C.F.I. OCCASIONAL PAPERS

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NO. 2

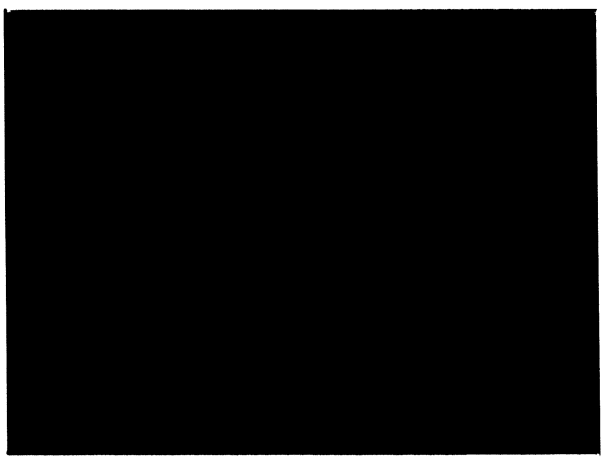
SITE INDEX CURVES
FOR
GMELINA ARBOREA ROXB.

by

A. Greaves

1978

DEPARTMENT OF FORESTRY
COMMONWEALTH FORESTRY INSTITUTE
UNIVERSITY OF OXFORD



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Summary

The construction of site index curves from stem analysis data is described for plantation grown Gmelina arborea Roxb. in Nigeria.

Acknowledgements

The text of this paper is extracted from a thesis submitted by the author for the Degree of Magister in Scientia of the University of Wales (Greaves, 1973). This work was funded by a Natural Resources Studentship awarded by the U.K. Ministry of Overseas Development.

The data on which the paper is based were compiled during field work undertaken in Nigeria during the period 1971-72. The author is indebted to Mr. Obaseki, then Chief Conservator of Forests, Mid-Western State, for his permission to carry out the field work.

Acknowledgements are also due to Dr. J.C. Hetherington, Department of Forestry and Wood Science, University College of North Wales, Bangor, for his guidance; to the Department of Forestry, University of Ibadan, for the provision of study facilities; and to the author's colleagues at the Commonwealth Forestry Institute and to Mr. R.H. Kemp, Principal Forestry Adviser to the Overseas Development Ministry, for their suggestions on the presentation of this paper.

INTRODUCTION

The construction of the site index curves formed part of a wider-ranging study into the site and productivity relationships of Gmelina arborea Roxb. plantations in Nigeria (Greaves, 1973). The study area was located within the Derived Savanna Zone (Keay, 1965) to the north-east of Benin City, between latitudes 6° 35' and 7° 10' north and longitudes 6° 15' and 6° 40' east.

The site studies entailed the establishment of 180 temporary sample plots of area 0.04 ha (0.1 ac), located to cover the full range of soils and topography encountered within the plantations. These plots also served as the data base for the site index curves.

DATA COMPILATION

(i) Dominant height was calculated for every sample plot, this being the arithmetic mean height of the four largest-basal-area trees per plot, equivalent to 100 trees per hectare (40 per acre).

(ii) The values of dominant height were plotted over age (see Appendix I). From this distribution it was estimated that the range in site index (dominant height achieved at ten years) was approximately 9.0 to 29.0. This range divided into five equal quality classes.

(iii) The site index values for the plots aged ten years and over were estimated from their locations in the height/age distribution. The plots were then divided into two groups; those with site index values above 19.0 (the mid-point in the site index range) and those with values below 19.0.

(iv) Twenty two plots were purposefully selected from each of the two groups, i.e. 44 plots in all, to cover the complete range of sites and growth responses.

(v) At all the 44 selected plots a dominant tree with a straight unforked stem was felled, preferably one of the four trees chosen for the calculation of dominant height. Discs, located to avoid the nodal swellings, were removed at intervals of about one metre.

(vi) The discs were planed smooth on one side. Satisfactory contrast of the terminal parenchyma marking the boundary of the annual growth rings (Hughes and Esan, 1969) was achieved by soaking the discs in water and viewing under a strong electric light whilst a thin film of water remained on the surface. From measurements on these discs, data of annual ring radii at measured intervals above ground level were obtained.

DATA ANALYSIS

The method of plotting height/age curves from stem analysis data by graphing height over age (Jerram, 1939) was found to be unsuitable for G. arborea. Owing to the fast growth of the species several consecutive sections were frequently found to have the same age as determined by ring count. Selecting only the first disc from each age class resulted in insufficient data points for accurate plotting of the height/age curve.

An alternative procedure was implemented as follows:-

(i) For each tree the growth ring radii were plotted against the heights of the sections above ground level.

(ii) Stem analysis profiles were drawn by joining all the points belonging to the same annual ring, beginning from the outside. The final interceptions with the height axis were extrapolated from the general trends of the rings within the profile (see Appendix II).

(iii) The heights achieved at intervals of one year were measured from the stem analysis profiles. Height/age curves for the individual trees were then plotted with this information (see Appendix III).

EXAMINATION OF THE HEIGHT/AGE CURVES FOR DIFFERENCES IN TREND ACCORDING TO SITE

The height/age curves were grouped by vegetation types and examined visually for differences in the trends between groups. Although there were distinct differences between trees, there were no obvious differences in the general trends.

The procedure was repeated using groupings by soil associations. Again no differences were apparent.

It was concluded that, from the evidence available, there was no evidence that different families of site index curves should be constructed for the different sites within the study area.

CONSTRUCTION OF THE SITE INDEX CURVES

(i) The site index values for the stem analysis trees were determined according to the heights at ten years, as shown by the height/age curves.

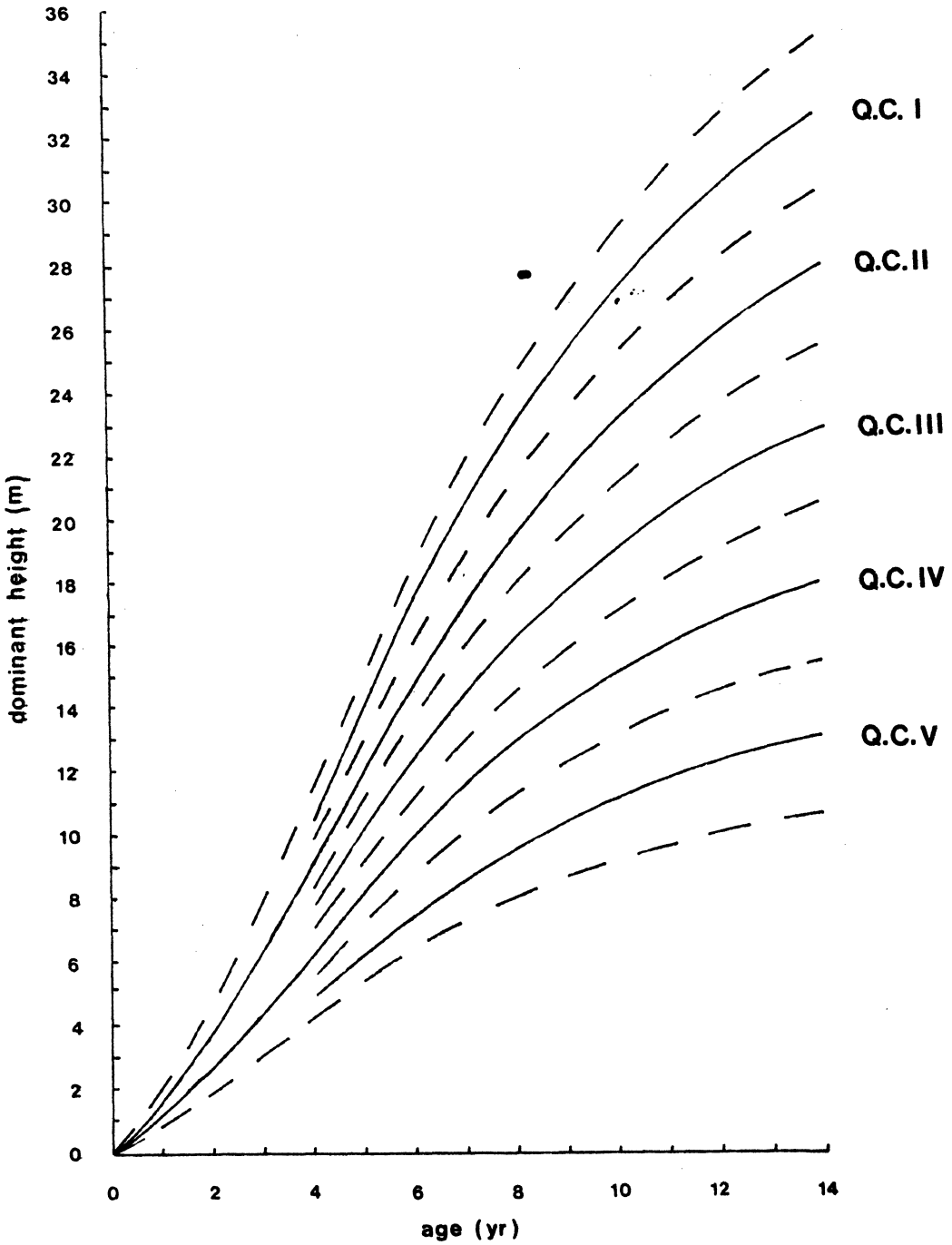
(ii) The height/age data were allocated to one of two groups - one for the trees with site index values between 9.0 and 19.0, and the other for values between 19.0 and 29.0.

(iii) Within each group the height/age data were pooled and the mean heights by one year age classes calculated.

(iv) The values of height were plotted over age for the two sets of pooled data and two curves fitted and smoothed by eye. The curves crossed the ordinate line for age ten years at site index values corresponding to the means of Quality Classes II and IV i.e. 23.0 and 15.0.

(v) The mean curve for Quality Class III was located by plotting the mid-points of the ordinate range between the two guiding curves. The mean curve of Quality Class I was then plotted at the same distance above the Quality Class II curve as the Quality Class III curve was below. The Quality Class V curve was similarly located below that of Quality Class IV. The curves marking the quality class boundaries were then plotted equidistant from the mean curves.

Site index curves



DISCUSSION

A possible objection to the use of stem analysis data for the construction of site index curves is that the height/age trends of the individual dominant trees do not necessarily parallel the dominant height/age trend of the sample plot. This is a valid criticism and probably explains why there was considerable variation in curve shape, even for trees of the same site index. This might have been due to genotypic differences, but is more likely to have arisen as a consequence of variations in the micro-environments of the trees during their existence. Of particular significance is the possibility of changes in the nutrient concentrations within the soil owing to the presence of termite galleries, or ash accumulations at the time of site preparation.

The use of a sufficiently large sample would result in these differences averaging out close to the population mean. It is believed that the sample used in this study was adequate for this purpose.

The use of stem analysis data also assumes that the sample tree has been a dominant tree throughout its existence. If thinnings are carried out, especially heavy thinnings at an early age, there could be a possibility of dominant and co-dominant trees interchanging crown positions. This is most unlikely to happen with a fast growing hardwood species in unthinned plantations.

The application of the stem analysis procedure as described in this paper is dependent on the narrow band of terminal parenchyma marking the boundary of the annual growth rings being visible. This study, and that of Hughes and Esan (1969) who first described the terminal parenchyma, were both based on G. arborea grown on sites which have a conspicuous dry season. There is a likelihood that the terminal parenchyma is not laid down on sites where G. arborea does not experience a period of water stress, in which case the method of site index curve construction described here will not be feasible.

APPLICABILITY OF THE CURVES

The site index curves described here should only be applied in circumstances which lie within the conditions of the original sample.

The data were compiled from unthinned plantations of G. arborea with a planting espacement of 2.44 m x 2.44 m (8 ft x 8 ft), and aged between five and fourteen years. The mean annual rainfall in the study area ranges from 1,300 mm to 1,840 mm with a distinct dry season from November to March.

Before the curves are used in other conditions their applicability in the new environment should be verified. The most likely deviations will arise on sites when there is an abrupt decrease in the rate of height growth through the early onset of die-back.

References

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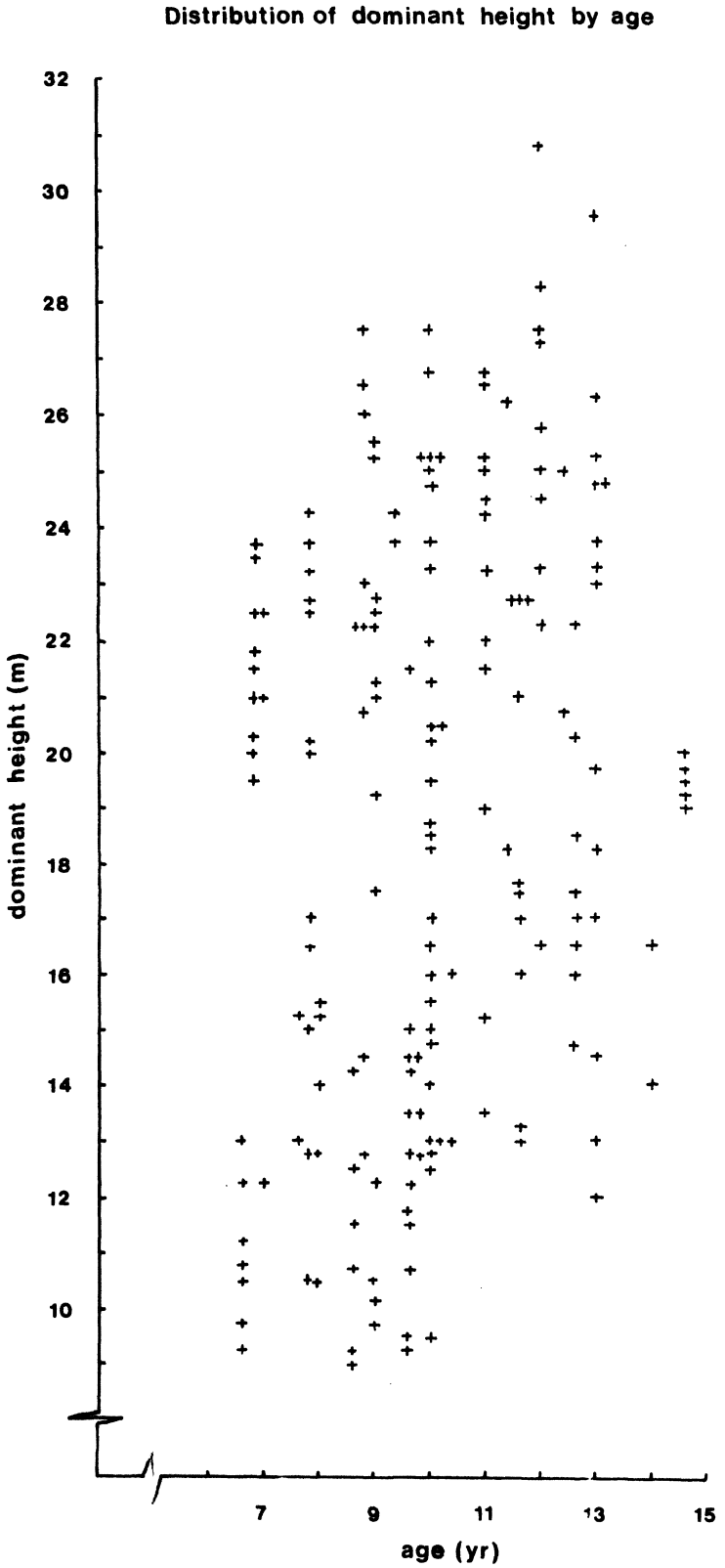
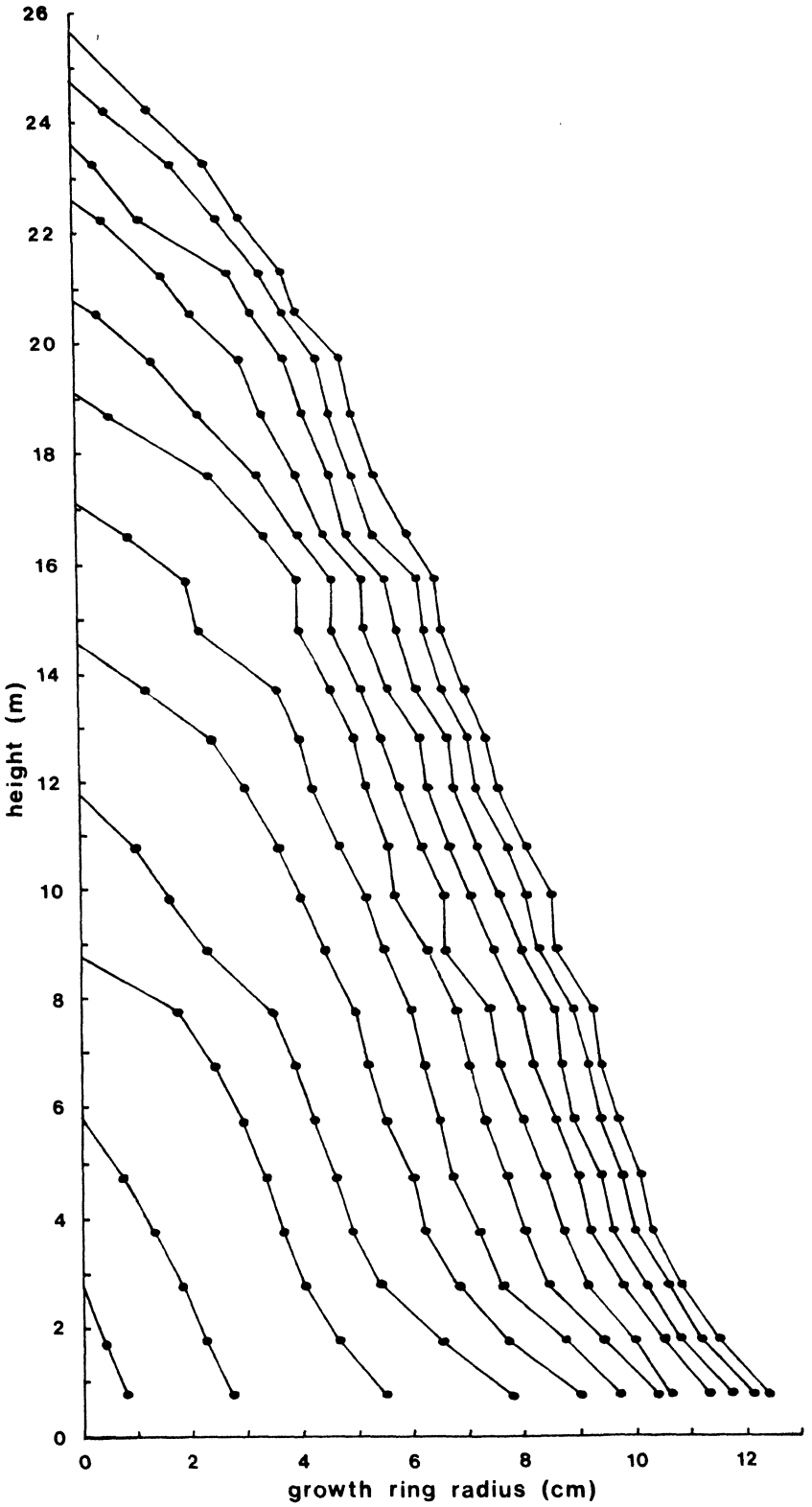
Appendix I


Distribution of dominant height by age
dominant height (m)
32
30
28
26
24
22
20
18
16
14
12
10
7
9
11
13
15
age (yr)

Appendix II

Example of a stem analysis profile



Appendix III

Example of a height/age curve prepared from stem analysis data