

aurivella и *Stereum hirsutum*, *Phellinus robustus*, *Phellinus tremulae* и *Laetiporus sulphureus* на увеличение рекреационных нагрузок реагируют увеличением частоты встречаемости и обилия.

К наиболее чувствительным видам к усилию рекреационного воздействия отнесены опенок осенний, опенок сернисто-желтый, трутовик окаймленный, которые снижали свою активность с увеличением антропогенной нагрузки на лесные экосистемы.

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A REVIEW OF STUDIES ON *HETEROBASIDION* AND ITS CONTROL IN LATVIA

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ОБЗОР ИССЛЕДОВАНИЙ КОРНЕВОЙ ГУБКИ *HETEROBASIDION* И ЛЕСОЗАЩИТНЫХ МЕРОПРИЯТИЙ В ЛАТВИИ

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Корневая гниль вызывает значительные лесохозяйственные потери в хвойных лесах Латвии. В ельниках выявлено в среднем 21,8% пораженных сердцевинной гнилью пней и в большинстве случаев основным возбудителем болезни является корневая губка *Heterobasidion annosum* s.l. Распространению патогена способствует инфицированная гнилая древесина (вываленные деревья, пни, лесосечные остатки), на которой образуются плодовые тела корневой губки. Особенно интенсивно гриб развивается в осушенном торфяном кисличнике. Для ограничения распространения корневой губки на сильно зараженных участках рекомендуется выкорчевка пней, а свежесрубленные пни обрабатываются биологическими препаратами. Для снижения влияния биологических препаратов на мико-

лору дереворазрушающих грибов целесообразно пременять штаммы флебиопсиса гигантского (пе-ниофоры гигантской) *Phlebiopsis gigantea* местного происхождения.

Approximately 50% of the total area of Latvia is covered by forest: of which 35% is dominated by Scots pine (*Pinus sylvestris*) and 18% by Norway spruce (*Picea abies*).

Inventory of ca. 25 000 stumps in 318 spruce forest sites revealed that 22% of stumps contained rot [1]. The main root rot causing fungus was *Heterobasidion annosum* sensu lato. The proportion of decayed trees was observed to increase for older stands. Data from 114 sampled *Picea abies* (age 40–120 years) showed that spread of decay column in the stem varied from 0,5 to 12,4 m ($6,6 \pm 2,6$ m on average). Economical losses caused by root rot during a rotation period were estimated to be 800–4790 EUR/ha (average 1070 EUR) [3].

Presence of *Heterobasidion* and *Armillaria* was also investigated in 42 young *Pinus sylvestris* stands (6–16 years) in 2012–2014. In the investigated area of 68,3 ha (size of individual sample plots 0,1–7,5 ha) it was found that among 1871 infected/dead trees, 178 trees were infected by *Heterobasidion* spp. and 1012 by *Armillaria* spp.

Picea abies wood decayed by *Heterobasidion* spp. is good substratum for development of fruit bodies of this fungus, and is associated with increased primary infection by basidiospores. We estimated the development of fruit bodies on 449 large dimension spruce logs, on 378 windthrown trees and on 20 stumps in different forest types. The surface area of *Heterobasidion* sporocarps during 3–5 years after harvesting was on average $4074 \text{ cm}^2/\text{m}^3$ of logging residuals (Figure 1).

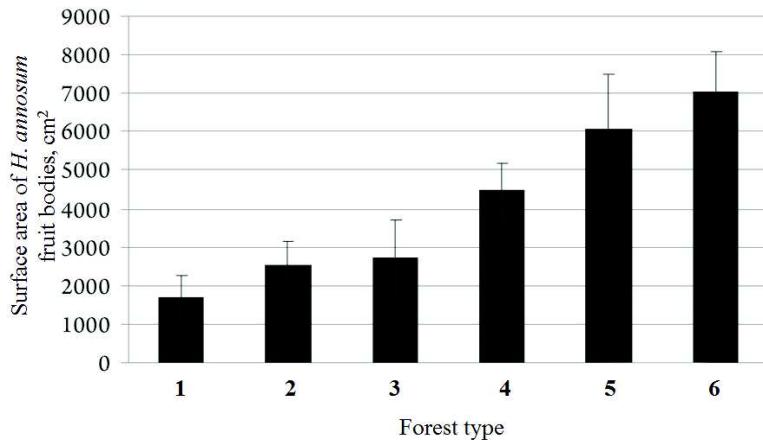


Figure 1. Total surface area of *H. annosum* s.l. fruit bodies per m^3 of four year old spruce logs in different forest types (1 – *Myrtillosa mel.*, 2 – *Mercurialisosa mel.*, 3 – *Myrtillosa turf. mel.*, 4 – *Oxiladosa*, 5 – *Aegopodiosa*, 6 – *Oxiladosa turf. mel.*)

Most abundant development of fruit bodies was found in the *Oxalidosa turf. mel.* forest type – about $7000 \text{ cm}^2/\text{m}^3$ (Figure 2). In two forest types, *Hylocomiosa* and *Oxalidosa turf. mel.*, we investigated the dynamics of the development of *Heterobasidion* fruit bodies on decayed spruce logs one year after cutting; the sporulating area of fruit bodies on logs in the *Hylocomiosa* site was $241 \text{ cm}^2/\text{m}^3$ and in the *Oxalidosa turf. mel.* site $553 \text{ cm}^2/\text{m}^3$. In the third year after cutting the corresponding values were $1197 \text{ cm}^2/\text{m}^3$ and $1433 \text{ cm}^2/\text{m}^3$. The biodiversity of other wood colonized fungi on logs was greater in the *Oxalidosa turf. mel.* than in the *Hylocomiosa* type: 45 and 24 species ($p=0,007$). On windthrown trees with uplifted root system, ca. 70% fruit bodies were found on stems and 30% on roots (Figure 3).

Fruit bodies were found also on very heavily decayed spruce wood – trees that were windthrown more than 10 years ago. Stumps with uplifted roots developed approx. two times more fruit bodies as compared with standing stumps. Factors favouring formation of sporophores are large upper roots of stumps and abundant ground vegetation.



Figure 2. Two years old fruit bodies of *H. parviporum* on decayed spruce log in a *Oxiladosa turf. mel.* forest type stand



Figure 3. *H. parviporum* fruit bodies on a stem of windthrown spruce on previous agricultural land

On the basis of the obtained data we recommend to remove coarse wood debris infected by *H. annosum* from forest stands [6]. It would be important to remove also infected stumps, at least on sites where are many stumps with a partly uplifted root system [2]. To evaluate the effect of stump removal on decay causing fungi *Heterobasidion* and *Armillaria* in 2012, five sample plots were established to assess:

- effect of different methods of soil preparation on spread of *Heterobasidion* spp. in coniferous stands;
- how different sizes of infected roots remaining in the soil affect the potential of infection by root rot fungi in the next rotation;
- the impact of stump removal on morphology of roots of coniferous seedlings and vitality of mycorrhizae;
- morphological parameters of coniferous seedlings in control sites and sites with removed stumps;
- spread of *Heterobasidion* and *Armillaria* spp. genotypes in infested sites;
- influence of stump removal on ground vegetation, lichens and insect diversity.

Decayed stumps are the main element for secondary spread of pathogen, but infection of fresh healthy stumps by spores creates new disease centres of *Heterobasidion* [5]. In a study on *Heterobasidion* spore production carried out in 2012 it was found that stumps in Latvia are subjected to spore infection from the end of April till November (Figure 4).

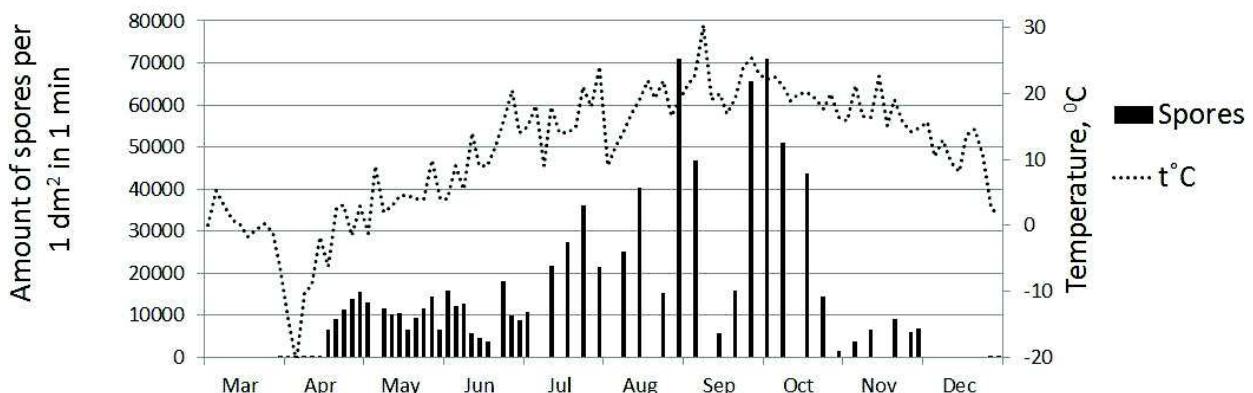


Figure 4. Sporulation dynamics of *H. parviporum* fruit bodies in 2012 (data on five fruit bodies from April till December)

Season, temperature and relative air humidity affect the spore production. Maximum production was measured in August and September: on average, 35 000 spores per dm² in 1 min under fruit bodies. To diminish the spread of *Heterobasidion* root rot, the biological control agent Rotstop, containing oidia of *Phlebiopsis gigantea*, is used in northern Europe. Since 2008, a Finnish preparation is used for treatment of conifer stumps in commercial thinning in Latvia [4]. From the point of view of biodiversity, to diminish effect of the single Rotstop genotype on the *P. gigantea* local population, it would be better to use native strains of *P. gigantea*. Starting from 2006, more than 100 strains of *P. gigantea* have been collected from different parts of Latvia. Several parameters like mycelium growth

rate, antagonism against *Heterobasidion* (*H. annosum* sensu stricto and *H. parviporum*) and oidia production were tested in the laboratory. For screening of the growth rate of *P. gigantea* strains, experiments were carried out in stem log pieces (billets) of spruce and pine. Two inoculation methods of fungus were used: spraying oidial suspension and pit method. Using the pit method, an oidial suspension is placed in a pit made on the cutting surface of the billet. With the latter method it is possible to test up to 15 strains in the same log piece. In further work on billets and stump experiments in the forest, antagonistic properties of *P. gigantea* strains against *H. annosum* were tested. The efficacy of Latvian strains was compared with the efficacy of Rotstop. Several strains were selected that did not show significant difference from the Rotstop preparation of Finnish origin. In spruce, control efficacy of these Latvian strains was 92 – 95%, compared to 96 – 97% for Rotstop. In further investigations we are planning to analyse effectiveness of mixtures of different *P. gigantea* strains in the treatment suspension.

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МАКРОСИСТЕМА ГРИБОВ – 2015

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FUNGAL MACROSYSTEM – 2015

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В связи со все более совершенствующимися методами исследований, используемых в систематике и таксономии грибов, система грибов динамически развивается, накапливая все больше фактов, которые делают ее все более совершенной, приближая ее к той естественной системе, которая отражала бы филогенетические связи внутри царства грибов и которая надолго останется идеалом, к которому будут стремиться микологи-систематики.

Широкое применение биохимических и молекуллярно-генетических методов в систематике грибов и грибоподобных организмов в последние два десятилетия привело к целому ряду