BlueWood

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Surface treatment of primary blue stained wood

Drought-induced mass outbreaks of the bark beetle *Ips typographus* cause extensive tree mortality in European Norway spruce forests.

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European Spruce Bark Beetle
Ips typographus

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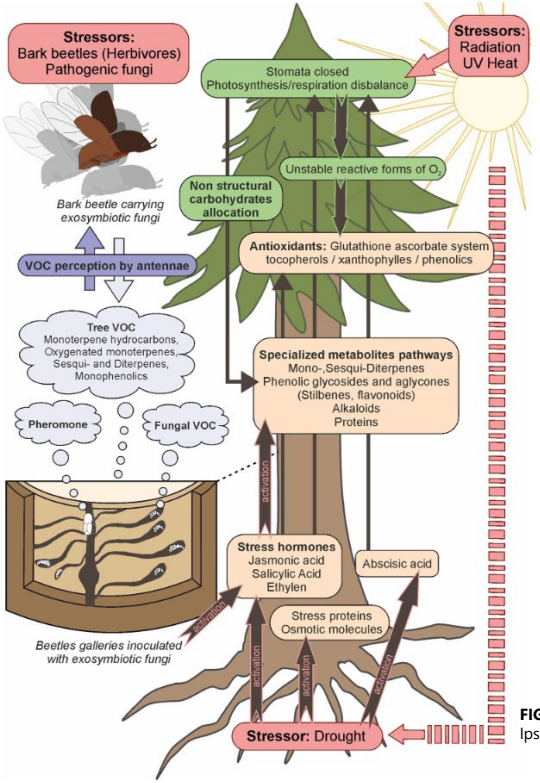

Destroyed Phloem

Disrupted nutrient flow

FIGURE 2. Conceptual scheme of interactions among Norway spruce, Ips typographus and symbiotic ophiostomatoid fungi under drought conditions. [1]

[1] Netherer, S., D. Kandasamy, et al. (2021). Interactions among Norway spruce, the bark beetle Ips typographus and its fungal symbionts in times of drought. Journal of Pest Science **94**(3): 591-614.
[2] Foto Beat Wermelinger, WSL ; [3] Foto Christian Endt, Fotografie & Lic

Blue stain fungi – *Ascomycetes*

Endoconidiophora polonica,
Grosmannia penicillata,
Ophiostoma bicolor,
Grosmannia europhioides
(synonym Grosmannia piceiperda)
Ophiostoma ainoae

Symbiosis between
bark beetle
and blue stain fungi

⇓

deadly for the host tree

[2]

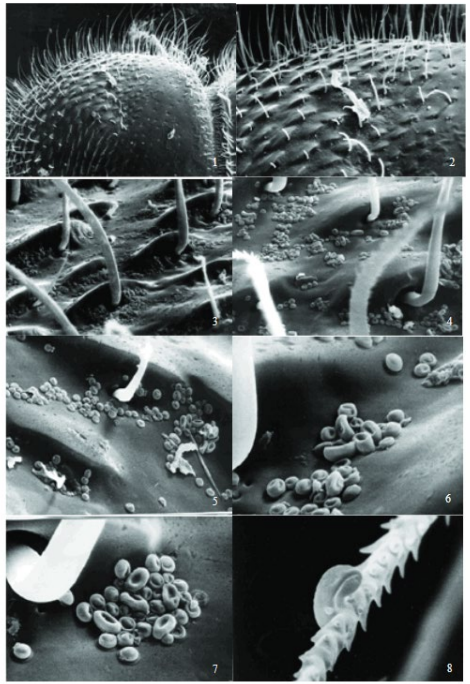

Plate 1. Microphotographs of the pronotum surface of *Ips typographus* L.
1. General view of the pronotum of *Ips typographus* 60×
2, 3. Nearer view, 150× or 750×
4–5. Tiny formations on the surface are ascospores of the genus *Ophiostoma* and conidia of various species, magnification 1,500×
6.–7. Nearer view of the group of spores, oval formations are ascospores of *Ceratocystis polonica* oval more undetermined conidiospores
8. A stuck spore on a seta protruding from the bark beetle body
(Original L. Jankovský, photo J. Lhotecký, 1996)

[1] Bark beetle *Ips typographus*

[1] Foto Beat Wermelinger WSL
[2] Jankovsky, L., D. Novotny, et al. (2003). "Induced wound response of Norway spruce Picea abies P. Karst. after artificial inoculation by imagoes of Ips typographus L." Journal of Forest Science (Prague) **49**(9): 403-411.

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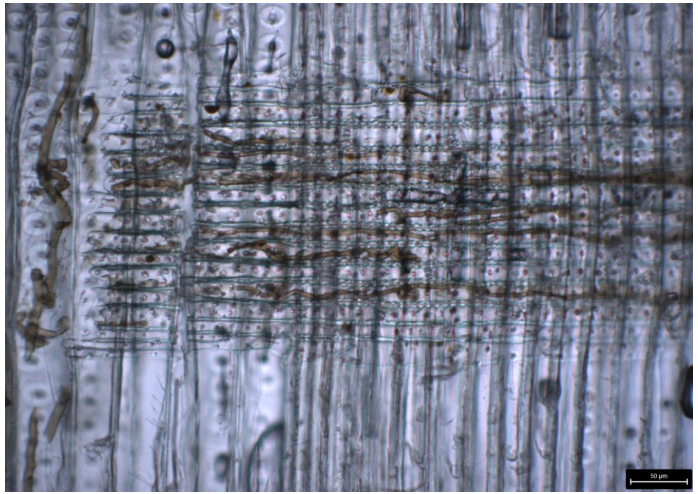
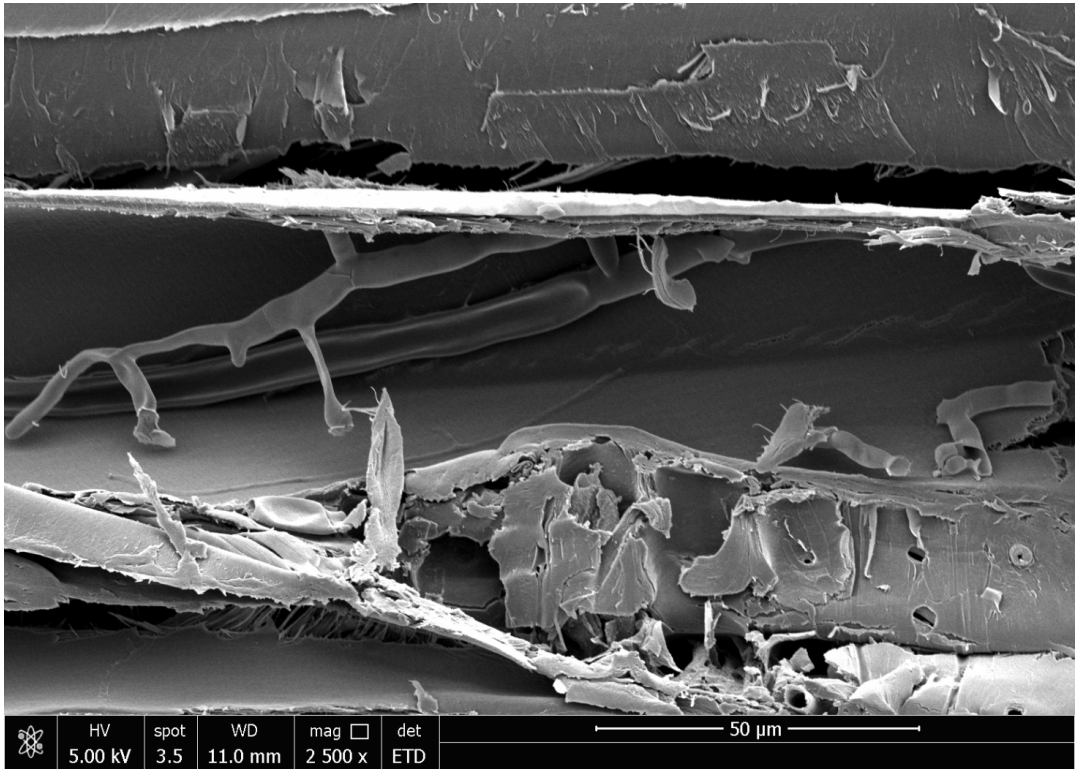




Produce beetle semiochemicals *

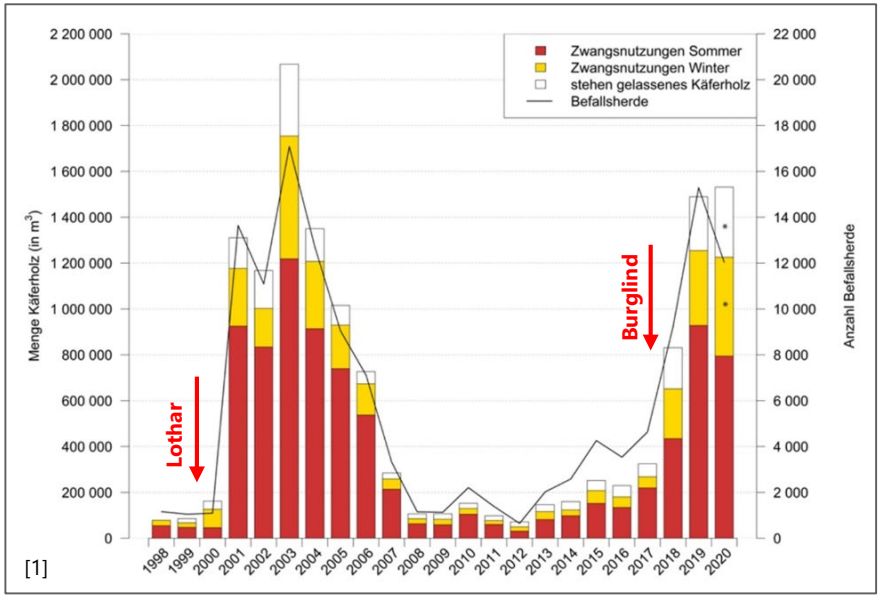
Fungal symbionts detoxify terpenes and phenolics *

Provide nutrition for larvae's and callow adults

Consume and deplete tree reserves * such as low molecular sugars and starch and disrupt water flow

* Netherer, S., D. Kandalama, et al. (2021). "Interactions among Norway spruce, the bark beetle Ips typographus and its fungal symbionts in times of drought." Journal of Pest Science 94(3): 591-614.

- **Hurricanes followed by hot / dry summer, mild / dry winter**
- 2020 more than 1.5 Mio m^3 wood infested by bark beetle -> one of the highest values in Switzerland since data recording



[1]

- **About 90% of the harvested (forced usage) wood is blue stained**

- Loss of revenue approx. 14.7 Mio SFr for Swiss forest industry in 2019
- Additional loss of revenue for timber processing industry

[1] Waldschutz aktuell, WSL, 2021/1 – Befall durch den Buchdrucker (*Ips typographus*) weiterhin hoch (10. Februar 2021)

- Timber stockyards overcrowded with blue stained wood
- No adequate literature on properties and application of spruce with **primary** blue stain for timber constructions
- **No experience and knowledge about the use of primary blue stained wood for coated wooden façades**

→ Greatest need to evaluate the properties of primary blue stained wood

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Lead: Tina Künniger

Term: 01.10.2020 – 30.09.2023

Budget: 208'300,- CHF (External funds WHFF and KWL 99'600,- CHF)
Project number: WHFF 2020.03 / KWL 2020.03

Team

- Daniel Heer, Roman Elsener, Markus Heeb, Anja Huch

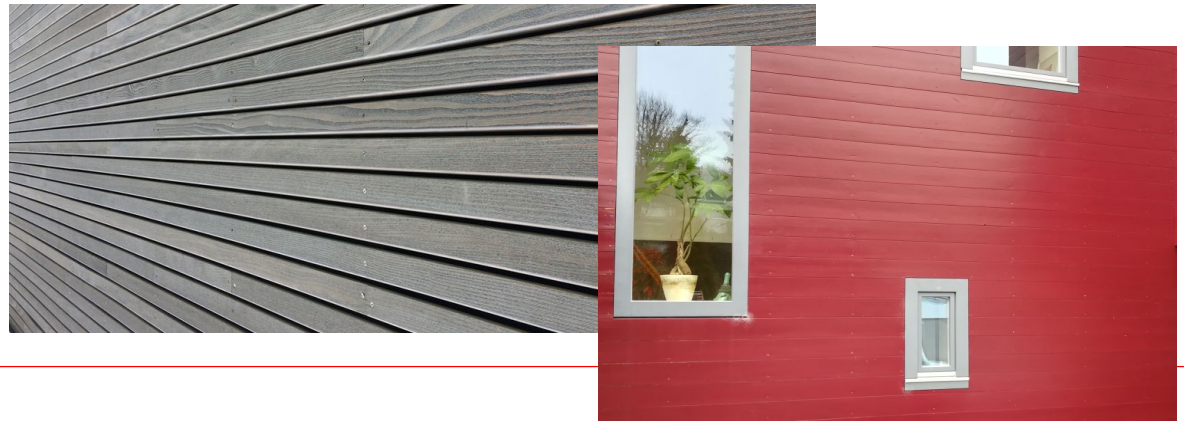
- Associations of Swiss forest and wood industry
    - Holzindustrie Schweiz / Industrie du bois suisse
    - VSH - Verband Schweizerischer Hobelwerke
    - WaldSchweiz – Verband der Waldeigentümer
- Swiss industrial partner
    - Forstrevier Stammheim / Konrad Keller AG
    - Mivelaz bois SA / OLWO AG / Eisenring AG
    - Bosshard & Co AG / …

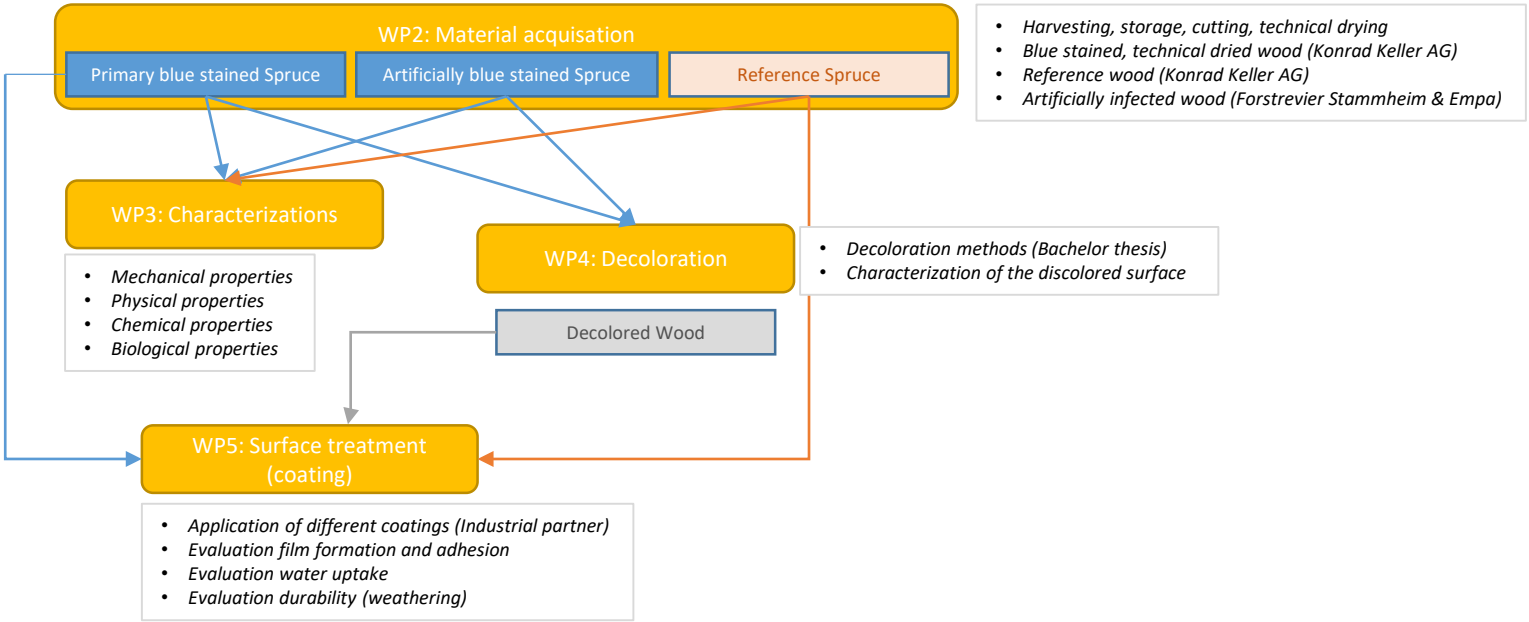
Primary blue stained Spruce

Typical galleries of the Bark beetle
Ips typographus

Objective

- Providing the missing knowledge about properties of primary blue stained spruce and its possible uses as coated wooden façades.
  - Characterization of primary blue stained wood in comparison to reference material
  - Determination of coating properties on blue stained wood and their performance during weathering
  - Development of suitable and durable surface decoloration methods
  - Recommendations to the wood industry about treatment and use of primary blue stained spruce




WP2: Material acquisation
Primary blue stained Spruce
Artificially blue stained Spruce
Reference Spruce
• Harvesting, storage, cutting, technical drying
• Blue stained, technical dried wood (Konrad Keller AG)
• Reference wood (Konrad Keller AG)
• Artificially infected wood (Forstrevier Stammheim & Empa)
WP3: Characterizations
• Mechanical properties
• Physical properties
• Chemical properties
• Biological properties
WP4: Decoloration
• Decoloration methods (Bachelor thesis)
• Characterization of the discolored surface
Decolored Wood
WP5: Surface treatment (coating)
• Application of different coatings (Industrial partner)
• Evaluation film formation and adhesion
• Evaluation water uptake
• Evaluation durability (weathering)