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THE DISTRIBUTION OF GROWTH IN A MAIZE LEAF

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Margaret Ann Ritchie

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ABSTRACT

The extension in a maize leaf phytomer was studied in terms of the one dimensional displacement of its fabric relative to its base as a function of position and of age. The relationship between displacement, position and age was termed the displacement field. The displacements, during a 24 hour interval, of a series of points spaced along the length of a particular phytomer was recorded. This provided an Eulerian evaluation of the 24 hour displacement field. A population of plants each representing a different age were used and the average displacement field of the phytomer during its period of growth was established.

Extension was localised in the region named the growth zone at the base of the phytomer. The length of the growth zone rose and fell following a wave shaped curve with respect to age. It was never constant. The relationship between the displacement of and position of points within the growth zone formed a smooth sigmoid curve. The presence of the ligule and of the node of leaf insertion did not give rise to any local reduction in extension.

A method of tracing the movement of a point in the leaf fabric, through the growth zone, over a period of time is explained. Such Lagrangian pathlines are described using referential notation, $x=x(t;x_o)$. The pathlines of points were constructed by a stepwise addition of the relevant displacement values read from the displacement field for each successive position and age.

The pathlines of two chosen points provided positions, as a function of age, for the boundaries of a growing and moving segment. The segment was in mid lamina. Its length increased from 0.025mm when its lower boundary was at 3.6mm from the leaf base to 2mm at maturity. The numbers by types of cells in the lower epidermis of the segment were surveyed at a series of plant ages. There was an initial decrease and then a considerable increase in the average length of the non stomatal cells during the period of the experiment. During the same period the segment increased in length and this was accompanied by an increase in the number of cells in the sample rows. This increase in cell numbers was continuing when the segment reached a position 40mm

from the base of the leaf within the then 67mm long growth zone. The associated cell division was occurring in all of the cell categories, not the stomatal complexes alone. The development of stomata with respect to plant age is discussed. Stomatal initiation in the leaf segment was not restricted to a single occasion or unique position in the growth zone.

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

CHAPTER 1

INTRODUCTION

Growth refers to the increase in size of a structure as a function of time. If the growth in length is observed and the length is subdivided, each of the subdivisions will contribute to the overall extension. The rate of increase in the subdivisions may differ. For example in a structure such as a plant root there is a mature region, showing no extension, and a growth zone. Within the growth zone the rate of extension is greater than zero and at any given time varies with the distance from the root tip. Structural and biochemical changes associated with tissue development take place in growth zones. The levels of these characters can be estimated at specified times and positions in a growth zone but if they are to be used as illustrations of the changes that occur during development it is necessary also to know how far the material at a particular site will travel during the time interval involved. This allows the observed differences in level to be discussed as a function of the age of the tissue and not merely as a function of position on a length of an axis.

The growth zone studied was that of a maize leaf. The species *Zea mays* L. is a member of the Gramineae and the leaves of this family are typically strap shaped. A strap shaped structure is built when expansion in a single dimension predominates. In the Gramineae this polarisation of expansion is associated with the occurrence of rows of cells running parallel to the long axis of the leaf. It is also associated with a growth zone restricted to the base of the leaf during the greater part of the leaf growth period. The Gramineae includes some of the most important crop species and this coupled with the simple geometry of the developing leaves has led to their being used as subjects for studies of foliar growth in a large number of experiments. As a result there is a considerable body of information about leaf development in the Gramineae. This includes Knowledge of the effect of environmental factors on the overall increase in length of the leaves as a function of age and of the levels of chemical and morphological characters of leaf tissues as a function of position. Only a small amount of attention has been paid to the distribution of growth through the length of the leaf however and a true age function is lacking in the majority of the structural and chemical studies. This thesis

describes a method of determining the distribution of growth by measuring the displacement of marks in the growth zone of a maize leaf. It also demonstrates the use of this information to establish the relationship between the position of a particular point in the leaf structure and time, and shows that this allows changes in the structure of the developing epidermis to be discussed as a function of age.