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SHOOT-BUDS FROM ROOT-CUTTINGS.

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It is the object of this paper to record the observations of the writer about the varied mode of orientation of shoot-buds from root-cuttings, with a note on the mode of their origin in the root. It is not possible to suggest, at this stage, any general rule bearing on the behaviour of root-cuttings as a whole. The problem of reversion and general behaviour of plants raised from the root-cuttings of variegated plants will be discussed in a later paper.

Method :—The medium found suitable for root-cuttings is about two inches of loose sand on the top, with light garden loam below; it is however necessary to see that the pots do not get water-logged. The pots are placed at a temperature of 60°F so that there is sufficient moisture and warmth. The cuttings should be placed about half to three-fourth inch deep.

The time of budding for root-cuttings of different plants varies considerably, the shortest time being 6–7 days as seen in *Euphorbia Cyparissias*, *Geranium macrodenum* and *Nasturtium sylvestre*; *Maclura aurantiaca*, among plants so far observed, takes the longest time to bud from the roots *viz.* 4–5 months. As a rule about three weeks is a normal period. It should, however, be noted that the period for budding is fixed for each species. The failure in some cases is due to the susceptibility of roots to some kind of rot as seen in *Acanthus mollis*, *Ailanthus glandulosa*, *Populus alba*, *Populus eugenia* and *Verbascum cupreum*. In these cases roots completely rot at either

end, especially so at the proximal end ; and buds, even if they appear, are stopped from further growth. Lateness in some cases is due to the wrong position of the cuttings in the sand-bed, which are usually placed horizontally. Cuttings in these cases prefer a vertical position with proximal end upwards. This was clearly seen in the case of *Tecoma radicans*—horizontally placed cuttings taking over 37 days while the vertically placed ones about 14 days. The cuttings of plants—*e.g. Anchusa italica*, *Acanthus mollis*, *Papaver orientale*, *Rumex alpinus* and *Verbascum phoenicum*—with a tendency to bud in a ring round the xylem at the proximal end prefer a vertical position. One cannot, however, predict beforehand the mode of budding nor the position preferred by the cuttings.

Mode of budding :—The buds may appear either (1) laterally as seen in the greater number of cases ; or (2) terminally in a ring round the xylem at the proximal end as in *Anchusa italica* (fig. 1), *Acanthus mollis*, *Erodium macradenum* (fig. 2), *Papaver orientale*, *Populus alba*, *Populus eugenia*, *Picris hieracioides*, *Rumex alpinus*, *Crombe maritima* (fig. 6), *Spiraea ulmaria* and *Verbascum phoenicum* (fig. 4) ; or (3) singly at the terminal end round the xylem as in *Maclura aurantiaca*, *Senecio pulcher* (fig. 5), *Spiraea filipendulina*, *Taraxacum officinale* ; or (4) laterally but towards the proximal end as in *Anemone buldensis*, *Ajuga reptans var. purpurea*, *Ailanthus glandulosa*, *Aristolochia Clematitis*, *Barbarea vulgaris*, *Nasturtium sylvestre* (fig. 3), *Pelargonium Volutis* and *Romneya coulteri* x *R. trichocalyx*.

Distinct polarity is seen in most of the cuttings which have a tendency to bud centrally round the xylem at the proximal end. Some of the cuttings of *Taraxacum officinale*, which buds in this fashion, were placed vertically with proximal end downwards to see whether the mode of budding would vary. It was, however, interesting to see that the bud appeared from the proximal end in a ring in spite of the unfavourable position (fig. 7).

It was thought that anatomy would shed some light on the varied behaviour of the root-cuttings ; but no definite structural peculiarities could be seen. Except perhaps in *Gaillardia var.* "*Lady Rolleston*" (fig. 8), the buds were endogenous. They started either (1) quite from the centre of the wood-cylinder, the most deeply seated ones being found in *Barbarea vulgaris* (figs. 9, 10), *Bocconia cordata* (fig. 11), *Cnicus arvensis* (fig. 12), *Convolvulus arvensis* (fig. 13) and *Geranium sanguineum* (fig. 14) ; or (2) from just inside the pericycle as in *Bouvardia var.* "*President Cleveland*" (fig. 15), *Erodium macradenum* (fig. 16), *Euphorbia Cyparissias* (fig. 17), *Papaver orientale* and *Verbascum phoenicum* (fig. 18).

It was further observed that the woody tissue in cuttings which were characterised by polarity was comparatively poor, sclerenchyma being considerably reduced.

It seems that the woody tissue greatly influences the formation of shoot-buds and its feeble development accounts for the failure of cuttings of *Cochlearia*, Peas and other herbaceous plants. It is perhaps possible to raise plants from the tender roots of these plants which cannot survive in the sand bed the resting period required for the development of buds, by manipulation of temperature so as to quicken the process of bud-formation.

The writer is indebted to the late Prof. Bateson for his kindly interest and to the staff of the John Innes Horticultural Institute, Merton, London, for their consistent help throughout the progress of the work. Thanks are also due to Mr. Osterstock, the artist of the Institute, for photographs of root-cuttings.

Summary.

I. Loose sand on top of light loam forms a good medium for root-cuttings.

II. Position of cuttings in sand-bed, time of budding, as well as mode of orientation of shoot-buds varies in different plant species.

III. Polarity correlates with the tendency to bud centrally.

IV. Anatomy helps in the study of the origin of shoot-buds from root-cuttings.

V. Woody tissue greatly influences the formation of shoot-buds from root-cuttings.

VI. Manipulation of temperature may help in raising plants from root-cuttings with feeble development of woody tissue.

Explanation of figures. (Plates I—III.)

Fig. 1. *Anchusa italica var. dropmore*, showing distinct polarity.

Fig. 2. *Erodium macradenum var. roseum*, showing buds in a ring from the proximal end.

Fig. 3. *Nasturtium sylvestre*, with shoot-buds arranged laterally in a ring round the edge of the proximal end.

Fig. 4*a*. *Verbascum phoenicum* showing distinct polarity.

Fig. 4*b*. *Verbascum phoenicum var. album*, showing polarity.

Fig. 5. *Senecio pulcher*, showing shoot-buds appearing terminally but singly from the wood.

Fig. 6. *Crombe maritima* (Seakale), showing shoot-buds arranged in regular rings round the wood at the proximal end.

Fig. 7. *Taraxacum officinale*, cuttings placed upside down vertically. Shoot-buds curving upwards.

Fig. 8. *Gaillardia var.* "*Lady Rolleston*," T. S.

Fig. 9. *Barbarea vulgaris*, T. S.

Fig. 10. *Barbarea vulgaris*, L. S.

Fig. 11. *Bocconia cordata*, T. S.

Fig. 12. *Cnicus arvensis var. setosus*, T. S.

Fig. 13. *Convolvulus arvensis*, T. S.

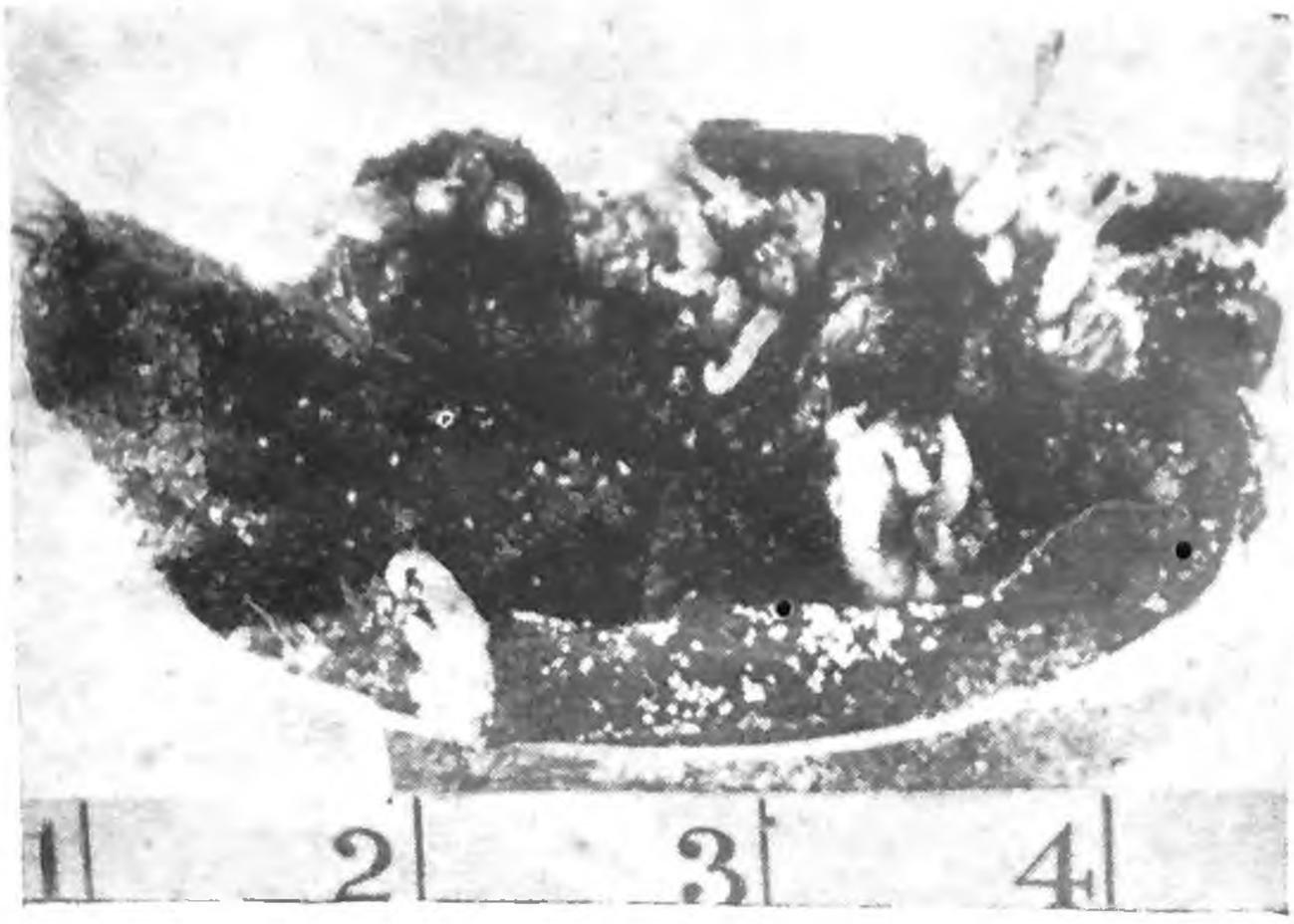
Fig 14. *Geranium sanguineum*, T. S.

Fig. 15. *Bouvardia var.* "*President Cleveland*," T. S.

Fig. 16. *Erodium macradenum var. roseum*, L. S.

Fig. 17. *Euphorbia Cyparissias*, L. S.

Fig. 18. *Verbascum phoenicum*, T. S.



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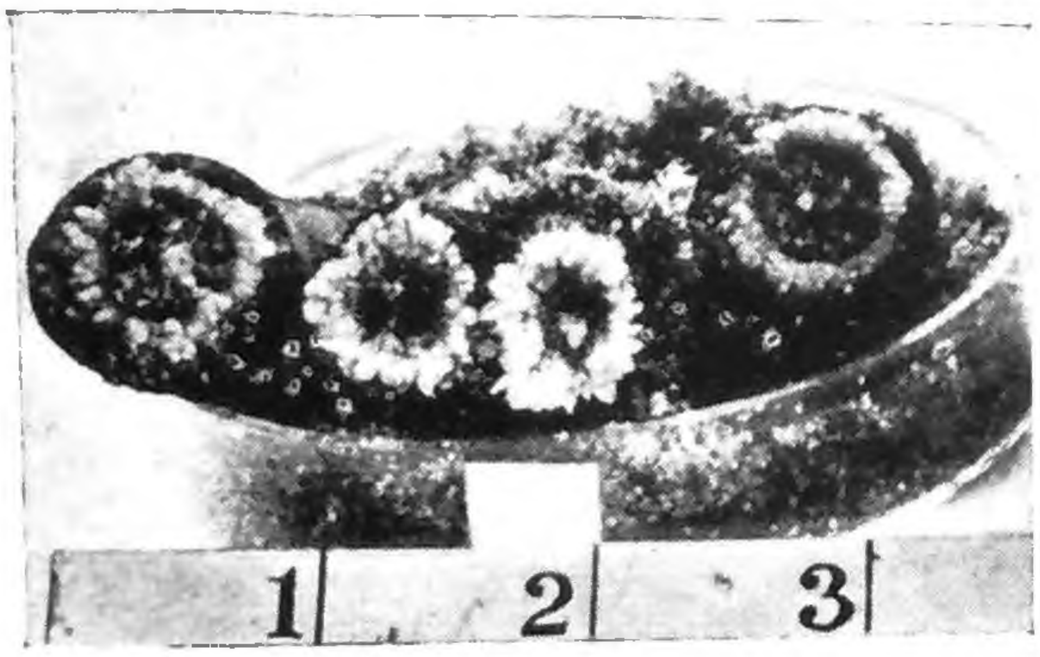

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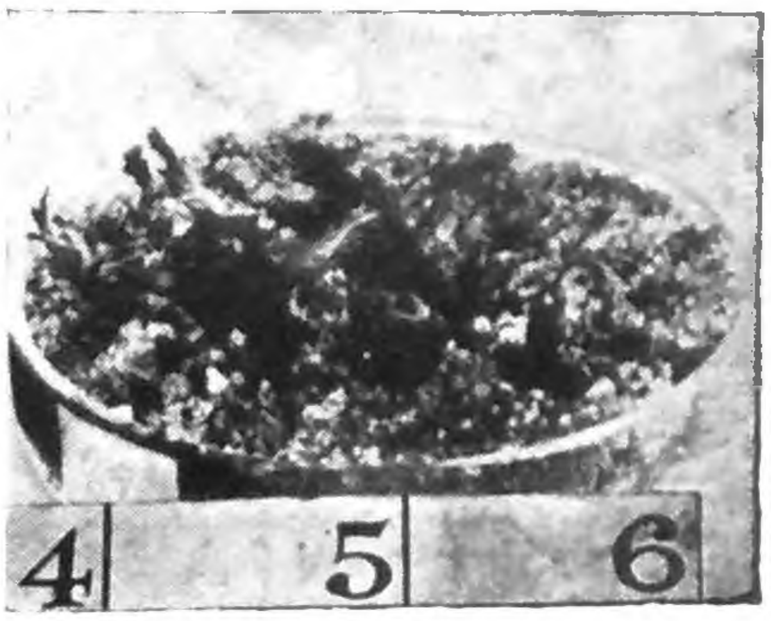

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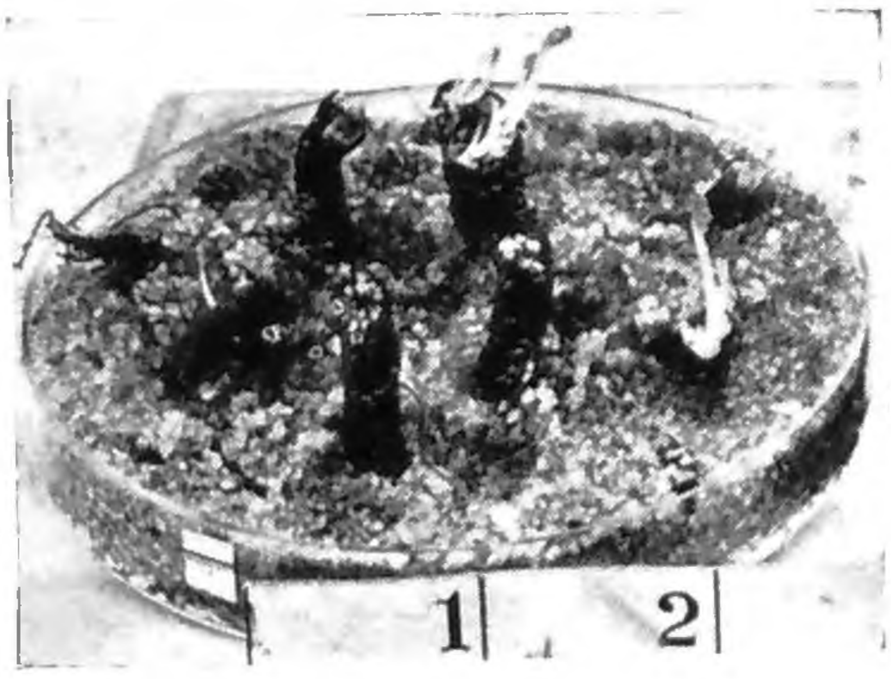

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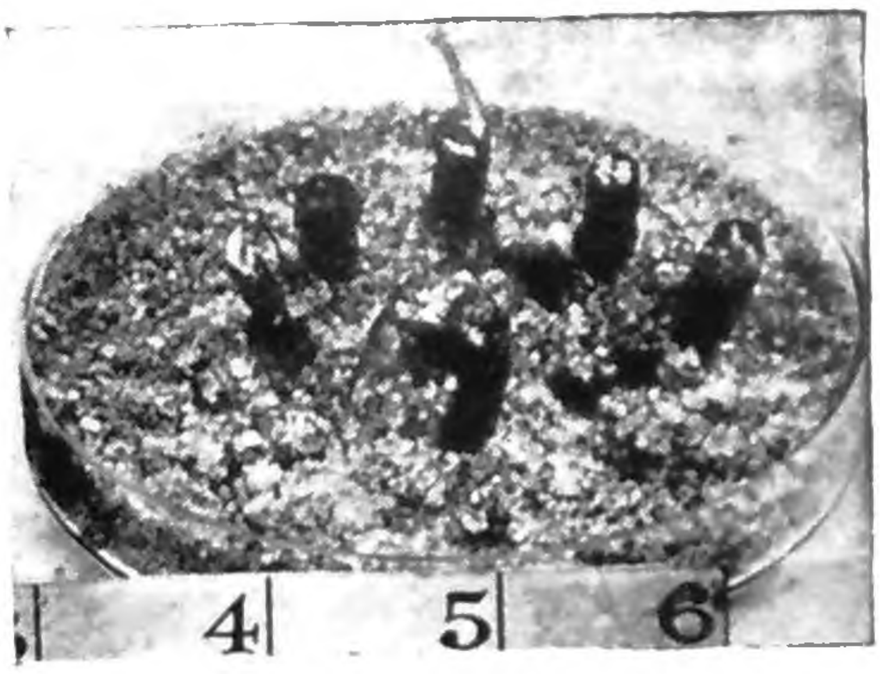

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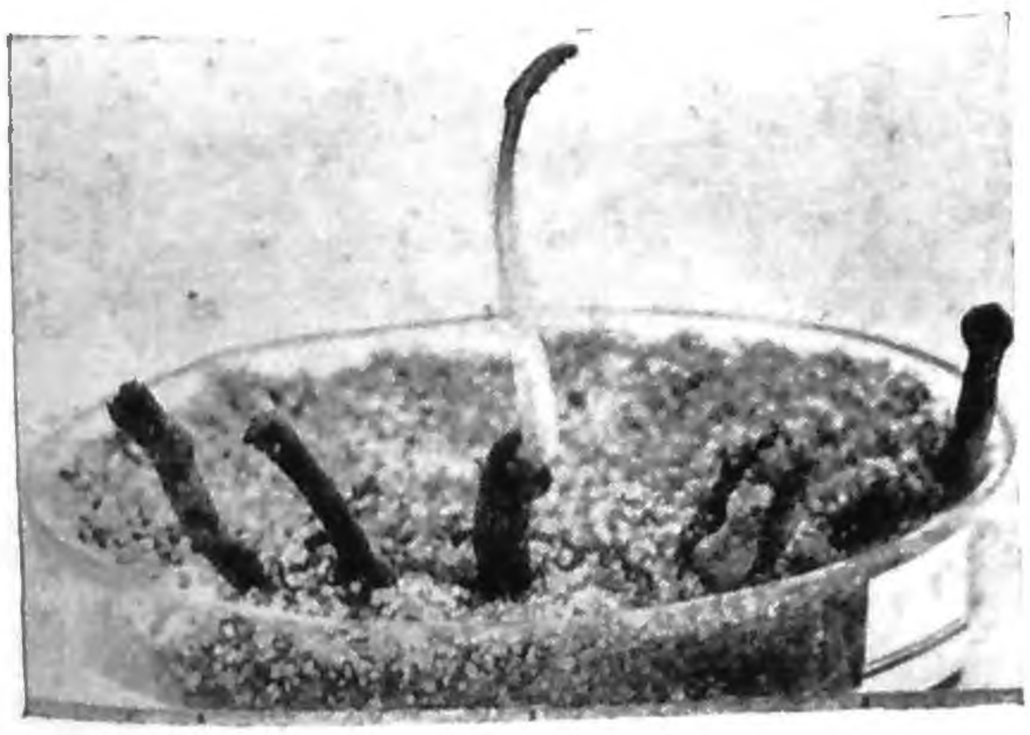

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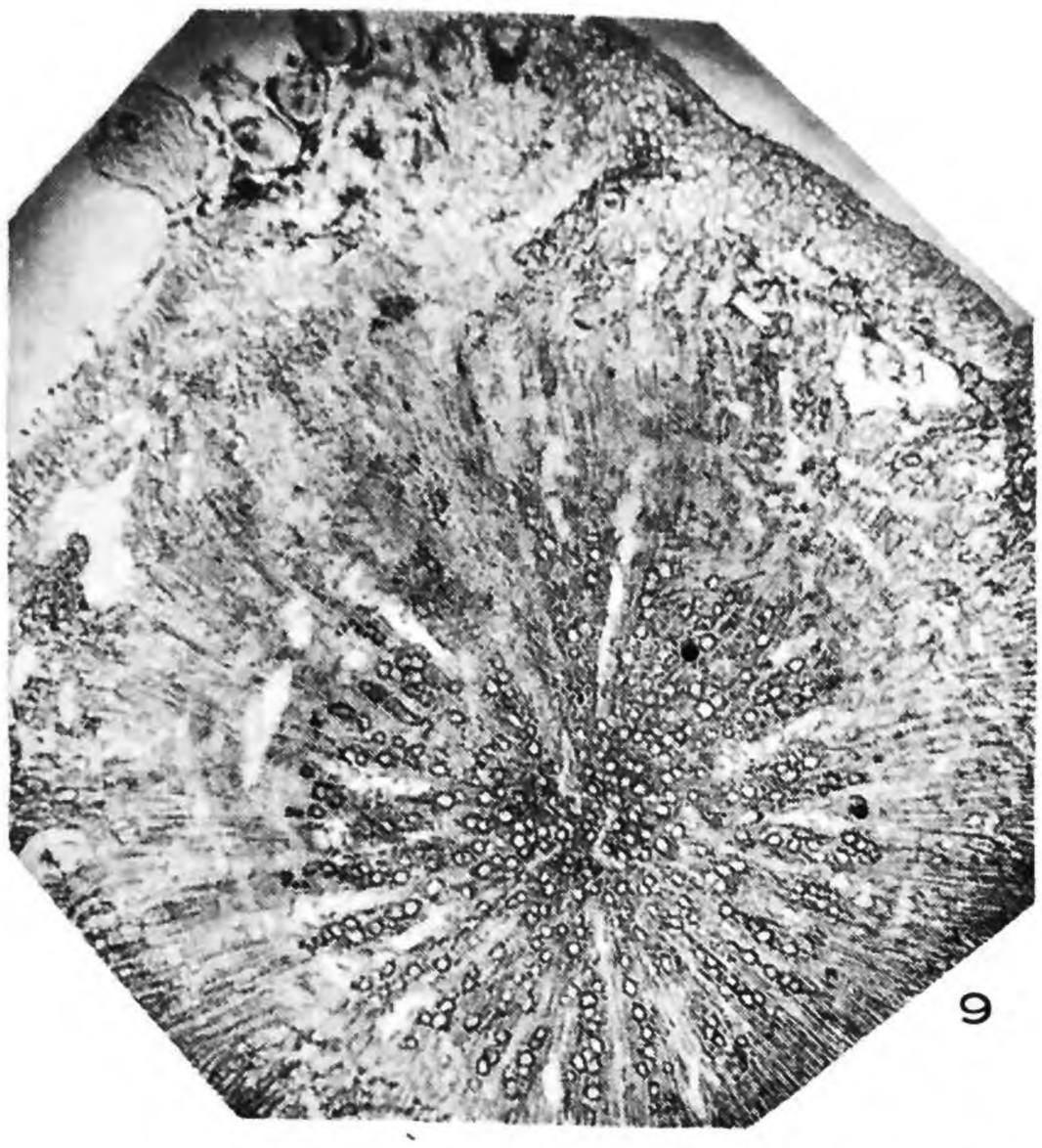
Osterstock Photo.



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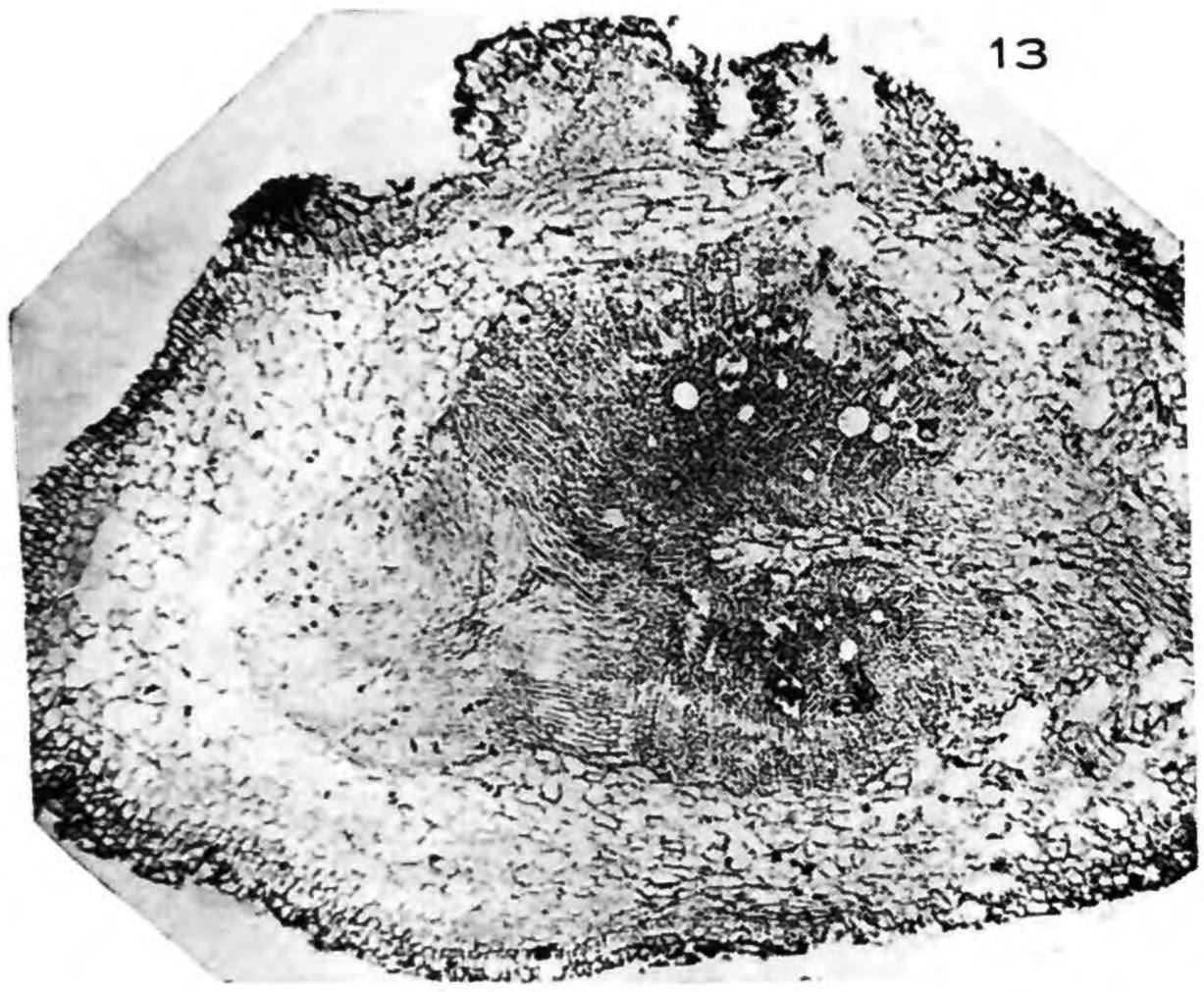

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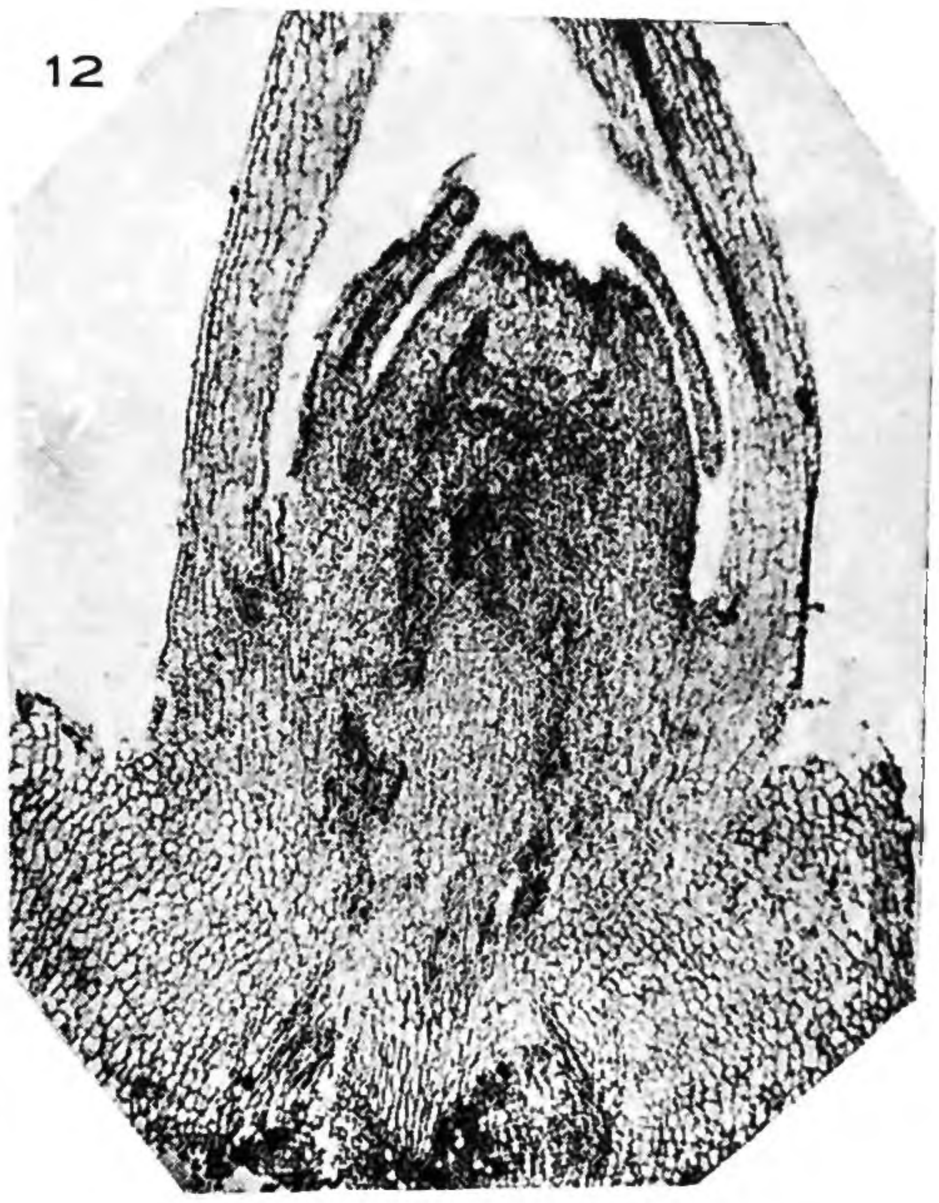

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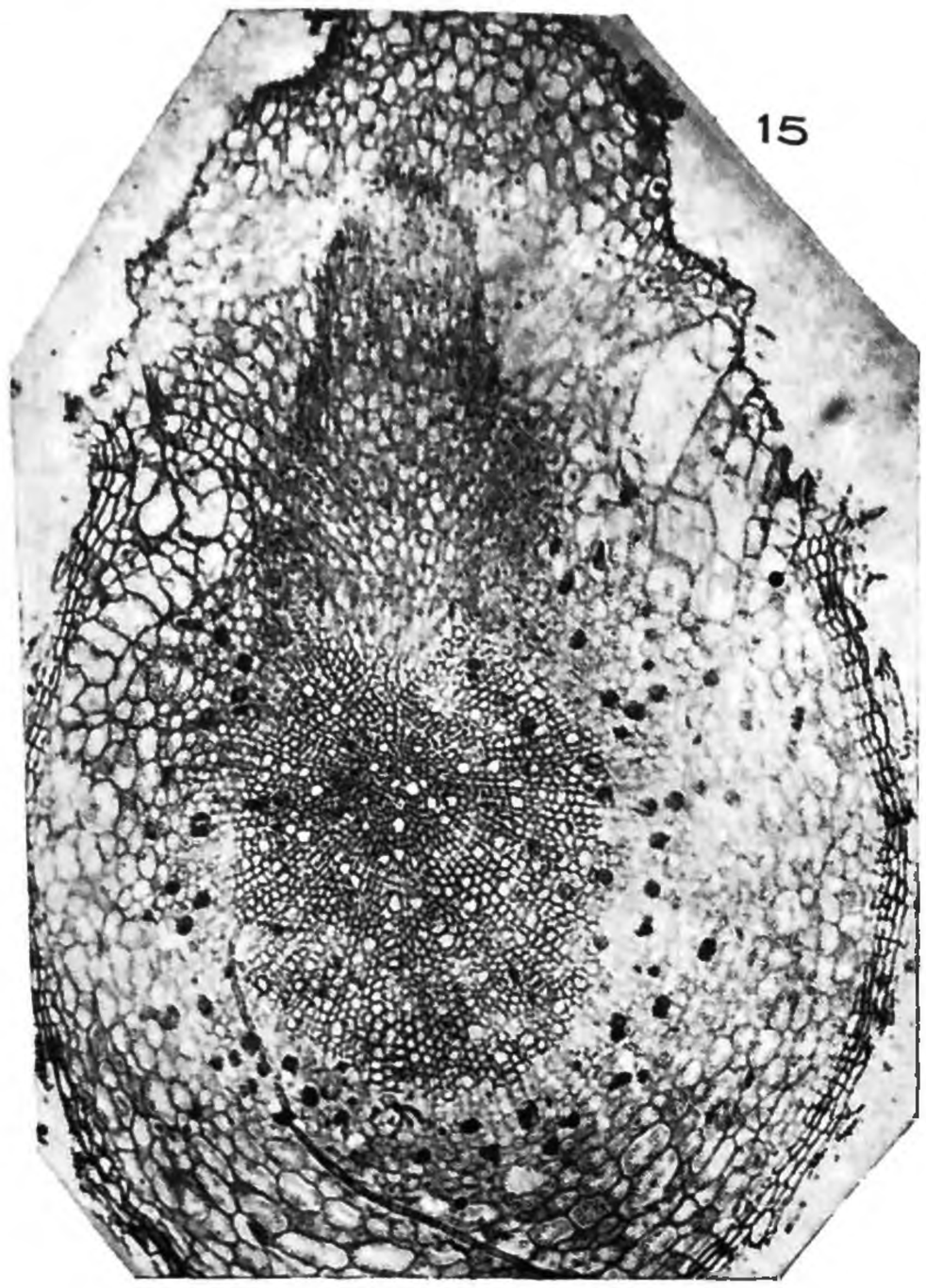
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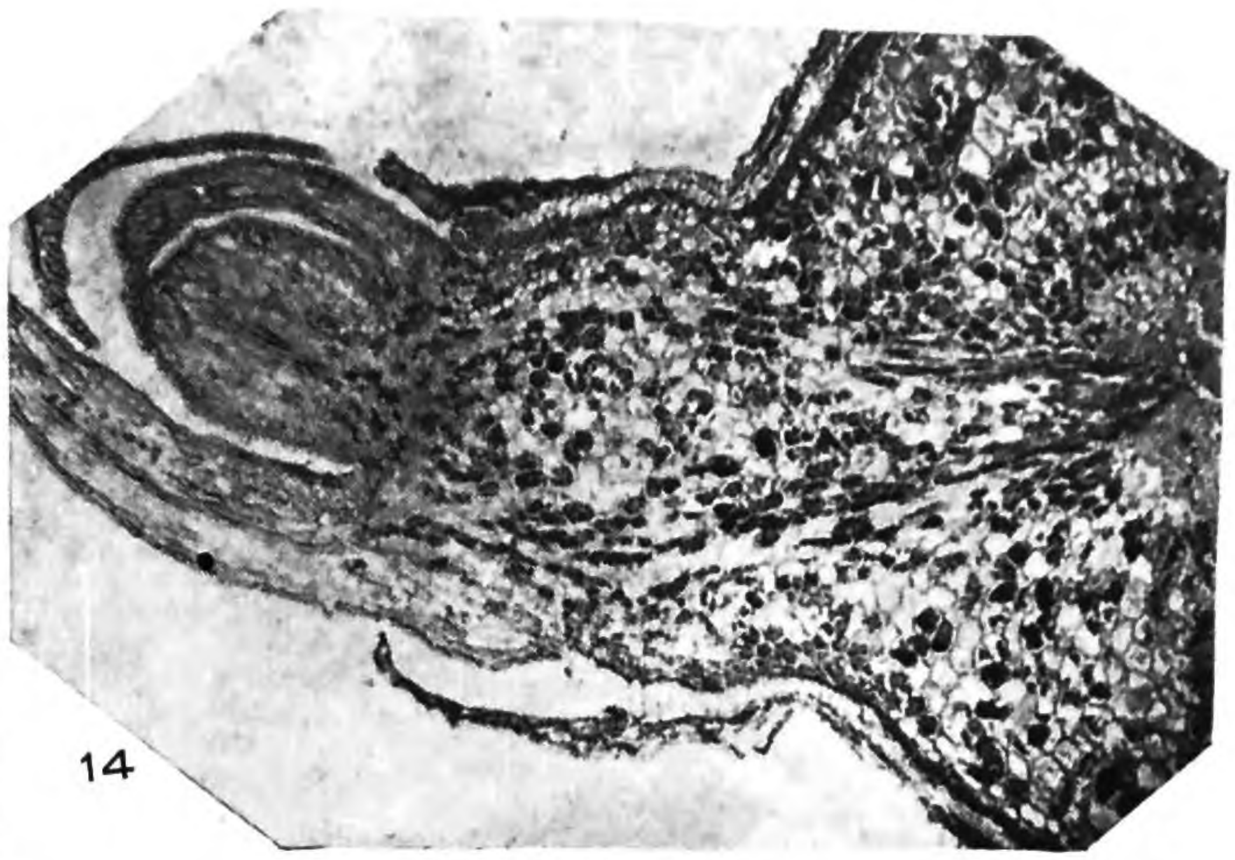
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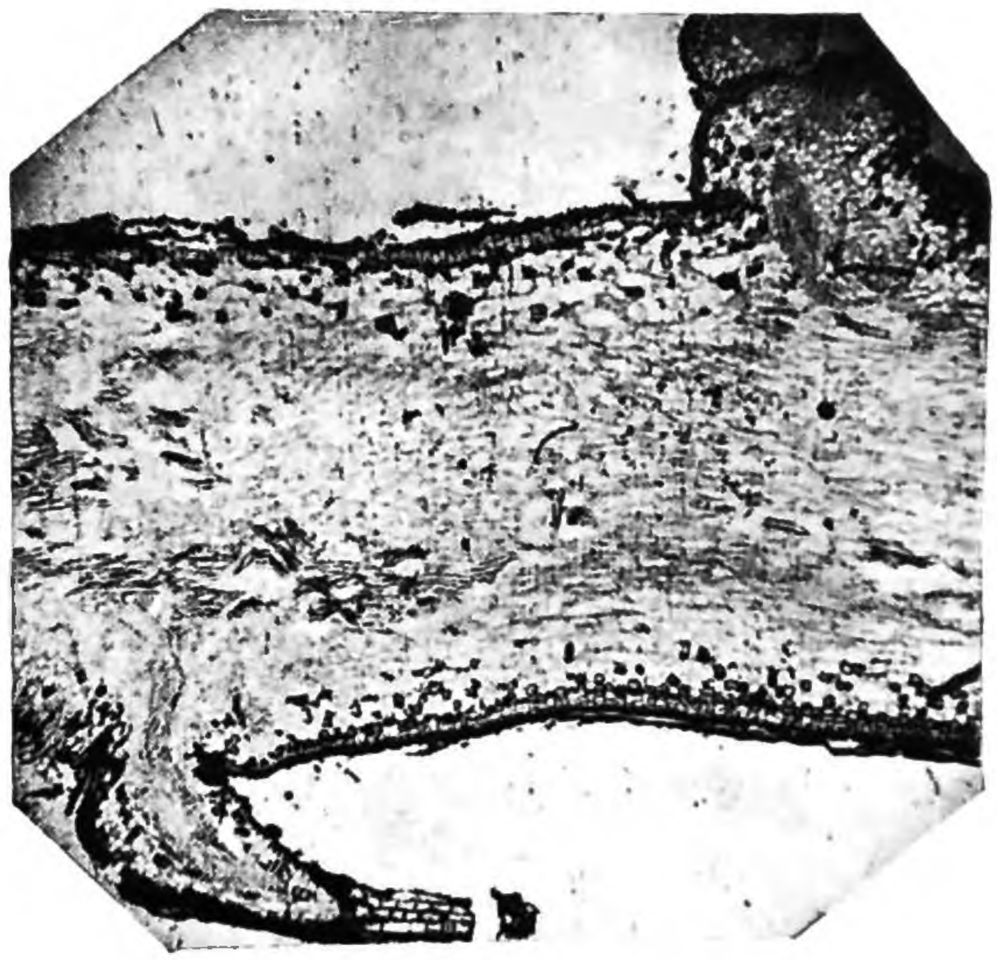
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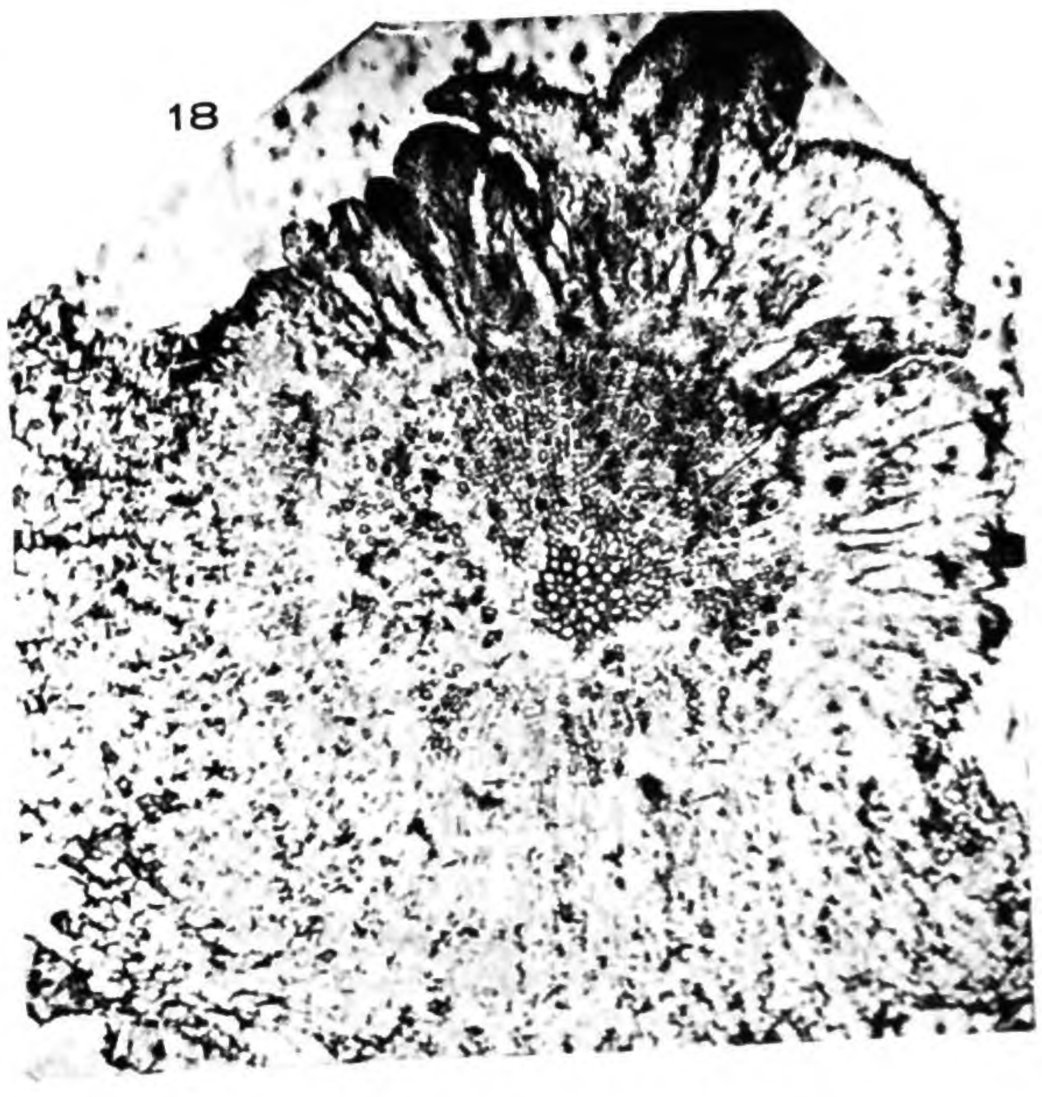
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