FOREST STRUCTURE

Stephen Elliott

Introduction

The physical structure of a forest greatly affects its ecology. Forest structure includes such elements as: number of layers in the canopy; canopy density; the size distribution of the trees and the relative abundance of different plant habits (trees, shrubs, climbers etc.).

The structure of a forest determines the NICHE SPACE – the variety of microhabitats within which plants and animals have evolved to exist. The more niche space, the greater the number of different species that can evolve to fill it. Therefore, forest structure has a big effect on overall biodiversity. When managing a forest, it is important to maintain or increase the complexity of the forest structure, since that will increase biodiversity and increase the conservation value of the forest.

Forests growing in dry areas have a simple structure. During the dry season there is insufficient water in the soil to meet the transpiration needs of the trees. In order to avoid excessive water loss, the trees loose their leaves (DECIDUOUS) and consequently, photosynthesis and growth stops for a few months each year. The trees are relatively small and the canopy is discontinuous and composed of only one or two layers.

Tropical rain forests, on the other hand, have a more complex structure. In areas of high rainfall there is always enough water in the soil for transpiration of the forest. There is no need for the trees to lose all their leaves at the same time and photosynthesis and growth can continue all year round. The trees are very tall and the canopy consists of many layers. The complex structure of the rainforest can support a greater variety of plants and animals than the simpler structure of dry forests. Different species adapt to exploit different layers of the canopy. For example certain squirrel species live only in the top of the canopy whilst others live in the middle of the canopy or on the ground. The multi-layered canopy of the rain forest also provides greater space for the growth of epiphytes.

Viewing the structure of tropical forests directly is difficult due to their complexity, density and tree height. Photographing forest structure is almost impossible, except along the edge of a forest – which is not typical of the forest interior.

Therefore, in order to record and analyze forest structure and compare it amongst different forest types, profile diagrams are constructed, which represent a narrow "slice" through the forest, drawn to scale. The data required to construct such a diagram include; position of each tree along the profile; tree height, lowest branch height and length of each tree crown, parallel to the profile direction. The standard width of a profile is 6 m. A wider profile gives a false impression of high tree density, whilst a narrower profile makes the forest look too sparse.

Although excellent for illustrating reports, profile diagrams do have limitations. They require a lot of labour to construct them and they cover only a very small sample of the forest – so they may not be representative.

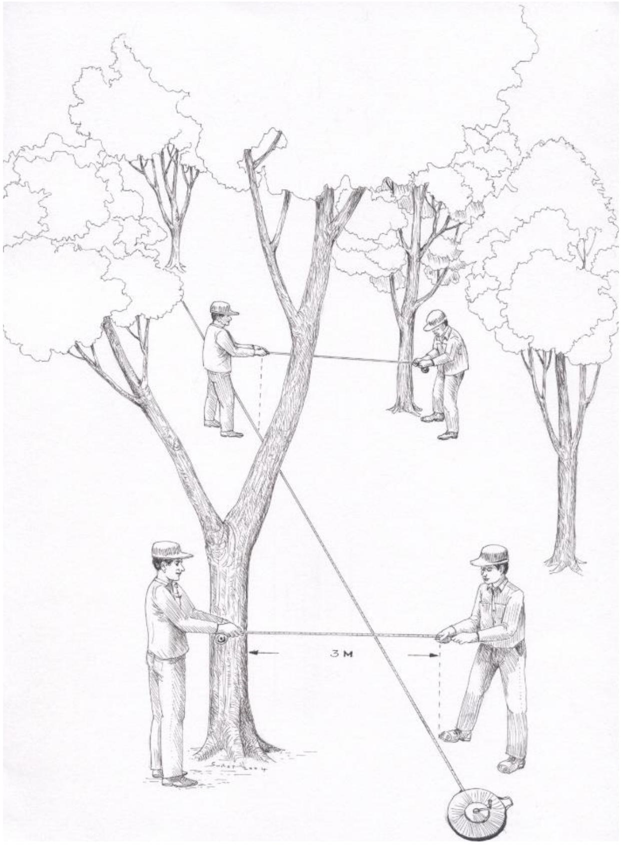
Objectives

To construct a forest profile diagram in order to record and analyze the structure of a forest ecosystem.

Materials

50 m tape measure, several 1-2 m tape measures, metal labels, waterproof marker pen or number punch, nails and hammer, 2 pieces of string exactly 3 m in length, clinometer, data record sheets and pen.

Methods



Lay out a tape measure 40 m in a straight line. To each tree less than 3 m from the tape measure on both sides (i.e. transect width is 6 m) attach a numbered metal label. Measure the circumference (or GIRTH) of each tree at exactly 1.3 m from the base (GIRTH AT BREAST HEIGHT GBH).

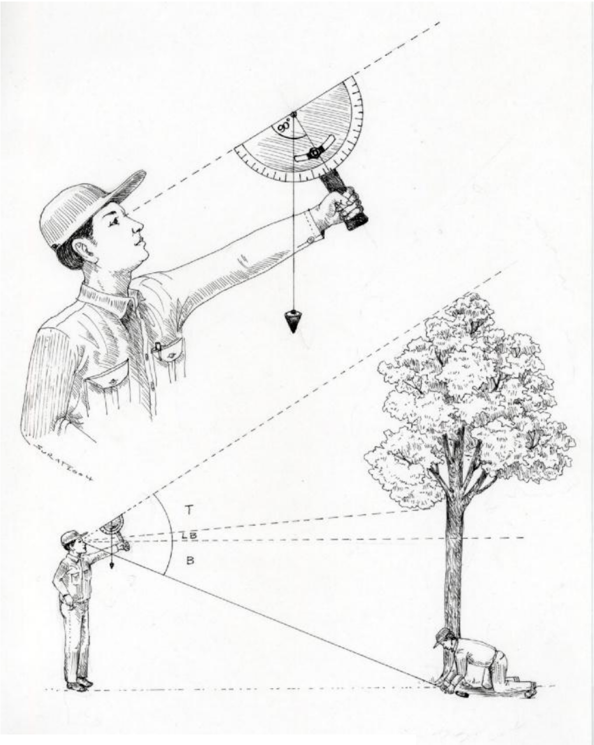
Stand UPHILL from the base of each tree where you can see the top of the canopy. Make sure that the top of the tree and the lowest branch are HIGHER THAN EYE LEVEL and the base of the tree is LOWER THAN EYE LEVEL. Measure the distance from the base of the tree to your eyes. Make sure that this distance is more than 10 m for small trees and more than 20 m for tall trees. With the clinometer, measure the angles (degrees deviation from the horizontal) of "B°" (angle to the base of the tree), "T°" (angle to the top of the tree and "LB°" (angle to where the lowest branch joins the trunk of the tree).

Calculate tree height and lowest branch height from these equations:-

B	=	angle to base of tree
T	=	angle to top of tree
LB	=	angle to lowest branch
DBE	=	distance from base of tree to eyes of observer
SQRT	=	square root of [....]

TREE HEIGHT = (sin B x DBE) + (tan T x SQRT [DBE^2 – $(\sin B \times DBE)^2$])

LOWEST BRANCH HEIGHT = (sin B x DBE) + (tan LB x SQRT [DBE^2 – $(\sin B \times DBE)^2$])



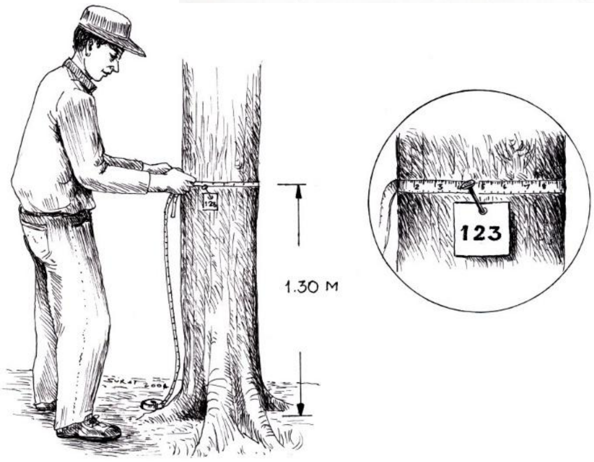
Estimate the crown length, parallel to the direction of the profile. Use the clinometer to measure the slope of the ground.

<u>Report</u>

A Xerox copy of the data collected by the whole class will be given to each group. Share the following tasks amongst the members of the group and submit a joint report:-

1. Construct a profile diagram like the one shown below as an example. Use the same scale for the vertical and horizontal axes. Indicate the species of trees where known.

2. Plot a graph of tree height vs. circumference. Calculate the regression coefficient R^2 to determine if it is possible to predict tree height by measuring GBH.



3. Draw a histogram to illustrate how canopy density varies from ground level upwards. Select all trees which have a lowest branch height less than 2 m and tree height higher than 2 m. Sum their canopy lengths and divide the sum by the length of the profile. Repeat for 4 m height, 6 m height etc. up to the height of the highest tree and present your data as a horizontal histogram like the example provided below. What does a mean canopy density of <1 or >1 indicate? How continuous is the canopy? Can you see distinct layers in the canopy?

4. Draw a histogram to present the size distribution of the trees. What conclusions can you draw, concerning regeneration of the forest ecosystem from this diagram?

Reference

ELLIOTT, S., J.F. Maxwell and O.P. Beaver, 1989. A transect survey of monsoon forest in Doi Suthep-Pui National Park. *Nat. Hist. Bull. Siam Soc.* 37(2):137-171.

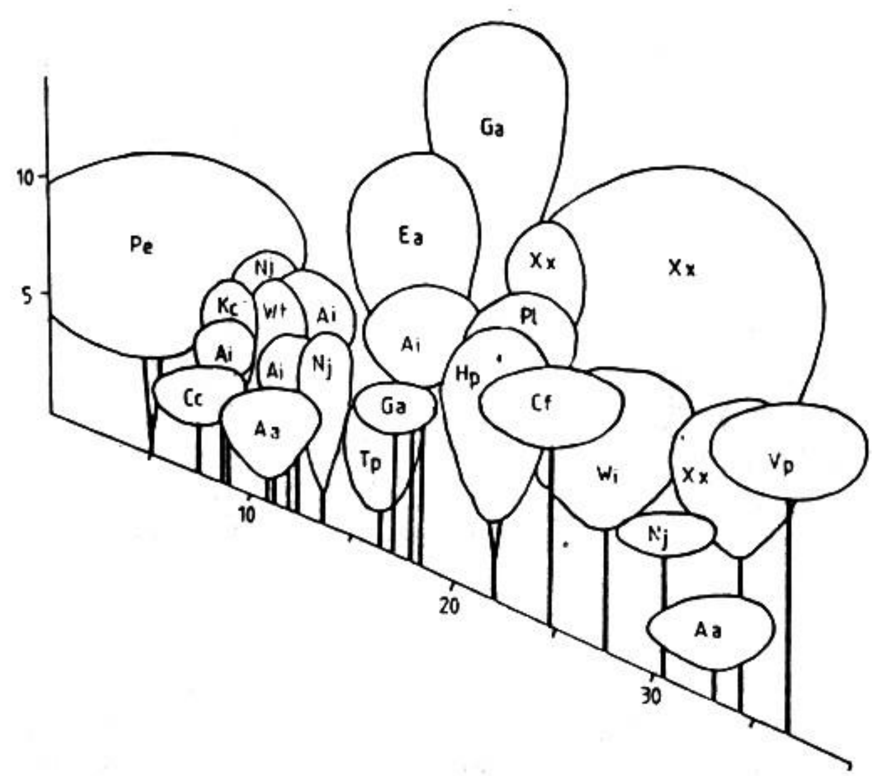


Figure 15. Profile diagram of the M_1 sub-association at quadrats 3 – 4. Aa, *Antidesma acidum;* Ai, *Anacolosa ilicioides;* Cf, *Colona flagrocarpa;* Cr, *Cratoxylum cochinchinensis;* Ea, *Eugenia albiflora;* Ga, *Gmelina arborea;* Hp, *Holarrhena pubescens;* Kc, *Kydia calycina;* Pl, *Phoebe lanceolata;* Nj, *Nyssa javanica;* Pe, *Phyllanthus emblica;* Tp, *Turpinia pomifera;* Vp, *Vitex*

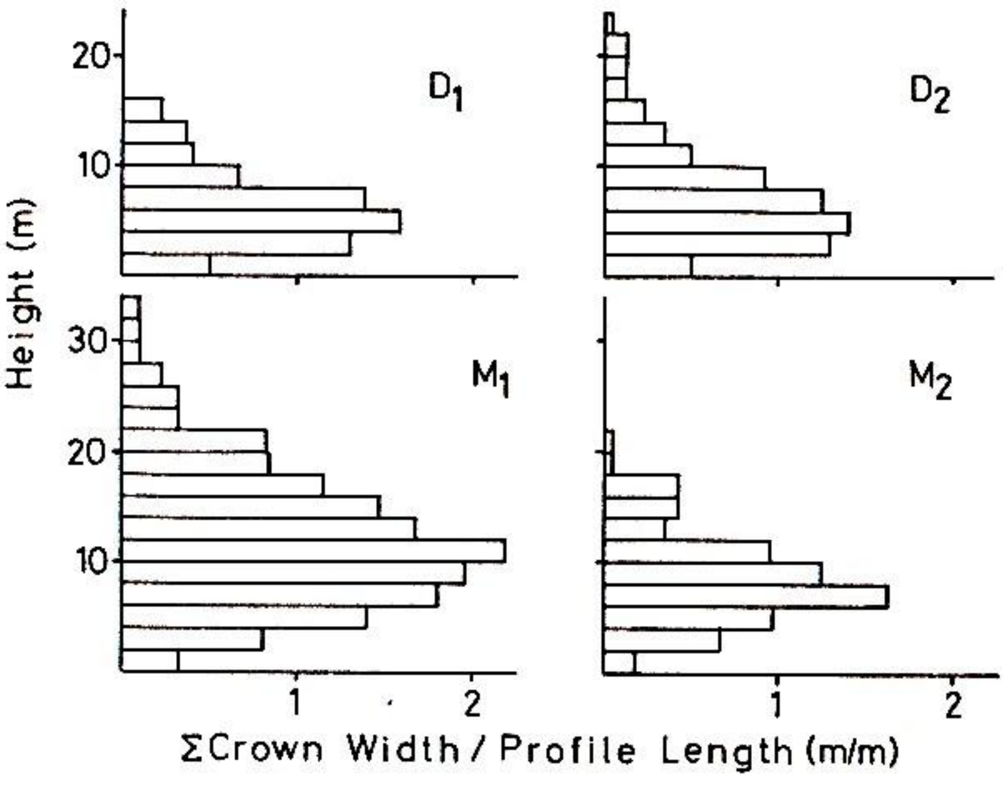


Figure 17. Variation in crown density with height above the ground for the four sub-associations.

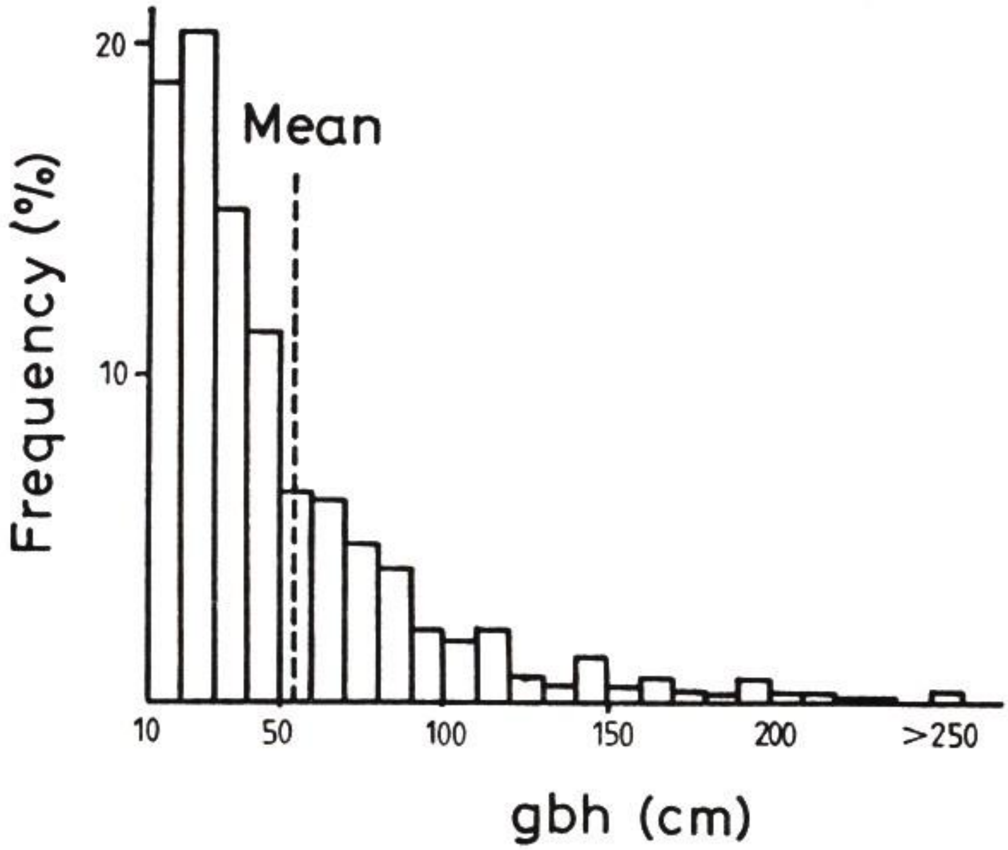


Figure 1. Frequency histogram of girth at breast height for 729 trees on a transect through monsoon forest in Doi Suthep-Pui National Park.