THE MUTATIONS AF1LA AND ACACIA IN CONNECTION WITH A MODEL FOR THE EARLY PHYLLOMORPHOGENESIS OF PISUM SATIVUM

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In a related article (2), proposals for a general model for plant morphogenesis were summarized. Applications of these proposals were also suggested. We now wish to apply these models to certain leaf mutations of Pisum. Specifically, we wish to examine the following question: is it possible to integrate the mutations afila and acacia into the phyllomorphogenesis model described?

The afila mutation is distinguished from the wild-type by: a) the number of ramifications per leaf is distinctly increased; b) the distance between the first ramification and the base of the leaf is greater; c) only tendrils are formed. These deviations have their origin in the mutation of only one gene. Fig. 1 shows schematically an afila leaf.

Since a single gene is responsible for the transition from a normal leaf to an afila leaf, one has to search for the deviation of a certain gene product of a kind which produces a series of causal events, with the altered form of leaf at its end. Following is a proposal for such a mechanism; the model assigns an isolation factor for the formation of leaflet/tendril meristems (LTM's). With the formation of a new pair of LTM's a signal is synthesized which suppresses the formation of more LTM's in a certain area. It is supposed that afila sharply reduces the synthesis of the signal (e.g. through an enzyme defect). Consequently the LTM's no longer hinder each other and therefore no longer develop by pairs in intervals, but in a greater number and in compact form (deviation a). Wherever a new meristem arises, a new auxin source is added to the leaf primordium. This affects the extension of growth, especially that of the basic leaf internode (deviation b). Furthermore, it is assumed in the model that a signal from the leaftip meristem (LM) determines whether a ramification leads to a leaflet or to a tendril. The number of ramifications determines the production rate of the signal. Where the concentration is above a specific threshold, tendrils develop, otherwise leaflets. Because afila elicits more ratifications, the production rate of the signal is also higher than that of the wild-type. Thus, the threshold is shifted so far in the direction of the base of the leaf primordium that all ramifications form in the area of the tendril determination (deviation c).

As to the mutation acacia, there are no tendrils; otherwise, the leaf habit is similar to that of the wild-type (Fig. 2). In order to reconcile this deviation with the model, it is supposed that the signal that decides whether leaflets or tendrils are formed will not be synthesized in the LM (e.g. because of an enzyme defect). Thus, its concentration along the leaf primordium remains under the threshold and only leaflets develop.

Fig. 3 depicts the hypothetical mechanisms and shows the starting points for the mutations leading to the genotypes afila and acacia.

If one combines the mechanisms which lead to the deviations

at afila and acacia, a form of leaf arises which shows numerous ramifications and lengthened leaf internodes, as well as leaflets only. Such a leaf form corresponds to that of the recombinant afila/acacia. However, the leaflets of this recombinant, compared with those of the wild-type and those of acacia, respectively, are very small. The model does not yet account for this and other characteristics.

This can only be considered as a first attempt to integrate the mutations afila and acacia into the phyllomorphogenetic model. A number of leaf mutations, e.g. apulvinic and cochleata, cannot be explained on the basis of the hypothetical mechanisms presented. Perhaps, however, the speculations will supply us with new starting points for questions of an experimental and theoretical kind.

1. Ingensiep, H. W. 1986. PNL 18:67-68.
2. Lenz, J. and H. W. Ingensieg. 1987. PNL 19:25.

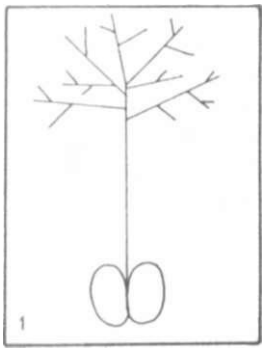

Fig. 1. Schematic of an afila leaf.

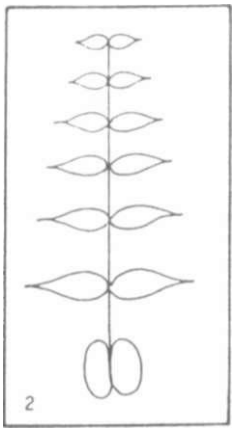

Fig. 2. Schematic of an acacia leaf.

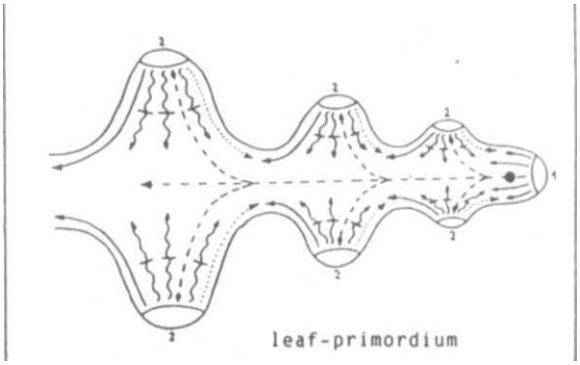

Fig. 3 Some basic mechanisms during phyllomorphogenes is and starting-points for the mutations afila and acacia.

1 : leaf-tip meristem
2 : leaflet/tendril meristem
: signal which isolates LTM's
: signal which promotes the synthesis of the following signal
: signal which decides whether leaflets or tendrils are to be formed
: auxin
— : starting-point of the mutation afila
● : starting-point of the mutation acacia

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