The Course of Root Differentiation from Root Primordia in Poplar Stems

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Abstract. Upon rooting of poplar stem cuttings the total inductive stimulation does not take place, but the individual root primordia maintain a relative independence. This becomes evident by various time parameters of their differentiation. Under experimental conditions, in dormant cuttings from one year individuals of the hybrid I 214 the activation of the first root primordia occurs after 24 h, the pre-emergent development of the roots formed was completed after 72 h.

The activated root primordium is divided into two regions. In the distal region with the predominating cell division the root apex with histogens is formed by the action of initials. From peripheral cell layers of the distal region the so-called "Wurzeltasche" develops which covers the root cap. Due to cell elongation in the proximal region the root apex is pushed up towards the stem surface. The beginning differentiation of the connective vascular tissue is a preparative step for the connection of the vascular system of the developing root with the secondary vascular system of the maternal stem. Following the penetration of the root through the peripheral stem tissues this connection is realized with progressing development. In the developed root the protoxylem elements differentiate continuously and acropetally in direct continuity with tracheids of the basal connective region.

The property which positively facilitates the vegetative propagation of plants is the capacity of forming root primordia in stems. According to BARANOVA (1951), their formation results from a special plant adaptability to the periodic change in environmental conditions. Root primordia are formed in those species the historical evolution of which occurred in moist stands and river bays of the temperate zone, regularly flooded at the time of spring thaws. Under favourable conditions, their existence enables a rapid development of adventitious roots. In an opposite case the root primordia remain in the stems in a latent state.

Our preceding paper (LUXOVÁ and LUX 1981) dealt with structural aspects of the initiation and development of root primordia in poplar stems. The inner organization of primordia is not advanced in this genus. The primordia from which roots develop under normal conditions of rhizogenesis (hence the term "root primordia"), may give rise to shoots after a specific hormonal treatment (LUX and LUXOVÁ, unpublished data). The present paper aims

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at elucidating the mode of root formation from the primordia mentioned as well as the course of differentiation of their vascular connection with the secondary vascular tissue of the maternal stem.

MATERIAL AND METHODS

The central stem cuttings of the poplar hybrid I 214, cut from one-year individuals at the period of dormancy (January), were loosely wrapped up in a moist filter paper. They were placed in a vertical position into cylinders with water on the bottom, to keep the filter paper moist by capillary elevation. Rhizogenesis took place in an incubator in the dark at a temperature of 30 °C. Following a 24-, 48-, 72-, 96-, and 120-h exposure of the cuttings to moisture and temperature, the initiating roots along with adjacent tissues of the maternal stem were fixed in Navashin's solution in the vacuum and then transferred through methylsalicylate in paraffin. The series of 7—10 µm thick cross- and longitudinal sections prepared on a microtome were stained with Heidenhain's hematoxyline and mounted in Euparal. Altogether 50 roots were processed in this way.

RESULTS

During rhizogenesis the total inductive stimulation does not occur even within one single cutting. The individual root primordia maintain a relative independence, and considerable differences may exist between the time parameters of their differentiation (Fig. 1A). As early as after a 24-h induction, the beginning of the elongation growth of cells and their vacuolation can be observed in the first activated root primordia, and that in their proximal region, adjacent to the cambium. The cells elongate in the direction perpendicular to the longitudinal axis of the maternal stem. In the central region of the primordium the cells are thin-walled, on the periphery they have irregularly thickened primary cell walls (Fig. 1B). In certain primordia the cells divide. A greater number of proliferating cells occurs in the central subdistal region which is the site of organization of the endogenously developing apical meristem of the root (Fig. 1C).

The repeated periclinal and anticlinal cell division brings about the periclinal zoning in the distal region of the primordium. On the base of the central region cell elongation and vacuolation continues. Cell division is less abundant there, the cells divide mostly cross-wise and form longitudinal cell columns. The enlargement of the differentiating root primordium results in an obliteration of cells in adjacent tissues, especially in the cortex.

With the continuing development the division of proemeristematic cells gives origin to the ground meristem and procambial cylinder, and onwards the initials produce the cells of the root cap (Fig. 1A). This is protected by an adjacent peripheral cell layer of the root primordium which forms a so-called "Wurzeltasche" around it. While in the distal region of the root primordium the root apex is being formed, in its proximal region the connection between the primary vascular tissue of the developing root and the secondary vascular tissue of the maternal stem begins differentiating. The differentiation begins with the formation of short connective reticulately or scalariformly thickened tracheids on the periphery of the root primordium base (Fig. 2B, C). In some cases they are distinguishable even prior to the