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This Week's Citation Classic®

Erickson R O & Michelini F J. The plastochron index. *Amer. J. Bot.* 44:297-305, 1957.
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A developmental index that is useful in studies of vegetative shoot development in many plant species is based on the simple observation that, in a growing plant, leaves are formed at equal intervals of time, intervals that are often called plastochrons. Thus, counting the leaves that are present gives a rough estimate of the age of the plant in plastochrons. Interpolation based on leaf-length measurements provides a precise plastochron index. [The *SCI*® indicates that this paper has been cited in more than 205 publications.]

How Does Your Garden Grow?

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Years ago I attempted to grow certain native *Clematis* species in the garden and greenhouse with the vague hope of learning something that might be helpful to understanding species relationships. At one point, I had a plant of *C. pitcheri*, a vine, growing vigorously in the greenhouse at the University of Rochester, New York, and in my delight at watching it grow, decided to make some measurements. Each day for a few weeks, internode lengths, leaf and leaflet lengths and widths, petiole lengths, etc., were recorded. These data were plotted in a great variety of ways, such as internode or leaf length vs. days, internode length vs. node number,[1] etc. The repetitive nature of shoot growth was of course evident—the same series of events occurring at each successive node—but nothing else striking appeared; so I simply put the data and graphs away in a messy folder.

Shortly thereafter, growing *Lilium longiflorum* for cytological studies of developing microsporocytes and pollen, I could show that the flower buds grow in an exponential manner and that anther length and developmental stage of the microsporocytes are tightly correlated with flower bud length. Stated in other words, the logarithm of bud length is a good developmental index for events occurring within the flower bud.[2]

Later, when our interests had come around to studying shoot apical meristem activity and leaf development, the need for a developmental index was apparent, but I did not know how to formulate it for a shoot. It seemed as if leaf serial numbers, used by many authors in describing transverse sections of apical buds, should be useful. But, having watched *C. pitcheri* grow, these numbers, P_1 for the youngest leaf primordium, P_2, P_3, etc., for successively older ones, seemed backward to me, that is, in the reverse order of leaf formation in time. Plotting leaf growth curves, as many people had done previously, showed that growth in length is exponential in early stages, and it seemed as if this fact should be useful, as it is in *Lilium* flower buds. But I could not see how to put these ideas together.

One day, talking with Francis Michelini, who was then a graduate student, about what we should be doing with the *Xanthium* plants growing in the greenhouse, I wrote the formula for the plastochron index (PI) at the blackboard, as if I had known it all the time.

Actually, the leaves exhibit a marked diurnal rhythm in growth rate. From a limited series of hourly photographs of leaves growing at a constant temperature of 23° C, with alternating periods of 16 hours of illumination and 8 hours of darkness, it is clear that the rate of elongation in the dark may be twice as great as during the light period. In one case, a leaf about 50 mm long varied in its rate of elongation from about 0.4 mm • hr^{-1} in the dark to 0.2 in the light. We have not considered in detail the implications of this periodicity in calculations of the PI, but we feel that it can be ignored in most studies in which interest does not center on direct periodic effects. The requirements that leaf growth be exponential, at equal rates for successive leaves and that successive plastochrons be equal, also came out in that discussion, as did the geometric proof.

The use of the PI became standard practice in my laboratory. Michelini showed, e.g., that such things as the rate of oxygen uptake of Xanthium leaves plotted vs. the closely related leaf plastochron index (LPI) gave clean plots, compared with messy graphs when the same data were plotted against age of the plants. R. Maksymowych made extensive studies of leaf development in *Xanthium*, in which most of his observations were referred to LPI.[3] And other research of ours has relied on this developmental index.

Other authors have found the PI or LPI directly applicable to many species and have often used it simply to select or specify experimental material; at other times, it is used as an aid in the analysis of a problem. In other cases, the PI has required modification or has been found to be inapplicable to the plant's growth pattern.[4] About a fourth of the citations to this paper are from journals with applied missions, in contrast to the abstract questions with which I have been concerned.

1. **Anderson E & Schregardus D.** A method for recording and analyzing variations of internode pattern. *Ann. Mo. Bot. Gard.* 31:241-7, 1944. (Cited 10 times since 1945.)
2. **Erickson R O.** Cytological and growth correlations in the flower bud and anther of *Lilium longiflorum*. *Amer. J. Bot.* 35:729-39, 1948. (Cited 110 times.)
3. **Maksymowych R.** *Analysis of growth and development in Xanthium.* New York: Cambridge University Press, (1973) 1990.
4. **Vendeland J S, Sinclair T R, Spaeth S C & Cortes P M.** Assumptions of plastochron index: evaluation with soya bean under field drought conditions. *Ann. Bot.* 50:673-80, 1982. (Cited 15 times.)

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