The Effect of Late Frost on the Wood of Acer Pseudoplatanus, Linn.

BY

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With Plates CXCI–CXCIII.

In the course of an investigation of the moisture content of the wood of *Acer Pseudoplatanus*, Linn., a tree was felled in the Royal Botanic Garden, Edinburgh, in March of 1921. Transverse cuts were taken from the bole and crown at measured heights above ground level. A superficial examination revealed the fact that one wood-ring of the lowest cut stood out conspicuously from all the others because of a narrow zone at its inner margin being much lighter in colour than the rest of the wood (Pl. CXCI, Fig. 1a). On the cut surface of the stump, the ring was also very well marked; but 180 cms. above ground level it was in no way different from the normal. A closer examination of this phenomenon gave results which, though in no way connected with the original line of research, appear to be worthy of record.

The annual ring referred to was apparently laid down in the year 1897. On examining transverse and longitudinal sections of it microscopically it became evident that the cambium, from the commencement of its activity in the spring of that year, and for some time later, had acted in a manner far from normal. In Plate CXCII, Fig. 1 shows a transverse section of two consecutive typical annual rings of *Acer*: Fig. 2., of the rings laid down in 1896 (a) and 1897 (b). In Fig. 1, it will be observed that the medullary rays run continuously through the adjacent rings; but in Fig. 2 this is not the case, for the cambium, instead of giving rise to tracheides, vasa, and medullary ray cells, has laid down at the commencement of its activity for the year, several layers of parenchymatous cells with rather thick, lignified walls. A transition from these to normal wood elements—formed later in

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the year—can be traced, but in no case is there any direct continuation of the medullary rays through the two consecutive rings. Plate CXCII, Fig. 3 and Fig. 4 respectively, show the above rings in longitudinal radial section, and in these the same features are illustrated. It is specially evident from Fig. 4, that an unsuccessful attempt to form vasa was made early in the year, the result being the production at intervals of short columns of large parenchymatous cells, the transverse walls of which have not disappeared (a). Later in the year a further stage in the transition to vasa can be seen, for though the columns of cells are still short, the transverse walls have now disappeared (b). The transition from the parenchymatous cells to tracheides is clearly demonstrated in this figure.

This abnormal behaviour of the cambium appears to be the result of frost injury. In this connection it is interesting to note that, in the Records of the Scottish Meteorological Society for the year 1897,—the year in which the ring was laid down—frost was recorded in Edinburgh on consecutive days, from March 30th to April 6th, and on the 1st of April the ground was covered with snow.

Hartig* found a somewhat similar condition in the wood of several frosted conifers e.g. Pine, Spruce, etc. According to this author, the formation of an ice layer between the cortex and the young wood, results in the crushing and killing of the latter. The medullary rays extend through the ice zone undamaged, and when the ice melts they become extraordinarily broad, since they can expand without any counter pressure. On the inner side of the phloem, the cambium gives rise to parenchymatous tissue, and only eventually in the wood zone is normal wood formed.

In the cases described by Hartig, normal spring wood of the year had been formed before the frost took effect, while in the tree under discussion, the cambial cells, though probably turgid, had not undergone division.

Hartig also states that, in places liable to frost, it is in the under stem portions of coniferous trees, i.e. up to 1–2 metres in height, that these frost rings may be looked for, and it was just in that region of the *Acer* that the phenomenon could be observed.

A transverse cut, containing the abnormal wood-ring, was set aside to dry, and on examination some weeks later, exhibited not only the usual fractures along the medullary rays (Pl. CXCI, Fig. 2a), but also a well defined circular split (Pl. CXCI, Fig. 2b and Fig. 1b).

Tensions are set up in drying timber which result in splitting taking place along the lines of least resistance—usually the

* R. Hartig, Lehrbuch der Pflanzenkrankheiten (1900), p. 219.

medullary rays. In this case the zone of parenchyma also constituted a line of weakness in the wood.

It is noticeable also that in no case is a radial fracture in the outer portion of the wood in line with one in the inner portion, due, no doubt, to the break in the continuity of the medullary rays previously referred to.

Since the medullary rays are the routes, *par excellence,* along which water and food materials in solution move radially in the wood, the question arises as to whether the passage of these fluids was affected by the interruption of the medullary rays.

It is well known that in Summer, starch is stored in the medullary rays and wood parenchyma, after having been conveyed to these situations in the form of sugar. If the passage of sugar had been restricted, this would be apparent by an examination of the radial distribution of starch. A narrow transverse strip passing through the centre was therefore removed from each cut, and these were placed for some hours in a solution of iodine. The result is shown in Plate CXCIII.* The wood of strips B–G is normal, and the maximum amount of starch in each strip, judging from the depth of the stain, is found in the outermost wood-rings, with a gradual diminution towards the centre. In strip A there is a sudden, and very well marked decrease in the amount of starch in the wood within the abnormal wood-ring (a), which indicates, in a very convincing manner, that the inward passage of sugar had been very considerably restricted, and the internal economy of the tree consequently affected.

In conclusion, I wish to express my indebtedness to the late Sir Isaac Bayley Balfour, for placing the material for investigation at my disposal, and to Mr R. L. Harrow, Head Gardener, Royal Botanic Garden, for his care in carrying out the details of felling.

* The black areas at b and c are not indicative of presence of starch, but are discolourations in the wood, due to a knot, and decayed pith, respectively.

EXPLANATION OF PLATES (CXCI-CXCIII).

Illustrating Mr Templeton's paper on the Effect of Frost on *Acer Pseudoplatanus*.

PLATE CXCI. Fig. 1.—Block of wood showing abnormal wood ring (a) and split (b).
Fig. 2.—Wood block showing cracks caused by drying.
Fig. 3.—Block split into two portions at the frost ring.

CXCII. Photomicrographs of sections of the wood of *Acer Pseudoplatanus*. × about 75.
Fig. 1.—Normal wood in transverse section.
Fig. 3.—The same, in radial longitudinal section.
Fig. 2.—Abnormal wood in transverse section.
Fig. 4.—The same, in radial longitudinal section.

CXCIII. Wood strips stained with iodine, showing starch distribution at various heights above ground level.

Ground level to A	65 cms.
A–B	225 cms.
B–C	155 cms.
C–D	130 cms.
D–E	100 cms.
E–F	85 cms.
F–G	70 cms.
G to top of leader	230 cms.

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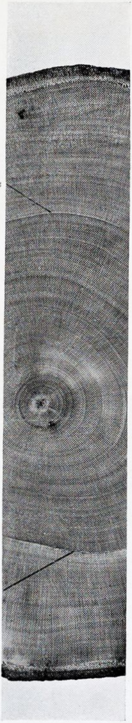
a



b

Fig. 1.

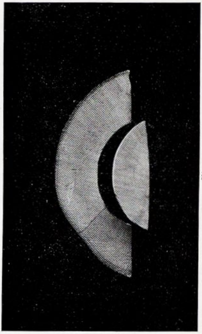


Fig. 3.

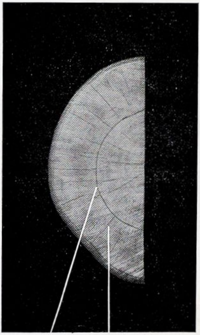
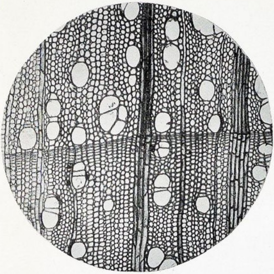


Fig. 2.

b a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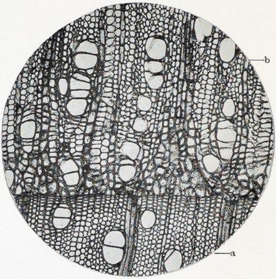
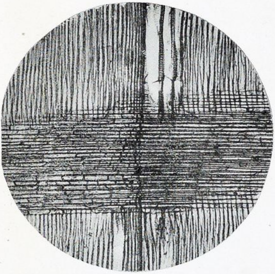


Fig. 2.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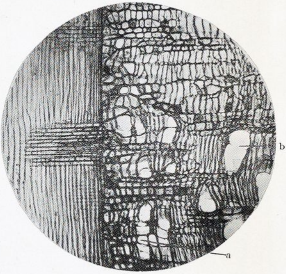
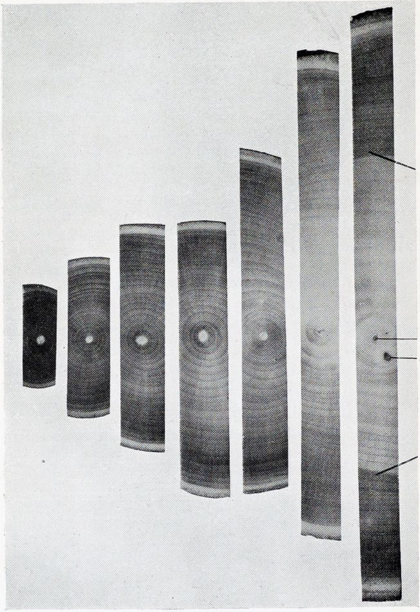


Fig. 4.



a

c

b

a

G F E D C B A