In order that you may have a chance to look over the constitution before the business meeting, we have copies here for distribution to the members of the Society. I only have 150, so will those of you that are guests, please do not take a copy. Let's restrict them because of the number, to the members. Look them over. If there are any questions you have about the constitution, the proposed constitution, consult with some member of the Executive Committee or the Constitution Committee, and we will try to explain it to you. It is basically the old constitution adapted to the procedures which we have developed during our previous 11 years of existance. They are here. I think to save a little bit of time I will not pass them out right now. We will pass them out at the end of the session.

The first part of this morning's program is a Symposium —Propagation of Plants by Means of Cuttings. The Moderator for the Symposium is Mr. Roger Coggeshall of Cherry Hill Nurseries, West Newbury, Massachusetts. I will turn the meeting over to Roger.

MODERATOR COGGESHALL: At this time, before we start the symposium, I would like to ask the speakers who are to participate in this morning program to please come up to the stage and sit at the table to my left.

The symposium this morning, as you can see on your program and as has been pointed out already to you, deals with the Propagation of Plants by Means of Cuttings, and to save time in the symposium, we will hear from all of the speakers and at the end of this time you can direct your questions to them We will not allow time for questions after each speaker but just as an overall period at the end of this morning's symposium.

At this time I would like to introduce to you a man who is certainly no stranger, who will speak to us first — Dr. W. E. Snyder of the Department of Horticulture, Rutgers University, who will speak to us on Plant Anatomy as Related to the Rootings of Cuttings. Dr. Snyder.

PLANT ANATOMY AS RELATED TO THE ROOTING OF CUTTINGS

William E. Snyder
Department of Horticulture
Rutgers, the State University
New Brunswick, N. J.

It is necessary for us to understand the structure of the stem before we examine the origin of roots on stem cuttings.

The vegetative parts of a seed-producing plant are the roots, stems and leaves. Each of these organs is composed of tissues and the tissues of cells. Some of these cells have become specialized, however others have remained almost unchanged since the time they were formed. Such unspecialized cells are called parenchyma. It is these relatively unspecialized cells which are important in the development of roots on stem cuttings.

Growth in plants is said to be primary or secondary. Growth resulting from cells formed by the growing points of stems and roots is primary growth and results in the elongation of the plant axis. Secondary growth results in an increase in diameter of the stem or root. It is the formation of additional vascular tissue (the tissue through which water, minerals, food, hormones, etc. are transported up and down the stem) by the cambium and of the bark as the stem or root increases in size. The place of origin of roots on stem cuttings depends on whether the base of the cutting has only primary growth or whether secondary growth has taken place.

Simply, we can compare the root-stem axis to a pencil. The pencil is composed of three concentric cylinders—the outer cylinder is the paint, the intermediate cylinder is the wood and the inner cylinder is the lead. Likewise, the stem-root axis is composed of three concentric cylinders–the outer cylinder is the epidermis, the intermediate cylinder is the cortex and the inner cylinder is the stele (Figure 1). In a young stem, such as the new growth of a woody plant, a chysanthemum or a bean, the roots originate in the inner portion of the intermediate cylinder, the cortex, and grows outward through the remainder of the intermediate cylinder and through the outer cylinder, the epidermis. In stems with secondary growth, the roots originate in vascular tissue formed by the cambium and grow outward through the stem.

Let us now examine, in more detail, the origin and development of roots in a stem cutting made from current season's growth. Examination of cross sections of stems will show that there are three major types of arrangements of the vascular tissue. These three types of vascular tissue arrangements are illustrated in Figure 1. It is immaterial which type of arrangement we find in a stem as far as the initiation of roots is concerned. The activity always occurs adjacent to and usually outward from the outer edge of the vascular tissue. This area is known as the pericycle and constitutes the inner portion of the cortex—the intermediate cylinder.

For some reason, which we cannot explain at present, groups of these pericycle cells, usually adjacent to the vascular tissue, begin to undergo cell division. As more and more cells are formed, the new mass of tissue gradually becomes a small tapered cylinder, called a

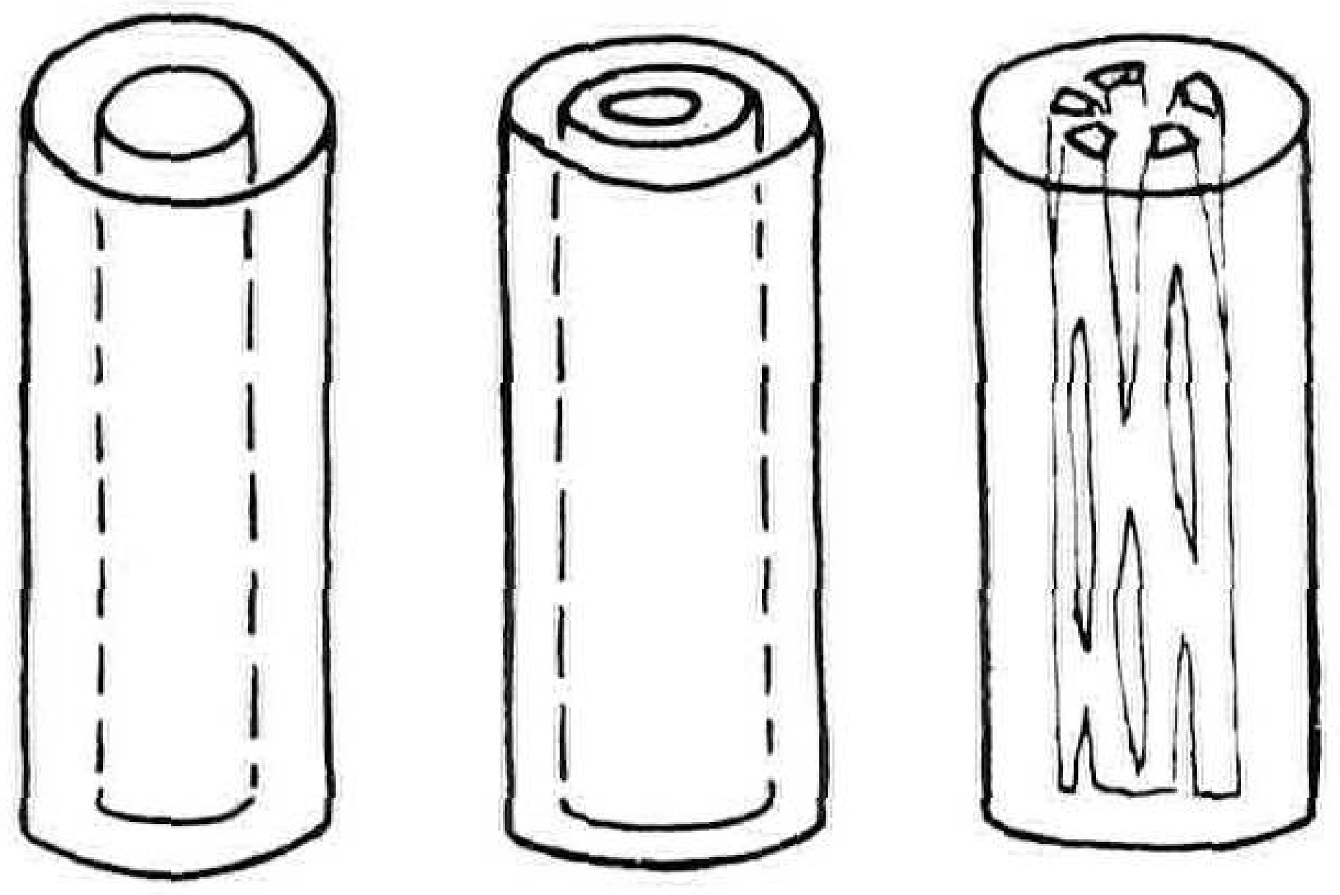

Fig. 1. Major Arrangements of Steles (Vascular Tissue) found in stems.

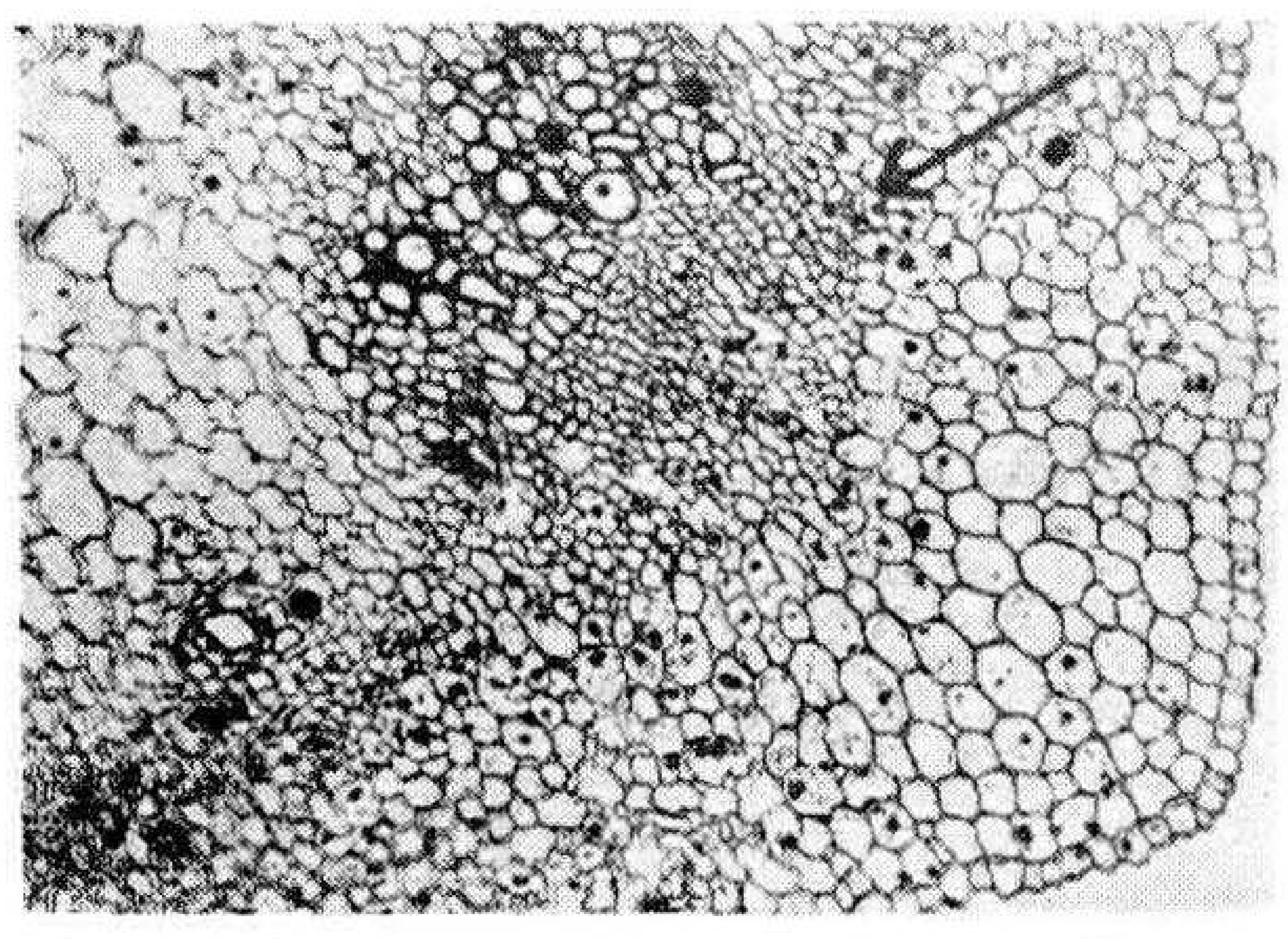

Fig. 2. Section of a chrysantheum stem showing location of root initial (at arrow) in pericyclic parenchyma at flank of a large vascular bundle. (from Stangler)

root primordium. An area of very active cell division develops in the point of this cylinder and the tip of the cylinder is pushed outward through the stem until it finally emerges as the new root. As this new root develops and grows, it reproduces the three concentric cylinders —the epidermis, the cortex and the stele—and each cylinder of the root becomes continuous with the appropriate cylinder of the stem.

Stangler (2) has studied the origin of roots on stem cuttings of the chrysanthemum and the carnation. The three concentric cylinders are recognizable in the small section of the chrysanthemum stem shown in Figure 2. Only one of the five major vascular bundles is shown in the illustration. A small area of cell division, indicated by the arrow, can be seen in the pericycle tissue on the flank of the large vascular bundle. Continued cell division eventually gives rise to a root structure which grows outward through the cortex and the epidermis. Figure 3 shows the stem structure and root origin in a carnation stem cutting. The vascular tissue is a continuous ring and the outer portion of the pericycle has become specialized as supportive fibers. The root primordium has started to develop in the area above the arrow. It will grow outward until it reaches the fibers of the pericycle; then, because of the mechanical barrier, grow downward and emerge through the basal cut surface.

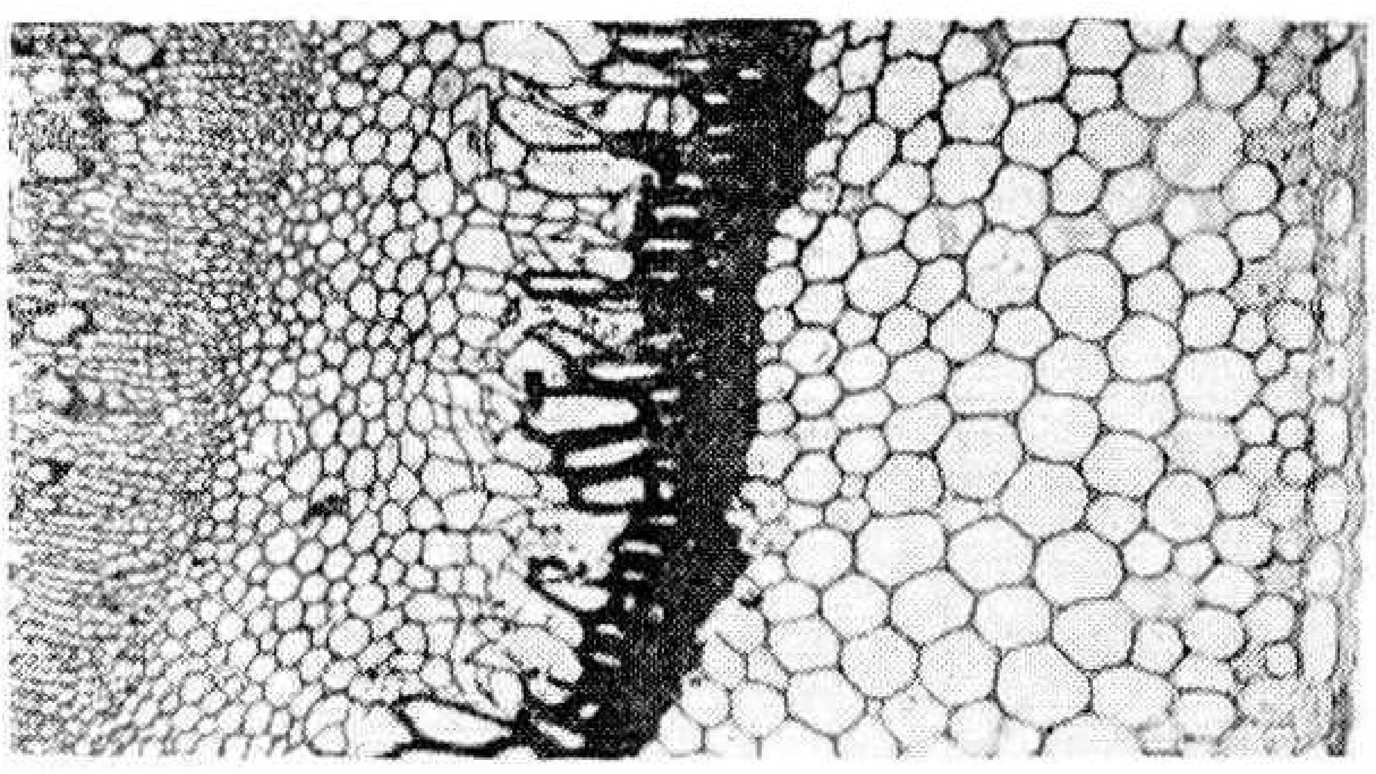

Fig. 3. Section of a carnation stem showing fibers in the outer portion of the pericycle. (from Stangler)

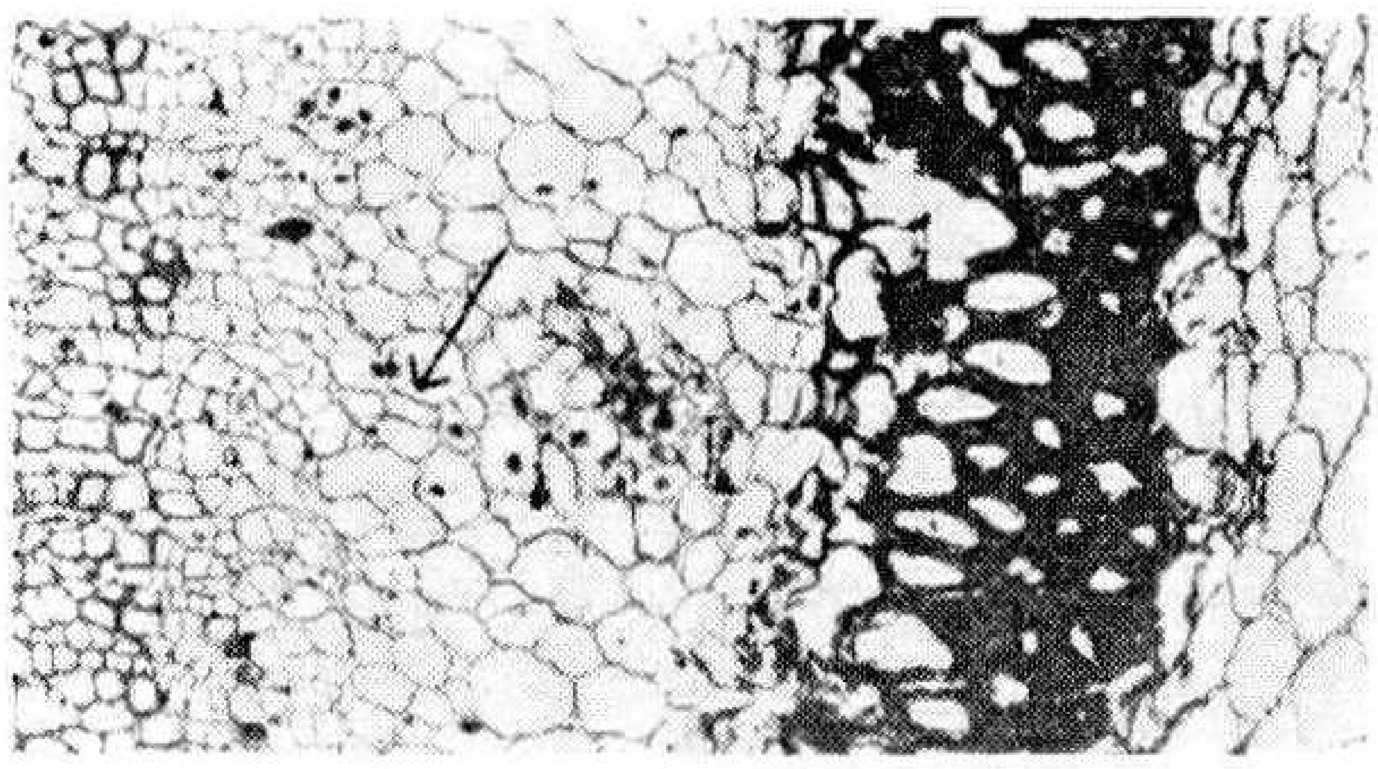

Fig. 4. Section of a carnation stem showing root primordium (above arrow) in pericycle parenchyma. (from Stangler)

Certainly by mid-or late-summer stems of woody plants have become somewhat more complicated by the formation of secondary growth. The cambium has formed and given rise to additional vascular tissue—xlem on the inside and phloem on the outside of the cambium. As these new cells are formed, the cells of the pericycle, cortex and epidermis gradually age, lose their ability to form new cells and are replaced by the bark.

In order to apply the pencil analogy to the stem with secondary thickening, we must imagine that the lead increases in size, thereby pushing the wood and paint cylinders outward. Eventually, as the amount of new lead increases, the wood and paint cylinders will be sloughed off and replaced by a new covering. This new covering is comparable to the bark of the stem.

Hiller (1) has studied the origin of roots in stem cuttings of the Japanese yew (*Taxus cuspidata*). A one-year old stem (Figure 4) has the three concentric cylinders described for the chrysanthemum and carnation—epidermis, cortex and stele. There has been considerable new vascular tissue produced by the cambium, however the cortex and epidermis still remain intact. The vascular tissue is arranged similar to the carnation. In the new vascular tissue there occur radial bands of unspecialized cells (parenchyma), called rays. The root primordium, as can be seen in Figure 5, develops in the portion of the ray located in the phloem. This root primordium grows outward through the stem until it emerges as the new root.

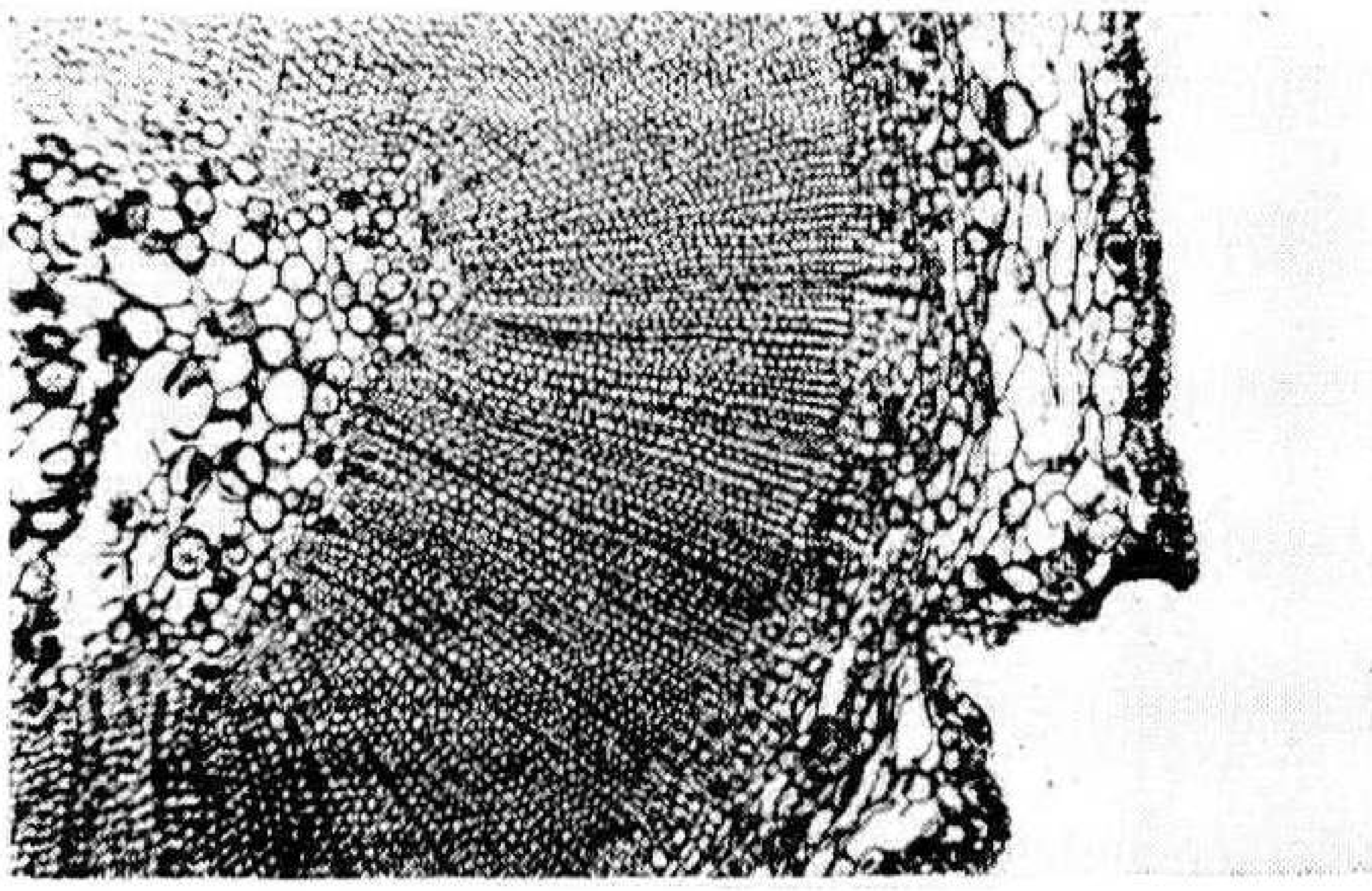

Fig. 5. Section of a one-year old stem of Japanese yew showing secondary vascular tissue formed by the cambium. (from Hiller)

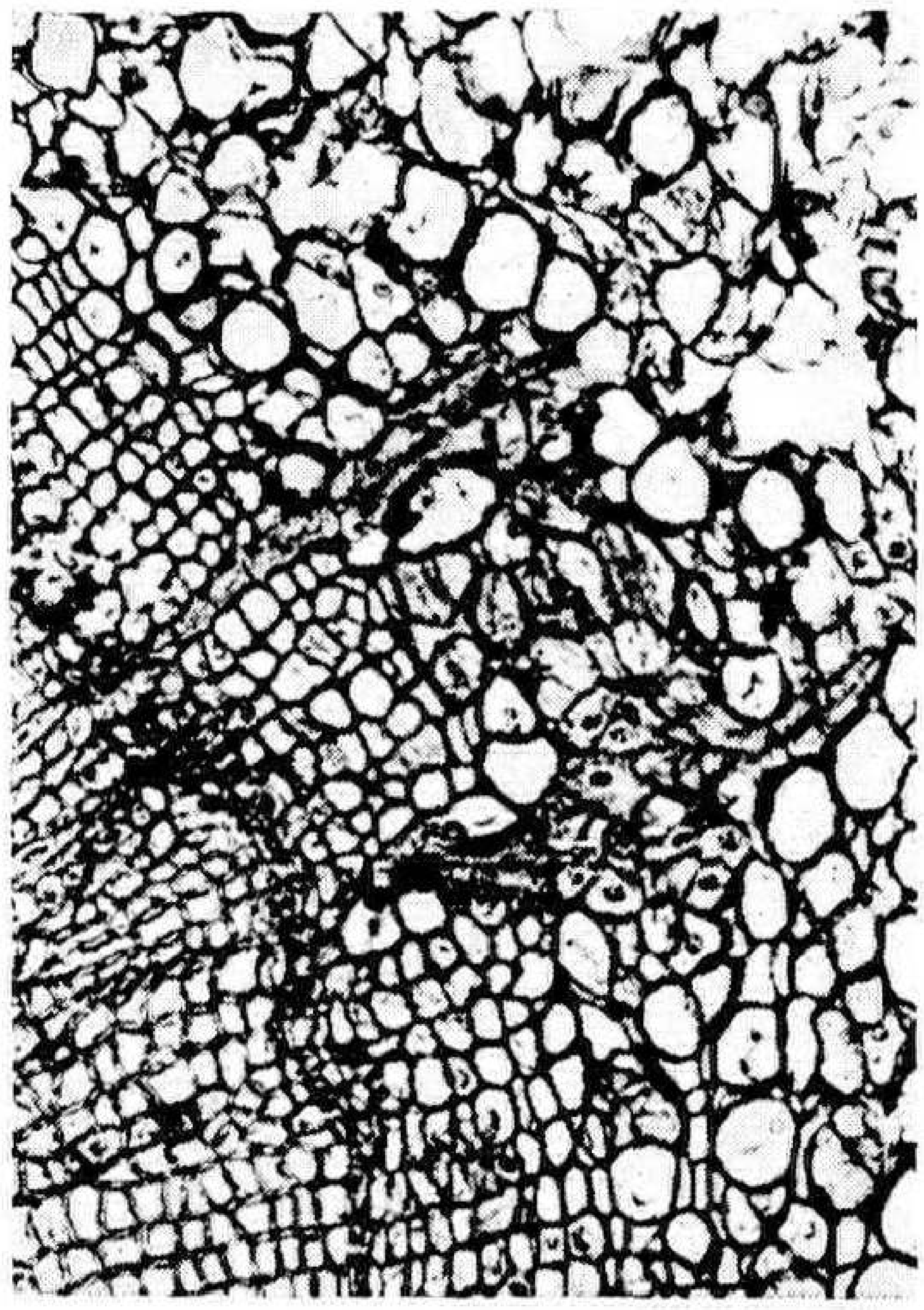

Fig. 6. Section of Japanese yew stem showing developing root primordium in phloem portion of the vascular ray. (from Hiller)

These studies have shown that the first root primordia to form are located just above the cut surface, usually within a quarter of an inch above the cut. Slightly later, root primordia are formed higher on the stem.

The only observed effects of the use of root-inducing chemicals are to increase the number of root primordia formed and to decrease the time required for the primordia to develop. The same tissues are involved regardless of whether or not a chemical stimulant is used.

By way of summary, let us now return to the pencil. Stems which are composed only of primary growth, such as those of herbaceous plants and very young woody stems, are composed of three concentric cylinders: 1) the outer cylinder, the paint of the pencil is the epidermis of the stem; 2) the intermediate cylinder, the wood of the pencil is the cortex of the stem; and 3) the inner cylinder, the lead of the pencil is the stele of the stem. Roots originate in the innermost portion of the intermediate cylinder, i.e., the pericycle portion of the stem which is the wood portion of the pencil nearest the lead.

If secondary growth has occurred, the vascular tissue (the lead of the pencil) has increased in size and contains radial bands of unspecialized cells, called rays. The pericycle (the inner wood portion of the pencil) ages and loses its ability to form new cells. However, the unspecialized ray cells, especially those in the newest phloem tissue, are capable of forming new cells which, under the proper stimulus, will develop into root primordia and eventually into new roots.

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PRESIDENT SNYDER: If there are any questions I will be glad to answer them during the question period.

MODERATOR COGGESHALL: The second speaker on the symposium this morning is Mr. James Wells, Wells Nursery, Inc. Red Bank, New Jersey. He will speak to us on Wounding of Cuttings as a Commercial Practice. I also understand Mr. Wells has some slides which he will show at a later date in the program, not this morning. Mr. Wells!

MR. JAMES WELLS: I dislike reading a paper, but when faced with this august assembly I don't think there is any alternative because I want to know precisely what I said.

WOUNDING CUTTINGS AS A COMMERCIAL PRACTICE

JAMES S. WELLS

The practice of wounding plant material as an aid to successful rooting is not a recent development. Textbooks of last century, describing methods to use for layering, say that the stem should be bent into a sharp U where it is fixed to the ground, and that for best results, the stem should be "nicked" at this point. This, of course, is a wound. Burbidge [2], in his book published in 1875, indicates the need for ringing the stem of many plants which are to be propagated by marcottage, a method which may more readily be recognized today as air layering. Old time growers recommended the splitting of the base of carnation stems and Sheat [10] mentions this for cuttings of *Daphne odora.*

Yet, despite the general acceptance of wounding in one form or another in old gardening journals, it is only recently that the method has been tested and applied in a scientific manner to the propagation of a wide range of plant materials.

In searching through the literature, I was not able to find many references until 1932. Day [4], then wrote a most interesting paper in which he showed that the rooting of cuttings of California Privet (*Ligustrum ovalifolium*), *Chaenomeles,* and Muscat grapes was greatly improved by wounding. His results appeared to indicate that wound had a definite effect upon the rapidity and quantity of water absorbed by the unrooted cutting, and furthermore, that the water