tubercular disease, if it be a disease, is not infectious; but it does clearly prove the influence of nitrate in the soil in diminishing the development of tubercles ¹.
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ON THE DEVELOPMENT OF THE ENDOCARP IN SAMBUCUS NIGRA.—It is well known that those species of plants which produce succulent fruits are mainly indebted to animals for their means of dispersal, and it is necessary, in order that this end may be attained, that whilst the pulpy or fleshy portion of the fruit should be as attractive as possible, the seeds should be furnished with such characters as shall either prevent their being eaten at all, or shall enable them to pass through the alimentary canal with their powers of germination still unimpaired. This requirement is provided for, in by far the greater number of cases, by a hard envelope in which the seed or its essential parts are enclosed. These envelopes may be divided broadly into two classes, the one including those which are derived from a specially differentiated portion of the pericarp, and which is usually designated as the endocarp, the other comprising those coverings which, as in many true berries, form part of the seed itself.

It is to the former of these two classes that *Sambucus* belongs, the development of which it is the object of this note to describe.

If sections of the ovary of this plant be made while the bud is still very young, it is readily seen that the two innermost cell-layers which surround the 2-4 cavities containing the ovules are perfectly distinct both from each other and from those cells which lie immediately outside them, and that this difference is due to the peculiar mode in which cell-multiplication takes place in the two layers. In the innermost of these two layers, that which bounds the cavities of the ovary, the divisions occur regularly and exclusively in a plane at right angles to the long axis of the bud, that is, they are all transverse, whilst the few longitudinal divisions which mark the limits of the original cells do not increase in number at all. The impression which is gained of this layer taken as a whole, is that of a series of contiguous and hollow rings which bound the spaces destined eventually to contain the seeds. Each ring is of course divided internally into cells which correspond in number with the primary

¹ For a full discussion of this subject, and references to literature, see Ward, Some recent publications bearing on the question of the Sources of Nitrogen in Plants, in *Annals of Botany*, vol. i, 1887-8.

longitudinal divisions already mentioned (the figures will make the arrangement plain). The cells composing the outer of the two innermost layers behave, as regards their mode of cell-multiplication, in precisely the same way as those of the layer just described, with the difference that the plane of division is parallel with the long axis of the bud. The result of this is, that in a transverse section the cells of the inner layer which lie in the plane of the section

Fig. 21.

Fig. 22.

Endocarp of *Sambucus nigra*. Fig. 21, Transverse section from young bud. Fig. 22, Longitudinal section of a somewhat older stage. *a, b, c*, The layers forming the endocarp. *d*, Innermost layer of pulpy tissue.

appear as a segmented ring-like cylinder, whilst those of the outer layer resemble a circular chain, the links of which represent the cut ends of the cells whose greatest diameter is parallel with the long axis of the flower. In a longitudinal section this arrangement must evidently be entirely reversed (compare figures 21 and 22).

As development goes on, and as the bud increases in size, the primitive walls, which cut the cylindrical rings into segments, undergo a change of position becoming more and more oblique; and whilst the circular or elliptical form of the band as a whole remains unaltered, the individual cells composing it suffer a change of shape and are finally converted into elements with long pointed ends, the pointed portions slipping over each other in such a way that the thickness of the whole ring remains for a time fairly constant throughout. As a consequence of this, sections transverse to the

planes of the rings now show irregularities in the number of cut ends present at any part of it, and instead of being uniform in size and only one cell deep, the size is variable and the numbers may be from one to three,—a fact which shows how very considerable the overlapping of the ends must be, for as no tangential divisions ever take place, the alterations are due entirely to the causes just described. At a later period in development the regular outline of the rings is distorted by the continued slipping of the ends, and the wavy outline of the older endocarp as a whole is partly to be attributed to this circumstance.

During the period of lengthening of the cells the nucleus, as might have been expected, undergoes a change in its appearance. From presenting an approximately circular outline it becomes spindle-shaped and remarkably drawn out at the two ends; it is of a relatively large size, and the whole cell is very rich in protoplasmic contents—a feature which would of course be looked for in a tissue where metabolism is extremely active.

Meanwhile a third cell-layer, which lies immediately outside the two I have described, has undergone changes, preparatory to its taking part in the formation of the stone. And although the modifications which arise in it begin at a somewhat later period than those in the inner cells, they advance with great rapidity and soon cause this portion of the endocarp to be the most striking of all in appearance. The cells which compose it are much larger in transverse section (2–3 times) than those lying internally to it; but, like them, they are very densely filled with protoplasm in which a nucleus of a very large size is imbedded. The first change which takes place beyond mere increase in size, consists in a slight radial extension of the cells, and at the same time, just as in the case already described, the nucleus alters in form, becoming spindle-shaped, and lies at first somewhat

Fig. 23. Transverse section from nearly ripe fruit. *a, b, c*, The layers forming the endocarp. *x*, The unthickened portion of *c* in Figs. 21, 22. *d*, Innermost layer of pulpy tissue.

nearer the central end of the cells. Very soon after flowering, thickening of the cell-walls of each of the three layers commences. The mode of thickening, which the cell-walls of the two inner layers exhibit, does not differ from that common to ordinary sclerenchymatous tissues, and when completed the whole shows the usual stratification and pitted markings. The process is however a little more complicated in the outer layer, and recalls, in some degree, the manner in which the peristome of mosses is formed. Commencing at the central wall, the thickening deposit advances on the radial ones, but only extends to about four-fifths of the distance outwards towards the peripheral end of each cell, where it stops rather abruptly, and comparison of longitudinal and transverse sections shows that it is more strongly developed on the transverse than on the longitudinal walls. Bars and ridges of cellulose rise into the lumen of the cell both from the base, i.e. from the inner or central end of the cell, and also from numerous points on the radial walls. One result of the whole process is to drive the protoplasm, which suffers considerable diminution in bulk during the process, outwards towards the peripheral end of the cell, the thickening substance being itself meanwhile converted into an almost solid mass of extreme hardness. Transverse sections taken at a somewhat later period show the endocarp, which is very hard and lignified, to be apparently enclosed in a sheath of tangentially flattened cells (*x*, Fig. 23), an appearance which results from that peculiar absence of thickening in the peripheral regions of the cells of the third layer already referred to. It is not easy to arrive at a conclusion as to the use of such an unthickened portion, for it does not, as might be supposed, form a separation-limit, by which the stone is severed from the pulp when the fruit is ripe, but it becomes more and more indistinct as maturity is reached and is at length almost obliterated.

Although the stony endocarp has been treated of as enclosing the seed as a whole, it is in reality discontinued at that place where the placenta is found; and the passage immediately above this, which served for the entrance of the pollen tube, is also never completely filled up. It is probable that this weak spot is of importance in allowing the growing radicle to push its way out of the shell, which it would certainly experience considerably difficulty in doing, were the covering continued evenly round the seed as a whole.

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