

Effects of cold treatment on wood-destroying fungi important in cultural heritage

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In the polar sea

Caspar David Friedrich (1774-1840)

Possibilities of control through physical effects

1 Control through temperature changes

Heat treatments

Freezing treatments

2 Changing air humidity and material moisture content

3 Use of pressure differentials

Reduced pressure

Elevated pressure

4 Use of light

Daylight

Ultraviolet rays

5 Utilizing sound

Ultrasound

Microwaves / High frequency waves

6 Utilizing electromagnetic waves

X-rays

Gamma rays

Influence of physical effects on wood-destroying organisms

<u>Effect</u>	<u>Larvae in wood</u>	<u>Fungi (mycelium)</u>	
		<u>on the surface</u>	<u>in wood</u>
Daylight	-	(+)	-
UV-rays	-	+	-
X-rays	-	-	-
Gamma rays	+	+	+
Ultrasound	-	-	-
Microwaves/HF	+	+	+
Freezing treatment	+	(+)	(+)
Heat treatment	+	+	+
Reduced pressure	-	-	-
Elevated pressure	(+)	-	-

Parameters for use of physical control methods

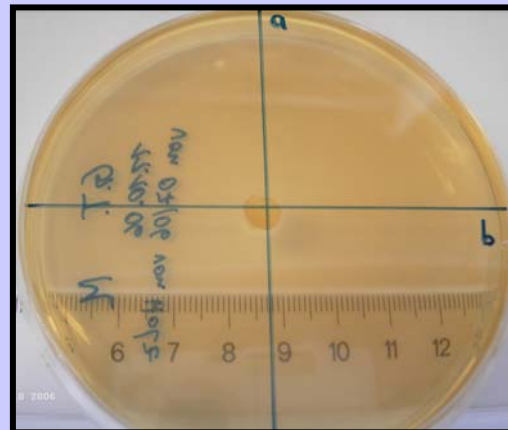
Method	Device /Facility	Parameter to	
		Insects	Fungi
Freezing	freezer chest freezing chamber	- 20 to – 30°C 48 - 72 h	?
Heating	<u>Mobile objects</u> baking oven drying chamber climate container <u>Buildings</u> hot-air generator	55 - 57 °C (temp. in wood; in minimum 1h) temp. 90–100 °C	<u>Mycelium</u> 37 - 40 °C 3 - 6 h <u>Spores</u> 80 °C, 8 h
Microwaves/ High frequency	Magnetron HF-generator	frequency: 2,45 GHz frequency: 13,56 to 40,68 MHz 5- 30 min	<u>Mycelium</u> 13,56 MHz ~ 3-12 min
Gamma rays	stationary irradiation facility with radio nucli- des ⁶⁰ Co- or ¹³⁷ Cs	0,25- 3kGy	<u>Wood rotters</u> 2-3 kGy <u>Mould</u> 15- 18 kGy

Material and Methods (I)

Wood decay fungi: *Serpula lacrymans*, *Coniophora cerebella*, *Lentinus lepideus*, *Oligoporus placenta*, *Gloeophyllum trabeum*, *Trametes versicolor*, *Chaetomium globosum*

Blue stain fungus: *Ophiostoma piliferum*

Measurement of fungal growth



A spider line at the bottom side of a Petri dish

Material and Methods (II)

Exposure regimes

1. Cultivation at temperatures of 5 °C, 10 °C, 15 °C and 20 °C
2. Storage for one month at temperatures of – 20 °C or – 80 °C before re-cultivation
3. Treatment with liquid nitrogen for 30 minutes at – 195,8 °C

Results (I)

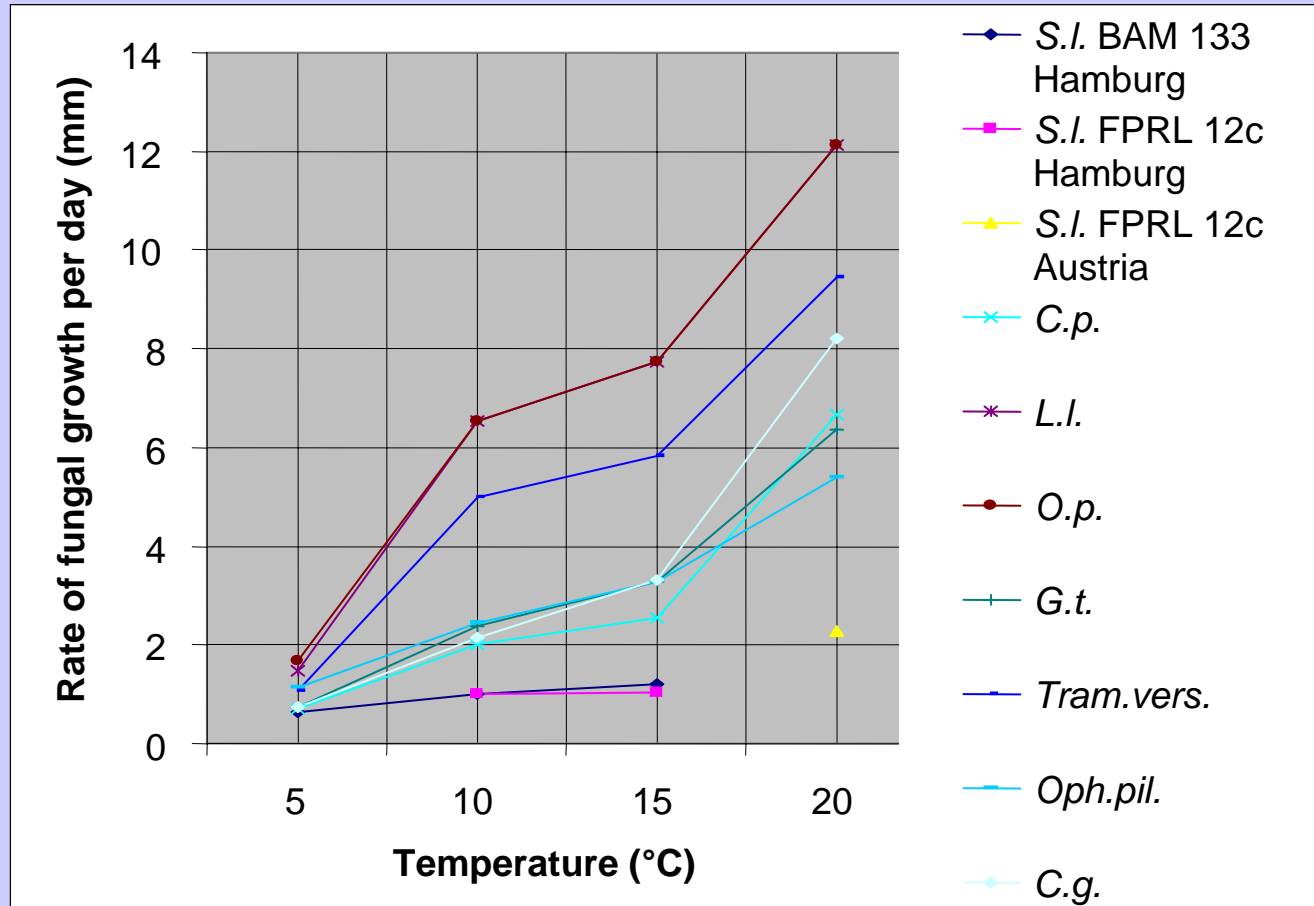


Diagram of the fungal growth at 5 °C, 10 °C, 15 °C and 20 °C

Results (II)

Medial fungal growth after storage for 1 month at freezing temperatures of - 20 °C or – 80 °C

Species of fungus	Rate of fungal growth per day (mm)	
	- 20 °C	- 80 °C
<i>Serpula lacrymans</i> BAM 133 Hamburg	0	0
<i>Serpula lacrymans</i> FPRL 12c Hamburg	0	0
<i>Serpula lacrymans</i> FPRL 12c Austria	0	0
<i>Coniophora puteana</i>	0	3,07
<i>Lentinus lepideus</i>	6,64	7,94
<i>Oligoporus placenta</i>	7,73	7,73
<i>Gloeophyllum trabeum</i>	4,78	5
<i>Trametes versicolor</i>	7,6	8,07
<i>Chaetomium globosum</i>	7,6	7,73
<i>Ophiostoma piliferum</i>	6,04	7,81

Results (III)

Viability of fungal cultures after treatment with liquid nitrogen (- 195,8 °C)

Species of fungus	Growth of new mycelium
<i>Serpula lacrymans</i> BAM 133 Hamburg	-
<i>Serpula lacrymans</i> FPRL 12c Hamburg	-
<i>Serpula lacrymans</i> FPRL 12c Austria	-
<i>Coniophora puteana</i>	+
<i>Lentinus lepideus</i>	+
<i>Oligoporus placenta</i>	+
<i>Gloeophyllum trabeum</i>	+
<i>Trametes versicolor</i>	+
<i>Chaetomium globosum</i>	+
<i>Ophiostoma piliferum</i>	+

Legend: - No new fungal growth; + New fungal growth

Conclusions

Serpula lacrymans was highly sensitive to cold treatment. No fungal growth occurred from - 20 °C to – 196 °C.

Oligoporus placenta and *Lentinus lepideus* were very resistant to cold.

Ophiostoma piliferum and *Chaetomium globosum* showed an atypical growth of mycelium.

Only the mycelium of the dry rot fungus *Serpula lacrymans* can be extinguished using cold treatments.

The positive result opens a way for control of *Serpula lacrymans* in movable objects of historic value.

Facilities for freezing (I)



Freezing chamber of the
Ethnological Museum in
Berlin, Germany

Temperatures: - 20 °C to – 30 °C

Exposure times (insects): 48-72 hours



Facilities for freezing (II)



Movable refrigerated storage containers

Application of liquid nitrogen. Temperature after evaporating of nitrogen in the containers: - 90 °C. Valuable objects must wrapped in plastic foil to keep the moisture content constant.

Potential object of application for freezing treatments



Attack of the wooden parts of an historic camera by
Serpula lacrymans

