explanation for the effect of diameter on sprouting (Hawley 1946, Solomon & Blum 1967). Poor growth of sprouts emerging from the stumps of smaller diameter could be linked with the inadequate reserves or nutrient supply to support the growth (Mann 1984). The increased sprouting and growth of sprouts with increasing stump height as observed in the present study (Chapter III) agree with the observations of DeBell (1971), Bellanger (1976), El Houri Ahmed (1977) and Harrington (1984) in other tree species. In the case of stumps of low height the population of dormant or trace buds happens to be low (Hook & DeBell 1970) and this could cause decrease in sprouting from such stumps. Poor growth of sprouts emerging from such stumps may be due to the inadequate food reserves in these stumps to support luxuriant sprout growth. Maximum mortality of the sprouts emerging from the stumps
of low height could be ascribed to the observed fast decay of such stumps at the study site. The heavier mortality of sprouts that emerged from the stumps of greater height than those from medium height is presumably due to greater damage caused to the former by the heavy rain and high wind velocity prevailing in the area. Better survival of the sprouts emerging from the stumps of medium height may be attributed to slower decay of the stumps and less risk of damage to the sprouts from the heavy rain and high wind velocity. Other factors which might have influenced the stump sprouting and survival and growth of sprouts have been discussed in Chapter III.

It is concluded that the regeneration of tree species depends mainly on the interactive influence of biotic and abiotic factors of the environment. Though the prevailing disturbances in the forest at Upper Shillong play a positive role in the regeneration of trees, the impact of frequency and intensity of prevailing disturbances on regeneration needs to be investigated in detail. Tree seedling populations are largely regulated by overhead canopy, ground vegetation, litter accumulation, soil moisture and temperature. Sprouting and survival and growth of the sprouts are directly related to diameter and height of the stumps.

The present investigation throws light on certain important aspects of tree regeneration in Meghalaya. In order to gain further insight into the problem of regeneration of forest trees, the following studies need to be undertaken in detail:

1. Studies on the impact of frequency and intensity of prevailing disturbances on regeneration and survival and growth of
tree seedlings and sprouts in different types of forests could give an idea of the extent of disturbances which a forest can withstand without much detriment to tree regeneration.

(2) A study pertaining to the recruitment, survival and growth of seedlings in different sizes of gaps occurring in the undisturbed forests which are supposed to represent the climax, could predict the future of undisturbed forests such as the 'Sacred grove' at Mawphlang.

(3) A study of the influence of predators on the seed and seedling populations in different habitats may explain the role of these organisms on population dynamics of the tree species.

(4) Studies on tree seed population dynamics in relation to various types of disturbances prevailing in the forests may reveal the effect of these disturbances on future prospects of important forest trees.

A thorough investigation of the above aspects could help in understanding the regeneration behaviour and population response of the tree species, based on which appropriate strategies could be evolved to conserve the forest wealth of the region.