E-1.1 Population structures and dynamics of major tree species in a hill dipterocarp forest.

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Abstracts

Population structures of major tree species and distribution of palm, bamboo, and canopy gap were studied in a hill dipterocarp forest at Semangkok Forest Reserve, Peninsula Malaysia. The characteristic of this study is to obtain the whole demographic data from seeds, seedlings, saplings to mature trees.All trees larger than 15 cm in gbh were tagged and their gbh were measured on March, 1993 and on April, 1995. Seed production, seedling establishment were examined in the 2 ha core area. One hundred seed traps were set up adjacent to the corner post at every 20 m point and the center of the 20 m x 20 m quadrat. We censused new seedlings at 100 of the 1 m x 1 m quadrats adjacent to the seed traps. Saplings were tagged and measured at 600 sub-quadrats (1 x 4 m) in the 6 ha plot every 10 m. Distributions of canopy gaps, palm and bamboo were censused every 5 m x 5 m quadrat in the whole 6 ha plot. We analyzed the spatial structure and size structure of 30 abundant species by cluster analysis. These 30 species were divided into a ridge-group and a slope-group. We recognized four size groups, emergent, canopy, understory and others. The distribution of *Shorea curtisii* is restricted to ridge and upper slope which is completely overlapped with that of the palm. This palm occurred 40% of 5 m x 5 m quadrats in the 6 ha plot. The relationship between the regeneration success of *S.curtisii* and the shading effect by the palm must be studied in the future. Distribution pattern of bamboo was restricted to lower slope. This bamboo prevents regeneration of tree species. Its growing area was 1.8% of the 6 ha plot. Percentages of canopy gaps were 15.6%.

Key Words Hill dipterocarp forest, major tree species, population structure, Peninsula Malaysia

1. Introduction

Recently the importance of long-term studies in ecology (Likens,1987) has been recognized, particularly in tropical forests (Appanah and Weinland, 1993; Hubbell and Foster, 1992; Manokaran et al. ,1990; Condit, 1995; Yamakura et al., 1995). Large plots of 50 ha have been established in Panama, Malaysia, India and Thailand. The network of these plots will largely contribute to community and population ecology of tropical forests. Although these studies has many advantages, they cannot avoid several disadvantages. For example, these study lack the data of the most important regeneration process through seed production, seed dispersal, germination, seedling establishment, and recruitment to a sapling stage. An analysis of tree population dynamics requires demographic data throughout the life cycle. In this study, therefore, we focused on the demography of major tree species through whole life stages on a hill dipterocarp forest.

2. Purpose

The purpose of this study is to clarify the population structure and dynamics of major tree species through whole life-cycle in a hill dipterocarp forest. Special emphasis of this study is to complete their whole demography from seeds, seedlings, saplings to mature trees. In this sense our study differs from other ecological studies in the tropics(Hubbell and Foster, 1992; Manokaran et al. ,1990; Condit, 1995; Yamakura et al., 1995).

3. Study area

Semangkok Forest Reserve (SFR) is located besides the road on the way to Fraser's Hill about 60 km north from Kuala Lumpur. The study plot is located within compartment 30 of Semangkok Forest Reserve. It is a virgin jungle reserve of about 28 ha surrounded by forests that have been selectively logged in 1980s. A typical hill dipterocarp forest have developed on the narrow ridge and steep slope (Putz, 1978), ranging from 340 m to 450 m above sea level. The nearest meteorological station is at Kuala Kubu Baharu, 15 km south west from the plot: the average annual rainfall is 2414 mm and the average yearly minimum and maximum temperatures are 21.9 °C and 33 °C, respectively (Saifuddin Sulaiman et al., 1991).

4. Methods

The life cycle of trees is separated into seven stages by size and morphology of the individual. This system is similar to the studies at 6 ha deciduous forest plot (Masaki et al., 1992) and 4 ha evergreen forest plot (Tanouchi and Yamamoto, 1995) in Japan. Studies on buried seeds will be arranged. Distinction between young and mature trees could not be done in advance before mass flowering is observed. One can classify the other stages distinctively following own definitions.

Fig.1 shows the basic design of the 6 ha plot. The shape is rectangular, 200 m in the direction of south to north and 300 m in the direction of east to west. The plot has east and west facing slopes and a ridge. A core area of 2 ha for the study of seed and seedling was set up within the 6 ha plot. One hundred sets of a seed trap and a seedling quadrat were arranged regularly in the core area. We measured saplings in 600 quadrats at every 10 m in the plot.

5. Results and Discussion

Species composition

About 500 tree species were identified in the 6 ha plot. Half of it were rare species less than four individuals. Dominant species was *Shorea curtisii* both in number and basal area. This is common phenomena in hill dipterocarp forests (Burgess, 1975; Wyatt-smith, 1963)

Spatial distribution

Major 30 species were categorize into a ridge-group and a slope-group by cluster analysis (Fig.2). The distribution of *Shorea curtisii* is restricted to ridge and upper slope which is completely overlapped with that of the palm (Fig.3). This palm occurred 40% of 5 m x 5 m quadrats in the 6 ha plot. The relationship between the regeneration success of *S.curtisii* and the shading effect by the palm must be studied in the future. Distribution of bamboo was restricted to lower slope. This bamboo prevents regeneration of tree species. Its growing area was 1.8% of the 6 ha plot. Percentages of canopy gaps were 15.6%. Significant spatial correlation between gap site and tree species was observed only in *Macaranga trioloba*.

We recognized four size groups, emergent, canopy, understory and others (Fig. 4 and 5). *Shorea curtisii*, *Teijsmanniodendron coriaceum* and *Diospyros venosa* had abundant sapling populations which means a successive regeneration in the plot. *Anisoptera curtisii*, *Diospyros latisepara*, *Ochanostachys amentosa* and *Crypteronia grifithii* had not small saplings. This lack of the sapling mean that these species could not regenerate recently or their seedlings quickly grew out this stage. *Anisoptera curtisii*, *Arthorocarpus lancefolius*, *Eurycoma longifolia*, and *Knema conferta* lacked large sapling stage. This stage compete with bertam palm, because foliage of the palm overlapped with that of large saplings. Bertam palm, which is very abundant in the hill forest, has a important role to the structure and dynamics of the tree populations.This palm was distributed widely except shallow valley in the plot.

Coexistence of these major tree species can be partly explained by spatial segregation. For example, Distribution of *Lithocarpus wallichianus* was not overlapped with that of *Dialium platysepalum*. Distribution of most species, however, were largely overlapped. Recently Kohyama (1993) emphasized the importance of size structures for coexistence of tree species. Differentiation of size structure and regeneration ability may explain the coexistence of spatially overlapped species. For example, *S.curtisii* , *Lithocarpus wallichianus* and *Eurycoma longifolia* were distributed with large overlap but size structures were different. Although small part of coexistence can be explained with difference of spatial distribution and size structure, others were overlapped in both. In particular, coexistence of closely related species, such as *Diospylos venosa* and *D.styraciformis* was one of unsolved important questions in ecology.

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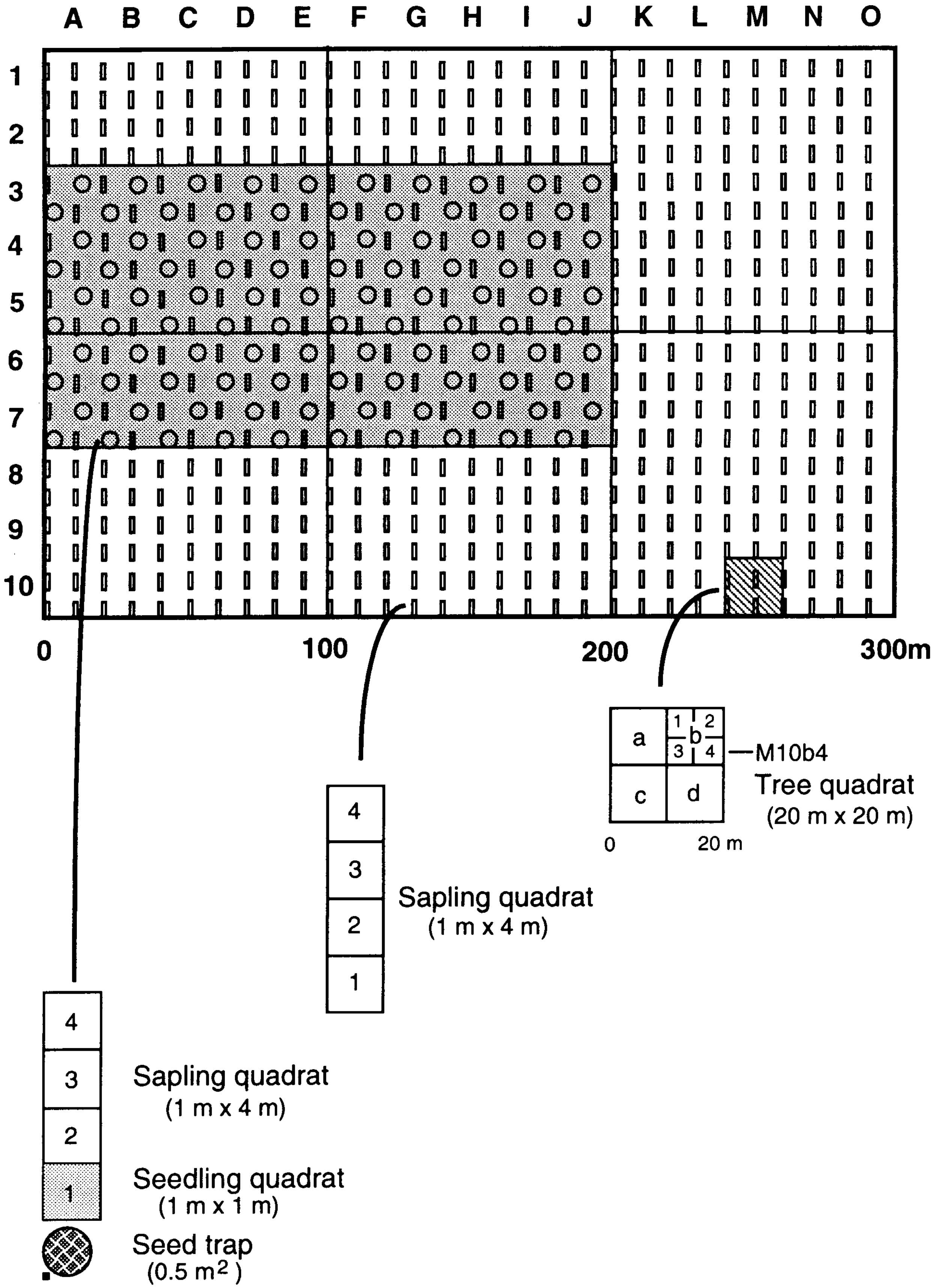
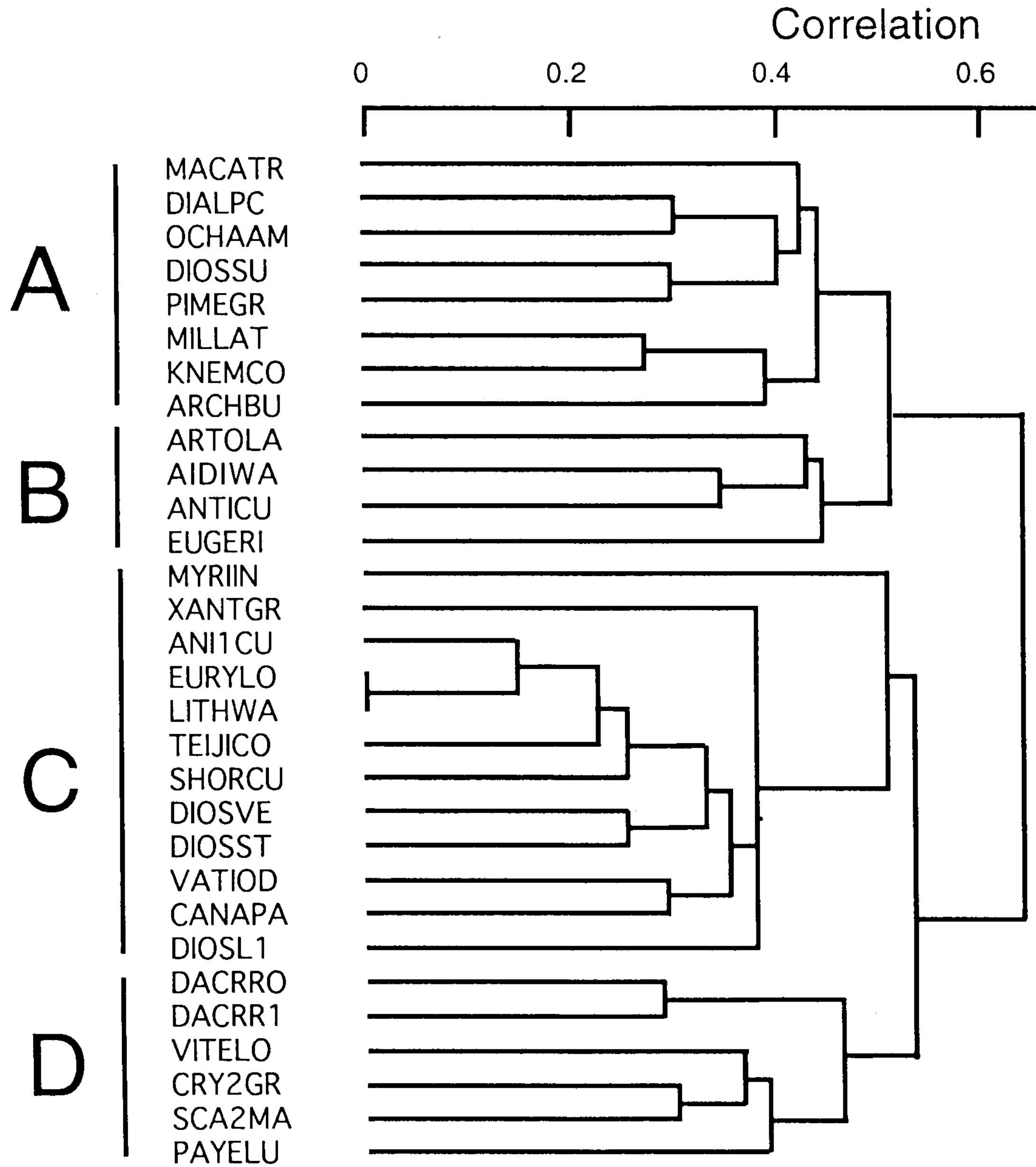


Fig. 1. Design of the 6 ha permanent plot. Hatched area of 2 ha is the core area for the study of seed production and seedling census. Position coding system is explained in text.



$$\phi^2 = \frac{(ad-bc)^2}{(a+b)(a+c)(b+d)(c+d)}$$

Fig. 2. Cluster analysis of spatial distribution patterns for 30 abundant tree species using phi-index.

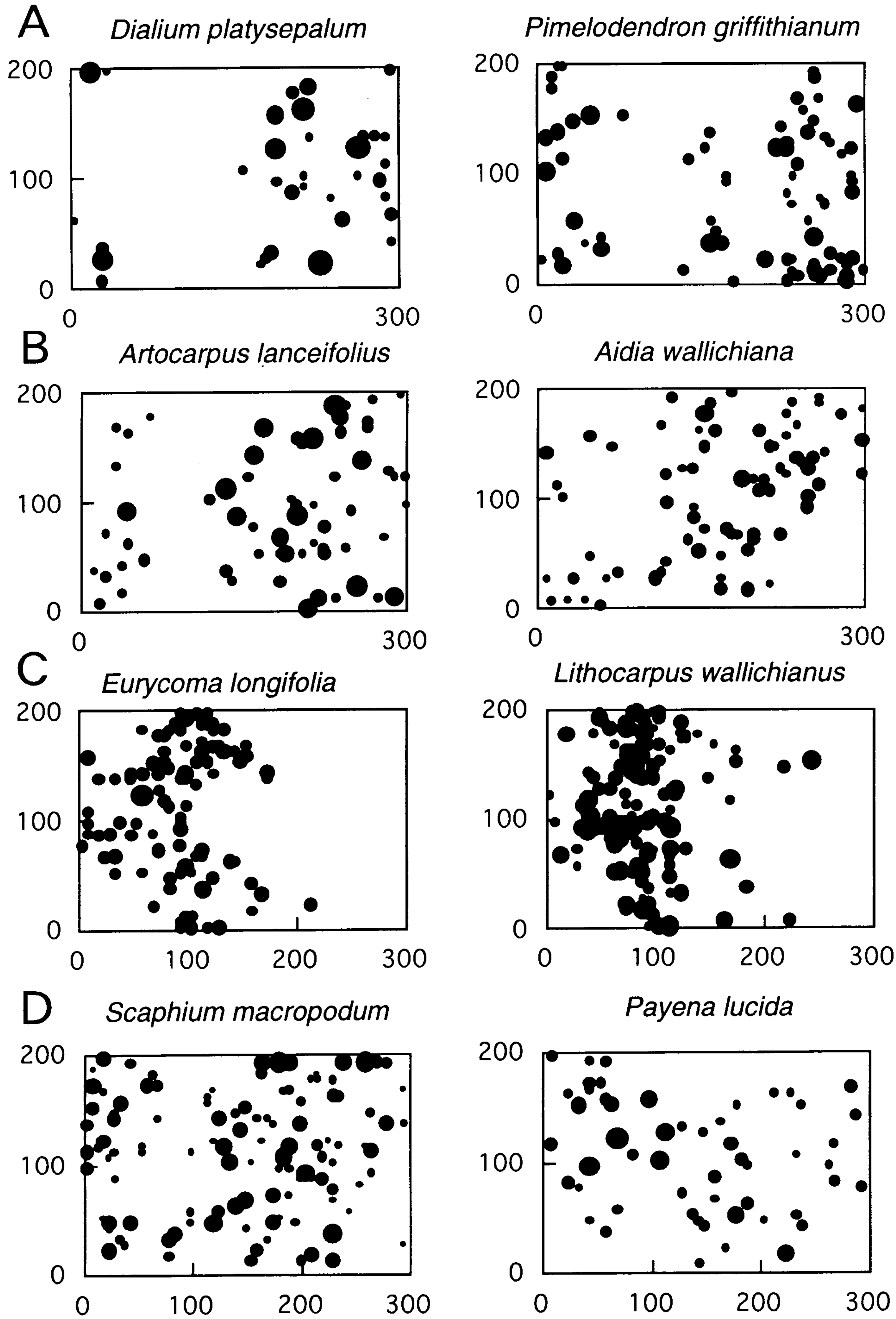


Fig.3. Four types of spatial distribution based on cluster anallysis. A and B groups were distributed on slope, C was on the ridge, and D was both on slop and the ridge.

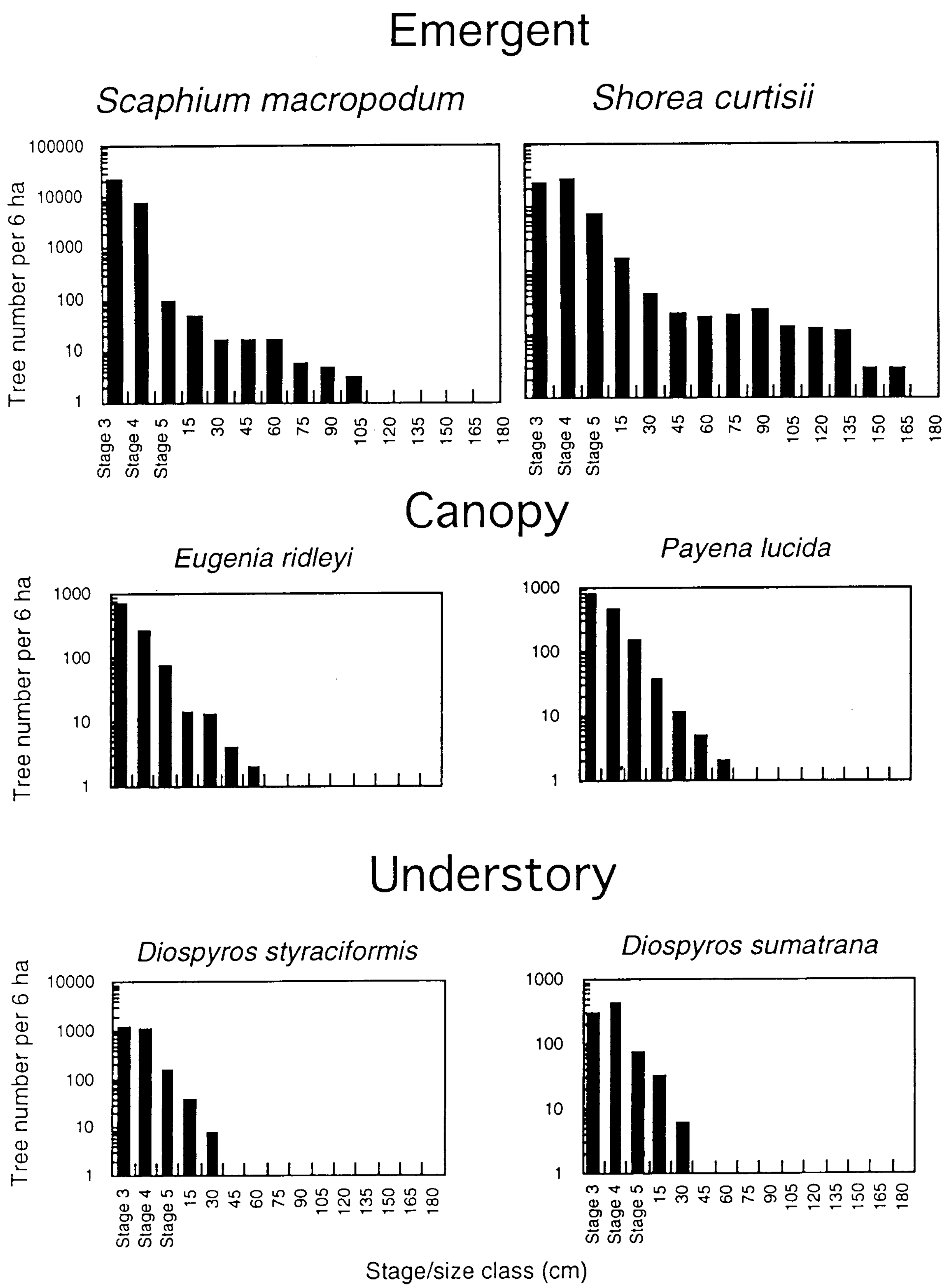


Fig. 5. Three types of size structure based on cluster analysis. Stage 3, 4, and 5 are saplings < 30 cm, 200 cm, and 5 cm in dbh, respectively.

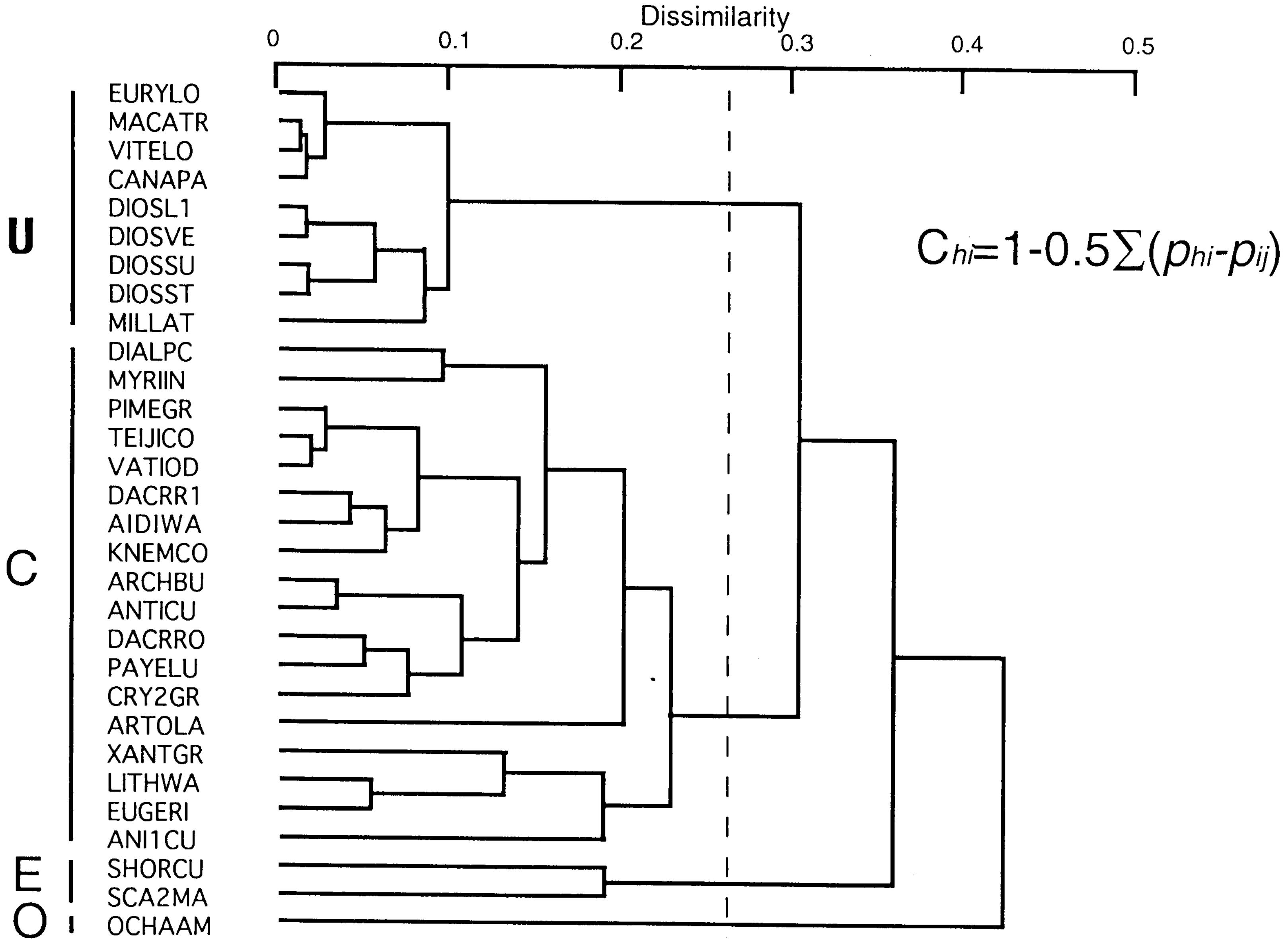


Fig.4. Cluster analysis of size structure for 30 abundant species. Four species groups, understory, canopy, emergent, and others were recognized based on percent similarity.