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# The Latex System in the Root of Taraxacum Officinale

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TARAXACUM OFFICINALE



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## Introduction

In 1930 Mr. Emil Madsen of this laboratory began some experimental work upon the roots of dandelions, for the purpose of determining the means by which a dandelion root, which has been cut off below the surface of the ground, regenerates new shoots. He found that such roots form adventitious buds in exposed pericycle and secondary phloem. Several such buds may be formed in a single root. They grow and appear above the ground as leafy shoot.

Mr. Madsen's work, unpublished, makes but brief mention of general root anatomy. After determining the method of regeneration he intended to treat wounded surfaces of roots with chemicals, already known to have killing effects, in order to determine what the nature of the inhibiting action might be on adventitious growth. This latter part he never completed.

I took up the investigation where Mr. Madsen stopped. The results of experimentation with chemicals appear under another title, also unpublished. But while working on this problem of the chemical treatment of roots at the University of Wisconsin, during the summer of 1932, it was suggested by Dr. Bryan of that laboratory that the anatomy of the normal root presented an unsolved problem of development, particularly with respect to the peculiar phloem and the latex system. That will constitute the subject matter of the present paper.

Previous investigators make little or no mention of dandelion root anatomy. Jeffrey (1) comments on the latex system of the dandelion, but at the same time states the need for further research. Ursula Tetley (2) discusses the secretory

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(1) Jeffrey, Anatomy of Woody Plants. University of Chicago Press 1917.
(2) Tetley, Secretory Systems of Compositae. New Phytologist 1925.

system of compositae in general but makes no specific mention of the dandelion.

The purpose of this paper is to consider only developmental root anatomy, particularly that of the phloem and pericycle, and the relation of the latex system to them. The chemical and physiological aspects of the work present problems outside the scope of this investigation.

## Method

Dandelion roots were collected from normal growing conditions of lawn and garden in the summer of 1931. Seedlings were grown in flats to obtain young roots prior to their secondary growth. Material was killed in formalin-acetic-alcohol and run up into paraffin. Both longitudinal and transverse sections were cut from variously aged roots, and in addition, transverse section series of achenes with enclosed embryos. Some series were stained in safranin and light green and others in Haidenhain's iron-haematoxylin and orange g.

## Investigation

The stele of mature dandelion root consists of solid core of xylem with no pith and surrounded by a cylinder of phloem (Fig. 1).

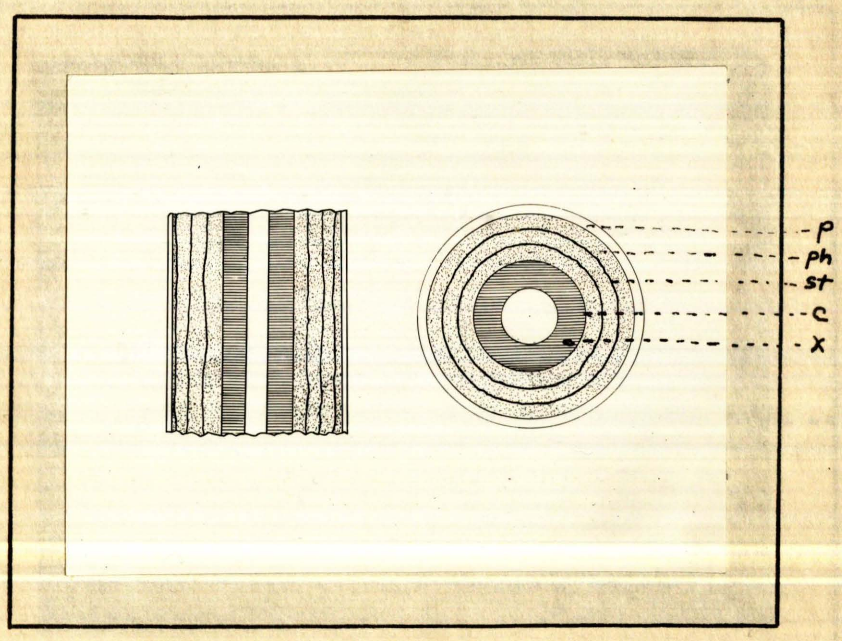


Fig. 1. Taraxacum officinale. - Diagrams of longitudinal and transverse sections of the mature root p, pericycle; ph, phloem; st, sieve tube groups; c, cambium; x, xylem.

The protoxylem is exarch in position (Fig. 9) with the metaxylem and secondary xylem making up the remainder of the xylem core. The secondary phloem is separated from the secondary xylem by the cambial layer. No traces of primary phloem are found in the mature root, it having been crushed by the growth of the secondary body. (See Figs. 2 and 3.)

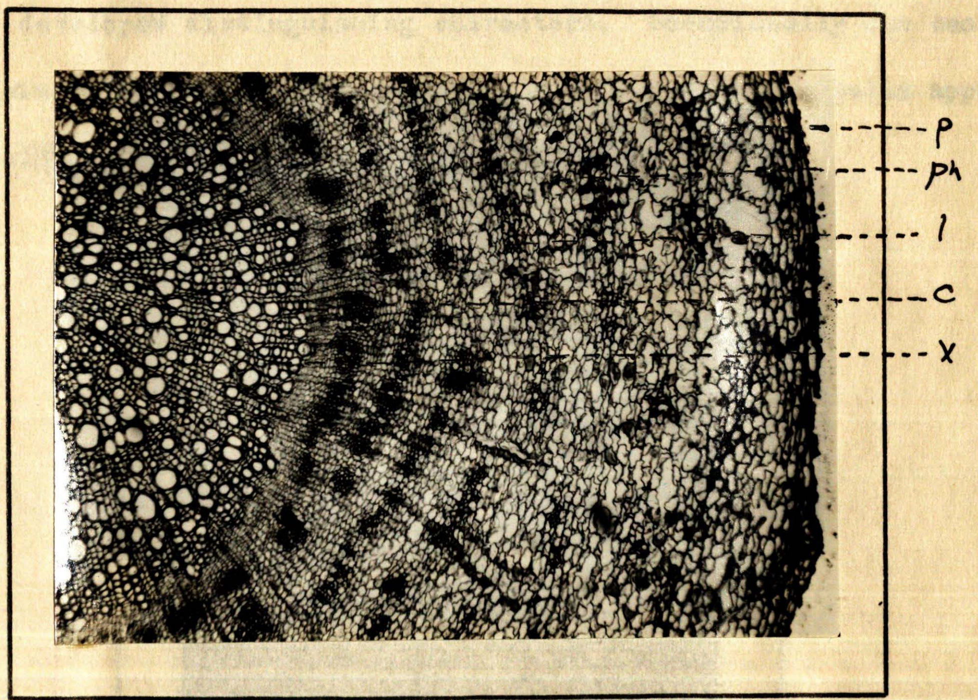


Fig. 2. Taraxacum officinale. - Transverse section of mature root p, pericycle; ph, phloem; l, latex groups; c, cambium; x, xylem.

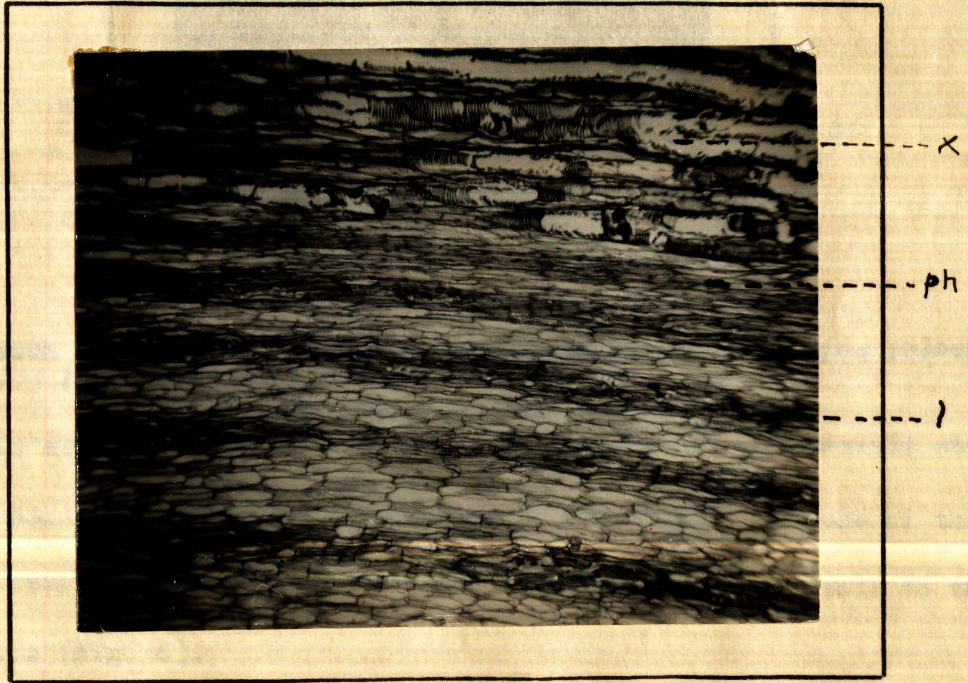


Fig. 3. Taraxacum officinale. - Longitudinal section of the mature root ph, phloem; l, latex-sieve tube area; x, xylem.

The secondary phloem is greater in radial extent than the secondary xylem. (Fig. 1) The phloem is characterized in transverse section by rings of phloem parenchyma alternating with narrower rings of densely staining cells which were determined to be groups of sieve tubes, companion cells, and latex vessels (Fig. 2 and 3). Sieve tubes are infrequent even in these groups, or, if frequent they exhibit feeble developed distinguishing characters. Occasionally one can be identified by sieve plates in the end walls (Fig 4). Companion cells appear only in connection with the sieve tubes.

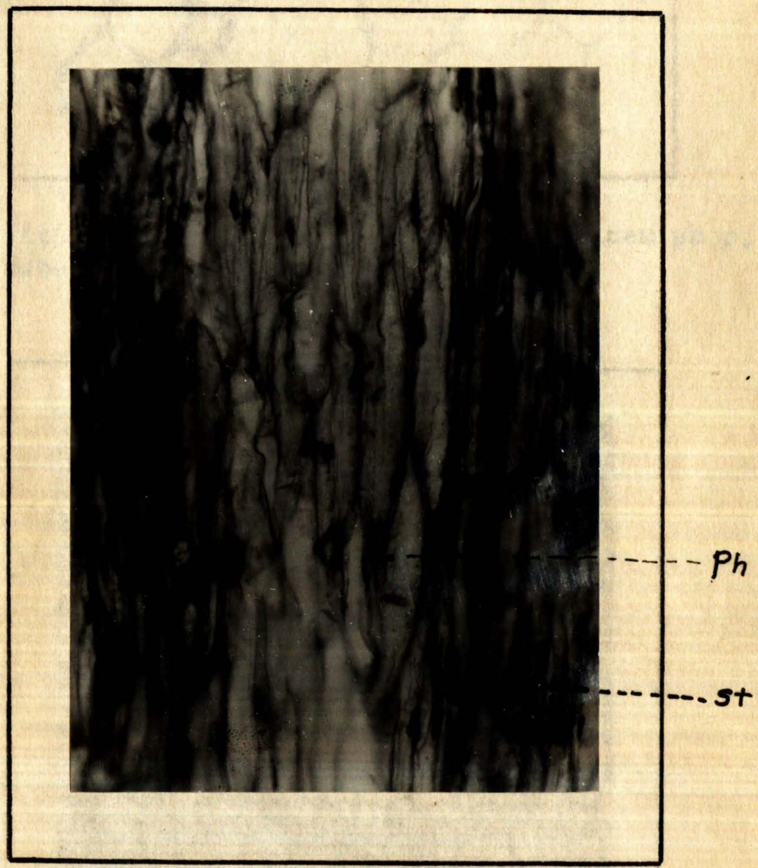


Fig. 4. Taraxacum officinale. - Longitudinal section of phloem ph, phloem; sp, sieve plate. (After Madsen).

Latex cells are identified in transverse section by their densely staining contents (Fig. 5). In longitudinal section the anastomosing nature of the latex system is very obvious, as is also the relation of the latex vessels to the sieve tube groups (Fig. 6).

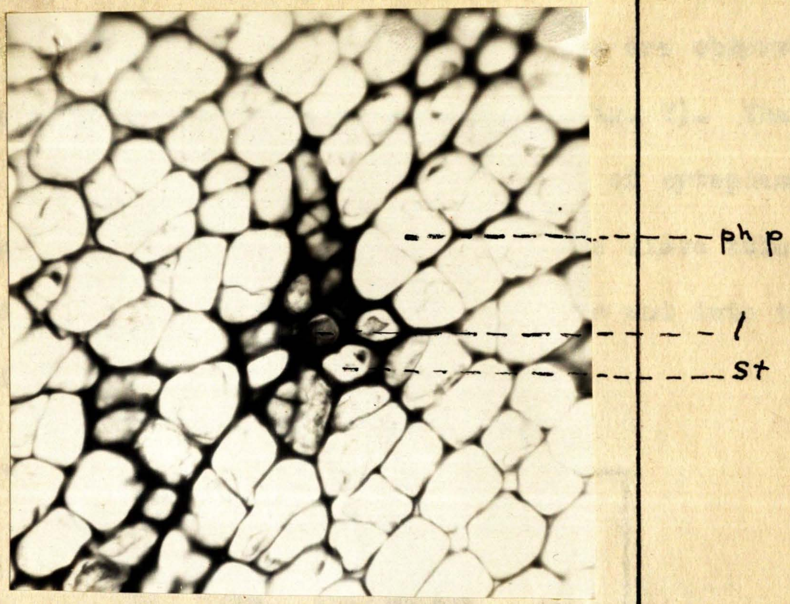


Fig. 5. Taraxacum officinale. - Transverse section of phloem ph p, phloem parenchyma; l, latex tube; st, sieve tube.

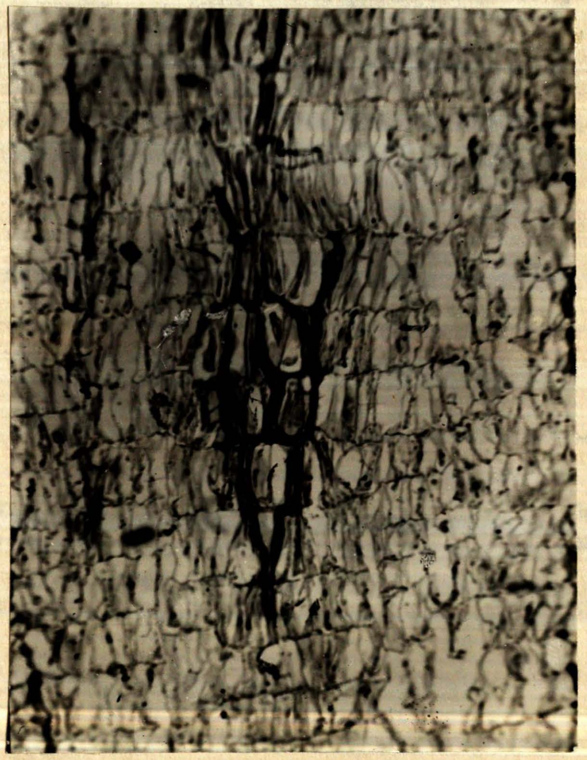

Fig. 6. Taraxacum officinale. - Longitudinal section of latex system showing the anastomosing.

Portion of fragmented end walls can be observed occasionally in latex vessels showing the vessels to be made up of joined cells which are the same length as neighboring phloem cells. The same staining characteristics are observed in longitudinal section that are seen in transverse section (Fig. 7). That the cells of the latex system are living is indicated by the presence of cytoplasm and nuclei (Figs. 5 and 7). The latex system appears first only in the sieve tube-companion cell areas of the secondary phloem, but later it is extended out into the pericycle by means of dissolving cell walls (Fig. 2).

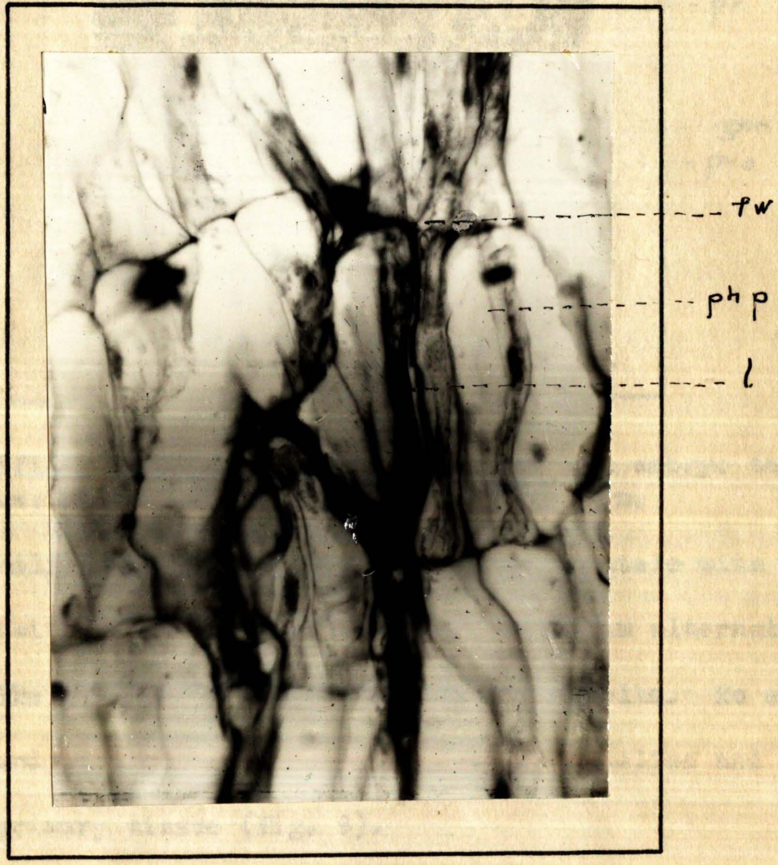


Fig. 7. Taraxacum officinale. - Longitudinal section of the latex system highly magnified l, latex vessel; fw, fragmented wall; ph p, phloem parenchyma.

The pericycle, only a few cells in radial extent, consists of large parenchyma cells, the outer ones of which become corky. In the mature root endodermis, cortex, and epidermis have been sloughed.

In order to trace the origin of the latex system it was necessary to start with the study of the embryo, enclosed within the achene. A transverse section of the radical shows only undifferentiated procambium, groun meristem, and protoderm. No evidence of latex cells is seen (Fig. 8).

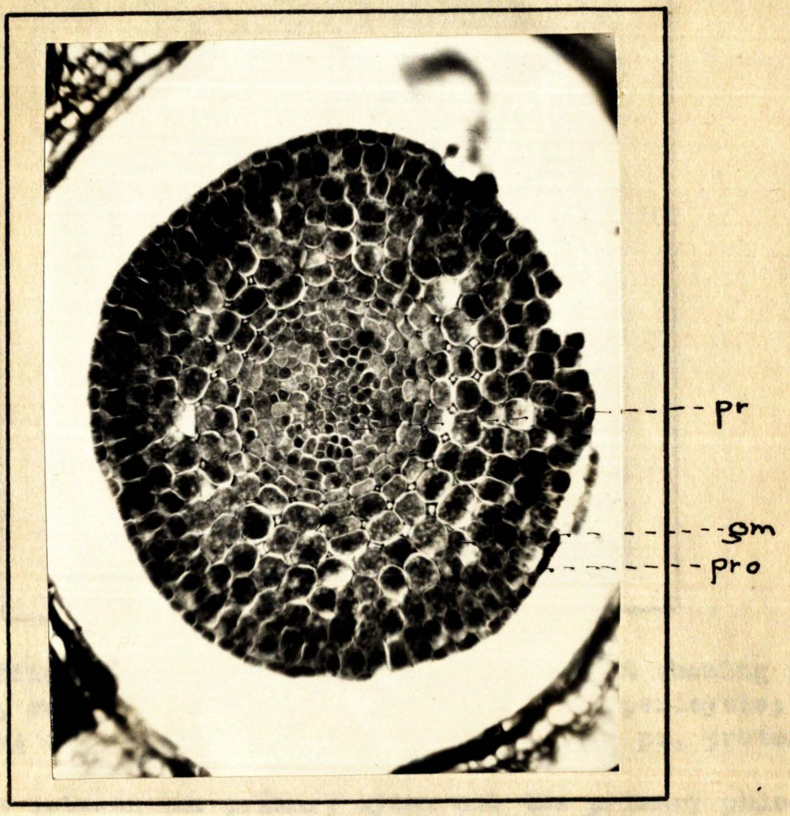


Fig. 8. Taraxacum officinale. - Transverse section of the embryo through the radical pr, pro cambium; gm, ground meristem; pro, protoderm.

The tip of a seedling root has a diarch radial protostele with the protoxylem in an exarch position. Two patches of primary phloem alternate with the radial xylem arms. The stele is surrounded by cortical cells. No evidence of latex cells is found in the primary tissues of the dandelion and their origin cannot be traced to primary tissue (Fig. 9).

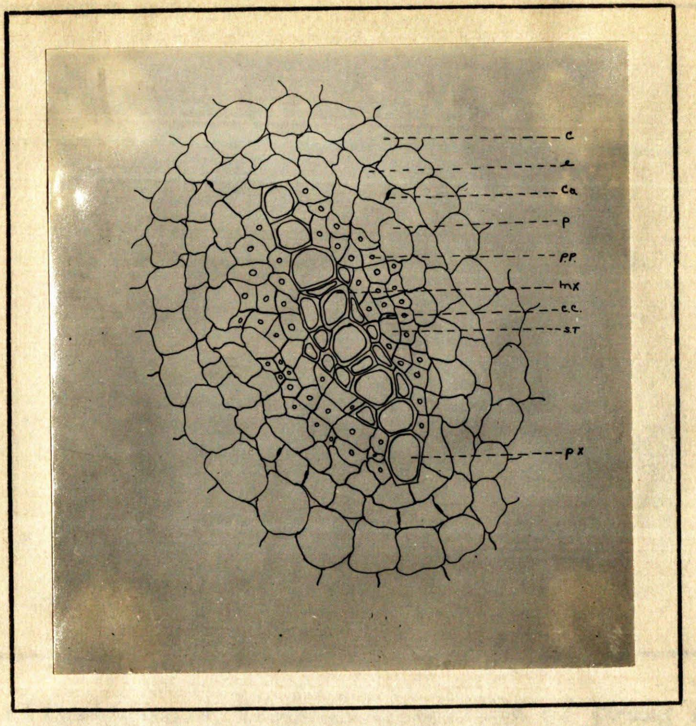


Fig. 9. Taraxacum officinale. - Transverse section of root showing primary tissues c, cortex; e, endodermis; ca, casperian strip; p, pericycle; pp, primary phloem; mx, metaxylem; cc, companion cell; st, sieve tube; px, protoxylem.

Cambium develops between the primary xylem and the primary phloem strands, forming secondary phloem toward the periphery and secondary xylem toward the center. The first phloem cells to be formed are parenchyma. Differentitation occurs early however, for the sieve tube-companion cell-latex groups can be found within three cells of the cambium. Within eight to ten cells of the cambium the characteristic banding of the phloem appears (Figs, 2, 3 and 10).

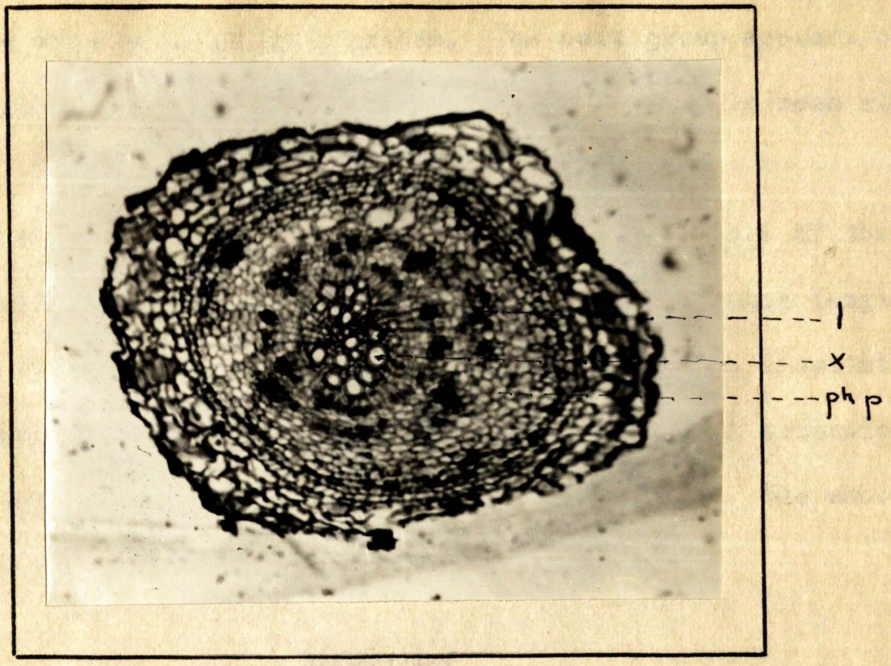


Fig. 10. Taraxacum officinale. - Transverse section of young root showing early banding of the phloem x, xylem; l, latex-sieve tube group; ph p, phloem parenchyma.

The production of secondary xylem and phloem crushes the parenchymatous primary phloem and it is resorbed before the secondary body is very extensive (Fig. 11).

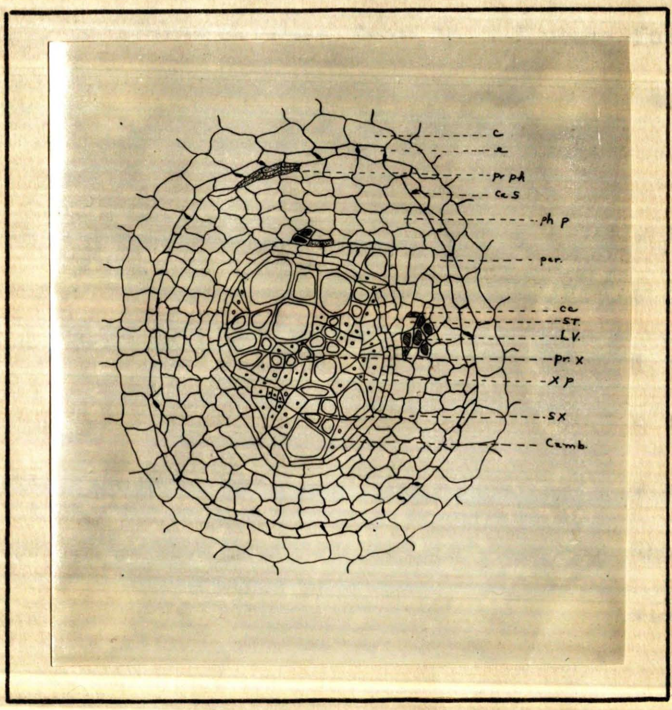


Fig. 11. Taraxacum officinale. - Transverse section of the root showing the earliest developed latex cells c, cortex; e, endodermis; pr ph, crushed primary phloem and pericycle; ph p, phloem parenchyma; per, pericycle; cc, companion cell; st, sieve tube; lv, latex vessel; pr x, primary xylem; xp, xylem parenchyma; sx, secondary xylem; camb, cambium.

The first groups of sieve tubes and latex cells appear in the secondary phloem opposite one of the strands of primary phloem. The next group appears opposite the other primary phloem strand, and from then on development is seen all around the xylem.

Latex vessels are found either in connection with sieve tube of the secondary phloem, or in the secondary pericycle. They are at first the same length as neighboring cells, but they are soon extended vertically by the dissolution of end walls and laterally by the dissolution of side walls. Such extension may occur in cells derived from the cambium or in pericycle cells. The whole system appears as a network of anastomosing cells.

## Discussion

Jeffrey (loc. cit.) in discussing the laticiferous tissue of compositae remarks about the characteristic banding of the phloem in dandelion roots. His statements that these bands indicate the position of the latex tissue agrees with my findings. He further states that sieve tubes appear in conjunction with latex tissue and cannot always be distinguished from it. I have found the general appearance and staining reactions of the latex very similar to that of the sieve tubes.

The development of the latex organ is one of two kinds, articulated or non-articulated (3). The articulated type originates from a row or meristematic initials in which the transverse septa become absorbed at an early stage. Such vessels develop numerous branches and anastomose freely. In the non-articulated type the tube arises from a single mother cell. "It becomes enormously elongated and abundantly ramified with the growth of the plant." In this type the anastomoses are absent or infrequent. As has been shown above the dandelion is of

(3) Haberlandt, Physiological Plant Anatomy. MacMillan Company 1914.

the articulated type. The meristematic initials are the cells given off the cambium which lose their end walls as they develop into latex vessels (Figs. 6 and 7).

Tetley (loc. cit.) has found laticiferous tissue to occur in secondary phloem in connection with sieve tubes in several others of the compositae as for example Inula Helenium where they appear only after a considerable amount of secondary growth had taken place.

## Summary


This paper seeks to explain the anatomy of dandelion roots especially the latex system and its relation to the other root tissues.

1. The seedling root exhibits a diarch protostele.

2. No latex vessels are found in primary tissue.

3. Latex vessels appear in secondary phloem in connection with sieve tubes and companion cells.

4. The secondary phloem shows banding due to alternation of phloem parenchyma and sieve tube-companion cell-latex groups.

5. Latex vessels are formed by the dissolution of end walls or side walls in phloem cells derived from the cambium or in cells of the pericycle.

6. The latex system thus anastomeses freely.


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The writer wishes to take this opportunity of thanking Dr. W. L. Miller for his suggestions and help in working out this problem.