

The role of lignin decomposing basidiomycetes in the decay of water reed

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1. Introduction

- reed as building material
- research on reed at the Institute of microbiology

2. Experimental

- isolation of microorganisms from thatched houses
- microbial decomposition of reed
- impact of environmental parameters on fungal reed decay

3. Summary

1. Historical review

- first thatched houses ca. 6000 BC in southern Scandinavia
- dominating the landscape of the European coasts
- until 13th century favoured building material
- decline caused by proceeding urbanisation



<http://upload.wikimedia.org/wikipedia/commons/thumb/c/c7/Ukranenland01.jpg/300px-Ukranenland01.jpg>

1. Reed as building material today

Origin of reed used in Germany today

- 90 % imported from European countries
- reasons for high import rates of reed in Germany: *demand has overtaken supply*

German reed-growing areas diminish due to

- *landscape cultivation*
- *river bed strengthening*
- *expansion of nature protection areas*



www.1a-passivhaus.de/media/images/schilf-reet-daemmstoff-passivhaus.jpg

1. Reed as building material today



<http://www.urlaub-reise-tourismus.de/images/friesenhaus-reetdach.jpg>

Key benefits

- thermal insulation
- sound abatement
- natural building material
- conservation of cultural assets
- **durability ?**

1. Focus on reed at the institute of microbiology

Start of research in 2008

- isolation of microorganisms from plants (*Phragmites australis*) and thatched houses
- screening of lignocellulolytic enzyme pattern
- tests for microbial ability to decompose reed
- characterization of reed-decomposing fungi
 - taxonomic determination
 - auxanography
 - temperature tolerance
- fungal decomposition of reed samples
 - influence of temperature, pH-value, metals, phosphate, nitrogen
 - protection of reed against microbial attacks

2. Isolation

Fruiting bodies collected from thatched roofs in Northern Germany



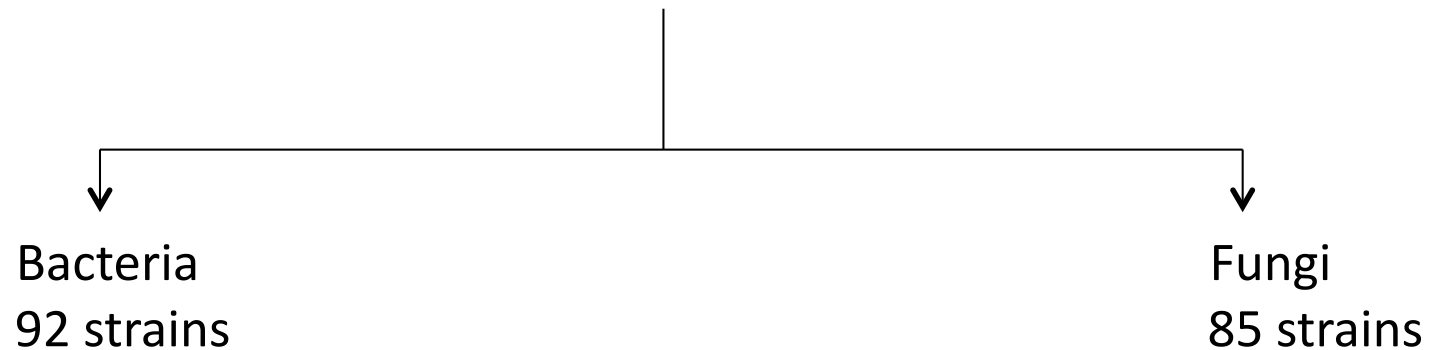
2. Isolation

Mycelium collected from thatched roofs in Northern Germany



2. Isolation

isolated organisms from thatched houses

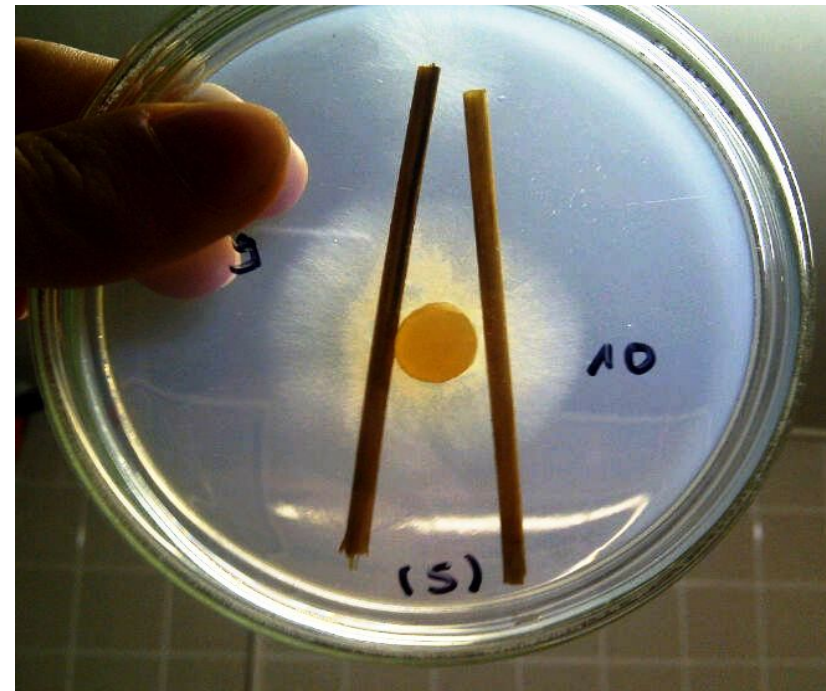
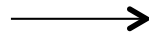
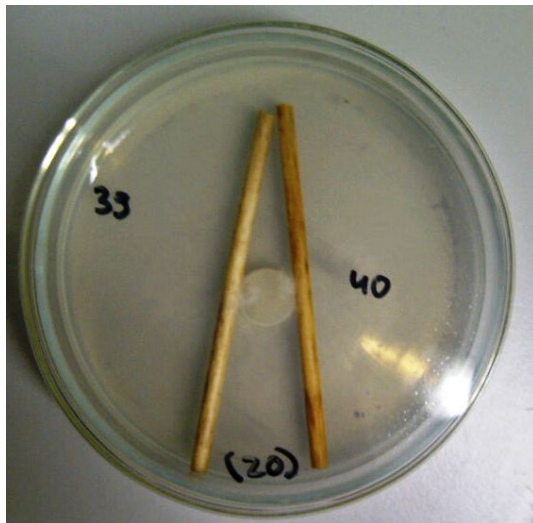


all strains were characterized with respect to their ability to

- degrade cellulose, hemicellulose and lignin-like model substances
- to decompose reed samples

2. Decay of reed

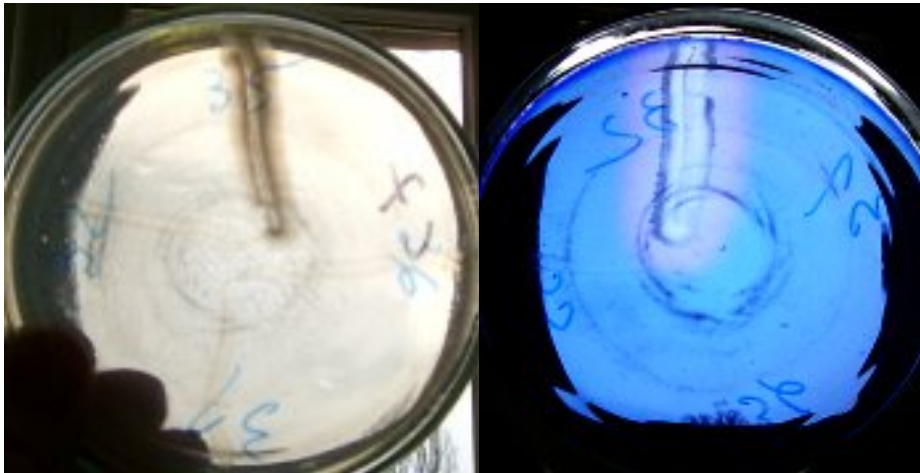
- test for decomposition of reed by fungi



2. Decay of reed: results of bacteria

- although 15 strains showed cellulolytic and hemicellulolytic enzyme activity
- no ligninolytic activity could be observed

NONE of the bacterial strains was able to decompose reed



analysis of cellulolytic enzyme activity of bacterial strains
a.) bacterial culture on nutrient agar with carboxymethylcellulose
b.) degradation of carboxymethylcellulose

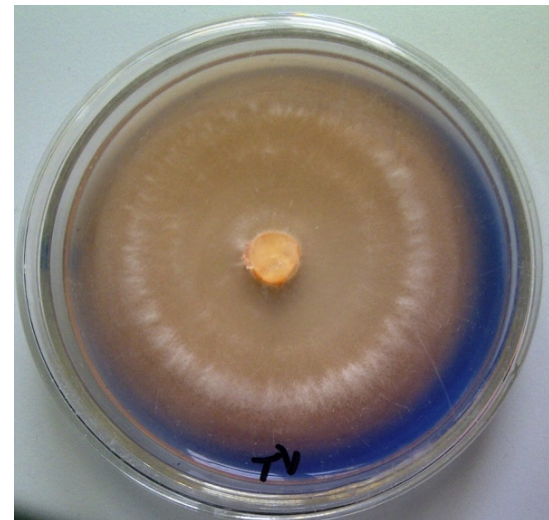
2. Decay of reed: results of fungi

53 out of 85 fungal strains were capable of cellulose and hemicellulose degradation

21 were able to decompose lignin-like model compounds



Decolourization of Orange G® by
Trametes versicolor SBUG 1050 after 3 d



Decolourization of RBBR® by *Trametes*
versicolor SBUG 1050 after 10 d

2. Decay of reed: results of fungi

53 out of 85 fungal strains were capable of cellulose and hemicellulose degradation

21 were able to decompose lignin-like model compounds



only these fungi caused weight loss of reed samples

- degradation rate: up to 68 % after 70 days
- e.g. *Trametes*, *Pycnoporus*, *Mycena*



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2. Decay of reed: results of fungi

| fungal strain | weight loss [%] | weight loss [%] |
|---|--------------------|--------------------|
| | of reed after 45 d | of reed after 70 d |
| Control (without fungus) | 0,36 ± 0,21 | 0,40 ± 0,12 |
| <i>Mycena arcangeliana</i> SBUG 1709 | 5,66 ± 2,40 | 17,21 ± 6,02 |
| <i>Mycena spec.</i> SBUG 1706 | 4,77 ± 1,19 | 14,00 ± 2,99 |
| <i>Mycena epip. var. viscosa</i> SBUG 1630 | 28,61 ± 5,50 | 45,17 ± 8,20 |
| <i>Mycena gal. var. leucogala</i> SBUG 1699 | 2,04 ± 0,69 | 7,75 ± 2,76 |
| <i>Trametes versicolor</i> SBUG 1050 | 28,66 ± 1,18 | 51,5 ± 2,82 |
| <i>Pycnoporus cinnabarinus</i> SBUG 1044 | 33,03 ± 8,42 | 67,95 ± 9,79 |

2. Decay of reed: results of fungi

lignin seems protects cellulose fibres and hemicelluloses against penetration of

- water
- microbial degradation

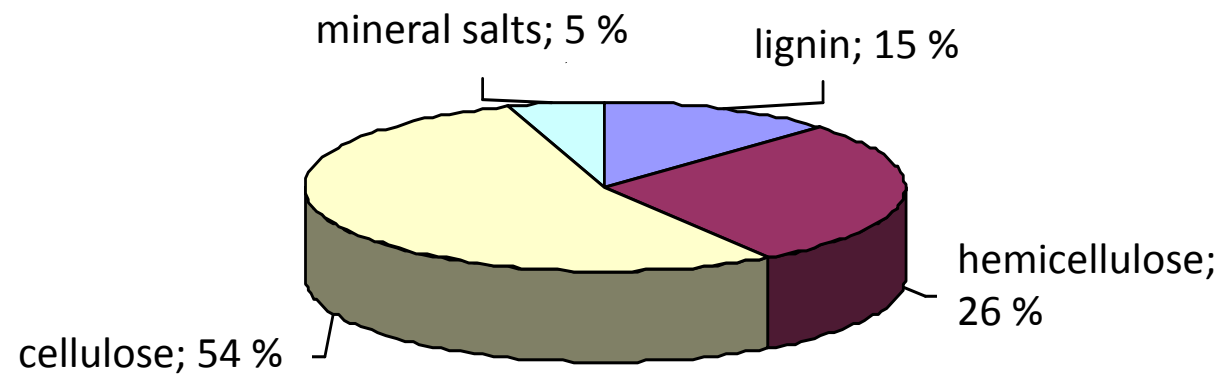
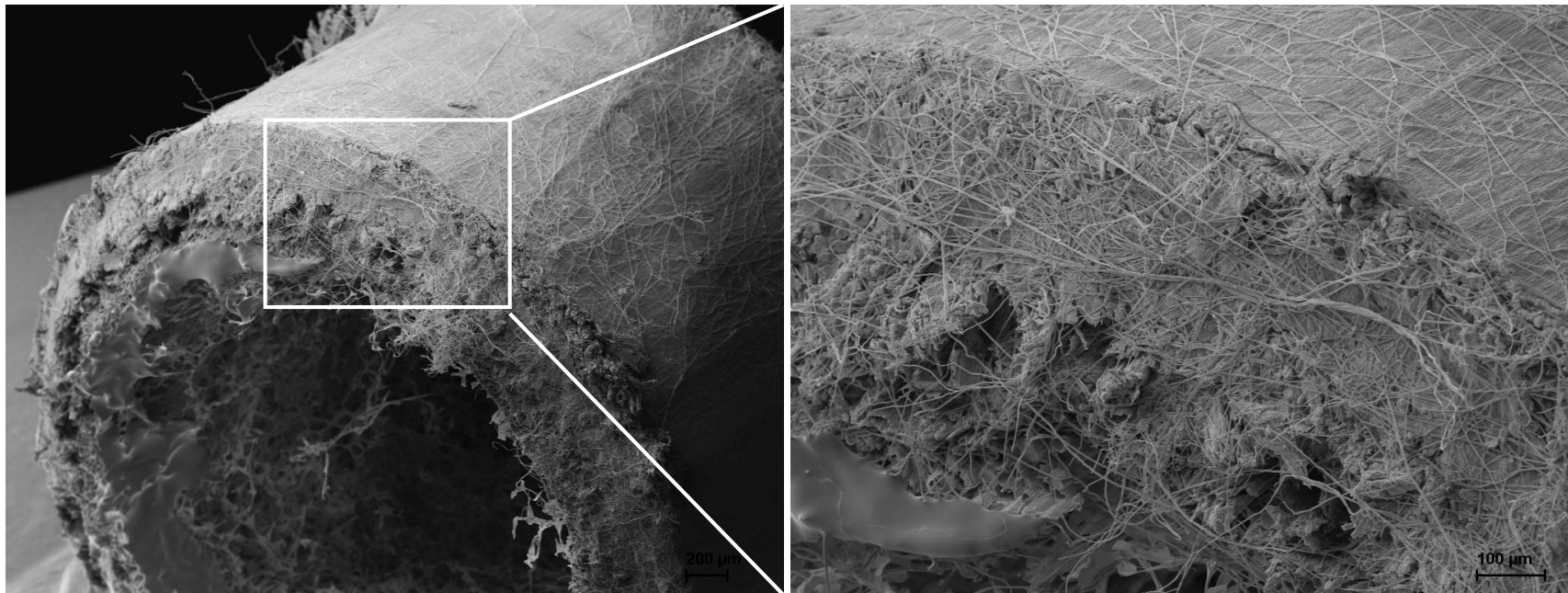


Fig. 1: Reed composition

2. SEM

***Mycena epip. var. viscosa* SBUG 1630 after 4d-growth on reed**

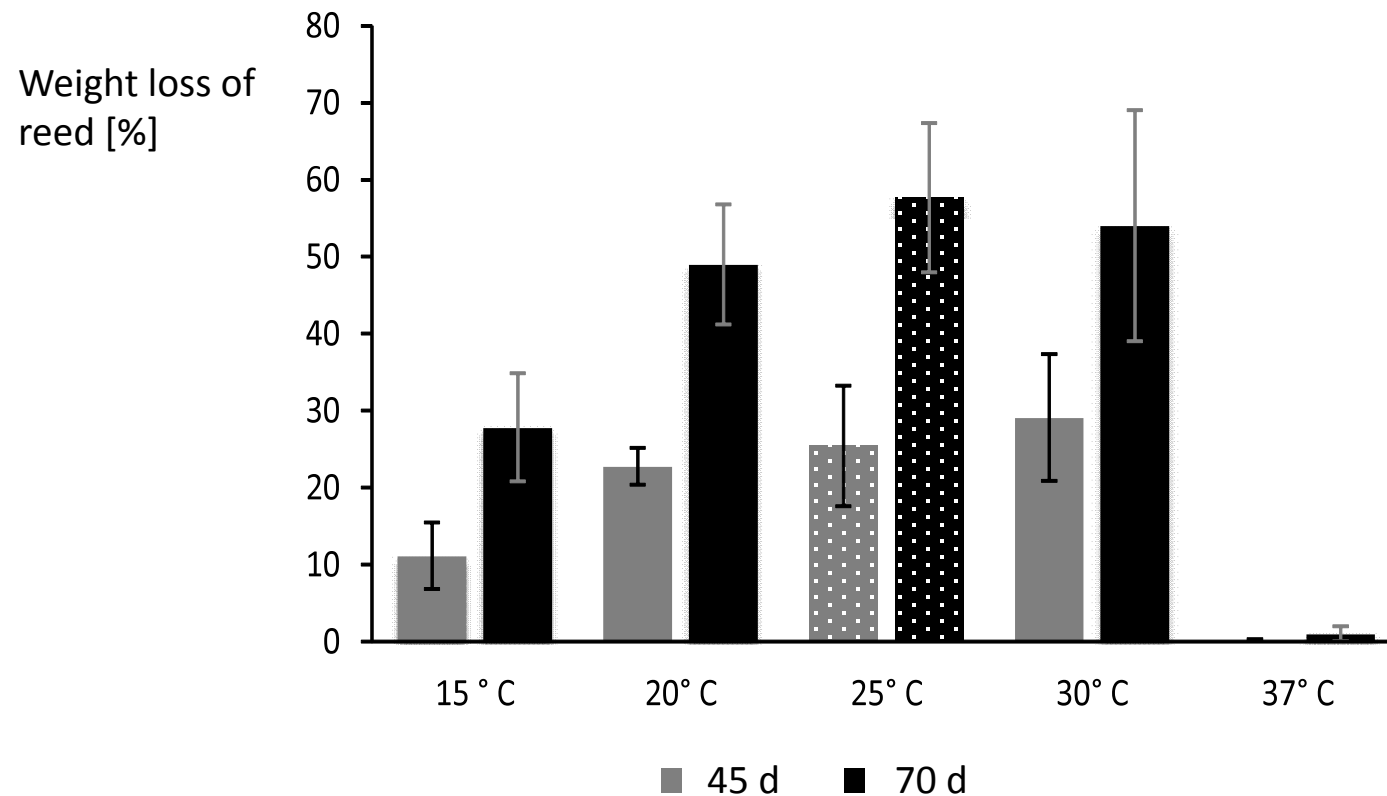
- fungus grows especially on the inner surface of reed samples



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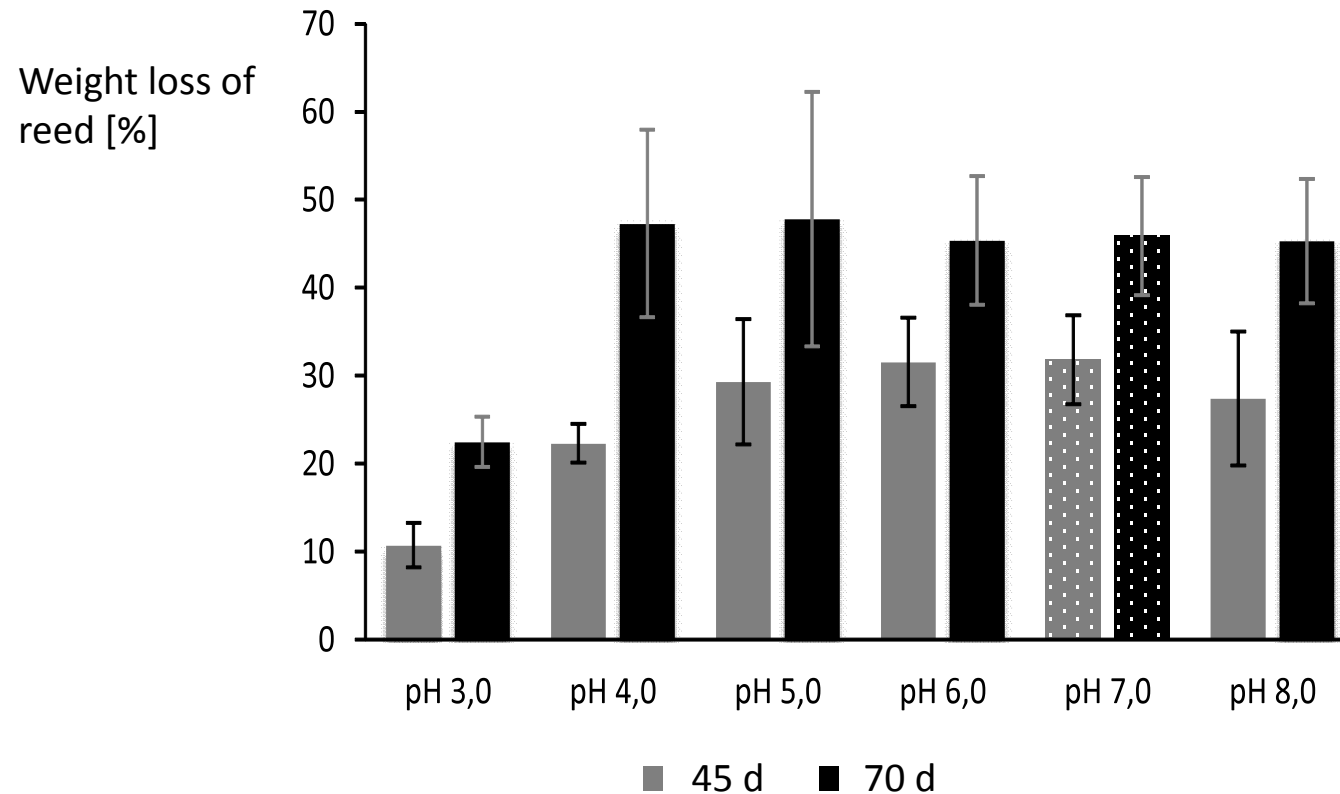
2. Impact of temperature on reed decay

Test organism: *Mycena epip. var. viscosa* SBUG 1630



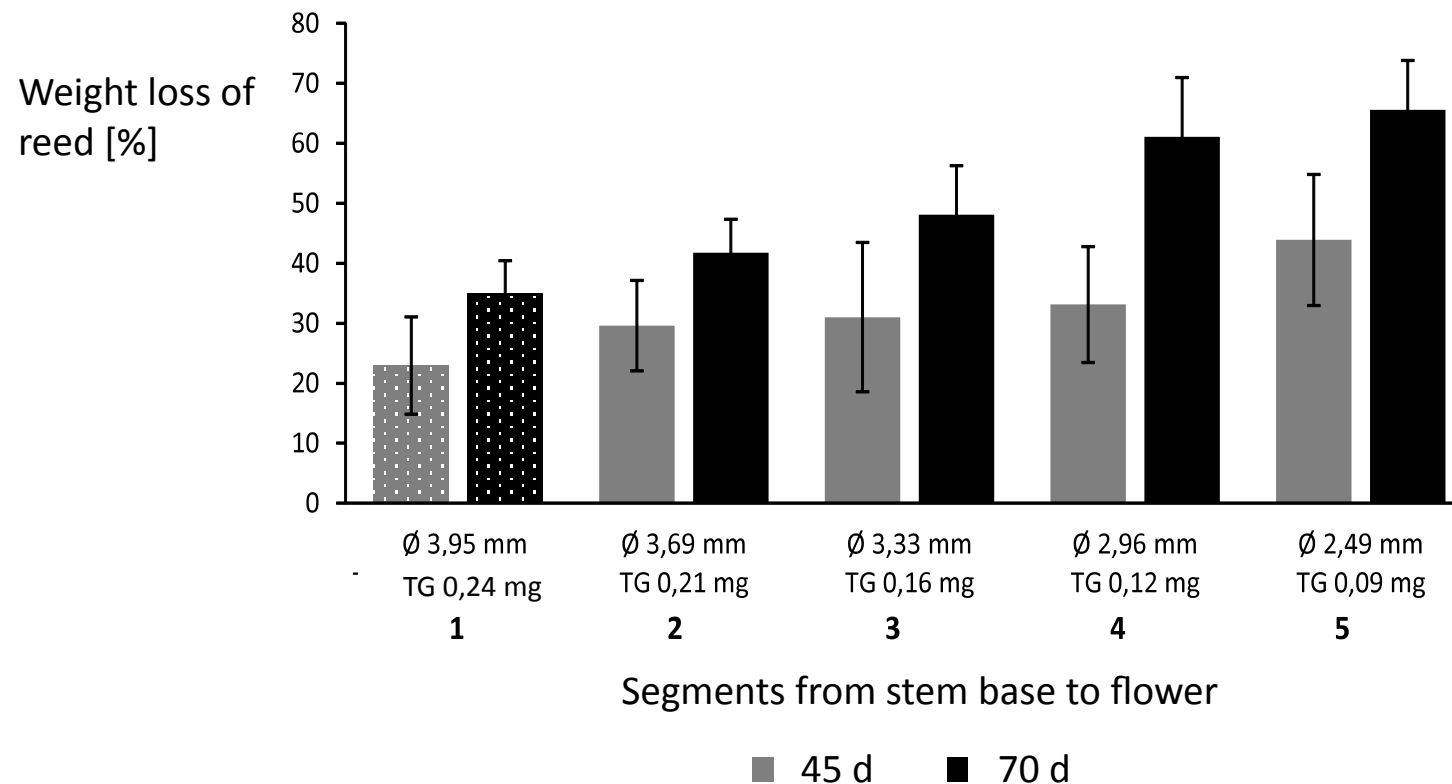
2. Impact of pH-value on reed decay

Test organism: *Mycena epip. var. viscosa* SBUG 1630



2. Impact of stem diameter

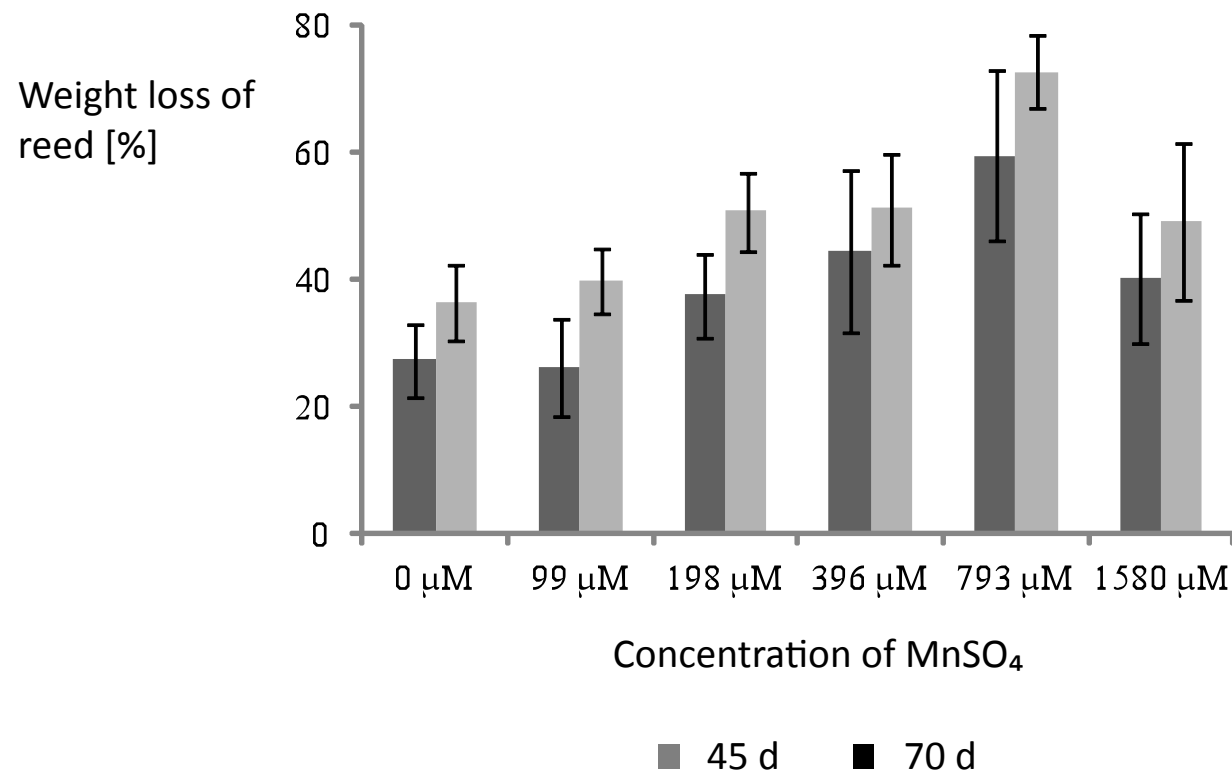
Test organism: *Mycena epip. var. viscosa* SBUG 1630



TG: dry weight

2. Impact of manganese

Test organism: *Mycena epip. var. viscosa* SBUG 1630



3. Summary

Isolation

- 92 bacterial and 85 fungal strains were isolated from thatched houses in Northern Germany

Enzyme activity

- 15 bacterial strains showed cellulolytic enzyme activity
- 21 fungal strains produced lignocellulolytic enzymes

Decomposition of reed

- only lignolytic fungal strains were able to decompose reed up to 68 %
- fungal hyphae attacked reed from inner and outer surface
- decomposition rate reached its maximum between 20 – 30 °C and pH 4 – 8
- reed stems of high diameters were more resistant against microbial attack
- supplementation with manganese led to increased decomposition rates

Acknowledgement

Thanks to:

QSR (*financial support*)

Prof. em. Dr. Hanns Kreisel (*taxonomic characterization*)

Dr. Klaus Hofmann (*isolation and characterization of bacteria*)

Franziska Preuß (*isolation and characterization of fungi*)

PD Dr. Wolf-Dieter Jülich (*statistic control*)

Dr. Michael Borriss/Nord Reet UG Greifswald (*establishment of tests systems*)

Rohrdachdeckerei Konrad Engemann Evchensruh (*reed delivery*)

Rohrdachdeckerei Carls Neuenkirchen (*reed delivery*)

Thank you very much
for your attention!

