An outbreak of *Gemmamyces picae* in the Ore Mts.

The Silva Tarouca Research Institute, Czech Republic

Karel Černý, Markéta Hrabětová, Ludmila Havrdová, Veronika Strnadová, Daniel Zahradník, Dušan Romportl, Vladimír Zýka

The Ore Mts. and *Picea pungens*

The Ore Mts. (Central Europe)

- Mountaineous plateau was deforested due to SO₂ pollution from brown-coal power plants built at foothills during 2nd half of 20th century.

*Picea pungens*

- North American species was then used for reforestation of ca 10 000 ha of the plateau due its tolerance to air pollution.

Bud blight

- An unknown but devastating disease was firstly identified in 2009.
A brief history of *G. piceae*

Borthwick 1909
- 1906 – Abercairney (Scotland)
- *Cucurbitaria piceae* (teleomorph stage)
- *(Cucurbitariaceae, Pleosporales)*
- Cucurbitaria bud blight (*Picea pungens*)
  - Naumov 1925
  - *Megaloseptoria mirabilis* (anamorphic)

Ferdinandsen, Jørgensen 1938
- supposed that identical fungus

Casagrande 1969
- new name: *Gemmamyces piceae*

2015: molecular analysis (LSU, SSU)
- *Gemmamyces* is correct

---

**Gemmamyces piceae**

(a) (b) (c) (d) (e) (f) (g)
Initial stage of bud blight

Anamorph

Teleomorph
Advanced stage of bud blight

Characteristic change of branching system of dying trees
2009: bud blight widespread in the Ore Mts.
loss of buds about ca 45 % in avg.
2017: loss of buds ca 75 % in avg. many stands dying or death

The cause of the epidemics was revealed, many stands dying or dead, but many important questions still had remained...

- Where was the homeland of the fungus?
- What was the real history of the pathogen in CZ?
- What really happened in the Ore Mts.?
- What is its ecology and disease epidemiology?
- What is the perspective of affected stands?
- What can we do against the pathogen?
G. piceae – alien to Europe?

1906 – Picea pungens / Scotland
Later – next European findings mainly on P. pungens
1946 – 1st. finding on P. abies in its native area (Kujala 1950)

Known hosts: Picea pungens, P. engelmannii (the most susceptible), P. sitchensis, P. glauca, P. schrenkiana, P. asperata, P. abies

• GP in Tianshan
• mountain forests with P. schrenkiana

Desprez-Loustau (2009)
• G. piceae cryptogenic?

Extremely psychrophilic

Place of origin: Asia?

Presence in CZ

Köck (1918)
• NW Bohemia, 1909
• 2nd finding worldwide
• ornamental plantations surrounding the hunting castle Kladská (NW Bohemia)
• pathogen introduced with the host from nurseries

Tubeuf (1919)
• last report in CZ in 20th century

CZ after 2000
• pathogen suddenly widespread
**Epidemics onset in the Ore Mts.**

Logistic model
- Using known data about disease extent development (2009–2013)
- 29 plots with 25 trees, R-plus
- Epidemics started around 2000

Potential earlier onset of the epidemics was probably blocked by air pollution – high SO$_2$ concentrations probably inhibited germination of conidia till late 1990.

**Identification of environmental factors affecting the disease impact**

Methodics
- 55 stands with 20 trees covering overall variability of conditions of stands
- Dependent variable: loss of buds (%)
- Explanatory variables (35)
  - silvicultural (State Forests): area, proportion of *P. pungens*, height, canopy, spacing, density of stocking…
  - environmental (FMI, GIS): watercourse, soil type, slope, exposition, TPI, landform, altitude, …
  - climatic (GIS): long-term avg. temperature and precipitation
  - microclimatic (dataloggers THI Minikin, EMS): measuring of temperature and humidity (VII–IX) in stands

R plus (GLM)
- 3 models for 3 space scales (trees, stands, whole mountains)
Example: model 1 (for trees)

<table>
<thead>
<tr>
<th>variable</th>
<th>reg. coef.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>1.985</td>
</tr>
<tr>
<td>relat. height</td>
<td>-1.332***</td>
</tr>
<tr>
<td>competition</td>
<td>2.170***</td>
</tr>
<tr>
<td>canopy</td>
<td>0.378***</td>
</tr>
<tr>
<td>proportion birch</td>
<td>-0.164*</td>
</tr>
<tr>
<td>proportion rowan</td>
<td>-0.182</td>
</tr>
<tr>
<td>site class</td>
<td>0.735***</td>
</tr>
<tr>
<td>open water</td>
<td>20.547***</td>
</tr>
<tr>
<td>orientation E</td>
<td>0.000</td>
</tr>
<tr>
<td>N</td>
<td>-50.398***</td>
</tr>
<tr>
<td>NE</td>
<td>-11.220***</td>
</tr>
<tr>
<td>NW</td>
<td>-16.629***</td>
</tr>
<tr>
<td>S</td>
<td>-6.987**</td>
</tr>
<tr>
<td>SE</td>
<td>3.973</td>
</tr>
<tr>
<td>SW</td>
<td>-3.343</td>
</tr>
<tr>
<td>W</td>
<td>-5.016*</td>
</tr>
<tr>
<td>coef. of determination</td>
<td>0.39</td>
</tr>
</tbody>
</table>

Explanatory variables – summary

Silvicultural
+ competition, canopy, stand height
- relat. height of tree, presence of birch and rowan

Environmental
+ presence of water, valeys and lower slopes, wet and poor soil types
- N and S (open) slopes, upper slopes, rich soils

(Micro)climatic
+ precipitation
- temperature
Map of environmental suitability of the Ore Mts. for *G. piceae*

**Summary**

*G. piceae*
- likely alien to Europe; native to *P. schrenkiana* forests in Tianshan?
- adapted to harsh climate of boreal forests (cold and wet summers)
- extremely dangerous for *P. pungens* (and other NA species?)
- the outbreak in Central Europe was probably delayed by air pollution ($SO_2$)
- poses probably high risk for North American mountaineous or boreal forests