Vegetation studies on the foothills of Mt. Pangasugan, Leyte, Philippines, Part II: forest structure and life forms

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Abstract

The vegetation on the foothills of Mt. Pangasugan was studied using a plot sampling technique. All vascular plants except epiphytes were recorded. Five hundred one species were found, 303 of these were trees. Above a plant height of 2.5 m, 90-100% of the species rooting in the ground were trees, between 0.5-2.5 m still 76% of the species were tree species, and 11% shrub species. The ground vegetation (up to 0.5 m) was mainly composed of tree and shrub seedlings, herbs, ferns and fern allies. The study also revealed that tree height increased down slope. Layers or storeys could not be observed as a general feature of the studied plots. A dense undergrowth with a coverage of about 70% could be observed along the ridge and the upper slope.

While life forms composition of the strata taller than 2.5 m did not show an obvious change with varying topography, life form composition of plants smaller than 2.5 m changed down slope. Especially within the vegetation up to 0.5 m, the contribution of tree-and shrub-species decreased down slope. The same was observed with climbers and creepers. At the same time the contribution of herbs, ferns and fern allies to life form composition increased.

Introduction

This paper was based on the data gathered for an on-going PhD thesis on forest vegetation on the foothills of Mt. Pangasugan. The objectives of the thesis are to define site factors which influence occurrence and growth of plants, and to describe correlations between occurrence and structure of plant communities and their distribution along a slope gradient (ridge to lower slope). The first paper on the forest vegetation of Mt. Pangasugan (Langenberger 1997)

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gave an overview of tree species occurring in the study area. This present paper provides a first analysis of forest structure and life form composition of the studied plots.

Methodology

This study follows the plant-sociological method of Braun-Blanquet (1964). Forty-five plots were analysed using a stratified sampling method. Included were 12 plots along ridges, 6 on upper slopes, 7 on middle slopes, 5 on lower slopes representing shallow soil conditions, 2 on lower slopes representing deeper soil conditions, 2 on recent landslides on lower slopes, and 11 along Paghubasan and Kalbigaa streams. Because of the different site conditions along the streams, methodology had to be changed. Therefore, in this paper, data of the 11 riparian plots are included only for calculating the life form spectra of the studied plots (Fig. 3). All plots are located in the primary forest except the riparian plots. Due to their accessibility, the lower reaches of the streams lost their original forest cover to logging and kaingin activities (shifting cultivation). The upper reaches did not show obvious signs of destruction. The plots along the lower reaches were selected under secondary growth forest.

All vascular plants except epiphytes were recorded in the sample plots. Using a 'nested quadrat design' (Kent & Coker, 1992), all plants higher than 2.5 m were recorded from 100 m^2 plots, and all plants smaller than 2.5 m were analysed from 25 m^2 subplots.

The vegetation was divided into six groups. All plants higher than 2.5 m were assigned to one of four tree layers (T1-T4). Two bottom layers were delimited in the subplots, one up to 0.5 m = undergrowth layer 1 (U1), and one between 0.5 and 2.5 m (U2). This resembles the classic layers A-E sensu Whitmore (1985, p. 19), with an additional subdivision of the E-layer into two separate undergrowth layers. Dominant trees were classified as T1-layer. Their height was the scale for the classification of plants higher than 2.5 m. Plants higher than 2.5 m up to one third the height of the dominant trees were classified as T4-layer, plants higher than one third up to two thirds of T1 as T3 layers. All plants higher than two thirds but not reaching the height of the dominant trees were classified as T2-layer.

Climate of the study area

The PAGASA Agromet Station at ViSCA (7 m a.s.l.) is situated ca. two kilometers west of the study area. An average annual rainfall of 2,616 mm was measured by this station between 1976 and 1997 (author's own calculation). Minimum annual rainfall occurred in 1987 with 1,775 mm, and maximum annual rainfall in 1994 with 3,598 mm. Although the monthly mean values of precipitation do not show a distinct dry season, dry periods of several months duration with less than 100 mm monthly precipitation occurred. Of the 272 months with rainfall records, 56 months (21%) received less than 100 mm rainfall. The data also revealed that 22 months (8%) had a precipitation below 50 mm, which must therefore be classified as drought months (Walsh 1996). Dry periods with a duration of three months or more occurred in intervals of ca. 3 years (Table 1).

The area is also exposed to tropical cyclones. Between 1948 and 1982, an average of five cyclones in three years were observed (Kintanar 1984). Cyclones often occur as typhoons and are usually connected with heavy rainfalls. Typhoons result in heavy damage to the vegetation, like crown damage or uprooting of whole trees (Walsh 1996). Heavy rainfalls cause numerous landslides which are typical features of the area.

TABLE 1. The occurrence of dry periods with a duration of three months or more since 1976.

Date	Average monthly precipitation
Feb - May 1981	72.9 mm
Feb - May 1983	17.8 mm (May with 5.2 mm)
Mar - Jun 1987	32.4 mm (Apr - Jun with an average of 12.9 mm)
Feb - Apr 1990	58.9 mm
Jan - May 1992	36.5 mm (May with 4.8 mm)
Feb - May 1995	79.4 mm (Mar with 102 mm)
Feb - Aug 1998	68.4 mm (Aug last available data)

Tree height

Tree height increased from the ridge with ca. 25 m to middle slope with ca. 29 m (Fig. 1). On lower slopes, two scenarios were distinguished. Some slopes, especially on higher elevation, become steeper before reaching the often deep ravines of the streams. This resulted in very shallow soils, sometimes even bare rock. In such area, tree growth was obviously hampered and tree height decreased compared to that in the middle slope. Lower slopes having deep soil (2 plots) were correlated with an average tree height of 33 m, and represented a continuation of the gradient.

Vertical structure

A first analysis of the vertical structure showed much variations from plot to plot. More detailed analysis is needed. Nevertheless, there was a dense undergrowth 'storey' along the ridge and the upper slope with a cover of about 70% (Fig. 2). This confirms the impression achieved during numerous field trips. No other obvious strata or layers could be observed so far.

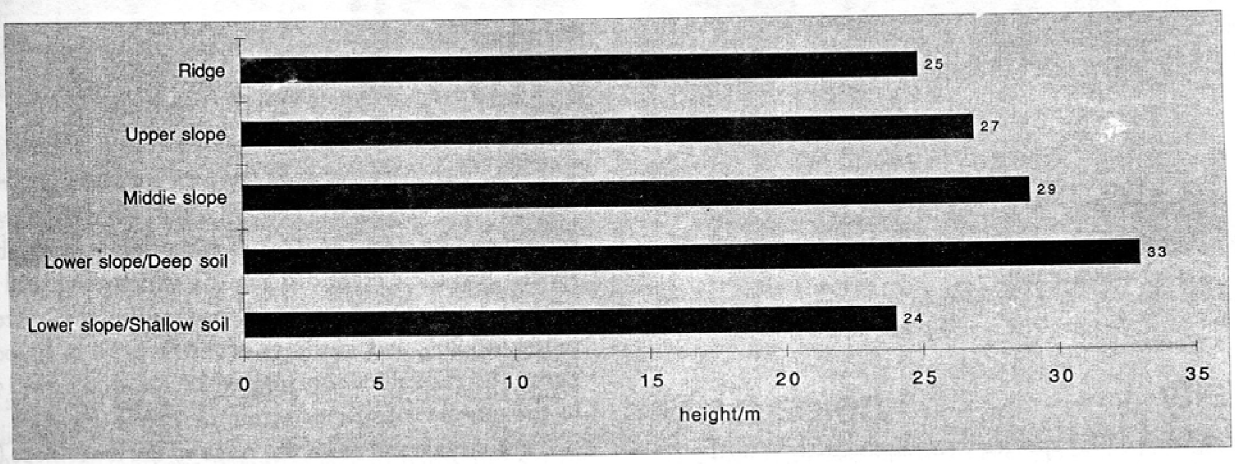

FIGURE 1. Average tree height depending on location on the slope.

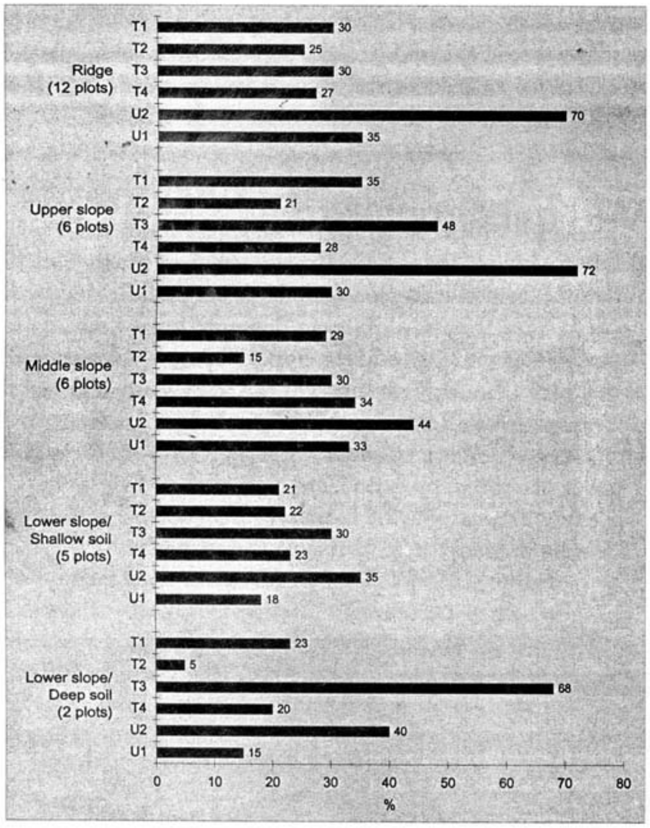

FIGURE 2. Average cover of 4 tree and 2 ground strata along a topographic gradient.

Diversity

Five hundred one (501) species were distinguished until now. Trees were clearly dominant with 303 species (60%). Shrubs contributed 30 species (6%). Ferns and fern allies were represented by 70 species (14%), climbers and creepers by 43 (ca. 9%) and herbaceous plants by 41 species (ca. 8%). Grasses, rattan, and erect palms were represented by 6 (ca. 1.2%), 5 (ca. 1%) and 3 (ca. 0.6%) species, respectively (Fig. 3).

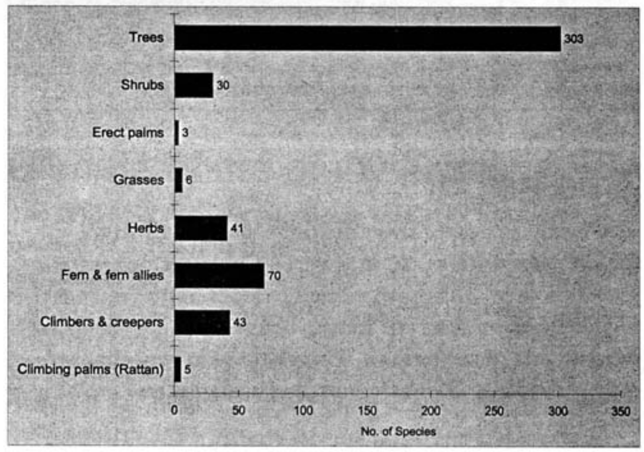

FIGURE 3. Life forms in the study area (vascular plants without epiphytes).

The data likewise revealed that the area above 2.5 m was nearly entirely occupied by trees (occurrence of epiphytes not considered). The U2 layer (>0.5-2.5 m) was also dominated by trees (76.2%). Within that layer, shrub species had their main distribution which comprised 10.6% of the species. On the ground, tree seedlings (<0.5) represented 46.2%, and seedlings of shrubs 5.3% of all species. Ferns and fern allies contributed 27.7%, and herbs 14.8% to the number of species within that layer (Fig. 4).

A clear trend from the ridge to the lower slope (shallow soil) was observed within the U1 layer. The proportion

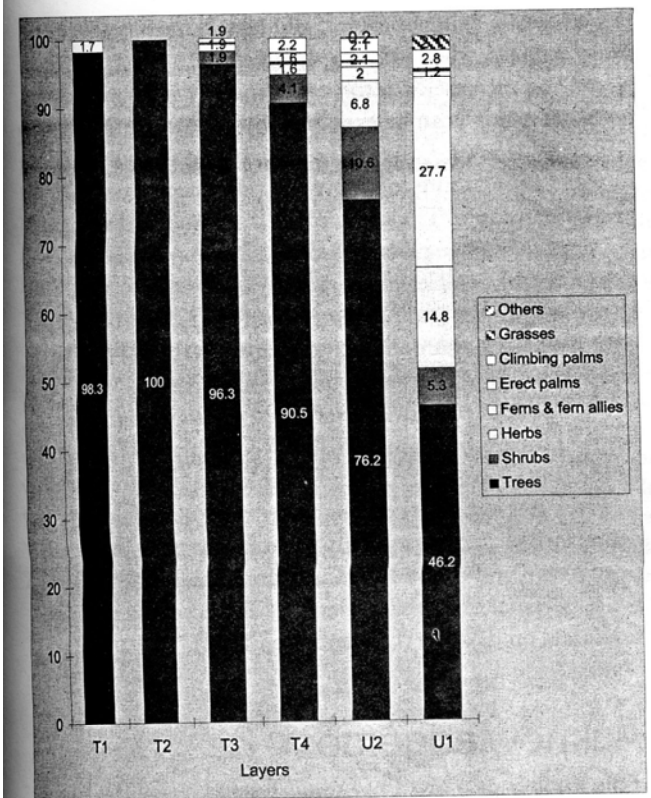

FIGURE 4. Average distribution of life forms (without epiphytes) in the defined strata (32 plots).

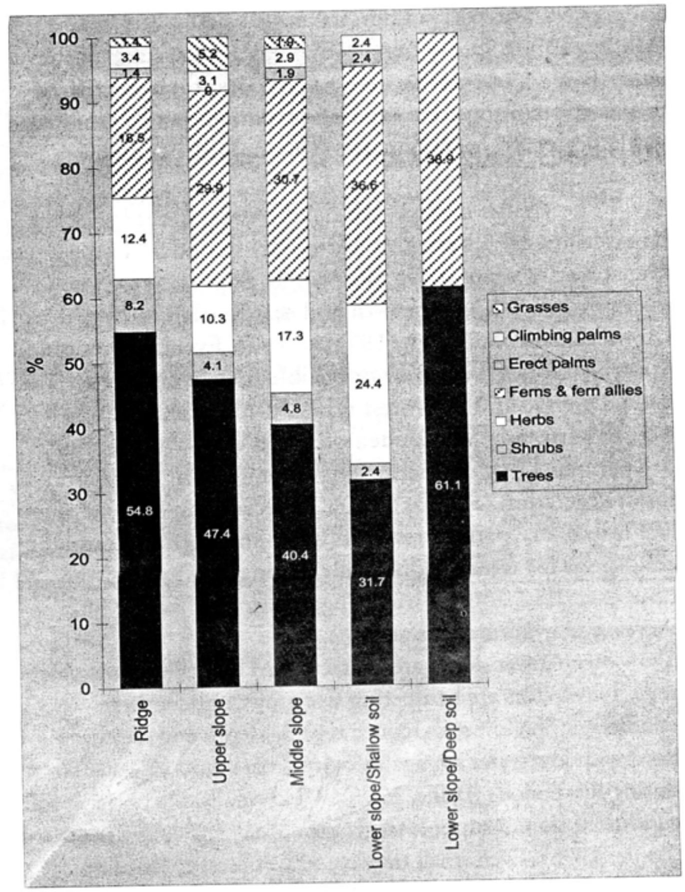

FIGURE 5. Distribution of life forms in the ground vegetation (U1: 0-0.5 m) under different topography.

of tree and shrub species decreased, while herbs, ferns and fern allies increased.

Remarkable was the complete lack of herbs and shrubs on lower slopes with deep soil (Fig. 5).

Discussion

Trees as dominant life form is a typical feature of tropical rain forests (e.g. Walter, 1990; Whitmore, 1998). The undergrowth of lowland rain forests is usually very sparse (Walter, 1990). Dense undergrowth along the ridge of the study area may be due to better light conditions compared to the slopes. Ridges are exposed to sunlight all day long while slopes receive only part of that light depending on steepness and exposition.

The smaller average tree height along the ridge could be explained by water stress during dry periods. "The availability of water is the most singly important environmental factor limiting growth and distribution of trees" (Zimmermann & Brown, 1971, p. 162). Even in the tropics the availability of water is responsible for the occurrence and species composition of forest types (Whitmore, 1985). The rainfall pattern in ViSCA demonstrates the occurrence of dry periods. Long dry periods have long lasting impact on forest vegetation (Schulz, 1960). Especially on exposed sites like ridges, dry periods result in water shortage and drought conditions for trees. Additionally, strong upwinds on the nearby vertical front of Mt. Pangasugan may lead to an increase in evapotranspiration.

Steep lower slopes are characterized by shallow, unstable soils. Two factors are hampering tree growth under these conditions. Shallow soils reduce rooting depth and are correlated with low water storage capacity. This results in water stress during dry periods (Bailie, 1996). Additionally, the unstable soil conditions do not support the weight of tall and heavy trees (Bailie, 1996). Even small trees could be observed bending downslope, or being uprooted, gliding into the ravines during heavy rainfalls, when soils are waterlogged.

The increase of herbs, ferns and fern allies in the U1 layer downslope can be explained by an increase of humidity (Richards, 1996). Lower wind impact and shady conditions in valleys contribute to higher humidity compared to ridges and upper slopes. The complete lack of shrubs and ferns on the two lower slope plots with deep soil and thus the high percentage of tree seedlings needs a more detailed analysis. Due to the low sample number of only two plots it may be the result of chance. This assumption is confirmed by the fact that the U2 layers of the plots showed shrubs as well as herbs.

The data presented confirmed the statement that tropical forests are dominated by woody plants. The patterns in life form composition can be explained by the availability of water. It is hypothesized that water stress during the dry periods which occur irregularly plays an important role in plant distribution and community formation. This is supported by the presence of tree species which are also occurring in Molave forest and on dry sites (Langenberger, 1997).

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