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Simultaneous Development of the Seed Coat and Embryo in the Seeds of Sweet Clover

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SIMULTANEOUS DEVELOPMENT OF THE SEED COAT AND EMBRYO IN THE SEEDS OF SWEET CLOVER

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Introduced by JOHN N. MARTIN

Sweet clover is one of our leading forage crops (2 and 10). Its value as such is materially decreased by the large per cent of impermeable seeds which do not germinate the first year. This increases the expense of seeding. Furthermore, such seeds may germinate in later years and the plant become a weed.

Several methods of treatment have been shown to be effective in changing the percentage of impermeable seeds, but none of them have been proven entirely satisfactory. Michalowski (1894), Nilson and H. D. Hughes (1913) have devised machines with which to scratch the seed coat, thus allowing the entrance of water (7). Chemical treatment, chiefly with sulphuric acid, has been used by several workers since 1898, according to W. O. Whitcomb (9). A third method has been that of temperature control, using both dry heat and hot water (7). The latest method is that of treatment with cathode rays by Besse and Daniels (1).

Workers are divided as to the cause of impermeability (8). Miss A. M. Lute (4), working with alfalfa, found it to be a phenomenon of the palisade (malpighian) cell wall. Coe and Martin (3), working with sweet clover, found it to be due to an impervious layer (light line) extending through the thick outer wall of the malpighian cells. Contrary to these views, Schmidt believed it to be due to the coating of waxy substance (cuticle) on the outside of the malpighian cells.

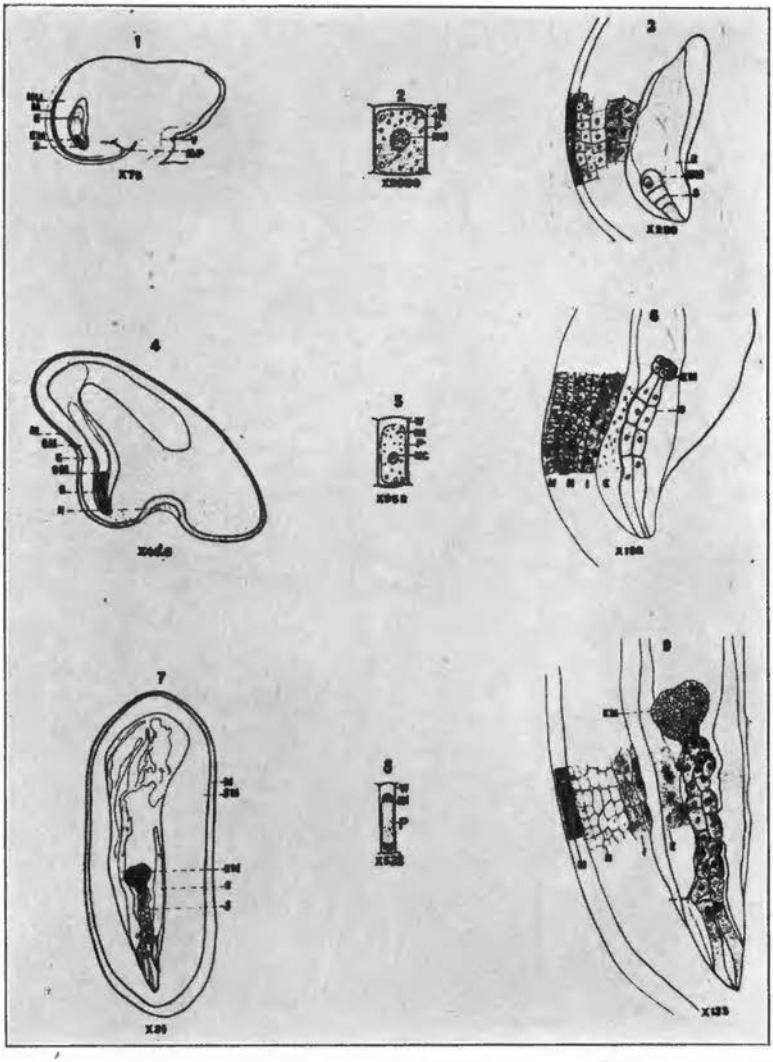
The development of the seed coat of white sweet clover, *Melilotus* alba, relative to stages in the development of the embryo, was followed in order to throw further light on the phenomenon of impermeability. The results of this study are here reported.

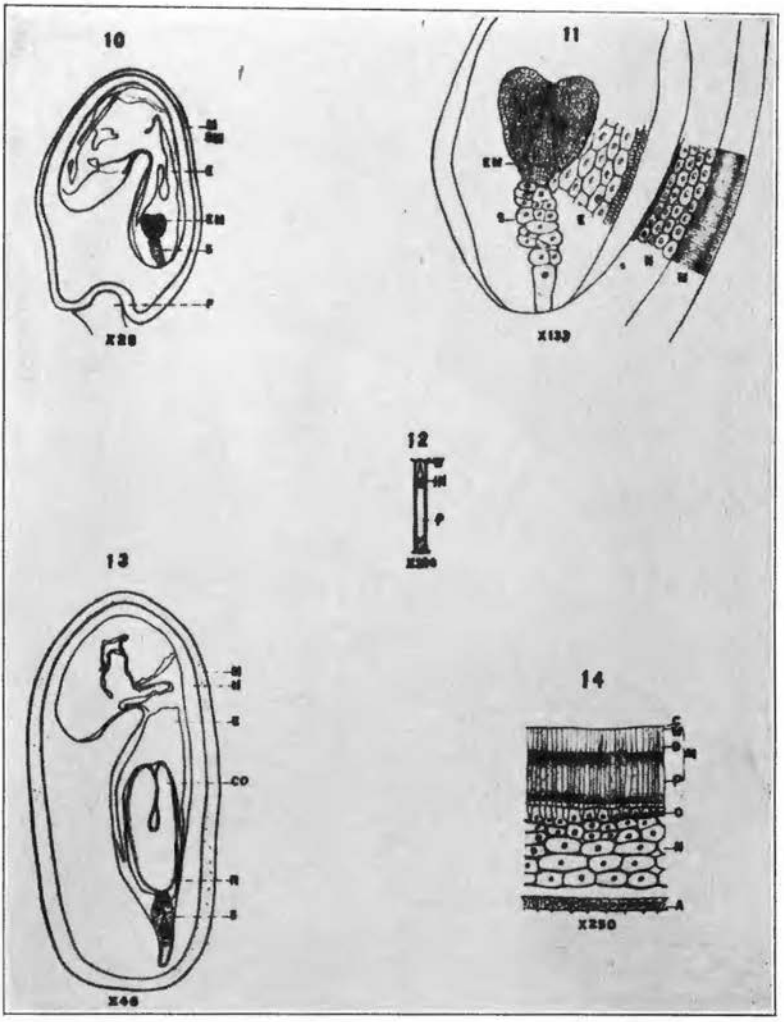
For this purpose, sections were made from seeds of known age. The flowers were hand pollinated during the spring and summer of 1929. The seeds were taken at intervals of 24 and 48 hours, dating from the time of pollination, from three days up to thirty days. They were killed with acetic alcohol and the sections were stained with safranin and fast green.

EXPLANATION OF FIGURES

In figures one to 18 the following symbols are used: M, malpighian layer; W, cell wall; L, light line; IN, cell inclusions; P, cytoplasm; D, domes of the malpighian cells; C, cuticle; O, osteosclerids; N, nutritive layer; SM, sub-malpighian tissue; T, tracheid-like cells; H, hilum; F, funiculus; MP, micropyle; V, vascular strand; NC, nucleus; E, endosperm; EM, embryo; S, suspensor; NU, nucellus; CO, cotyledon; PL, plumule; R, radicle; RC, root cap.

Fig. 1. Section of the seed of sweet clover three days after pollination. X 75.
Fig. 2. Malpighian cell three days after pollination. X 2,000.
Fig. 3. Section of the embryo and seed coat three days after pollination. X 250.
Fig. 4. Section of the seed coat of sweet clover five days after pollination. X 45.8.
Fig. 5. Malpighian cell five days after pollination. X 958.
Fig. 6. Section of the embryo and seed coat five days after pollination. X 192.
Fig. 7. Section cut longitudinally and the narrow way through the seed of sweet clover eight days after pollination. X 31.
Fig. 8. Malpighian cell eight days after pollination. X 533.
Fig. 9. Section of the embryo and seed coat of sweet clover eight days after pollination.
Fig. 10. Section of a seed nine days old. X 133.
Fig. 11. Section of the embryo and seed coat nine days old. X 133.
Fig. 12. Malpighian cell nine days after pollination. X 314.
Fig. 13. Section of the seed of sweet clover twelve days after pollination. X 46.
Fig. 14. Section of the seed coat twelve days after pollination. X 250.
Fig. 15. Section of the seed of sweet clover sixteen days after pollination. X 32.
Fig. 16. Enlarged view of a section of the seed coat sixteen days after pollination.
Fig. 17. Section of a seed of sweet clover twenty days after pollination. X 17.5.
Fig. 18. Enlarged section of the mature seed coat twenty days after pollination. X 250.

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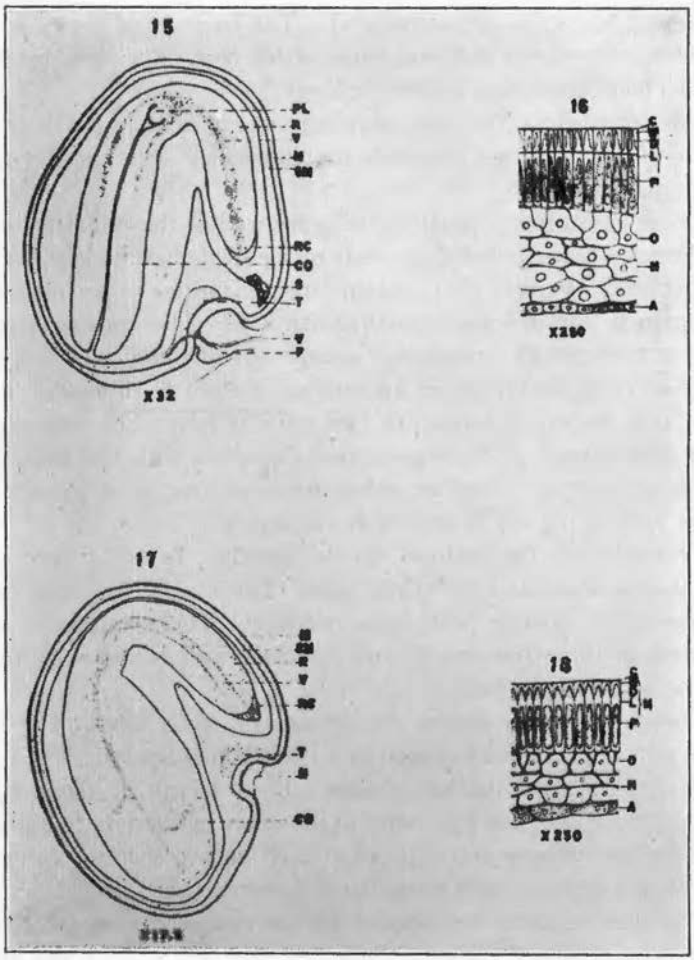
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X250
X250

The impermeable seed coat of white sweet clover is made up of three layers and a coating of cuticle (6). The outer layer is formed by one row of malpighian cells which are very much elongated radially and thick walled. They are divided by a "light line" into an outer and an inner region. The middle layer is also one cell in thickness. The cells are urn-shaped with thickened ridges. These cells are osteosclerids. The inner layer varies in the number of layers at different parts of the coat. The cells are thin walled and function as a nutritive layer.

The formation of the seed coat begins very early in the development of the seed and proceeds simultaneously with the development of the embryo.

Three days after pollination the outer wall of the epidermal cells at the micropylar and chalazal ends of the ovule has already started to thicken. The cells also contain large quantities of an inclusion common to the developing malpighian cells. The embryo at this time is a single cell terminating a suspensor of three cells.

The five day stage shows an embryo of eight to thirty-two cells on a long suspensor formed by two rows of cells. The malpighian cells now extend all the way around the ovule with the exception of the micropyle. They are about twice as long as wide and the outer wall of the cell is noticeably thickened.

The cells of the embryo divide rapidly. In eight days the cotyledons show as very slight lobes. The malpighian cells have continued to change with equal rapidity. Their length is now about four times their width and the outer wall is almost as thick as the width of the cells.

The ninth day shows the cotyledons as distinct lobes. The embryo now appears heart shaped in a longitudinal section. The malpighian cells show marked change. Their length is about eight times their width, and the lumen at the outer end tapers to a point. The inclusions have accumulated at each end so that the contents of the cell appear much more dense towards the ends.

The osteosclerids first appear in the twelve day stage. Here they have assumed the urn shape, but the cell wall is still thin. The malpighian cells have elongated to about sixteen times their width and the domes are very long and slender. Only a few of the domes now contain cytoplasm. The embryo shows a continued growth of the cotyledons and the appearance of a radicle.

At sixteen days the domes of the malpighian cells are dark, with a distinct "light line" at the base. The walls of the osteosclerids are thickened. The embryo has elongated consider-

ably and the root cap, the plumule and the vascular strands are recognizable.

In twenty days all parts of the embryo are present and are mature in size. The seed coat is likewise mature in structure.

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