

ADHESION MODELS FOR ANALYSIS OF THE TROPICAL ECOSYSTEM DIAMETRIC STRUCTURE

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Abstract:

In order to prove the validity of the dominance expression as a function of basal area, according to Cain et al. (1956), six mathematical models were tested. The models tested were: $D_{cp} = a + b(d_{1,3}) + c(1/d_{1,3})$; $D_{cp} = a + b(d_{1,3}) + c(d_{1,3})^2$; $D_{cp} = a + b(d_{1,3})$; $D_{cp} = a + b(1/d_{1,3})$; $D_{cp} = a + b(d_{1,3})^2$; and $D_{cp} = a + b(\log d_{1,3})$; which: D_{cp} = crown diameter; $d_{1,3}$ = diameter at 1,30 m from the soil, ou diameter at breast height (DBH) e a.b.c = coefficients of the regression equation. Proven DCP / $d_{1,3}$ relation, it was calculated the basal area (G), which is the sum of the cross-section (g) of each tree bole of a species, expressed per unit area, in this case hectare.

There is a strong correlation between crown diameter (DcP) and diameter at breast height (DBH) in the studied forest. Among five models tested, only two, $D_{cp} = a + b(1/d_{1,3})$ e $D_{cp} = a + b(\log d_{1,3})$, not exhibit good degree of adjustment, should not be used in this type of forest. The values of r^2 above 0,70 show that is possible use DBH and therefore the basal area to express the dominance, mainly considering the relation crown diameter /DBH is very specific.

Keyword: Mathematical Models, Diametric Structure, Tropical Ecosystem.

ADERÊNCIA DE MODELOS PARA ANÁLISE DA ESTRUTURA DIAMÉTRICA DE ECOSSISTEMA TROPICAL

Resumo:

Para comprovar a validade da expressão da dominância em função da área basal, conforme sugerido por Cain et al. (1956), foram testados seis modelos matemáticos. Os modelos testados foram os seguintes: $D_{cp} = a + b(d_{1,3}) + c(1/d_{1,3})$; $D_{cp} = a + b(d_{1,3}) + c(d_{1,3})^2$; $D_{cp} = a + b(d_{1,3})$; $D_{cp} = a + b(1/d_{1,3})$; $D_{cp} = a + b(d_{1,3})^2$; e $D_{cp} = a + b(\log d_{1,3})$; onde: D_{cp} = diâmetro da copa; $d_{1,3}$ = diâmetro a 1,30 m do solo, ou diâmetro à altura do peito (DAP); e a.b.c = coeficientes da equação de regressão. Comprovada a relação $D_{cp} / d_{1,3}$, calculou-se a área basal (G), que é a somatória das secções transversais (g) dos fustes de cada árvore de uma espécie, expressa por unidade de área, neste caso o hectare.

Existe forte correlação entre o diâmetro das copas (D_{cp}) e o DAP na floresta estudada. Dos 5 modelos testados, somente dois, $D_{cp} = a + b (1/d_{1,3})$ e $D_{cp} = a + b (\log d_{1,3})$, não apresentam bom grau de ajuste, não devendo ser utilizados nesse tipo de floresta. Os valores de r^2 acima de 0,70 indicam que é possível utilizar-se o DAP e portanto a área basal para expressar a dominância, principalmente considerando que a relação diâmetro da copa/DAP é muito específica.

Palavras-chave: Modelos matemáticos, Estrutura diamétrica e Ecossistema tropical.

INTRODUCTION

The diametric structure has been evaluated through the diameter distribution of the number of individuals by Finol (1964, 1969), Veja (1966, 1968), and besides through diametric distribution of basal area and volum Longhi (1980), can be made for isolated species or a forest as a whole. When the analysis includes isolated species, according Finol (1969), few are those with regular diametric distribution, as defined by Finol (1964, 1969) and Veja (1966, 1968). By the other hand, when it is analyzed the structure of native tropical forests, they usually have a regular shape, which, according Finol (1969) and Veillon et al. (1976) is due to the large number of individuals of the species that occur only in the lower classes, which correspond to 25% of the total species.

Rollet (1974) distinguishes six types of diametric distribution for the species of rainforest, relating them to the different light requirements of each species, and states that the species categories of sub grove species in exponential balance (with large amplitude variation of DBH) represent almost 90% of species with DBH more than 10 cm, then the species category with abundant regeneration and balance, so called builders forest.

MATERIALS AND METHODS

To review the sampling Husch et al. (1972) mention within the random processes, the process of sampling in two stages, that is a limited random process, where the second stage of sampling is restricted or dependent on the first stage. Its main advantage is the reduction of costs resulting from the concentration of subsampling within primary units. In this process, the primary and secondary sampling units are pre-defined in shape and size. Higuchi et al. (1982) tested several sizes of sample plots, concluding that the rectangular plots show better results than the square ones and can be used in general installments of up to 40 m wide by 150 m long. For Lamprecht (1964) the sample size for structural studies should be not less than 1 hectare, varying the shape, however recommended to use samples from 20 m to 500 m as

standard. Samples of smaller units will not have the same efficacy in tropical forests.

The target population of this study consists of vegetation cover compounded of individuals with total height (h) more than or equal to 10 cm, which implies a large amplitude distribution. The sample was divided into three levels of approach, depending on the size of individuals, thus there are: Level I - To approach individuals with total height more than or equal to 10 cm and DBH less than 5 cm; Level II - To approach individuals with DBH more than or equal to 5 cm and less than 20 cm. Level III - To approach individuals with DBH more than or equal to 20 cm.

For Level I of approach, it was used bands of 2 m wide and 100 long, which are the primary units, divided into plots of 2 m. 10 m (secondary units), which in turn were divided into square plots of 2 m side. Sample units used in Level II consisted of bands of 10m wide and 100 m long (secondary units) located in the middle of the unit of 20 m by 500 m of level III (primary units) and divided into square plots of 10m side. The shape and size of the sample units of level III have previously been established, based on the shape and size proposed by Lamprecht (1964) and Finol (1971). Thus, bands of 1 hectare, with 20 m wide and 500 m long, divided into plots of 20 m by 100 m, and these in subplots of 10m x 20 m.

The secondary sample units level II were randomly drawn and distributed within the sample units of Level III, and secondary units of Level I were randomly drawn and randomly distributed within the secondary level II units, thus characterizing the sampling process in two stages described by Husch et al. (1972). The preliminary sampling consisted of measuring 30 units of level III , 25 secondary units at Level II and 100 secondary units at level I. From the data collected in this preliminary sampling , the optimal sampling intensity was calculated to quantitatively approach of the population. The suitable approach qualitatively , ie , to approach the floristic composition of settlement intensity was obtained by species area curve Oosting (1951) .

The horizontal structure is represented by those parameters that indicate the occupation of land by the species in the horizontal direction of the forest. Therefore, to represents the values of relative abundance, relative dominance and relative frequency, obtained on the adult population, ie, formed of individuals with DBH more than or equal to 20 cm, which were approached by level III, according to proposition Lamprecht (1964). To prove the validity of the expression of dominant in function of the basal area as suggested by Cain et al. (1956), six mathematical models were tested. The models tested were as follows: $D_{cp} = a + b(d_{1,3}) + c(1/d_{1,3})$; $D_{cp} = a + b(d_{1,3}) + c(d_{1,3})^2$; $D_{cp} = a + b(d_{1,3})$; $D_{cp} = a +$

$b (1/ d_{1,3})$; $D_{cp} = a + b (d_{1,3})^2$; e $D_{cp} = a + b (\log d_{1,3})$; which: D_{cp} = crown diameter; $d_{1,3}$ = diameter at 1,30 m from the soil, ou diameter at breast height (DBH) e a.b.c = coefficients of the regression equation. Proven the relation $D_{cp} / d_{1,3}$, it was calculated the basal area (G), which is the sum of the cross sections (g) the bole of each tree of a kind, expressed per unit area, in this case hectare.

To calculate the individual cross-section was used corresponding to the center of each diametric class, through the expression $g = \Pi d^2 / 4$, which allowed the preparation of a table (Table 1) to calculate the basal area of each morphospecies, whose value was obtained by sum of the product of cross-sectional of each diametric class by the number of individuals of morphospecies in this class.

Table 1 - Individual Cross - Section

Diametric Class (cm)	Central Class $d_{1,3}$ (cm)	$g = \frac{\Pi d_{1,3}^2}{4}$
20-29,9]	25	0,053
30-39,9]	35	0,089
40-49,9]	45	0,163
50-59,9]	55	0,245
60-69,9]	65	0,354
70-79,9]	75	0,452
80-89,9]	85	0,601
90-99,9]	95	0,703
> 100	105	0,872

To obtain the absolute frequency of level I, it was considered five plots of 2m x 10m as a sample. Thus, each plot occupied by the species is 0.2 (20%) of absolute frequency. Since the pattern unit of structural analysis is a sample of 1 hectare (20 m x 500 m), which were measured in 3 groups of 5 plots of 2 m x 10 m, the absolute frequency level I is given by the arithmetic average of the values of samples or groups of 5 plots.

To obtain the absolute frequency of level II, it was considered samples of 10 mx 100 m, divided into square plots 10m of side. Each plot occupied by the species is 0.1 (10%) of

absolute frequency. Three samples were measured with 10 plots, the absolute frequency of level II by the arithmetic average of the samples or groups of 10 plots.

RESULTS AND DISCUSSION

The statistical analysis of the level III provided the parameter estimates frequency and basal area.

Table 1 - Frequency and basal area

Parameter	x	s	\bar{x}	CV(%)
Frequency (n° of individuals)	189,462	12,953	3,578	6,25
Basal Area (m ² /há)	23,043	1,753	0,095	5,06

Confidence intervals (CI) for the average frequency and basal area, also obtained from the analysis are: Frequency (CI) = $177.871 < \bar{x} < 219.424 = P0, 05$ and basal area (CI) = $22,574 < \bar{x} < 27,417 = P0,05$. Table 2 shows the analysis of variance for the data obtained at level II of approach.

Table 2 - Analysis of variance for level II of approach

Source	GL	SQ	MQ	F
Between UP	7	2572,823	384,875	1,676 $\bar{n} s$
Inside UP	16	4217,692	285,645	
Total	23	6678,857		

F 7/16 = 2,66
0,05

From the data analysis were obtained the following parameter estimates: average (x) = 1225.342 individuals / ha ; Variance between UP (s^2e) = 41,217; Variance among UP (s^2d) = 255,712, and standard error (s^2x) = 3,947. The confidence interval (CI) for the mean number

of individuals per 1000 m², this fraction of the population with DBH between 5 cm and 20 cm is $CI = 108,963 < \bar{x} < 128,262 = P0,05$. There is no significant difference between the primary units of level II of approach, with greater variation within the primary units, ie, between secondary sampling units, which recommends the use of random sampling process for this fraction of forests. For forests with this structure, the results of the statistical analysis of the sampling process in two stages show that for the same area (200 ha) , the number of 6 to primary units with 1 hectare, each one with three secondary units with 1000 m, are sufficient to quantitatively evaluate the population with DBH more than or equal to 5 cm less than 20 cm.

Table 3 presents the analysis of variance for the data obtained in level I of approach. The analysis was performed for four fractions of the forest: total population, population without lianas, population without palm trees and population without lianas and palms.

Table 3 - Analysis of variance for the level I of approach

POPULATION	SOURCE	GL	SQ	MQ	F
TOTAL	Between	25	345345,776	381784,281	1,952
	Inside	98	245825,881	2493,533	
	Total	100	301516,787		
WITHOUT LIANA	Between	25	23992,698	169948,650	1,623*
	Inside	99	112062,156	1145,928	
	Total	100	154057,787		
WITHOUT PALM TREE	Between	25	76976,667	3487,244	1,653
	Inside	97	280262,852	2233,982	
	Total	100	305061,773		
WITHOUT LIANA AND PALM TREE	Between	25	34171,238	1487,574	1,515
	Inside	97	98507,345	989,644	
	Total	100	18272,213		

$F_{23,96} \cong F_{24,120} = 1,61$
0,05 0,05

From the analysis the results, the parameter estimates of the population for each fraction thereof were obtained.

Table 4 - Parameters of the population

POPULATIONS	$\bar{x}/20 \text{ m}^2$	s^2e	s^2d	s^2x
Total Population	142,764	176,386	2438,524	4,302
Population without Liana	113,715	103,211	1056,836	2,989
Population without Palm tree	129,718	189,864	2322,902	4,142
Population without Liana and Palm tree	90,913	90,689	95,688	2,729

In Table 5, the results of the regression analysis are presented of the 6 tested mathematical models to express Dcp / DBH ratio.

Table 5 - Regression analysis of the relation Dcp / DBH

Pattern	a	b	c	r^2	sxy	IF(sxy%)
$Dcp = a + b(d_{1,3}) + c(1/d_{1,3})$	3,220	13,287	-0,065	0,730	2,287	36,351
$Dcp = a + b(d_{1,3}) + c(d_{1,3})^2$	2,196	16,552	-2,012	0,734	2,038	28,822
$Dcp = a + b(d_{1,3})$	2,722	13,867		0,728	2,957	29,091
$Dcp = a + b(1/d_{1,3})$	10,317	-0,700		0,333	3,223	45,582
$Dcp = a + b(1/d_{1,3})^{1/2}$	-2,597	18,251		0,713	2,112	29,872
$Dcp = a + b(\text{Log } d_{1,3})$	13,268	10,352		0,581	2,553	36,112

$d_{1,3}$ = diameter at the breast height (DBH) at 1,30m from the floor.

Dcp = crown diameter.

a, b, c = coefficients of the regression.

IF(sxy%) = Furnival index.

The results presented in Table 5 show that there is strong correlation between the diameter of the cups (Dcp) and the DBH in the forest studied. Within 6 models tested, only two, $DcP = a + b (1/d_{1,3})$ and $Dcp = a + b (\log d_{1,3})$, do not show a good degree of adjustment. The r^2 values above 0.70 indicate that it is possible to use the DBH and therefore the basal area to express dominance, especially considering that the diameter ratio of the pantry / DBH is very specific. Thus one can use the model $Dcp = a + b (d_{1,3}) + (d_{1,3})^2$ to ratify the expression of dominance as a function of basal area.

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