STUDIA FORESTALIA SUECICA

Nr 41 1967

Changes in impact bending strength, weight and alkali solubility following fungal attack on birch wood

Förändringar i slaghållfasthet, vikt och alkalilöslighet vid svampangrepp på björkved

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Ms mottaget 21 nov. 1966
Ms received Nov. 21 1966
Esselte 1967

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Introduction

The present study is part of a comprehensive investigation of microbial attack on pulpwood of birch and aspen. The purpose of this study was to find out whether the various fungi which attack birch wood affect the strength of the wood to differing extents. It was also intended to discover whether there was a substantial loss in strength before any loss in weight could be recorded. Later, when the study had already begun, the author's interest was focussed on the relationships between alkali solubility, strength and weight loss. Hence it seemed natural to discuss the underlying cause of the reduction in strength.

Material and methods

Sapwood from *Betula verrucosa* was cut into test-blocks measuring 80 × 20 × 7 mm. Seven adjacent blocks constituted one group. Block no. 4 in each group was chosen as the control of the group—see Fig. 1, in which the orientation of the annual rings within the test-blocks may also be seen. All the test specimens were cut from a single birch *(Betula verrucosa)* grown at Bogesund, a forest experimental area situated north-east of Stockholm. The d.b.h. was 10 inches, and the average width of the annual rings about 3 mm. A total of 966 test specimens was taken from the trunk.

With some modifications, the samples were decayed according to the soil jar method, as described by RENNERFELT (1963). However, instead of their being placed vertically in the soil, these samples were placed horizontally. Furthermore, it should be noted that, except for the control, the six samples belonging to a group were placed in the same jar.

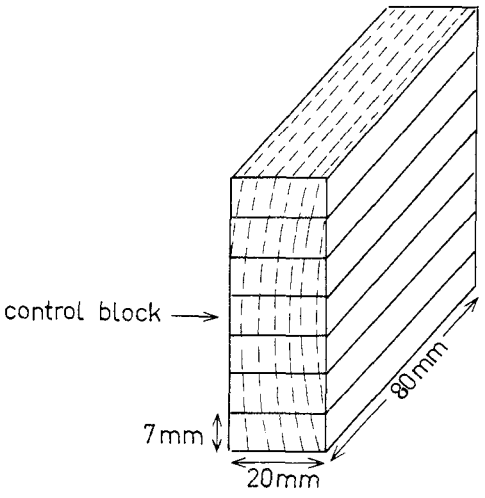


Fig. 1. Size and orientation of the test samples.

After autoclaving, each jar was inoculated with 10 ml of a mycelium suspension of the selected fungus. Twelve jars, each one containing 6 samples, were used for each of the following fungi:

Polyporus hirsutus	White rot fungi
Polyporus zonatus	
Polyporus adustus	
Polyporus versicolor	
Lenzites betulina	
Stereum hirsutum	
Stereum purpureum	
Corticium leave	Uncertain type of rot
Polyporus betulinus	Brown rot fungi
Polyporus marginatus	
Coniophora cerebella	
Chaetomium globosum	Soft rot fungus

The fungi were taken primarily from the reference collection of pure cultures of wood-destroying and other fungi, which is kept at the Department of Forest Products, Royal College of Forestry, Stockholm, Sweden (KÄÄRIK 1963). The organisms selected are all commonly found in birch

wood; *Polyporus betulinus* and *Polyporus marginatus* act as parasites and attack living birches, whereas the other fungi saprophytically decay the wood after felling. It may be noted that *Corticium laeve* is difficult to classify. This fungus may be regarded as a brown rot fungus, since, according to KÄÄRIK (1965), it does not oxidize phenolic compounds. However, as discussed on page 16, the solubility in 1 % NaOH and the microscopic features of wood decayed by this fungus do not agree with the corresponding characteristics of wood decayed by other brown rot fungi.

The jars were kept at 23°—25° C in a moist chamber. At the end of each week two jars of each fungus were withdrawn. The weight loss and the moisture content were calculated for each sample by weighing the samples wet and dry. In the case of *Corticium laeve* and *Stereum purpureum*, which decompose wood very slowly, the withdrawals were made at longer intervals.

The samples were conditioned at room temperature (23°—25° C) after the moisture contents and weight losses had been determined. The control samples were treated in the same manner as the decayed samples.

The moisture content of each sample was taken a second time immediately before the sample's strength was tested. A pendulum hammer was used to break the samples, the impact bending strength being calculated as the energy in kpcm absorbed by the samples.

Using the strength obtained for the control sample in the group as a base, and assuming that figure to be 100 per cent, percentage values were calculated for the relative strengths of the decayed samples in the group. Because two jars were always withdrawn at the same time, the average relative strength of the 12 samples in these two jars was obtained.

Groups of decayed and broken samples and corresponding control samples were ground up. Solubility in 1 % NaOH solution was then determined, using the TAPPI standard Method T 4 m—59, except that in accordance with COWLING (1961), one-gram samples were used instead of two-gram samples.

Results

The results of the tests are presented in Tab. 1 and Fig. 2. It is clear that the decrease in impact bending strength was much more rapid than the loss of weight. Seven days after the inoculation, when the weight losses were almost negligible, substantial losses in the impact bending strength had already occurred. It is interesting to note that fungi such as *Corticium laeve* and *Stereum purpureum*, which are considered to be fairly harmless because of their low activity in wood (as measured by weight loss), rapidly reduced the strength of the wood. In seven days after inoculation, the first-mentioned fungus had reduced the strength of the wood by 12 per cent, whereas

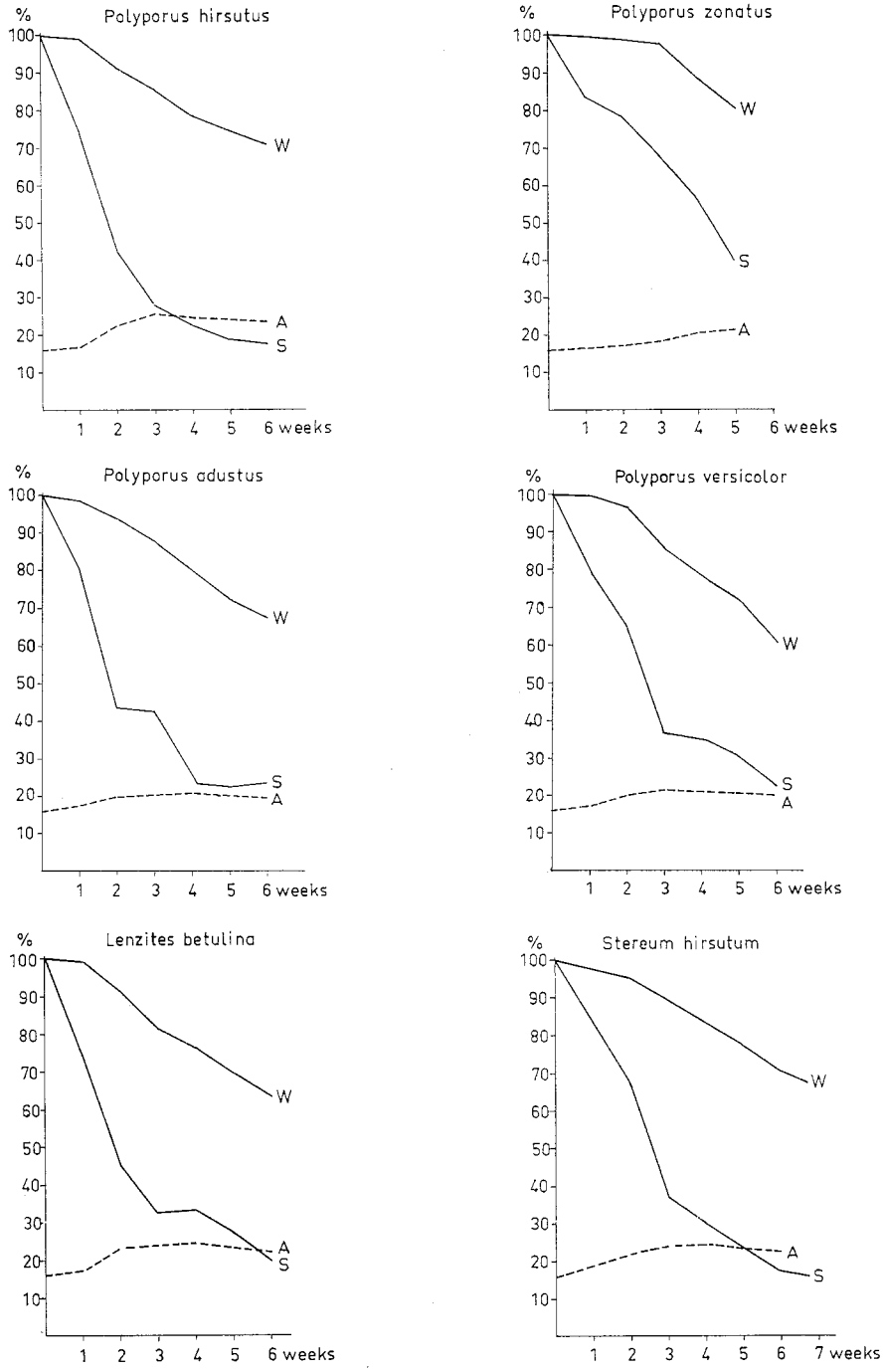
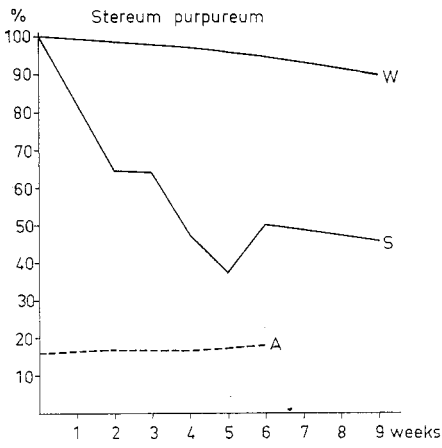
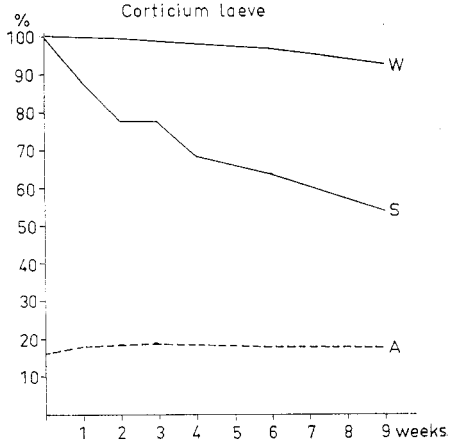
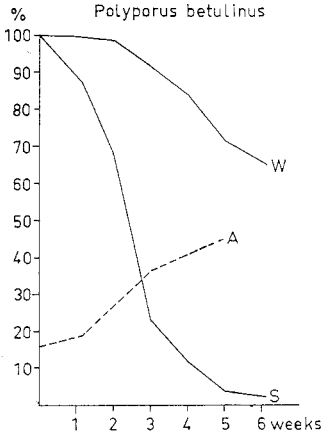
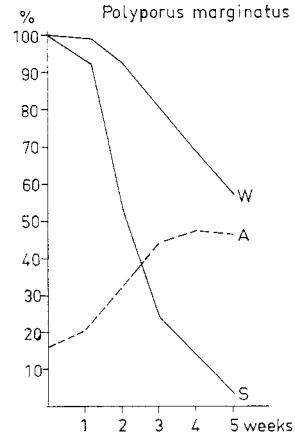


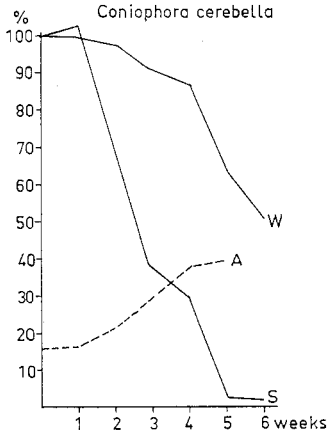
Fig. 2. The change with time of weight (W), strength (S) and solubility in 1 % NaOH (A) for samples decayed by the various fungi. When calculating the solubility in 1 % NaOH, the solubility of each control was assumed to be 16 %, which was the average solubility of the control samples.

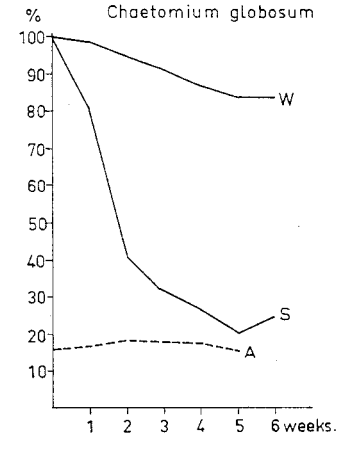

%
Stereum purpureum
100
90
80
70
60
50
40
30
20
10
W
S
A
1 2 3 4 5 6 7 8 9 weeks


%
Corticium laeve
100
90
80
70
60
50
40
30
20
10
W
S
A
1 2 3 4 5 6 7 8 9 weeks


%
Polyporus betulinus
100
90
80
70
60
50
40
30
20
10
W
A
S
1 2 3 4 5 6 weeks


%
Polyporus marginatus
100
90
80
70
60
50
40
30
20
10
W
A
S
1 2 3 4 5 weeks


%
Coniophora cerebella
100
90
80
70
60
50
40
30
20
10
W
A
S
1 2 3 4 5 6 weeks


%
Chaetomium globosum
100
90
80
70
60
50
40
30
20
10
W
S
A
1 2 3 4 5 6 weeks.

Tab. 1.
Weight loss, relative strength, relative solubility and moisture of test samples decayed by individual fungi. Each figure represents the average of twelve test specimens.

Fungus	Period of incubation days	Loss in dry weight		Relative impact bending strength		Relative solubility in 1 % NaOH calc. on		Moisture content in % of dry weight	
		%	standard error	%	standard error	decayed wood %	sound wood %	at the end of the incubation period	at the strength test
Polyporus hirsutus	7	1.1	0.1	74.7	7.0	106	105	40	5
	14	9.0	0.6	42.1	6.2	155	141	40	5
	21	14.7	0.7	27.5	1.7	188	160	42	5
	28	21.4	0.6	22.4	0.9	197	155	45	5
	35	25.7	0.9	18.5	1.6	—	—	45	5
	42	29.6	1.0	17.4	1.3	209	147	48	5
Polyporus zonatus	7	0.5	0.03	83.8	4.6	105	104	39	5
	14	1.3	0.2	78.6	8.6	111	109	41	5
	21	2.7	0.3	68.1	6.7	119	116	38	5
	28	11.4	1.1	56.9	2.7	143	129	41	5
	35	19.1	3.2	39.6	6.2	165	133	45	5
Polyporus adustus	7	1.3	0.2	79.9	3.8	110	109	41	5
	14	6.2	0.2	43.6	4.5	134	125	40	5
	21	12.5	0.8	42.5	3.5	—	—	41	5
	29	21.4	1.0	23.4	2.2	166	131	42	5
	35	27.5	1.5	22.7	4.2	—	—	44	5
	42	32.6	1.4	23.8	4.1	181	122	45	5
Polyporus versicolor	7	0.7	0.0	79.3	1.6	108	107	40	5
	14	3.8	0.6	64.6	3.3	131	126	40	6
	21	14.6	0.6	36.8	2.9	158	135	45	5
	30	22.7	1.7	34.9	2.3	—	—	46	4
	36	28.0	1.6	30.4	4.5	—	—	45	5
	43	39.1	2.1	22.8	4.0	210	127	59	5
Lenzites betulina	7	0.9	0.1	74.3	2.6	110	108	46	5
	14	8.9	0.5	45.3	3.9	160	146	48	5
	21	18.4	0.9	32.6	5.3	—	—	51	5
	28	23.9	0.9	33.3	2.7	202	154	52	5
	42	36.7	1.4	20.0	2.0	220	139	58	5
Stereum hirsutum	14	4.8	0.2	67.6	2.6	145	138	47	5
	21	10.3	0.5	37.1	3.1	167	150	58	5
	28	16.9	0.6	30.2	1.4	184	153	72	5
	35	22.5	0.7	23.8	0.1	188	146	82	5
	42	29.5	0.7	17.7	2.0	200	141	82	5
	47	32.2	0.6	16.2	1.1	—	—	79	5

Fungus	Period of incubation days	Loss in dry weight		Relative impact bending strength		Relative solubility in 1 % NaOH calc. on		Moisture content in % of dry weight	
		%	standard error	%	standard error	decayed wood %	sound wood %	at the end of the incubation period	at the strength test
Stereum purpureum	14	1.5	0.1	64.3	0.9	107	105	45	5
	21	2.1	0.1	64.1	3.2	—	—	47	5
	28	3.1	0.1	47.9	1.9	107	104	50	5
	42	4.1	0.2	37.3	3.4	118	114	52	5
	56	5.2	0.3	50.2	1.6	—	—	55	5
	78	10.3	0.4	46.0	4.4	—	—	66	5
Corticium leave	7	0.3	0.1	88.0	3.2	111	111	40	5
	14	0.8	0.1	77.9	2.1	—	—	40	5
	21	1.4	0.1	77.8	2.5	117	115	40	5
	28	2.1	0.1	68.1	2.2	—	—	42	5
	42	3.7	0.2	63.4	2.7	115	111	45	5
	63	7.5	0.4	54.0	3.5	118	109	48	5
Polyporus betulinus	8	0.8	0.1	87.2	3.3	120	119	61	5
	14	1.7	0.1	68.7	4.5	128	126	64	5
	21	8.3	0.4	23.2	2.5	247	227	68	5
	28	16.0	0.9	12.1	2.3	304	255	91	5
	35	28.6	0.5	4.0	0.3	393	281	95	5
	42	34.9	0.8	2.3	0.3	—	—	108	5
Polyporus marginatus	8	0.9	0.1	92.5	2.9	129	128	53	5
	14	7.1	0.6	53.4	6.0	217	201	58	5
	21	19.8	1.1	24.2	3.1	349	279	44	5
	28	31.3	1.7	14.4	2.6	432	297	46	5
	35	42.4	1.4	3.7	0.6	506	291	52	5
Coniophora cerebella	7	0.5	0.1	102.4	3.0	103	102	40	5
	14	2.3	0.3	68.3	7.4	137	134	44	5
	20	9.0	0.8	38.6	3.4	257	234	48	5
	28	13.1	2.0	29.4	6.6	268	233	56	5
	35	36.6	0.8	2.8	0.5	387	245	69	5
	42	49.8	1.7	2.0	0.3	—	—	106	5
Chaetomium globosum	7	1.8	0.1	80.3	4.0	107	105	62	5
	14	5.6	0.3	41.2	2.0	121	114	58	5
	20	8.5	0.4	32.7	2.2	—	—	61	5
	28	13.7	0.5	26.7	1.9	120	110	66	5
	35	16.2	0.5	20.2	1.3	115	96	81	5
	42	16.1	0.2	24.8	3.1	—	—	77	5

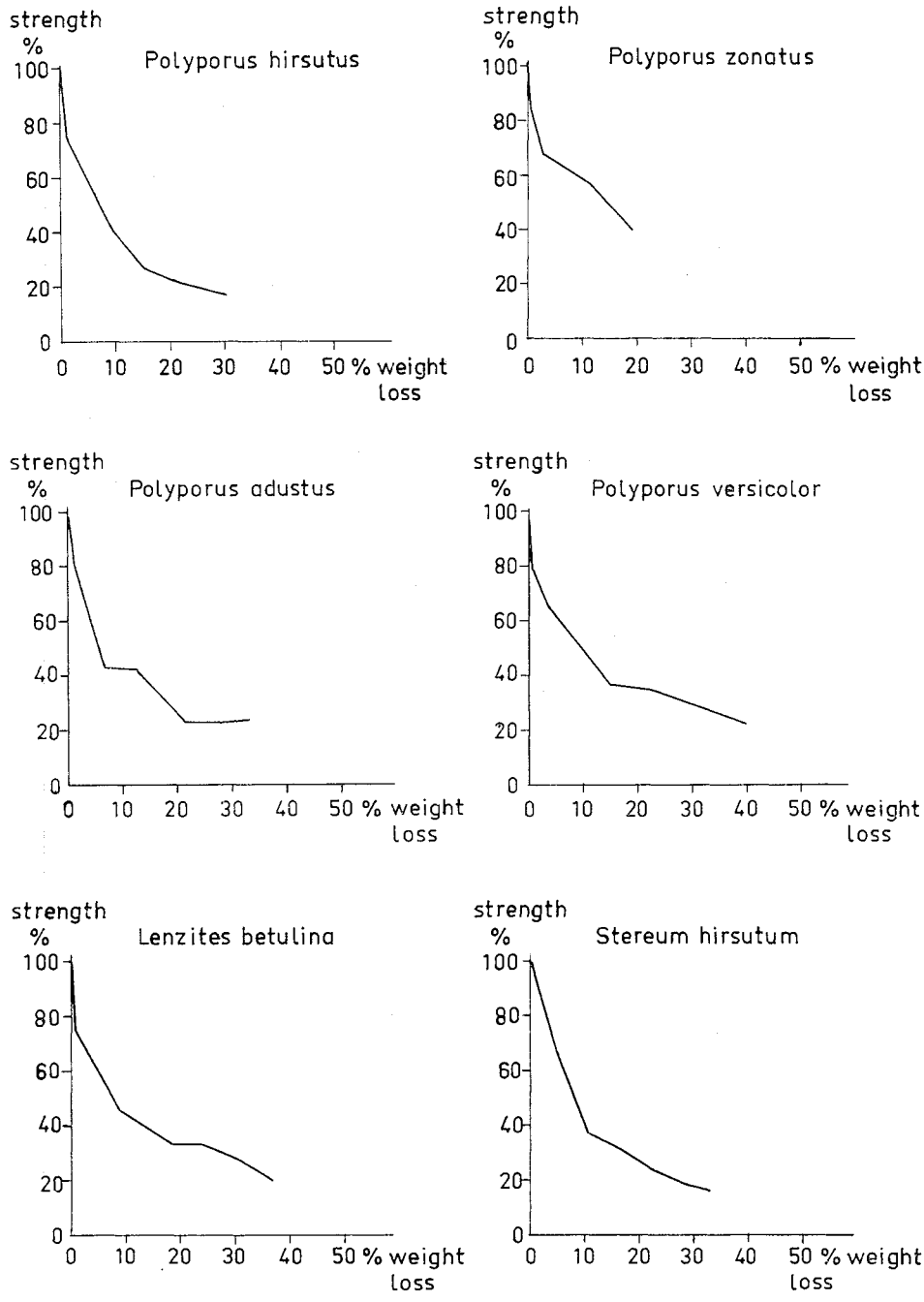
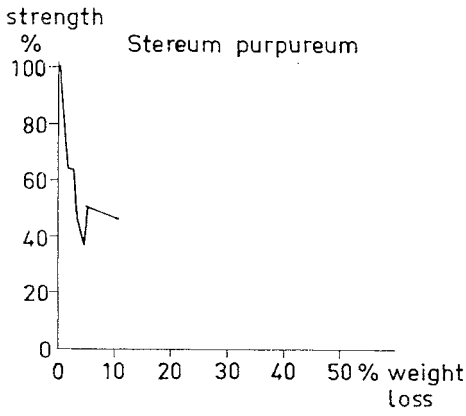
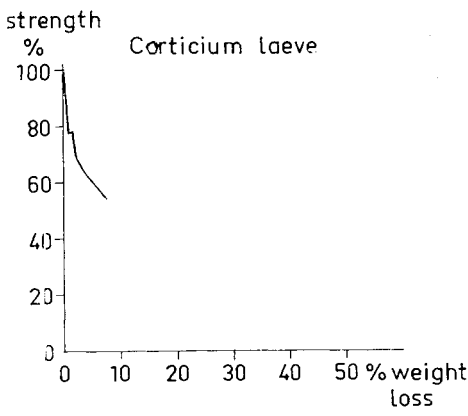
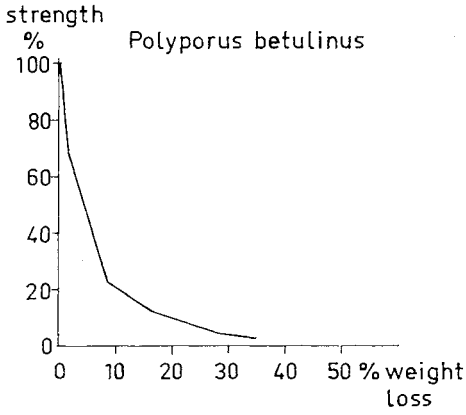
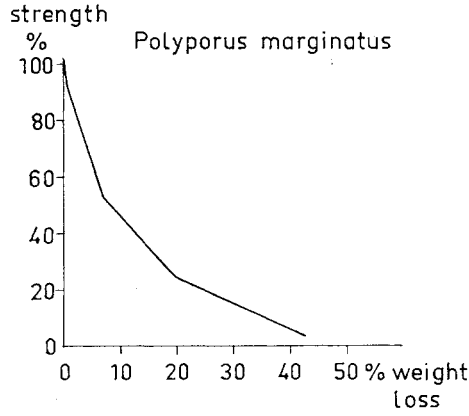


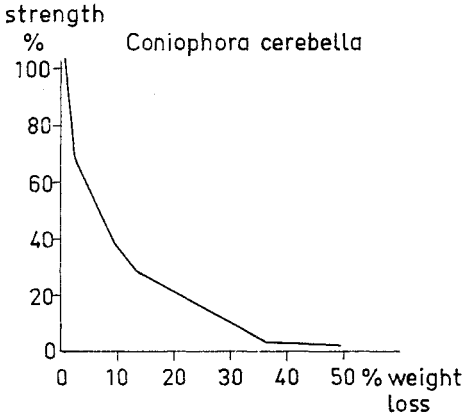
Fig. 3. Progressive changes in strength with increasing weight loss for the test samples.

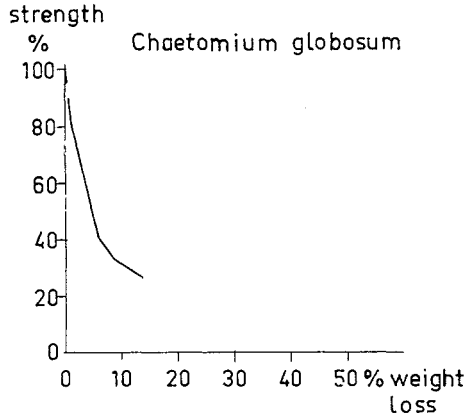

strength
%
Stereum purpureum
100
80
60
40
20
0
0 10 20 30 40 50 % weight loss


strength
%
Corticium laeve
100
80
60
40
20
0
0 10 20 30 40 50 % weight loss


strength
%
Polyporus betulinus
100
80
60
40
20
0
0 10 20 30 40 50 % weight loss


strength
%
Polyporus marginatus
100
80
60
40
20
0
0 10 20 30 40 50 % weight loss


strength
%
Coniophora cerebella
100
80
60
40
20
0
0 10 20 30 40 50 % weight loss


strength
%
Chaetomium globosum
100
80
60
40
20
0
0 10 20 30 40 50 % weight loss

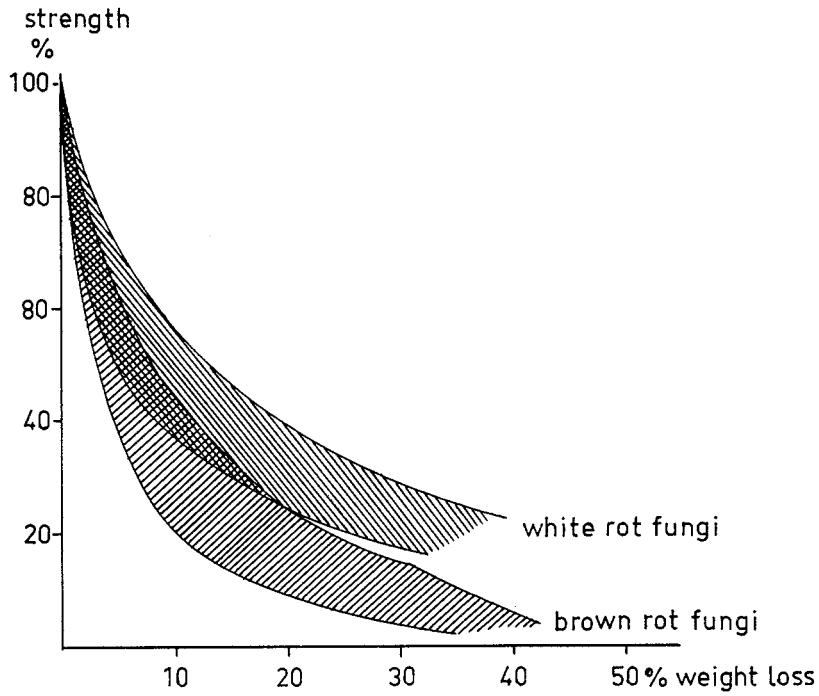


Fig. 4. The relationship between strength and weight loss for test samples decayed by white rot fungi and brown rot fungi.

the weight loss during the same period was only 0.3 per cent. Similarly, 14 days after inoculation, when the weight loss was 1.5 per cent, *Stereum purpureum* had reduced the strength by 35 per cent.

It may also be seen from Tab. 1 that the moisture content of the wood was increased during the experimental period. Except for *Stereum hirsutum*, the white rot fungi caused only a slight increase in moisture content. The brown rot fungi *Polyporus betulinus* and *Coniophora cerebella*, however, induced a high moisture content in the wood.

In Fig. 3, the relative strength has been plotted against the weight loss for each of the fungi tested. For high weight losses, the brown rot fungi generally caused a greater reduction in strength than did the white rot fungi. However, for lower weight losses, there seemed to be little difference between the two types of decay. Fig. 4 also demonstrates this. It is important to note that the two groups of fungi are heterogeneous within themselves. Thus comparative studies between the two groups based on one selected organism representing each group may give different results, depending on the choice of test organism.

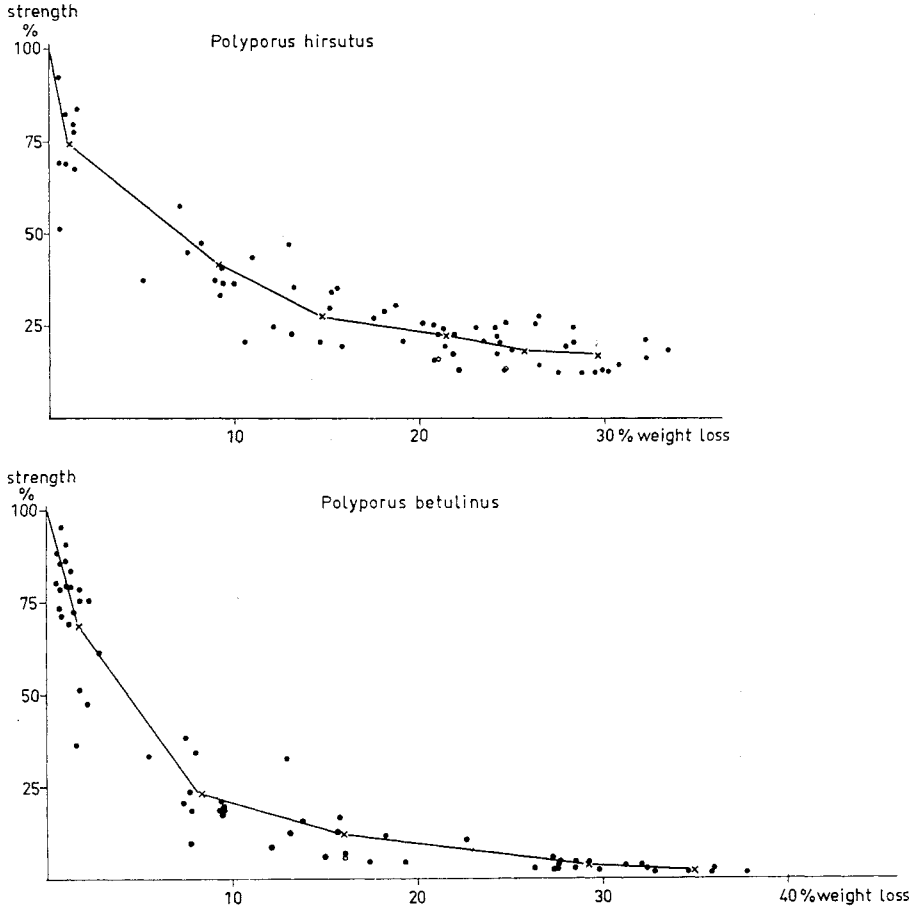


Fig. 5. Examples of the range of strength in individual test specimens for various weight losses.

When making strength tests on wood, and especially on wood affected by micro-organisms, it is impossible to avoid some variation between similarly treated samples. In Tab. 1 the standard error of the reported average figures is given. It is evident that the variations were of a reasonable order in these experiments, as a result of the careful selection of test pieces. Within the groups, the variations in weight loss were in most cases very small, while the strength showed greater variation. Two examples of the distribution of the individual test results are given in Fig. 5, where the relative strength is plotted against the loss in weight for samples attacked by *Polyporus hirsutus* and *Polyporus betulinus*.

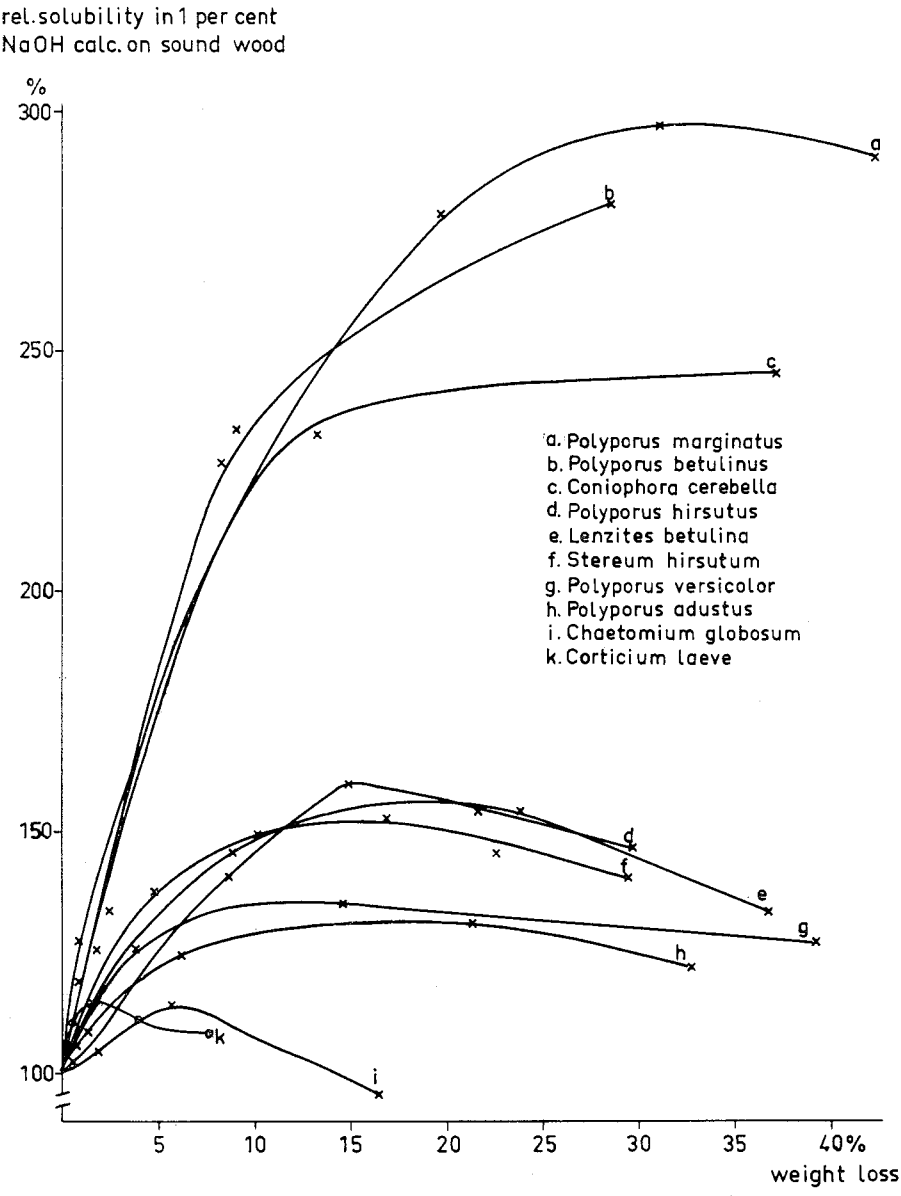


Fig. 6. Progressive changes in relative solubility in 1 % NaOH for samples decayed by the various fungi.

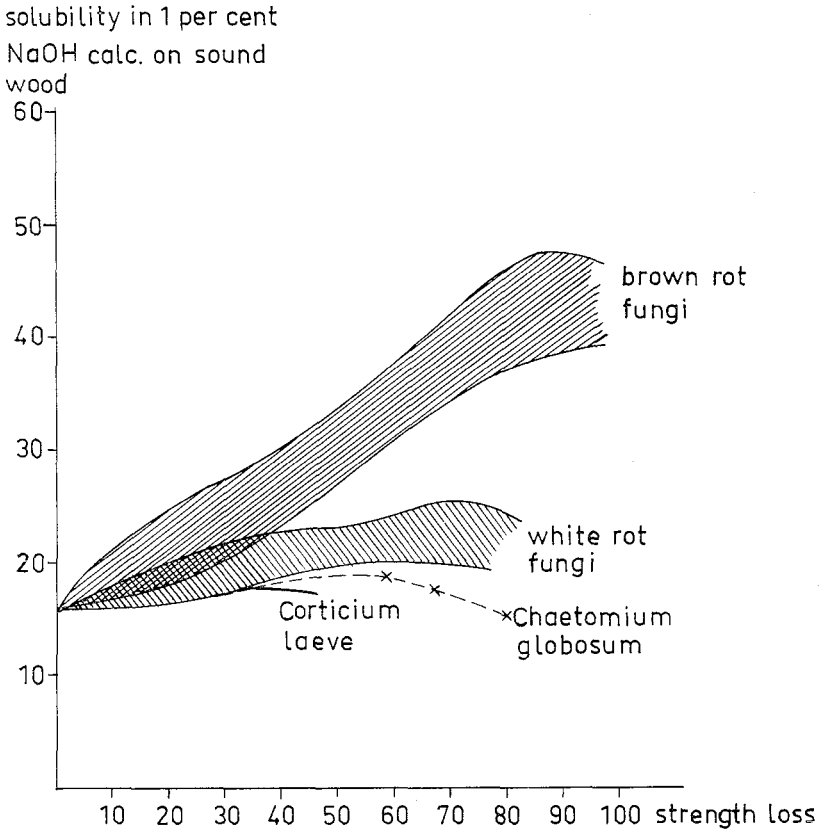


Fig. 7. The relationship between solubility in 1 % NaOH and the strength loss of test samples decayed by white rot fungi and brown rot fungi.

The results from the solubility tests can be seen in Tab. 1 & Figs. 2, 6 and 7. It is obvious that there is a fundamental difference in alkali solubility between wood attacked by brown and white rot fungi. Wood decayed by white rot fungi showed in general only a slight increase in alkali solubility in the early stages of decay. When the wood had reached a weight loss of 15—20 per cent, corresponding to a reduction in strength of 60—80 per cent, the solubility decreased. Brown rot fungi caused a rapid increase in the alkali solubility of the decayed wood. Maximum solubility was reached at weight losses of 30—40 per cent, which correspond to a reduction in strength of no less than 85—97 per cent. This means that when the maximum alkali solubility was reached in wood decayed by brown rot fungi, almost all the impact strength had vanished.

In Figs. 6 and 7 it is also shown that the soft rot fungus *Chaetomium globosum* caused a decay in birch wood which was characterized by an alkali solubility so low that this fungus is clearly distinguished from the white rot fungi.

Owing to its inability to oxidize phenols, (KÄÄRIK, 1965), *Corticium laeve* should be regarded as a brown rot fungus. On examining Figs. 6 and 7, however, it will be evident that the alkali solubility of wood decayed by *Corticium laeve* fails to resemble that of wood decayed by brown rot fungi. The alkali solubility in wood decayed to more than five per cent weight loss by *Corticium laeve* was even lower than that in wood decayed to a corresponding weight loss by the soft rot fungus *Chaetomium globosum.* Furthermore, it was established by studying the decayed wood under the microscope, that the decay pattern of *Corticium laeve* corresponded fairly closely to that of some soft rot fungi. The secondary walls of the cells were irregularly attacked, leaving the cell walls with a rough, cavernous appearance. Because of these facts, it seems difficult to classify the decay type of *Corticium laeve* after traditional criteria.

Discussion

The effect of decay on the strength of wood has been studied by several authors. Amongst the early publications is that of LIESE and STAMER (1934), who studied the influence of *Coniophora cerebella* and *Merulius domesticus* on the compressive strength of pine wood. In another early publication, the effect of *Trametes serialis* on the compressive and bending strength was investigated by ARMSTRONG (1935). If the results of these two publications be compared with those of von PECHMANN and SCHAILE (1951), or with those of the present investigation, it should be clear that the reduction in impact bending strength proceeds more rapidly than does the reduction in bending and compressive strength. MARKWARDT and WILSON (1935) also reported that the shock-resisting ability when measured, for instance, as impact bending strength, was one of the first properties affected by decay. It has recently been shown that the impact bending strength is rapidly affected even in wood attacked by soft rot fungi such as *Chaetomium globosum, Trichoderma viride* and *Paecillomyces sp;* cf. ARMSTRONG and SAVORY (1959), LIESE and von PECHMANN (1959) and LIESE and AMMER (1964). Consequently, there seems to be little doubt that the impact bending strength is a sensitive measure of all types of fungal attack on wood.

It is considerably more difficult to find the cause of the rapid decrease in the strength of wood, which is associated with fungal invasion. SCHEFFER

(1936), who studied the effects of *Polyporus versicolor* on Red Gum sapwood, found it extremely difficult to establish correlations between alterations in the strength of the wood, and the chemical decomposition caused by the fungus, e.g. a reduction in strength, measured in terms of the modulus of rupture, occurred before any loss of cellulose could be registered. However, lignin content, alkali solubility and warm water solubility were all more or less changed when weight losses were very small. SCHEFFER therefore suggested that, in non-attendance of early cellulose decomposition, the reduction in the modulus of rupture might be a result of the removal of minute amounts of cell wall lignin and soluble carbohydrates, which had cemented the cellulose units together, or of changes in these substances.

In the investigation by v. PECHMANN and SCHAILE (1951), the influence of several brown rot fungi and the white rot fungus *Polyporus versicolor* on the impact bending strength of wood was studied. Different curves were obtained for the reduction in strength of beech wood attacked by *Polyporus versicolor*, on the one hand, and wood attacked by the brown rot fungi, on the other. The curve for *Polyporus versicolor* was not as steep as the curves for the brown rot fungi. However, comparing the results of von PECHMANN and SCHAILE with those of the present investigation, it is evident (Tab. 1) that *Polyporus versicolor's* reduction of the impact bending strength is less than that of many other white rot fungi. This might have led to a difference greater than the average difference between white and brown rot fungi.

Von PECHMANN and SCHAILE also performed chemical analyses of the decayed wood. For the wood decayed by brown rot fungi they found a close relationship between the reduction in strength, and increasing solubility in dilute sodium hydroxide. They suggested that the real cause of the fragility of decayed wood is the splitting of the cellulose molecules. It has also been shown, for instance, by COWLING (1961), that the polysaccharides in wood are depolymerized at random (at least in the early stages of decay) by the brown rot fungi. This leads to a rapid fall in the degree of polymerisation (DP) of the cellulose, until a ten per cent weight loss of the decayed wood has been reached. This should result in a rapid decrease in strength. However, there is evidence which indicates that the random splitting of the cellulose chains may not be the sole cause of the early rapid decrease in strength of wood attacked by fungi, viz:

1) For instance, CLARKE (1935) found, when studying samples of ash wood, broken in an impact bending test, that the failures almost exclusively followed the middle lamella, which is very rich in lignin and has an extremely low cellulose content. In contradiction to the hypothesis which suggests that increased fragility is a result of the splitting of the cellulose molecules,

this observation indicates that some factor in the middle lamella is very important in this respect. KOLLMANN (1963) also concludes that stresses of short duration initiate cracks in the viscous-plastic middle lamella.

2) White rot fungi such as *Polyporus versicolor* reduce the impact bending strength rapidly in the early stages of decay. This is shown clearly in the present investigation, and was shown earlier by, e.g., ARMSTRONG and SAVORY (1959). However, according to von PECHMANN and SCHAILE (1951), and the present investigation (Tab. 1, Fig. 6), this fungus, like the other white rot fungi, causes only a slight increase in alkali solubility, and as pointed out by COWLING (1961), *Polyporus versicolor* causes only a gradual decrease in the average DP of the cellulose. Consequently, according to the hypothesis which regards cellulose chain splitting as the real cause of increasing fragility, there should be only a minute reduction in the strength of wood decayed by white rot fungi, which is not the case.

3) Furthermore, it was shown by IFJU (1964) that the tensile strength of wood cellulose is reduced much more rapidly in the low than in the high DP regions. In fact, the main reduction in strength did not occur until the average DP was lower than 600, a figure which cellulose from wood decayed by *Polyporus versicolor* (according to COWLING, 1961), did not reach even when the weight loss of the wood was 70 per cent.

In the very early stages of decay, for instance, with weight losses below 2.5 per cent, there seems to be no difference in the reduction in strength of wood decayed by white rot fungi and that of wood decayed by brown rot fungi, (see Fig. 4). But there is a pronounced difference between the wood decayed by white and by brown rot fungi even in the very early stages of decay as regards alkali solubility (see Fig. 6). Thus the alkali solubility itself has probably very little to do with the reduction in strength in the earliest stages of decay.

In a recent publication by SEIFERT (1966), data are presented from lignin analyses performed on beech wood decayed by *Coniophora cerebella* and *Polyporus versicolor*. The results show that in wood decayed by brown rot fungi, lignin I (the hardly soluble fraction of lignin) decreases, and that lignin III (an easily soluble, demethoxylated form of lignin), accumulates. In wood decayed by white rot fungi, the accumulation of lignin III does not occur. SEIFERT suggests the hypothesis that the hardly soluble lignin which is physically or chemically bound to the carbohydrates in the wood is transformed into the free, easily soluble form as a result of the splitting of the linkages between the lignin and the carbohydrates, when the latter are enzymatically decomposed by the fungus. According to SEIFERT, the only difference between brown rot and white rot appears to be that the liberated, easily soluble lignin fraction accumulates in brown rot, whereas in white

rot it is completely decomposed. The disappearance of lignin I proceeds in both types of decay at approximately the same rate as does the decomposition of carbohydrates.

In considering the results published in the above-mentioned publications and in the present investigation, it may be permissible to regard the splitting of linkages between lignin and carbohydrates as the cause of at least the early reduction in impact bending strength. This splitting may, as suggested by SEIFERT, be a passive result of the carbohydrate decomposition, but it may also be a result of unknown ferments acting on these specific linkages.

Summary

Specimens of birch sapwood were decayed according to the soil jar method. Twelve different fungi commonly found in birch wood were used as test organisms. Every week after the inoculation, the moisture content, the weight loss and the impact bending strength were investigated. Samples with the same incubation time were ground up, and their solubility in 1 % NaOH was calculated.

During the course of decay, the moisture content increased more rapidly in samples decayed by brown rot fungi than in samples decayed by white rot fungi.

After an incubation time of seven days when, in many cases, the weight loss was negligible, there was already a substantial loss in strength. For high weight losses, the samples decayed by brown rot fungi had lost more of their strength than those decayed by white rot fungi. For low weight losses, however, there seemed to be little difference in the reduction in strength between samples decayed by white rot fungi and samples decayed by brown rot fungi.

The alkali solubility of the samples decayed by brown rot fungi increased steeply during the course of decay, unlike that of the samples decayed by white rot fungi, the solubility of which increased only slightly.

The possible cause of the reduction in impact bending strength resulting from fungal attack on wood is discussed. The hypothesis is presented that the dissolution of the chemical and physical linkages between lignin and carbohydrates is the cause of at least the early reduction in impact bending strength.

REFERENCES

ARMSTRONG, F. H.: Further tests on the effect of progressive decay by *Trametes serialis* Fr. on the mechanical strength of the wood of Sitka Spruce. Forestry, 9, 1935.

ARMSTRONG, F. H. and SAVORY, J. G.: The influence of fungal decay on the properties of timber. Holzforschung, 13: 3, 1959.

CLARKE, S. H.: Recent work on the relation between anatomical structure and mechanical strength in English ash. Forestry, 9, 1935.

COWLING, E. B.: Comparative biochemistry of the Decay of Sweetgum sapwood by the white-rot and brown-rot fungi. U.S. Dept. Agr. Tech. Bull., 1258, 1961.

IFJU, G.: Tensile strength behavior as a function of cellulose in Wood. For. Prod. J., Aug. 1964.

KÄÄRIK, A.: Reference collection of pure cultures of wood-destroying and other fungi. R. Coll. For., Dep. For. Prod., Res. Notes R44, Stockholm 1963.

— The identification of the mycelia of wood-decay fungi by their oxidation reactions with phenolic compounds. Studia Forestalia Suecica, 31, 1965.

KOLLMANN, F. F. P.: Phenomena of Fracture in Wood. Holzforschung, 17: 3, 1963.

LIESE, J. und STAMER, J.: Vergleichende Versuche über die Zerstörungsintensität einiger wichtiger holzzerstörender Pilze und die hierdurch verursachte Festigkeitsminderung des Holzes. Angew. Botanik, 16, 1934.

LIESE, W. und von PECHMANN, H.: Untersuchungen über den Einfluss von Moderfäulepilzen auf die Holzfestigkeit. Forstwiss. Cbl., 78, 1959.

LIESE, W. und AMMER, U.: Über den Einfluss von Moderfäulepilzen auf die schlagbiegefestigkeit von Buchenholz. Holz als Roh- u. Werkstoff, 22, 1964.

MARKWARDT, L. J. and WILSON, T. R. C.: Strength and related properties of woods grown in Unites States. U.S. Dept. Agr. Tech. Bull., 479, 1935.

v. PECHMANN, H. und SCHAILE, O.: Über die Änderung der mekanischen Festigkeit und der chemischen Zusammensetzung des Holzes durch den Angriff holzzerstörender Pilze. Forstwiss. Cbl., 69, 1950.

RENNERFELT, E.: A comparison between Swedish field tests and laboratory experiments with some wood preservatives. Am. Wood-Preservers' Ass., 59, 1963.

SCHEFFER, T. C.: Progressive effects of *Polyporus versicolor* on the physical and chemical properties of Red Gum Sapwood. U.S. Dept. Agr. Tech. Bull., 527, 1936.

SIEFERT, K.: Chemischer Abbau der Buchenholz-Zellwand durch den Weissfäulepilze *Polystictus versicolor* (Linn.) Fr. Holz als Roh- u. Werkstoff, 24, 1966.

Sammanfattning

Förändringar i slaghållfasthet, vikt och alkalilöslighet vid svampangrepp på björkved

Splintvedsprover av björk rötades enligt jordbruksmetoden. Tolv olika i björkved vanligen förekommande svampar fick angripa proverna. Efter infektionen med de olika svamparna studerades varje vecka viktsförlust och slaghållfasthet. Prover, som rötats lika länge, maldes och lösligheten i 1 % NaOH undersöktes.

Under rötförloppet steg fuktkvoten snabbare och till en högre nivå i prover, som angripits av brunrötesvampar, än i sådana som angripits av vitrötesvampar.

Redan 7 dagar efter infektionen, då i många fall viktsförlusten var negligerbar, hade redan en avsevärd sänkning av slaghållfastheten inträffat. Vid höga viktsförluster hade prover, som angripits av brunrötesvampar, förlorat mer av sin ursprungshållfasthet än prover, som angripits av vitrötesvampar. Vid små viktsförluster föreföll emellertid skillnaderna i hållfasthetsreduktion mellan brunrötade prover och vitrötade prover vara obetydliga.

Alkalilösligheten hos brunrötade prover tilltog mycket snabbt under rötförloppet till skillnad från vitrötade prover, vilkas alkalilöslighet endast ökade obetydligt.

Den tänkbara orsaken till den reduktion i slaghållfasthet, som kan registreras, när svampar angriper ved, diskuteras. En hypotes framläggs, att spjälkningen av kemiska och fysikaliska bindningar mellan lignin och kolhydrater skulle vara den direkta orsaken till åtminstone den tidiga reduktionen i slaghållfasthet.

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Edited by J.G.K.Flower-Ellis