BULL. BOT. SURV. INDIA
Vol. 10, Nos. 3 & 4 : pp. 309-311, 1968

CONSIDERATION OF AGE FOR QUANTITATIVE MEASUREMENTS IN ECOLOGICAL STUDIES

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ABSTRACT

The physiological age of a plant or its parts is important for quantitative studies in Ecology. It is demonstrated by measurements of leaf size that the number of nodes from the apex in individuals is a good indicator of the physiological age among natural populations. Hence, it is suggested that for measurements of leaf and internode of individuals in a heterogenous population a definite size range for the uppermost or the first visible leaf or internode be fixed for counting downwards. The plastochron index be, however, used for other quantitative estimations in ecological studies.

INTRODUCTION

The sizes of constant internodes and the leaves borne on a particular node, the fresh and dry weights, the amount of chlorophyll, minerals, etc., have widely been used as indices of variability of plant populations with respect to the differences in habitats. We very well know that these characters are governed by the following factors:

1. Genetic set up
2. Age
3. Environmental conditions.

When a character is governed by a number of factors and one wishes to determine the variability of that character with reference to a particular factor, the other factors must be kept strictly constant. In an uniform population genetic set up could be taken to be constant, and as such in any consideration of these quantitative data, the caution be taken that the data are being collected from individuals of approximately the same age. Only then we can assume that the variations obtained are the functions of environmental variations.

MEASUREMENTS OF LEAF AND INTERNODE SIZES

Went (1957) has shown in case of tobacco that the unfolding of a new leaf always takes a constant time in a set of conditions, and the variation in the time of unfolding is not at all significant. If we take a plant which has 10 nodes and another having 7 nodes and measure the leaves on the 5th node from the base, as has been the usual practice, then the leaf being measured from the former plant is definitely older than that of the latter. The variations obtained in this case may either be due to age or habitat or both. At times these may yield constant readings, but this cannot be taken as the index of constance.

Jacobs and Bullwinkel (1953) have numbered the leaves and the internodes from the apex to the base in determining the compensatory growth in *Coleus* shoot. Erickson and Michelini (1957) have utilized the concept of 'plastochron', a concept developed by Akenasky (1880). According to Sinnott (1960)—"The period between the initiation of two primordia (or two pairs if the leaves are opposite) is termed 'plastochron' ...The term 'plastochron index', for the interval between corresponding stages of successive leaves, has been proposed as a better measure of the stages of development of a growing shoot than is its chronological age".

Let us first analyse the data presented by Erickson and Michelini (1957) giving the measurements of *Xanthium* leaves as follows:

TABLE I

Date	Leaf node numbers 3	4	5	6	7	8	9	10
	Length in mm							
21	52	54	40.4	18.6	8.5	4.1		
22	55	60	42	30	12.7	5.8		
23	57	64	54	45.2	19.9	9.0	4.0	
24	57	67	62	47	29.4	12.7	6.1	3.2
25	58	70	67	58	40.3	17.6	7.5	4.0
26	59	70	72	42	42	24.7	11.1	5.1

On analysing the leaf size of the 5th node from the base and taking the mean as the expected value at one time and the 5th node from the apex at another time we get

	χ^2	P (between)
5th node from the base	15.222	0.005 & 0.01
5th node from the apex	4.4088	0.03 & 0.05

This clearly indicates that the measurement comes near to the expected value when the measurement of the leaves as counted from the apex is carried out. In this case it must be visualized that the reading underlined above in the original data does not seem to be correct as the same leaf measured 58 mm a day earlier. If the analysis is made after excluding that reading we get $\chi^2=1.817$ with P between 0.20-0.10. This result suggests that the data have been derived from a very uniform material. Such a result is expected as the readings are of the same plant. On the other hand the data collected by counting the nodes from the base suggests its derivation from a heterogenous material.

In order to obtain still more standard data a range of sizes has to be fixed for the uppermost leaf to be designated as leaf no. 1. In the above data itself on fixing the size range of the uppermost leaf between 4-5 mm the size of the leaves on the 5th node comes to be 54, 54 and 58 mm. Salisbury (1955 a & b) has designated the leaf number 1 to those leaves which are just longer than 10 mm while estimating the photoperiodic response of *Xanthium* quantitatively.

In certain weeds the measurement of the leaves on the 5th node from both the apex and the base was made and the χ^2 values and the P are determined for them. These are tabulated below.

TABLE II

Species	Counted from base		Counted from apex	
	χ^2	P	χ^2	P
Anisomeles ovata	31.869	below 0.001	1.590	0.75-0.90
Mecardonia dianthera	4.10	0.25-0.50	0.058	above 0.995
Peperomia pellusida	8.05	0.01-0.05	0.040	above 0.995
Sida sp.	3.45	0.50-0.75	0.523	0.97-0.995

In all these cases it is seen that counting from apex to base is more appropriate than that from the base.

DISCUSSION

The counting from apex to base gives a clear idea that the age of the material being measured is kept uniform and hence out of the three variables indicated earlier the two are kept constant and thus the variability now obtained can easily be considered to be due to the environmental impact.

This procedure, however, cannot be adopted universally. In certain plants the shape and the size of the leaf may be functions of other factors than age an environmental influence. Ashby (1948) has shown in cases of cotton, beet, dahlia, *Ipomoea*, *Ranunculus*, etc., that the shape of the leaves is a function of the node. In these cases the leaves on a particular node counted from the base shall have definite shape and size. In such cases, therefore, the plants of the same age group, *i.e.* having the same number of nodes may be selected, and any leaf then could be taken for measurements.

The age does not influence the size of the leaves and internodes alone, but most of the variables such as, percentage mechanical tissue, aerenchyma and other tissues, fresh weight, dry weight, chlorophyll content, mineral content, etc., are affected by it. Thus when analysing these characters, care be taken to take plants of the same age from the different populations.

From the view point of circulation of materials and flow of energy through the individual plant species the consideration of age seems to be important. In all these considerations the 'chronological age' is not so important as the 'physiological age'. Erickson and Michelini (1957) say—"Unless one is working with genetically uniform plants under exactly controlled conditions, variability may be so great that the plants of the same chronological age may have reached quite different stages of development while plants which are identical morphologically may be of quite different chronological ages."

The 'Plastochron index' has been proposed as the measure of the developmental stages, which can be determined by the following formula:

$$P.\ I. = n + \frac{\log Ln - \log x}{\log Ln - \log Ln+1}$$

where n = serial number of the leaf which just exceeds a constant minimum size x mm.

x = the supposed constant size of the leaf in. mm.

log Ln = log of the nth leaf.

log Ln + 1 = log of the (n+1)th leaf.

(In this case the nodes are counted from base to apex.)

CONCLUSIONS

For taking the measurements of the leaves and internodes, the following procedure be adopted in order to obtain a dependable quantitative data:

Determination be made if the shape and size is a function of the position of the leaf on the plant or not.

In case it is not a function of position, a definite size range for the uppermost visible leaf be ascertained and the measurement of a definite internode or leaf on a definite node be carried out counting the leaf falling under that size range as number 1 and the counting be done from apex to base.

In case it is a function of position, the plants with same number of nodes be selected from which a definite node be chosen for measurements.

For quantitative analyses of the fresh weight, dry weight, chlorophyll content, mineral content, etc., the plants with same 'plastochron index' be taken. In certain cases the determination of plastochron index becomes troublesome and impracticable in the field. Under such circumstances the plants with same number of nodes be taken for analysis.

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