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ANATOMY OF THE SEEDLING OF *TESSARIA ABSINTHIOIDES* (COMPOSITAE)

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Abstract

The anatomy of the seedling of *Tessaria absinthioides* was studied by the use of serial cross sections. Continuous with the diarch vascular system of the root there are bundles of two types in the hypocotyl: double bundles formed by two lateral groups of phloem and one of protoxylem, that will become the cotyledonary traces and intercalary collateral bundles formed by one median group of phloem and one group of metaxylem, going to the protophylls. *T. absinthioides* has unilacunar one-trace cotyledonary and protophyll nodes and trilacunar three-trace nomophyll nodes.

Introduction

Tessaria absinthioides (Hook. et Arn.) DC. (Inuleae, Compositae) is a subshrub, densely pubescent, with gemiferous roots and aerial shoots that are renewed each year. It is a native to South America which, because of its adaptability to diverse conditions of soil and climate, is spreading as a weed in various regions of Argentina. A study of its morphology has been undertaken to determine the strategies of propagation and adaptation of the species.

The vascularization of the seedling is the first representation of the connection between the axial vascular system of the root and the more complex vascular system of the stem, which develops in relation with that of the leaves (Esau, 1965; Hayat & Canright, 1968; Pyykko, 1974). Studies could help in the reconstruction of the changes that occur in the symmetry and structure of the vascular system in the transition region (Satija *et al.*, 1985). The number of cotyledonary traces and the place where reorientation of primary xylem occurs are the main variations in the structure of the transition zone (Pyykko, 1974). Such studies are also useful to interpret the phylogenetic and taxonomic relations between the taxa of a certain family. Hayat & Canright (1968) used them to establish relations between members of Annonaceae; Kavatekar & Pillai (1977) with some species of Ranunculaceae and Lee (1914) with some Compositae, tribe Inuleae, but not with the genus *Tessaria*.

Materials and Methods

Seeds of *T. absinthioides* collected from Pradere (62°27' 0,39°23' S) and Bahia Blanca (62°16'0,38°44'S) Buenos Aires Province, Argentine were germinated in Petri dishes and in containers with sand and harvested at 5 days intervals upto 60 days. Thirty day old seedlings were selected to study vascularization since there was no sign

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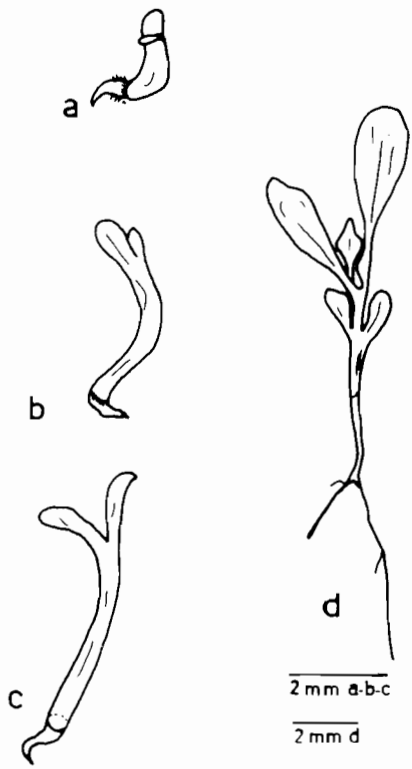

Fig.1. Seedlings in successive state of development.
a) two days old, b) 10 days old, c) 20 days old, d) 30 days old.

of Cambial activity. The seedlings were fixed in Navaschin (Johansen, 1949), dehydrated in tertiary butyl alcohol and embedded in paraplast. Serial transverse sections 8-10 μm thick were cut and stained with safranin-fast green. Drawings were made from the seedlings and from the serial sections using a Wild stereomicroscope and Wild M20 microscope fitted with a drawing tube respectively.

Results

Epigeal germination of the seeds produces small and slow growing seedlings (Fig.1). The rate of total and partial growth of the seedling and its components (main root, hypocotyl and cotyledons) during the first 30 days of germination is shown in Fig.2.

Twenty day old seedlings showed secondary roots and plumule. The first protophyll appeared on 25th day with three to four protophylls found in 30 day old seedlings (Fig.1). Cotyledons and protophylls elliptic spatulate with entire margins are mostly glabrous with only a few uniseriate multicellular non glandular hairs in the axils.

A cross section of the root 700 μm from the apex (Fig.3A) showed an epidermis with long root hairs, cortical parenchyma with small intercellular spaces, endodermis

with casparian strips and uniseriate pericycle from where secondary roots arise. There are two groups of exarc xylem joining in the center flanked by the phloem in a diarch structure. At a higher level (Fig.3B), while the stele maintains its diameter, there has been a gradual increase in root diameter, due mainly to the growth of the cortical cells and intercellular spaces appear as radial lacunae. At successively higher levels, (Fig.3C) the cortical parenchyma has polygonal intercellular spaces and there are chloroplasts in its cells, showing the transition to the hypocotyle. Each phloem group in the stele appears as a long flat semicircle, that gradually divides in three groups: two small laterals and a larger central (Fig.3C-D). The xylem divides in four bundles: two small lateral protoxylem bundles and two lateral median metaxylem bundles; these two become displaced until they appear in a plane perpendicular to the previous one (Fig. 3C-D). At each end of the cotyledonary plane both lateral bundles of phloem join together and then with the lateral protoxylem bundle (Fig.3E) forming the so called "double" bundle that diverge towards the cotyledon as the cotyledonary trace (Fig.3E-F). Each group of metaxylem joins with one median phloem bundle (Fig.3DE) forming two collateral bundles in a plane perpendicular to the cotyledonary plane. One of these bundles split in two (Fig.3F) with three collateral bundles in the epicotyl (Fig.3G) which are the "intercallary" bundles that will become the traces of the first three protophylls.

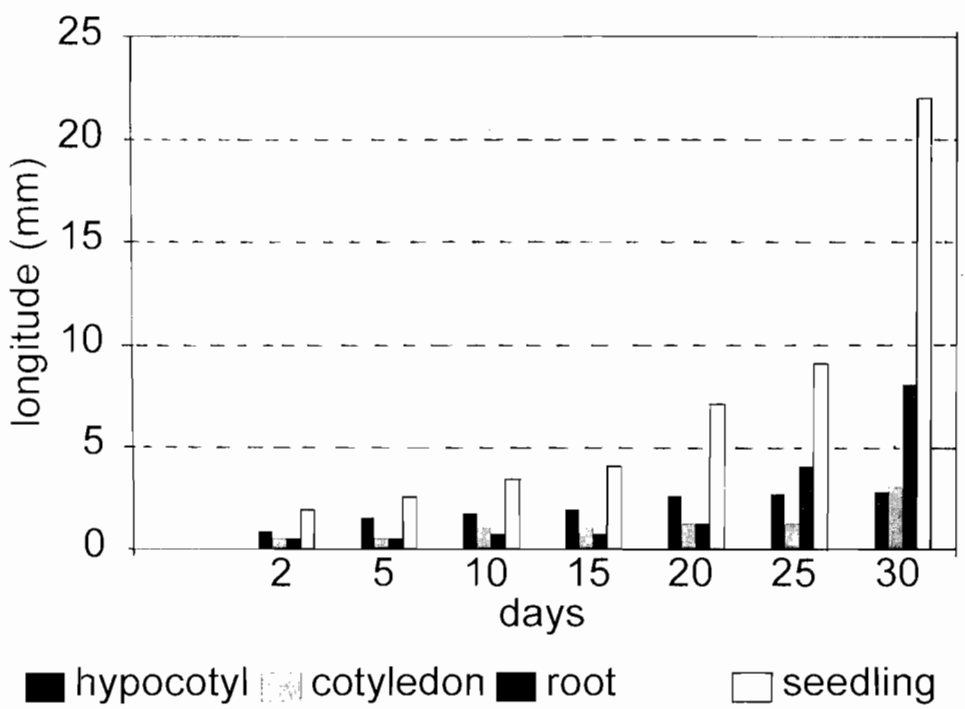

Fig.2. Rate of total and partial longitude of the seedling in days.

In the epicotyl small bundles that differentiate basipetally appear *de novo*; they will be the traces of the developing leaves. The cotyledonary node is unilacunar with one trace formed by a double bundle, the protophyll nodes are also unilacunar with one single trace and the nomophyll nodes are trilacunar with three traces. Cotyledons are anfistomatic with anomocytic stomata and epidermal cells with sinuous anticlinal walls (Fig.4). The only trace reaches the middle of the lamina where it divides and its branches are distributed throughout the blade.

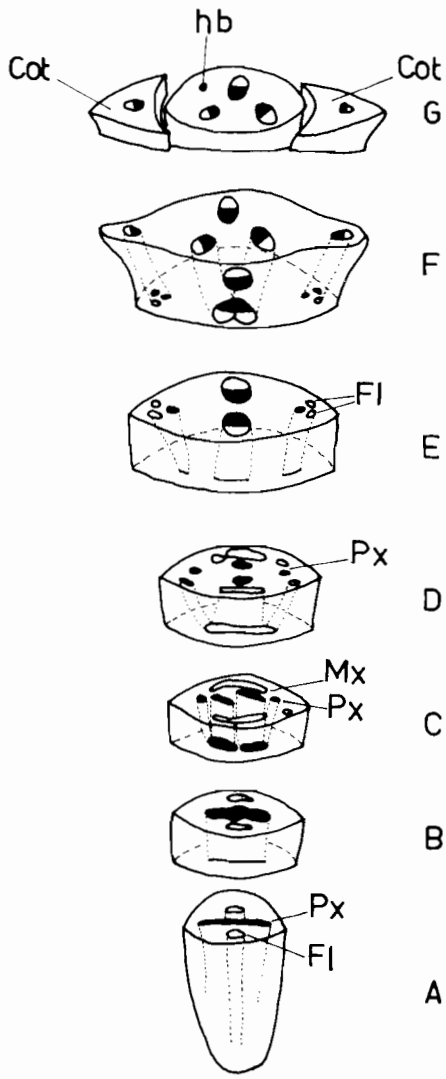

Fig.3. Schematic representation showing the vascular system of the seedling, from root to cotyledons. A) Primary root, B-F) hypocotyl, transition region, G) Cotyledons and first portion of the epycotyl. Cot: cotyledons, Fl: Phloem, hb: bundles basipetally differenciated, Mx: metaxylem, Px: protoxylem.

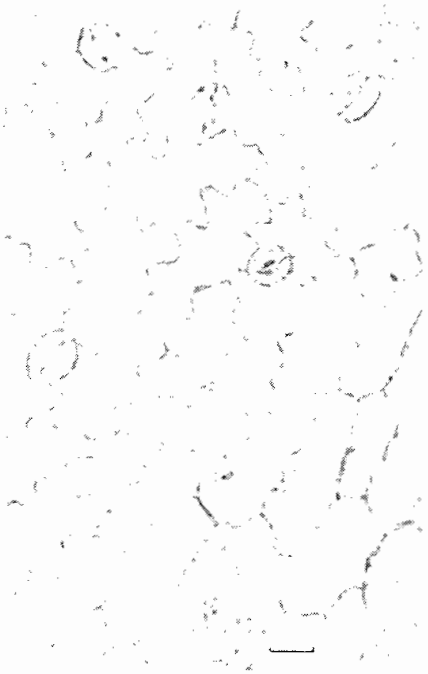

Fig.4. Epidermal cells and stomatas of cotyledons ___ 20μm.

Discussion

In his study of the Leguminosae, Compton (1912) concluded that the size of the seedling could be related to the number of root xylem poles, associating big seedlings with tetrarch roots and small ones with diarch roots. This character association was observed in *Tessaria absinthioides*, with very small seedlings and diarch roots, although Lee (1914), working with seedlings of Compositae, found several exceptions to this rule such as *Bidens pilosa* with tetrarch roots and *Heliopsis laevis* with diarch roots in the distal zone and tetrarch structure near the transition region, both having very small seedlings.

Continuous with the root vascular system there are, in the Compositae, bundles of two types: double bundles formed by two groups of phloem and one of protoxylem, that will become the cotyledonary traces (Siler, 1931; Phillips, 1937) and the intercalary bundles (Desphande & Kumar, 1968). Both types of bundles were found in *T. absinthioides*, but in this species no protoxylem goes to the intercalary bundles, in contrast to what was observed by Desphande & Kumar (1968), who reported intercalary bundles with protoxylem in all the Compositae they studied.

The presence in *T. absinthioides* of one trace unilacunar cotyledonary node, where the trace is formed by a double bundle, is a character of common occurrence in the Compositae (Lee, 1914; Siler, 1931; Philips, 1937; Desphpande & Kumar, 1968). Transitional leaves (protophylls) from one trace unilacunar nodes and nomophylls from three trace trilacunar nodes (Degano y Mújica, 1992) are characters found in *Cartha-*

mus (Pillai & Goyal, 1979) and support the position of Howard (1970) who established that the definitive pattern of mature structures could be different from that of the cotyledons and young leaves.

The primary vascular system of *T. absinthioides* seedling is a root-hypocotyl-cotyledon unit of independent origin from that of the epicotyl as was seen by Pillai & Goyal (1979) in *Carthamus tinctorius*. The transition from exarch to endarch xylem occurs in the hypocotyl and all the protoxylem goes to form the cotyledonary traces. This structure is of common occurrence among dicotyledons with epigeal germination (Kavathekar & Pillai, 1977). The splitting of one of the intercalary bundles, which will become the traces of the protophylls is not involved in the change of position of the primary xylem from exarch to endarch. The same happens in *Glycine max* as Weaver (1960) reports, in agreement with Compton (1912) who wrote about Leguminosae species with epigeal germination having all the protoxylem elements going to the cotyledons.

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