SPONTANEOUS MOULD INVASION IN DIFFERENT BUILDING CONSTRUCTIONS ON SAW TIMBER FROM EIGHT SWEDISH SAW MILLS

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ABSTRACT

Wood from eight Swedish sawmills was placed in four crawl spaces in order to study the differences in resistance to mould fungi. The wood was spruce fifths, spruce sixths and pine fifths. Two of the crawl spaces are situated in the south of Sweden and two in central Sweden. Analogous material of wood was also placed in two lofts and pine fifths in two houses under roof projections in central Sweden. The wood chosen was of a quality frequently used for wood constructions in Sweden. The material was placed in position during the period March-April 1987. Moisture and temperature were recorded continuously.

After 17 months of observations spontaneous mould ocurrences were recorded on all wood samples in the crawl spaces where high air humidity, a temperature favourable for mould growth and poor ventilation were recorded. In the other test environments the picture of mould attacks varied. Spruce wood was in general less subject to attack than pine wood. Wood from the southernmost and the northernmost sawmills and from one sawmill in central Sweden show the least attacks of mould fungi.

INTRODUCTION

Serious mould damage in houses in Sweden was first noticed at the beginning of the 1970s in housing estates at several places throughout the country. Samuelsson (5) shows that attacks of mould occur mostly in floors on strutted joists but also in crawl spaces and lofts. Attacks of mould in roof projections appeared late and their extent is not well documented.

Differences between moisture conditions in wooden pieces in poorly ventilated (7) and well ventilated crawl spaces are shown in Figure 1. The level of biological moisture risk exists during almost the whole year in the poorly ventilated space, but only for three months in the well ventilated crawl spaces.

Damage occuring in lofts is mainly found on boarding or board material when the loft has been extra-insulated. The brown and black stains which sometines cover the whole ceiling are usually caused by bluestain fungi such as Aureobasidium pullulans, Cladosporium s p p and Rhizopus nigricans.

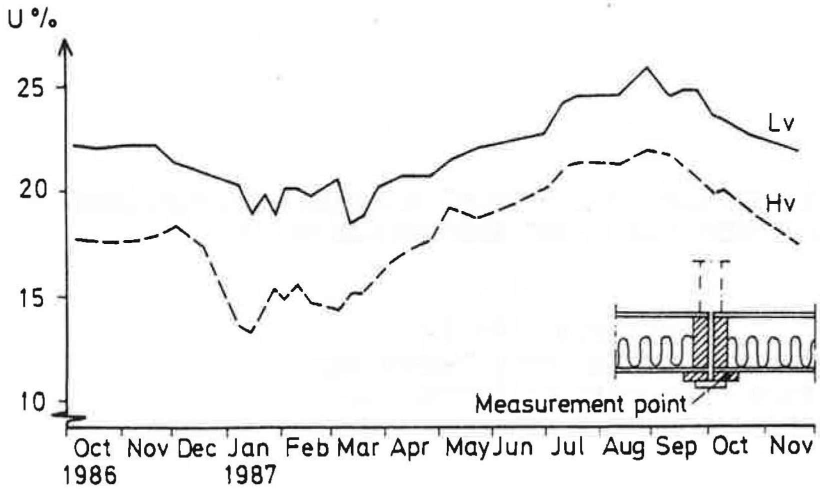

Figure 1. Annual variations in humidity ratios in a crawl space.

Boutelje (2) studied a number of factors which are presumed to affect the biological resistance of construction timber. Artificially dried timber has not proved to be more susceptible to mould or rot than naturally dried timber. Nor has the time of cutting any influence, or the annual ring width, growing place or "maturity". On the other hand several investigations denote the importance of the way the timber is handled and the way the sawn timber is stored at the timberyard and on the building site.

TEST METHODS

In order to study the differences in susceptibility to mould attacks which may exist between sawn timber from different sawmills, four crawl spaces, two lofts and two roof projections were chosen, in which identical wood samples were placed. The air humidity and temperature were determined by continual measurement. The wood moisture condition, establishment of mould and ventilation conditions were registered at various times of the year. The wood samples were normally unsterile and mould attacks occurred by the autochthonous mycoflora.

Sawn wood in the form of 50 x 10 x 2 cm pieces were selected from eight sawmills and timber yards in Sweden, regionally distributed from north to south. The material consisted of pine fifths, spruce fifths and spruce sixths. The samples were placed in wooden frames close to the blind floor and the boarding. No treatment or inoculation was performed. During the 17-month investigation period tests were made at least four times, when the moisture condition in the wood was determined and mycological analysis by means of lift-off discs were carried out. In this way the spontaneous spread of mould was determined as a percentage coverage of the whole wood surface.

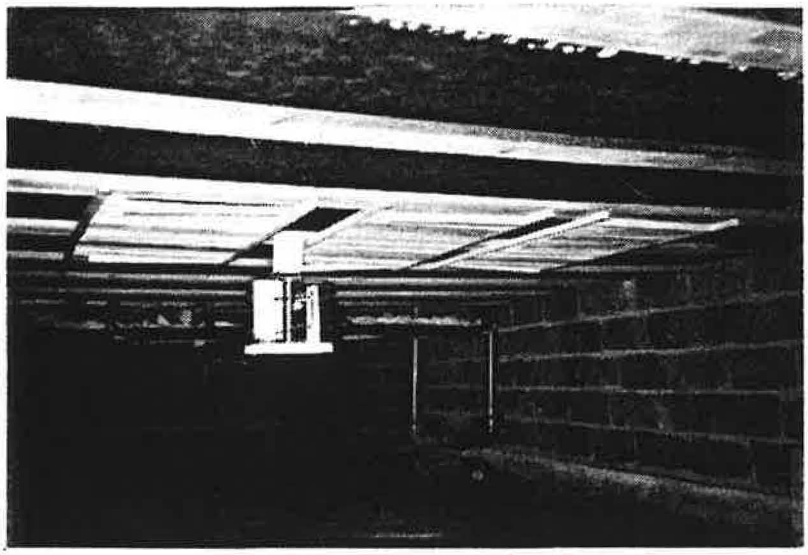

Figure 2. Wood samples in the crawl space.

RESULTS

A comparison between two identical houses in southern Sweden is reported below. The crawl space climate and the establishment of mould differed in some respects, as shown in Table 1.

Table 1. Comparison between crawl spaces in two identical houses in southern Sweden.

Building	Plastic film on ground	Ventilation air change/h	Number of days RH>90%	Number of days Temp.>10°	Visible mould
Markaryd 1	No	0.78	490	223	Plenty
Markaryd 2	Yes	1.90	93	294	None

Spontaneous mould establishment was first observed in the building listed as Markaryd 1. After only three months signs of attack on the pine fifths samples from five sawmills were observed. These attacks increased with time and at the final survey in 1988 all samples of the pine fifths quality including the control wood samples were completely covered. The attacks were sparse on the spruce samples, but increased with the exception of four samples from sawmills number 2, 4, 5 and 6.

In the building listed as Markaryd 2 there was no visible mould even at the final survey, 17 months after the investigation commenced.

In both Markaryd 1 and 2 potential mould existed as vital spores on the surface of the samples at all test occasions.

In the crawl spaces in central Sweden, Fisksätra, the first mould attack occurred after about 7 months of observation time and only in building No. 39 on pine fifths from four sawmills. After 17 months there was mould on all samples of pine fifths except from one sawmill in building No. 39.

The spruce samples were slightly mouldy at the same time of testing. The samples in building No. 43 were attacked by mould fungi to a small extent and on a few sample pieces. Table 2 summarizes the mycological status at the end of the test period.

The spontaneous mycoflora on the surface of the wood is dominated by species belonging to the Penicillium genus. This is true principally of the crawl spaces. In the lofts and under the roof projections, however, Cladosporium species occurred more frequently, possibly because the original panel board had been attacked previously by the blue stain fungus Cladosporium sphaerospermum.

Changes in the occurrence of the various species and families of microfungi were less than expected. The most remarkable change was at Markaryd 1, where Penicillium species dominated at the beginning of the observation time, but were later replaced by Cladosporium species.

The dominant species during the whole observation period were:

Penicillium aurantio-griseum
Penicillium brevi-compactum
Penidillium echinulatum
Penicillium hirsutum.

Penicillium expansum
Penicillium viridicatum
Penicillium crustosum
Cladosporium herbarum
Cladosporium sphaerospermum

Table 2. Comparison between mould attacks on sawn wood of pine fifths and spruce fifths in crawl spaces, lofts and roof projections after 17 months' observation.

Site	Location of samples	Type of wood	Occurrence of mould % Sawmill No.								
			1	2	3	4	5	6	7	8	9 C
Markaryd 1	Crawl space	Pine fifths	55	95	99	99	95	100	65	75	80
		Spruce fifths	30	30	45	30	45	25	55	35	-
Markaryd 2	" "	Pine fifths	0	0	0	0	0	0	0	0	0
		Spruce fifths	0	0	0	0	0	0	0	0	-
Fisksätra 39	" "	Pine fifths	10	45	20	80	30	5	5	30	10
		Spruce fifths	0	2	30	0	0	0	0	0	-
Fisksätra 43	" "	Pine fifths	0	20	5	2	0	±	0	0	0
		Spruce fifths	0	5	5	0	0	0	10	±	-
Ullvi 1	Loft	Pine fifths	0	0	0	2	0	2	2	0	0
		Spruce fifths	2	0	5	0	0	2	5	0	-
Ullvi 2	"	Pine fifths	0	0	0	0	0	0	0	0	0
		Spruce fifths	0	0	0	0	0	0	0	0	-
Ullvi 1	Roof projection	Pine fifths	5	15	20	5	5	60	75	2	2
Ullvi 2	"	Pine fifths	10	20	5	2	2	70	60	0	2

9 C represents control wood of pine fifths from Träteknikcentrum, Stockholm.

Aspergillus niger and Rhizopus nigricans occurred sparsely in the central Sweden material. Trichoderma viride and Paecilomyces variotii, which are common in wooden constructions close to the bare ground, occur at an early stage in the southern Sweden crawl spaces, but later they disappeared completely from the tests.

With the exception of P. brevi-compactum the other isolated Penicillium species are described as powerful producers of mould odors, which is confirmed by the genuine odors of mould registered in the crawl spaces attacked.

SUMMARY AND CONSLUSIONS

The investigation reported above produced results which can be briefly summarized under three headings:

1. Generally speaking it takes a long time, in practice, for mould damage to occur. Under "optimal" moisture and temperature conditions, it was possible to note initial spontaneous mould attacks first after three months in the crawl spaces. For wood exposed outdoors; in the roof projections it took twelve months for the attacks to appear. This slow process, dependent partly on climate and competitive factors, is usually not given much attention to in the standard tests which are carried out in vitro under a short period of time at a high temperature and high level of humidity without the presence of competing micro-organisms.

2. Under "optimal" climatic conditions in the crawl spaces the differences in the resistance of the various wood samples to mould attacks almost completely disappear, as regards both pine and spruce wood. In those cases where RH-days >90 % are less than 100 in number over a seventeen-month period, there are no mould attacks at all. A high rate of air change in the crawl spaces together with plastic sheeting on the ground evidently result in a moisture of the space not reaching critical levels for the growth of mould.

3. In lofts with good ventilation, as in the test houses, the daily rhythm of moisture and temperature varies strongly. The considerable fluctuations which were recorded did obviously not favour the establishment and growth of mould fungi.

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