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PITH FLECKS AND RAY ABNORMALITIES IN BIRCH WOOD

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SELOSTE:

KOIVUN PUUAINEEN RUSKOTÄPLÄT JA YDINSÄTEIDEN EPÄNORMAALISUUS

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Samples that had extensive pith flecks, caused by the larvae of *Dendromyz a betulae,* were collected from two trees of *Betula pendula* and two of *B. pubescens*. The age of the trees varied from 45 to 56 years. The effect of larval injury on the rays was studied. The width of affected rays in both species was more than twice that of normal rays. The height and frequency also increased considerably. When describing the anatomy of *Betula* species the pith flecks should be treated with caution in order to avoid confusion and misinterpretation.

1. INTRODUCTION

According to the commonly used definition, a pith fleck is an irregular strand of abnormal parenchymatous tissue embedded in the wood and appearing on longitudinal surface as a streak (Multilingual glossary . . . 1964). Pith flecks are frequently found in both of the commercially important species of European birch, *Betula pendula* (ROTH.) Willd. and *B. pubescens* Ehrh. In many text books birch wood containing pith flecks is erroneously confused with masur birch (F. ex. Jane 1970, p. 260). Of course, masur birch or curly birch is a variety of *Betula pendula* (see SAARNIO 1976). Pith flecks, on the other hand, can be found in all birch wood species as they are caused by the larvae of an insect. According to KANGAS (1935), in birch the insect in question is *Dendromyza betulae* belonging to the family Agromyzidae.

The number of pith flecks in birch wood decreases on moving from the pith to the bark and from the butt upwards (HEISKANEN 1957, p. 53, 1958, p. 42, SIN'KEVIC 1968). Although they enhance the aesthetic value of the figure in wood, they are regarded as defects by the plywood industry.

In view of the lack of relevant information in the literature, an attempt is made in this paper to study the variablity of rays in relation to larval injuries in birch wood.

The original manuscript was rewritten by Matti Kärkkäinen, who also contributed information available from Finnish literature and carried out the statistical tests. The material was provided by the Finnish Forest Research Institute. The computing and typewriting was carried out by Tarja Björklund, Aune Rytkönen and Leena Iisalo.

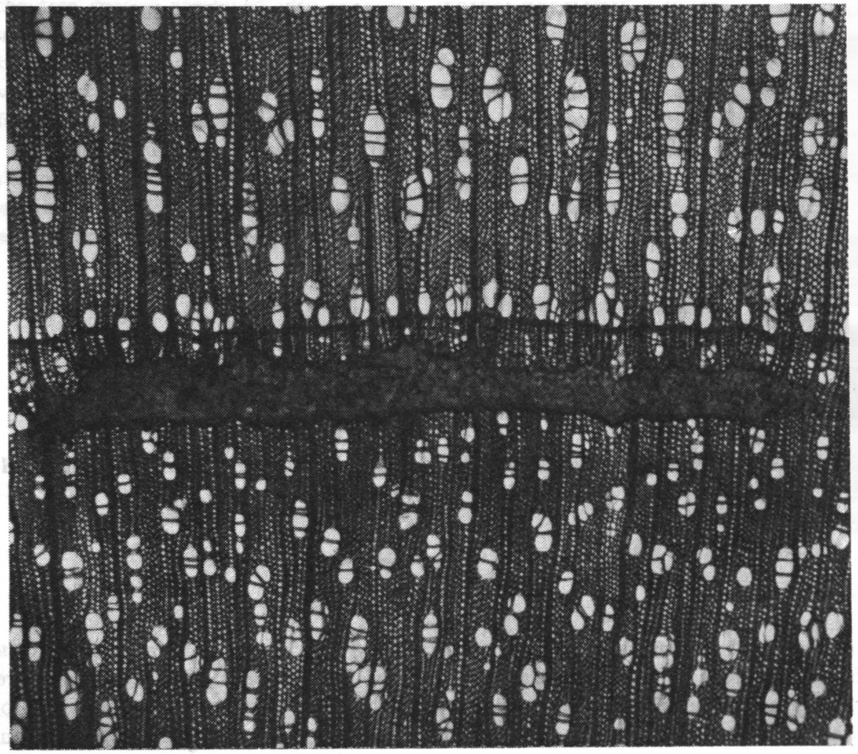

Fig. 1. Transverse section of *Betula pubescens* showing pith fleck in the later part of growth ring.
Kuva 1. Hieskoivun poikkileikkauksessa oleva ruskotäplä vuosiluston rajan lähellä (ydin on kuvassa alhaalla).

2. MATERIAL AND METHODS

Two trees of *Betula pendula* and two of *B. pubescens* were cut in the forests of Ruotsinkylä Forest Experiment Station near Helsinki, Finland. The age of trees was 45 . . . 56 years, based on measurements made at stump level. Discs were taken at the same time from the stump level and at a height of 4 m. A total of 42 samples were obtained. Transverse and tangential sections were made from each sample for microscopic examination and 50 measurements were taken from each species for frequency, height and width of rays.

3. RESULTS AND DISCUSSION

Observations made under the microscope of the transverse sections showed that the pith flecks occurred in the form of small dots or larger semicircular to elliptical patches up to 3 mm long in the tangential direction. They were mostly confined to the later part of the growth ring. They consisted of proliferated phloem cells with dark brown contents. In the neighbourhood of the pith flecks, there was an increase in

Table 1. Numerical data of normal and affected rays by pith flecks in *Betula pendula* and *B. pubescens.*
Taulukko 1. Normaaleiden ja ruskotäplien vaikuttamien raudus- ja hieskoivun ydinsäteiden ominaisuuksia.

Tree species *Puulaji*	Variable *Muuttuja*	t-value *t-arvo*	Normal *Normaali*		Affected *Ruskotäplien vaikuttama*	
			$\bar{x}$	s	$\bar{x}$	s
B. pendula *Rauduskoivu*	Ray width, µm *Ydinsäteen leveys, µm*	10,2^{xxx}	22,8	9,4	59.9	23,9
	Ray width, cells *Ydindäteen leveys, soluja*	5,6^{xxx}	2,6	0,8	3,8	1,2
	Ray height, µm *Ydinsäteen korkeus, µm*	2,8^{xx}	268,7	112,5	328,6	104,5
	Ray height, cells *Ydinsäteen korkeus, soluja*	1,4^{NS}	14,2	5,7	15,6	4,5
	Linear ray frequency, mm^{-1} *Ydinsäteitä, mm^{-1}*	3,5^{xxx}	13,5	1,8	15,1	2,8
B. pubescens *Hieskoivu*	Ray width, µm *Ydinsäteen leveys, µm*	20,4^{xxx}	18,6	4,3	65,5	15,7
	Ray width, cells *Ydinsäteen leveys, soluja*	14,9^{xxx}	1,9	0,5	4,9	1,3
	Ray height, µm *Ydinsäteen korkeus, µm*	4,3^{xxx}	253,9	103,0	325,8	56,8
	Ray height, cells *Ydinsäteen korkeus, soluja*	1,2^{NS}	12,7	5,4	13,8	2,7
	Linear ray frequency, mm^{-1} *Ydinsäteitä, mm^{-1}*	12,3^{xxx}	12,2	1,5	15,7	1,3

the width, height and frequency of the rays. According to t-tests, all the differences were statistically significant with the exception of the ray height in cells.

The results are presented in Table 1. It can be seen that the effect of pith flecks was more severe in *Betula pubescens* than in *B. pendula.* According to HEISKANEN (1957), pith flecks are more numerous in *Betula pubescens* than in *B. pendula.* Our observations do not conflict with this observation.

The most striking effect of pith flecks was the increase in ray width. This was the result of both an increase in size and in number of cells. Some of affected rays were 8 cells wide while the normal rays in *Betula* species are only 4 or rarely 5 cells wide. METCALFE and CHALK 1950). The larger size of the cells might be attributable to the formation of callus like occluded ray cells due to the injury to ray initials. Increase in the number of cells is by rapid divisions of ray initials themselves (BARGHOORN 1940) as the larval injury probably influences the cytological behaviour of ray initials.

Ray height was also increased. It is probable that the injury increased the rate of transverse anticlinal divisions in the marginal ray initials, thus producing rays of abnormal height (BAGHOORN 1940).

A slight but statistically significant increase in ray frequency was observed, too. Larval stimulus may have caused the conversion of some of the fusiform initials into ray initials by cell division. However, it is not clear how some external force is responsible for these particular divisions (WHITE and ROBARDS 1968).

In many tangential sections the discontinuity in the normal alignment of rays was found to be due to the pith flecks. In addition to this, the presence of mor-

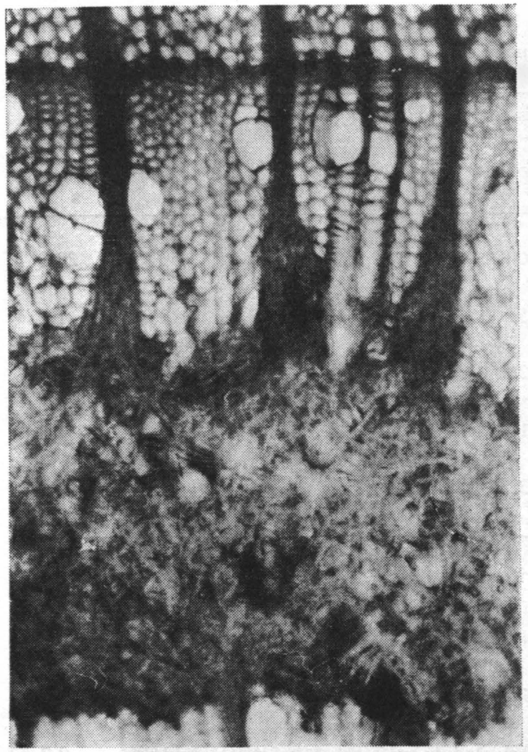

Fig. 2. Transverse section of *Betula pendula* showing the widening of rays in the boundary of pith fleck and proliferated parenchyma cells of phloem with dark contents.
Kuva 2. Rauduskoivun poikkileikkaus, jossa näkyy ydinsäteiden laajeneminen ruskotäplän rajalla ja niiden tummat parenkyymisolut.

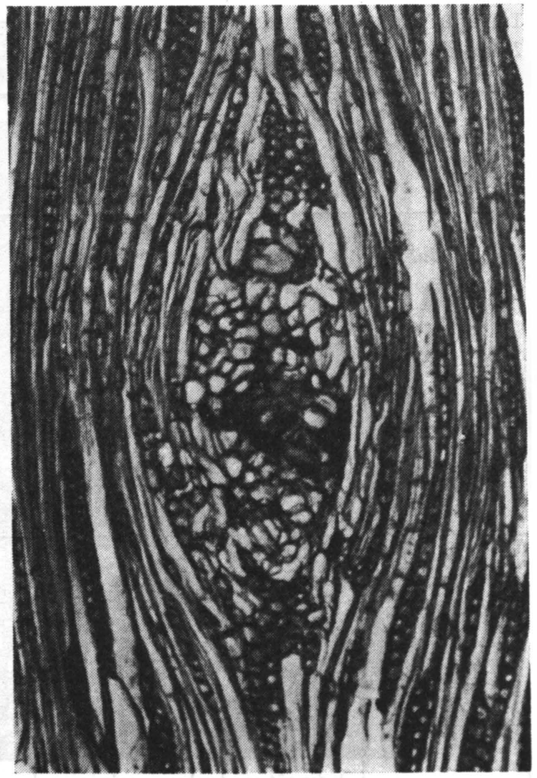

Fig. 3. Tangential section of *Betula pubescens* showing disruption of the alignment of rays and other wood elements due to larval injyry.
Kuva 3. Hieskoivun tangenttileikkaus, jossa näkyy ydinsäteiden ja muiden puuaineen osien epäjärjestys hyönteisvaurion seurauksena

phologically different, laterally branched rays was of particular interest. This appears to be a very unusual characteristic of rays both in hardwoods and softwoods. Larval disturbance during ontogeny probably causes some of the cells of two or more rays to fuse together and hence such an abnormal ray tissue is developed. This tendency of rays to come together might suggest the possibility of achieving aggregate ray, a highly specialized structure in the consecutive series of ontogenies (Barghoorn 1941).

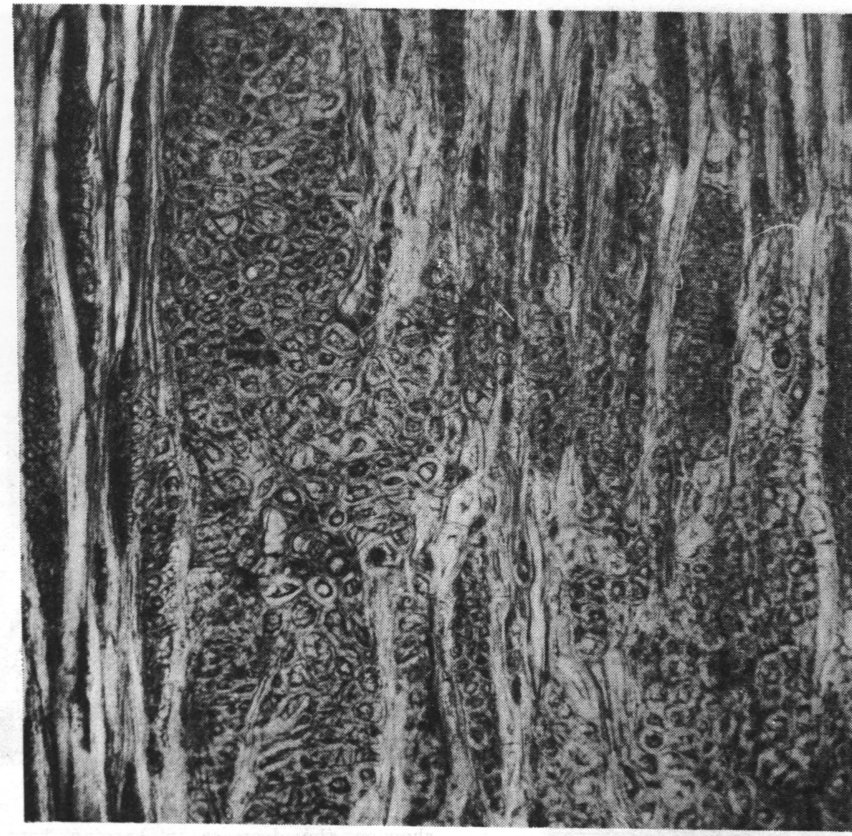

Fig. 4. Tangential section of *Betula pendula* showing abnormal rays with occluded ray cells and the tendency of fusion.
Kuva 4. Rauduskoivun tangenttileikkaus, jossa näkyy epänormaaleja ydinsäteitä ja niiden yhdistymistaipumusta.

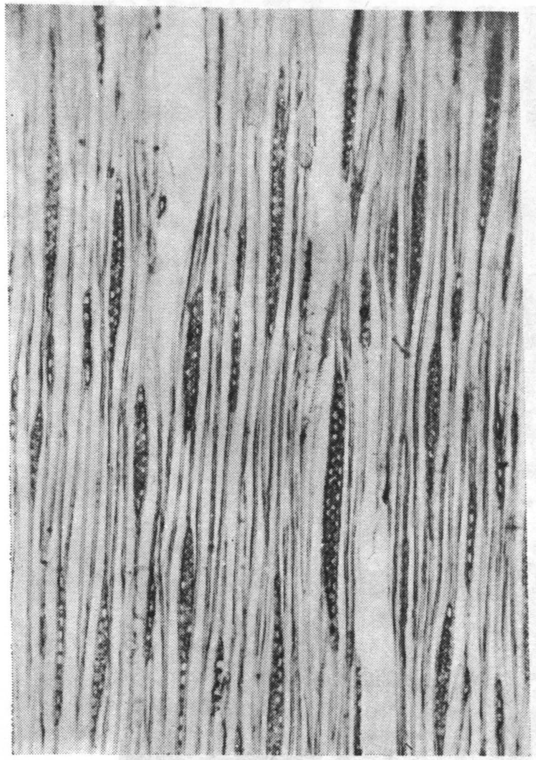

Fig. 5. Tangential section of *Bentula pubescens* showing the normal rays.
Kuva 5. Normaalin hieskoivun tangenttileikkaus.

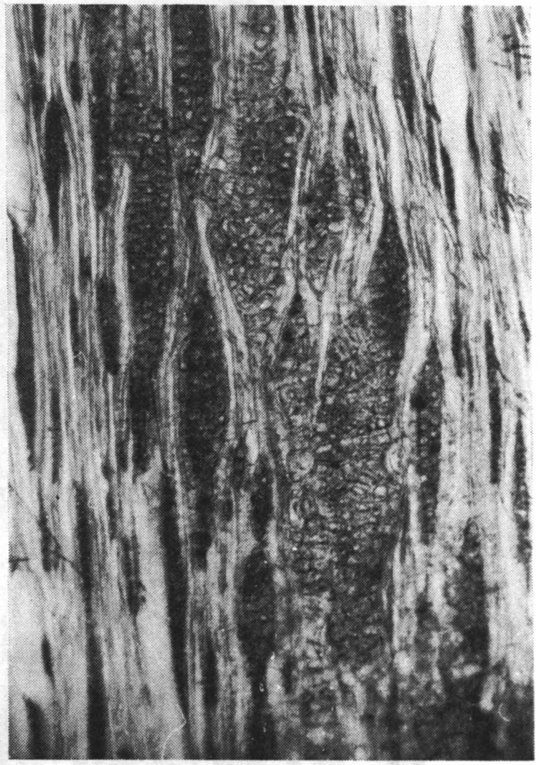

Fig. 6. Tangential section of *Betula pubescens* showing the decrease in spacing between the affected broad rays.
Kuva 6. Tangenttileikkaus ruskotäpliä sisältävän hieskoivun puuaineesta niiden läheltä. Kuvassa näkyy ydinsäteiden leveys ja niiden esiintymisen tiheys.

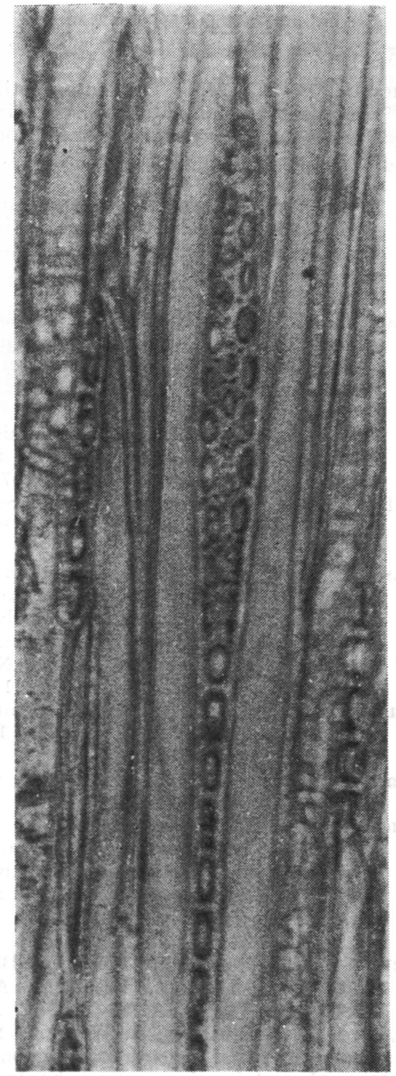

Fig. 7. Tangential section of *Betula pendula* showing normal individual ray.
Kuva 7. Normaalin rauduskoivun tangenttileikkaus ydinsäteineen.

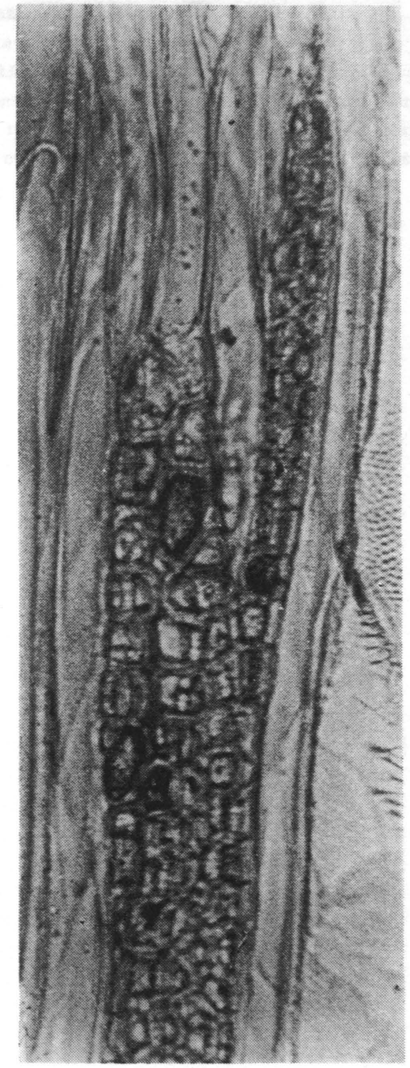

Fig. 8. Tangential section of *Betula pubescens* revealing branching in rays due to the fusion during ontogeny.
Kuva 8. Hieskoivun tangenttileikkaus, jossa näkyy ydinsäteiden haaroittuminen, joka johtuu ydinsäteiden yhdistymisestä niiden kehityksen aikana.

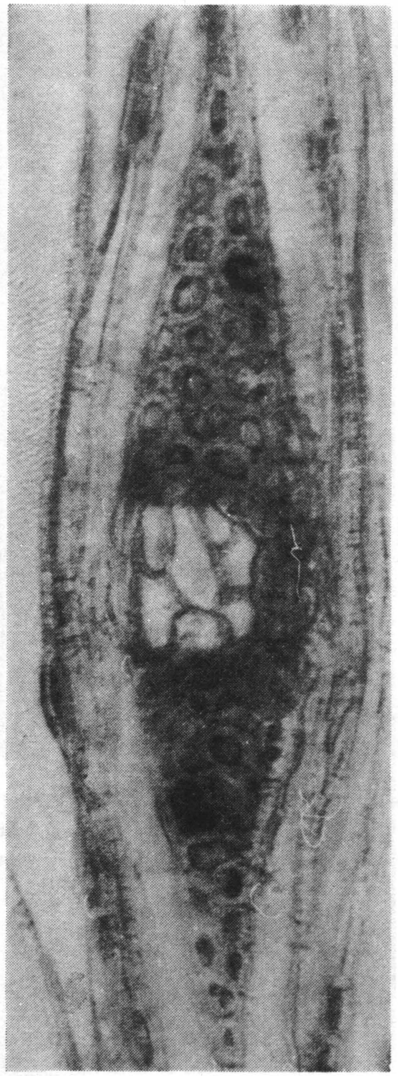

Fig. 9. Affected broad ray of *Betula pendula* showing the inclusion of abnormal parenchymatous tissue.
Kuva 9. Epänormaali rauduskoivun leveä ydinsäde, jossa on epänormaalia parenkyymisolukkoa.

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Monissa oppikirjoissa koivun puuaineesta usein tavattavat ruskotäplät sotketaan visan muodostukseen. Ero on kuitenkin selvä ja olennainen: ruskotäplät aiheutuvat ruskotäpläkärpäsen toukkien jällelle aiheuttamasta vauriosta, mutta visa on perinnöllinen ydinsäteiden epämuodostuma.

Sikäli väärinkäsitys on kuitenkin oikeutettu, että ruskotäplät aiheuttavat muutoksia lähellä

oleviin ydinsäteisiin. Kaksi raudus- ja kaksi hieskoivua käsittävän aineiston mukaan ydinsäteiden leveys tulee normaaliin verrattuna yli kaksinkertaiseksi, ja myös korkeus sekä ydinsäteiden määrä pinta-alayksikköä kohti lisääntyy selvästi. Lisäksi ruskotäplät saattavat aiheuttaa ydinsäteisiin huomattavia epämuodostumia, jotka saattavat muistuttaa mm. pihkatiehyellisiä ydinsäteitä. Myös haarautumia saatetaan tavata.

Hieskoivulla ruskotäplien vaikutus oli suurempi kuin rauduskoivulla. Mahdollisesti tämä heijastaa sitä, että ruskotäplät ovat hieskoivulla yleisempiä.