Annex 2b. Summary of Professional Achievements (in English)

Contest

1. Name and surname

Paweł Zarzyński

2. Diplomas and degrees – with the name, place and year of them obtaining and the title of the doctoral dissertation

Ph.D. in Forest Sciences, Apr 6th, 2004

Faculty of Forestry, Warsaw University of Life Sciences – WULS-SGGW

Supervisor: prof. dr hab. Andrzej Grzywacz

Doctoral thesis title: ‘The methods of decreasing the rot of oak and lime wood by injection with systemic fungicides’ („Ograniczanie zgnilizn drewna dębów i lip za pomocą iniekcji fungicydami systemicznymi”).

Master of Science in Forestry, May 25th, 2000

Faculty of Forestry, Warsaw University of Life Sciences – WULS-SGGW

Supervisor: prof. dr hab. Andrzej Grzywacz

Master thesis title: ‘The Honorary Members of Polish forest Society in years 1882-2000’ („Członkowie Honorowi Polskiego Towarzystwa Leśnego w latach 1882-2000”)

3. Information on education and employment

I was born on February 25th, 1976 in Sochaczew. In 1991, I graduated the Gen. Stanisław Grzmot Skotnicki Primary School in Młodzieszyn and I began to study in the Fryderyk Chopin High School in Sochaczew. In 1995 I received a high school diploma with distinction and a medal. After graduating from high school, I entered the Faculty of Forestry of the Warsaw University of Life Sciences. During my studies I specialized in the field of nature protection. I obtained my master's degree in forestry on May 25th, 2000, based on the thesis entitled ‘Honorary Members of the Polish Forest Society in years 1882-2000’ written under the supervision of prof. dr hab. Andrzej Grzywacz. This work, in a slightly changed and expanded form, was published in the same year under the title ‘People and Facts’ on the occasion of the 100th Jubilee Congress of Polish Forest Society, which took place in September 2000 in Poznań. After receiving my diploma, I was admitted on June 1st , 2000 to the full-time Doctoral Studies at the Forest Department of the Warsaw University of Life Sciences. Specializing in the field of mycology and phytopathology under the supervision of prof. dr hab. Andrzej Grzywacz, I conducted research in the Section of Forestry Microbiology and Phytopathology at the Department of Forest Protection and Ecology and I prepared a dissertation entitled: “The methods of decreasing the rot of oak and lime wood by injection with systemic fungicides". On its basis, on April 6th, 2004, I obtained the title of doctor of forestry sciences. As a PhD student in December 2003, I applied to the Scientific Research Committee of the Ministry of Science and Higher Education for funding a research project ‘Identification of fungicides naturally occurring in wood and their application for the protection of monumental trees against the rot of trunks’ under my leadership. This application was considered successfully and - thanks to the funds obtained – I was employed on 1st October 2004 in the Department of Forest Protection

and Ecology SGGW as a technical employee for a period of two years. In 2004-2007, I conducted research in the field of the above-mentioned research project.
At the same time, I started working in the zoological industry. In the years 2005-2015 I was employed as a manager in the marketing department in one of the largest European companies producing accessories for pets. From 2003, I also worked in thematic publications as: editor in the monthly magazine ‘Magazyn Akwarium’ (2003-2011), editor-in-chief of ‘Magazyn Akwarium’ (2011-2012 and 2015), editor-in-chief of the bi-monthly magazine ‘Akwarium’ (2011-2012), editor the editor of the monthly magazine ‘Zeszyty Akwarystyczne’ (2012), editor of the monthly magazine ‘ZooBiznes’ (2014-2015), editor of the monthly magazine ‘ZooBranża’ (from 2015) and editor of the bimonthly magazine ‘Pies Rasowy’ (from 2015). Since 2015 I have been running an independent business providing marketing services and related to the publishing industry.

4. Summary of scientific achievements

In total, I am the author or co-author of 50 scientific publications related to forestry published in peer-reviewed journals (of which 37 after obtaining the degree of doctor of forestry sciences). Their list can be found in Annex 3.

4.1. The number of scientific publications

Type of publication	**before doctor’s thesis**	**after doctor;s thesis**	**Total**
Original scientific articles	4	16	20
Review and popularizing articles in peer-reviewed journals	6	18	24
Book publications	1	4	5
Chapters in book publications	-	3	3
Conference publications	2	1	3
Total	13	42	55

4.2. Scientific indicators

Numerical indicators regarding publication	without publication being the subject of evaluation as a habilitation dissertation	together with publication being the subject of evaluation as a habilitation dissertation
Number of publications / scientific reports in total	**55**	**63**
- before doctor's thesis	**13**	**13**
- after doctor's thesis	**42**	**50**
Number of works in journals from the JCR list	**24**	**26**
- before doctor's thesis	**7**	**7**
- after doctor's thesis	**17**	**19**
The number of other works	**30**	**36**
- before doctor's thesis	**6**	**6**
- after doctor's thesis	**24**	**30**
Total Impact Factor of publication in accordance with the year of publication	**5,914**	**6,212**
- before doctor's thesis	**0**	**0**
- after doctor's thesis	**5,914**	**6,212**
The sum of MNiSW points according to the year of publication	**409**	**449**
- before doctor's thesis	**77**	**77**
- after doctor's thesis	**332**	**357**
The sum of MNiSW points according to the points from 2018	**596**	**677**
- before doctor's thesis	**131**	**131**
- after doctor's thesis	**465**	**546**

The number of citations according to the Web of Science database	**2**
Hirsch index according to the Web of Science database	**1**

5. The scientific achievement forming the basis for the habilitation procedure under art. 16 item 2 of the Act of March 14, 2003 on Academic Degrees and Titles as well as Degrees and Titles in Arts (Journal of Laws No. 65, item 595, as amended).

5.1. The title of scientific achievment forming the basis for the habilitation procedure

The scientific achievement forming the basis for the habilitation procedure consists of a series of eight original academic publications entitled 'Natural phenolic compounds in wood of different tree species and possibilities of their usability for protection of wood of monumental trees against fungal wood decay' („Naturalne substancje fenolowe występujące w drewnie oraz perspektywy ich wykorzystania do ochrony drewna drzew – pomników przyrody przed rozkładem przez grzyby").

5.2. The list of publications forming the basis for the habilitation procedure

1) Zarzyński P. 2007. The range of trophic preferences of Oak Mazegill (*Daedalea quercina* (L.): Fr.) isolate examined *in vitro*. Acta Scientiarum Polonorum Silvarum Colendarum Ratio et Industria Lignaria 6(2): 113-118 (punktacja MNiSW = 4).

2) Zarzyński P. 2009. Zdolność do dekompozycji drewna wybranych gatunków grzybów – sprawców rozkładu typu brunatnego w warunkach ex situ ('Wood decomposing ability of chosen fungi species causing the brown pattern of wood decay in *ex situ* conditions'). Sylwan 153 (8): 548-562 (punktacja MNiSW = 6, IF = 0,149).

3) Zarzyński P. 2009. Zakres zdolności i preferencji troficznych drewna izolatu pniarka modrzewiowego (*Fomitopsis officinalis* (VILL.) BONDARTSEV et SIGNER) pochodzącego z obszaru chronionego „Chełmowa Góra" badany w warunkach *in vitro* ('The range of trophic abilities and preferences of Fomitopsis officinalis (Vill.)Bondartsev and Singer isolate, collected in nature protected area of <<Chełmowa Góra>> and investigated in vitro'). Parki Narodowe i Rezerwaty Przyrody 28 (2): 15-28 (punktacja MNiSW = 2)

4) Zarzyński P. 2009. Identyfikacja i analiza ilościowa substancji o charakterze fenolowym naturalnie występujących w drewnie wybranych gatunków drzew europejskich i egzotycznych

('Identification and quantitative analysis of phenolic compounds naturally occuring in wood of selected European and exotic tree species'). Leśne Prace Badawcze Vol. 70 (1): 27-39 (punktacja MNiSW = 6)

5) Zarzyński P. 2009. Ocena zależności między występowaniem w drewnie substancji o charakterze fenolowym a jego rozkładem przez wybrane gatunki grzybów saprotroficznych i pasożytniczych ('Correlations between phenolic compounds in wood and its decay by chosen species of saprotrophic and parasitic fungi'). Leśne Prace Badawcze Vol. 70 (2): 113-122 (punktacja MNiSW = 6)

6) Zarzyński P. 2009. The evaluation of in vitro fungitoxicity of chosen phenolic compounds naturally existing in wood by using the AG nutrient agar medium tests. Acta Scientiarum Polonorum Silvarum Colendarum et Industria Lignaria 8(1): 43-54 (punktacja MNiSW = 4)

7) Zarzyński P. 2009. Wpływ iniekcji wybranych substancji fenolowych do pni żywych drzew na rozkład drewna powodowany przez grzyby ('The influence of phenolic compounds injections to the stems of living trees on wood decay caused by fungi'). Leśne Prace Badawcze Vol. 70 (3): 205–211 (punktacja MNiSW = 6)

8) Zarzyński P. 2009. Ocena praktycznej możliwości wykorzystania substancji fenolowych naturalnie występujących w drewnie do ochrony drewna drzew pomnikowych przed grzybami powodującymi jego dekompozycję ('The evaluation of practical usability of phenolic compounds naturally existing in wood for protection of monumental tree wood against fungi causing its decomposition'). Sylwan 153 (9): 579−586 (punktacja MNiSW = 6, IF = 0,149)

5.3. The scientific purpose of the above the work and results achieved, and discuss them possible use

The scientific aim of the research was to find in the wood natural chemical substances that could find practical use as safe fungicides and protective (impregnating) wood against decay by fungi, in particular in the case of old trees, living trees - nature monuments to extend their lives. The basis of this search was the assumption that for the differences in the rate of wood distribution of particular tree species by a given fungi species, the presence or absence of natural chemical compounds acting as inhibitors of its mycelium growth is responsible. The individual stages of work were as follows:

- in laboratory conditions, a range of trophic preferences was examined for 12 selected species of fungi decomposing wood in relation to wood 25 species of both European and exotic trees;

- laboratory identification of phenolic substances present in the wood of the 25 tree species was determined and their share in its dry mass was defined;
- using mathematical statistics tools (the study of the correlation between the share of individual substances in the dry matter of wood and the rate of its decomposition by particular fungi species), phenolic substances occurring in the wood of individual tree species that could inhibit the growth of mycelium of the fungi species examined were selected;
- the above fungicide and fungistatic substances have been acquired and their effectiveness has been experimentally confirmed (nutrient method);
- the composition of a mixture of active substances that could be a component of new fungicides for the protection of live wood of trees and usable wood was developed;
- mixtures of natural substances have been applied to live tree trunks (author's injection method), and the effectiveness of their action has been confirmed using laboratory tests (bold method).

The following species of fungi for the study were selected: *Daedalea quercina* (L.: Fr.) Pers., *Fomes fomentarius* (L.: Fr. Kickx), *Fomitopsis officinalis* (Vill.: Fr.) Bondartsev & Singer, *Fomitopsis pinicola* (Swartz: Fr.) P. Karst., *Heterobasidion annosum* (Fr.) Bref., *Laetiporus sulphureus* (Bull.: Fr.) Murrill, *Phellinus pini* (Brot.: Fr.) A. Ames, *Piptoporus betulinus* (Bull.: Fr.) P. Karst., *Schizophyllum commune* Fr.: Fr., *Serpula lacrymans* (Wulf.: Fr.) J. Schröt., *Stereum hirsutum* (Willd.: Fr.) Gray and *Trametes versicolor* (L.: Fr.) Pilát.

Among them were species causing different types of wood decay: white decay (*F. fomentarius, S. commune, S. hirsutum, T. versicolor*), white rot decay (*H. annosum, P. pini*) and brown decay (*D. quercina, F. officinalis, F. pinicola, P. betulinus, L. sulphureus, S. lacrymans*). Some species were typical tree parasites (*F. officinalis, H. annosum, P. pini*), others belonged to weakness parasites or saprothropes (*D. quercina, F. fomentarius, F. pinicola, L. sulphureus, P. betulinus, S. commune, S. hirsutum, T. versicolor*), and *S. lacrymans* belongs to the so-called domestic fungi that cause the decay of almost exclusively usable wood. Among the tested fungi, there were typically monophagic species (*D. quercina, F. officinalis, P. pini, P. betulinus*) occurring only on wood of one species of tree, as well as polyphagic species appearing on the wood of many of their species (others). Such a selection of test fungi was chosen for a view to the fullest possible and multifaceted testing of the trophic preferences of this group of organisms exhibited in laboratory conditions.

The mycelial strains of test fungi used in the research were collected in the forests of the Radziwiłł Forest District (*D. quercina, F. fomentarius, F. pinicola, H. annosum, L. sulphureus, P. pini, P. betulinus, S. commune, S. hirsutum, T. versicolor*) or obtained from the collection of pure cultures of the Department of Mycology and Forestry Phytopathology of SGGW-WULS (*F. officinalis, S. lacrymans* – the mycelium of *F. officinalis*, as a protected species, was previously obtained with the consent of the Main Nature Conservator of MOŚZNiL in the protected area "Chełmowa Góra" in the Świętokrzyski National Park for the purposes of the research project KBN No. 5PO6H02014 pt. Methods and conditions of endangered and disappearing reintroductions and translocations in arboreal fungi forests with healing properties). The mycelium of *F. officinalis* before using it in research, was passaged on European larch wood (*Larix decidua* Mill.), and the mycelium of *S. lacrymans* was passaged on Scots pine wood (*Pinus sylvestris* L.).

For the study the wood of 25 different species of trees, both European and exotic or introduced in Europe was selected. The first group included: silver fir (*Abies alba* Mill.), sycamore (*Acer pseudoplatanus* L.), common alder (*Alnus glutinosa* (L.) Gaertn.), European birch (*Betula pendula* Roth.), hornbeam (*Carpinus betulus* L.), European beech (*Fagus sylvatica* L.), European ash (*Fraxinus excelsior* L.), European larch (*Larix decidua* Mill.), Norway spruce (*Picea abies* (L.) Karst.), Scots pine (*Pinus sylvestris* L.), European aspen (*Populus tremula* L.), English oak (*Quercus robur* L.), willow (*Salix fragilis* L.), European lime (*Tilia cordata* Mill.) and white elm (*Ulmus laevis* Pall.). The second group was represented by: gaboon*/ „okume"** (*Aucoumea klaineana* Pierre), iroko* (*Chlorophora excelsa* Benth. & Hook syn. *Milicia excelsa* (Welw.) C. C. Berg.), courbaril* /„jatoba"** (*Hymnaea sp.*), merbau* (*Intsia bakeri* Prain), wengé (*Millettia laurentii* De Wild.), opepe* / „badi"** (*Nauclea trillesii* Merill), African padauk* / „padouk"** (*Pterocarpus soyauxii* Taubert), American red oak (*Quercus rubra* L.), ipé* (*Tabebuja sp.*) and obeche* / „samba"** (*Triplochiton scleroxylon* K. Schum.) (* names after Europaean norm EN-13556; ** - colloquial names commonly used in the wood industry).

From the seasoned wood of selected tree species, planed samples were made for use in subsequent stages of research.

Description of the achievements

The study of the rate of distribution of wood samples showed the existence of significant differences in the range of trophic abilities and preferences of the majority of tested species of fungi observed in laboratory conditions in relation to those known in nature. In most cases the range of trophic preferences of fungus species turned out to be much wider than that shown by its in nature - i.e. it was able to decompose the wood of a much wider spectrum of tree species. Also, the trophic preferences of individual species of tested fungi turned out to be most often different than in the natural environment – in many cases the fastest-decaying wood was the wood from trees, which are never their hosts in nature or are only sporadically.

Based on the chemical analysis of wood, there were found in the wood 47 phenolic substances present in various amounts in samples from all 25 tested tree species. Of these, 38 chemical compounds were identified. They were: Furfural (furaldehyde), Furfyryl alcohol, Furanone, Cyclohexanone, 2-Propenamide,N-(aminokarbonyl), 1,4-buthanodiamine-2,3-dimethoxy, 2-Cyclopentene-1-on-2-hydroxy-3-methyl, 1,4-dioxine-2,3-dihydro-5,6-dimethyl, 2,5-Furanodion-3-methyl, 2-furanocarboxy-5-(hydroxymethyl), Resorcinol, 2-metoxy-6-winylophenol, Syringol, Eugenol, Pyrogallol, Metoxybenzenodiol, Vanillin, Anisic acid, Isoeugenol, 1,6-Anhydro-beta-D-glucopyranose (Levoglukosan), Guaiacylo acethone, Vanillic acid, 3',5'-Dimethoxyacethophenone, Acethylobenzoic-2,5-dimethoxy acid, 2,6-Dimethoxy-4(propenyl)phenol, 3,4-dimethoxybenzoic acid, 4-hydroxy-3-methoxy acethylobenzoic acid, Syringe aldehyde, Coniferol, 2,6-Dimethoxy-4-(2-propenyl) phenol, Acetosyringolne+ ester of 4-hydroxy-3-methoxymethylo acetylosalicylic acid, 3-methxy cinnamic acid + Coniferol, 1-(2,4,6-trihydroxyphenyl)-2-pentanone, Palmitic acid, Isolapachol, 10-H-phenoxasilin-10,10-dimethyl, 9,12-octadecanoic Z,Z acid and alpha Lapachone.

Apart from the above chemical compounds the analysis also showed the presence of a number of other phenolic substances specific only to the wood of some of the species tested. They were: for *Tabebuja* sp. – Phenol, Guaiacol, 1,3-izobenzofuranodione, 1,4-ftalenodione—hydroxy; for *Hymnaea* sp.: beta resorcyloaldehyde; for *P. sylvestris*: Benzaldehyde, Benzyl alcohol, Benzyloacetone; for *Ch. excelsa*: 6-methylo-5-hepten-2-on, 2,3-dihydrobenzofurane (Coumaran), 4-hydroxy benzaldehyde; for *F. excelsior*: Guaiacol, 4-hydroxybenzenoethanol; for *P. tremula*: C6 acid or similar (closer identification was not possible); for *A. pseudoplatanus*: Guaiacol; for *S. fragilis*: 4-hydroxybenzaldehyde, 4-hydroxy propionic-benzoic acid and for *M. laurentii*: 2,5-dimethoxybenzyl alcohol, Phenol-4-(3-hydroxy-1-propenyl) and 1-propanone-3-hydroxy-1-(4-hydroxy-3-metoxyphenylol).

Looking for potential natural inhibitors of mycelium growth a total number of 1368 indexes of correlation between the content in wood 38 different phenolic substances, and the rate of its decomposition by 12 different test fungi species in three time variants (30, 60 and 90 days of exposure on mycelium) were calculated. In total, by comparing the results from all variants of the experiment, 10 substances that could be natural inhibitors of growth of fungi were found. These were: 2-Cyclopentene-1-on-2-hydroxy-3-methyl, Isoeugenol, 3',5'-Dimethoxyacethophenone, Furanone, 1,4-buthanodiamine-2,3-dimethoxy, Resorcinol, 1,6-Anhydro-beta-D-glucopyranose (Levoglukosan), Acethylobenzoic-2,5-dimethoxy acid, 2,5-Furanodion-3-methyl and Syringol. In total, there were also found 15 substances that could be natural fungal growth catalysers. These were: 2-furanocarboxy-5-(hydroxymethyl), 2-metoxy-6-winylophenol, Eugenol, Metoxybenzenodiol, Guaiacylo acethone, Vanillic acid, 3,4-dimethoxybenzoic acid, Syringe aldehyde, 1-(2,4,6-trihydroxyphenyl)-2-pentanone, Palmitic acid, Isolapachol, 10-H-phenoxasilin-10,10-dimethyl, alpha Lapachone, 4-hydroxy-3-methoxy acethylobenzoic acid and Coniferol.

The occurrence of correlation between the content of phenolic substances in wood and the rate of its decomposition by fungi may indicate the existence of natural inhibitors of this process in case of 6 species of fungi: *F. pinicola, H. annosum, L. sulphureus, P. pini, S. lacrymans* and *T. versicolor*. Analogical relations that may indicate the presence of natural mycelial growth catalysers in wood were detected for 9 species of fungi: *D. quercina, F. officinalis, F. pinicola, L. sulphureus, P. betulinus, S. lacrymans, S. commune, S. hirsutum* and *T. versicolor*.

Based on the results obtained in the previous phase of the experiment, 14 different phenolic substances were selected and purchased for testing in later stages of the study. They were: Eugenol, Vanillic acid, Isoeugenol, Cyclohexanone, Resorcinol, Syringe aldehyde, 2,6-Dimethoxyphenol, Pyrogallol, 4-dimethoxybenzoic acid, 2- Furfural, Furanone, 4-allyl-2,6-Dimethoxy-4-(2-propenyl) phenol, N',N',N',N' - tetramethyl-4-butanodiamine and 3',5'-Dimethoxyacethophenone. There were among them some compounds that on the basis of the statistical analysis results described above could be potential inhibitors of mycelium growth (Isoeugenol, Furanone, Resorcinol, 2,6-Dimethoxyphenol, N',N',N',N' - tetramethyl-4-butanodiamine, 3',5'-Dimethoxyacethophenone) as well as potential catalysers of mycelium growth (Eugenol, Vanillic acid, Syringe aldehyde, 4-dimethoxybenzoic acid). The other substances (Cyclohexanone, Pyrogallol, Furfural, 4-allyl-2,6-Dimethoxy-4-(2-propenyl) phenol) were not indicated by the results of statistical analysis, however, their exceptionally large variation in quantities in the wood of particular tree species allowed for the presumption of a possible potential impact on the growth rate of mycelium and encouraged to qualify for further research.

The nutrient tests were carried out for 14 substances mentioned above and 6 mixtures of them. The mixtures were: Eugenol + Isoeugenol (1:1); Pyrogallol + Resorcinol (1:1); Eugenol + Resorcinol (1:1); Eugenol + Pyrogallol (1 :1); Isoeugenol + Resorcinol (1:1) and Eugenol + Isoeugenol + 4-dimethoxybenzoic acid (1:1:1). As testing species *L. sulphureus* (brown pattern of wood decay) and *T. versicolor* (white pattern of wood decay) were used.

In the case of nutrient tests carried out on mycelium of *L. sulphureus* on the seven-point scale, the average result for the tested substances and their mixtures was equal 5,35 and the most effective among them were Eugenol (4) and Isoeugenol (4). In the case of nutrient tests carried out on mycelium of *T. versicolor* the average result for the tested substances and their mixtures was equal 5,55 and the most effective among them were Eugenol (4^{th} classs of fungitoxicity). Averaging the results for both fungi used in the test the most effective substances were: Eugenol (4,0), Isoeugenol (4,5), Pyrogallol (5,0), Furfural (5,0) and Resorcinol (5,0). These results are unsatisfactory from the point of view of the practical applicability of the abovementioned substances for the protection of wood against decomposition by fungi. In terms of the effectiveness of inhibiting the development of mycelium under the conditions of nutrient tests, they are much weaker than the currently used modern synthetic fungicides, especially systemic fungicides.

Although the results of the nutrient tests described in the previous section did not confirm their ability to inhibit the development of mycelium *in vitro*, it could not be ruled out that they would not be sufficiently active in the field. On the basis of the results of nutrient tests, five substances were selected that showed the strongest fungicidal activity in laboratory conditions (4^{th} class and lower classes of fungitoxicity). They were qualified for further research. These were: Eugenol, Isoeugenol, Furfural, Resorcinol and Pyrogallol. Solutions of these substances were given to a group of living test trees by hydrostatic injection.

The results of tests of wood samples collected from trees subjected to injection application of solutions of selected phenolic compounds have shown that all tested substances (Eugenol, Isoeugenol, Furfural, Resorcinol and Pyrogallol) given directly to the wood have the ability to protect it against decomposition by both mycelium of *L. sulphureus* (brown pattern of wood decay) and *T. versicolor* (white pattern of wood decay). The wood saturated with them was decomposed much slower than samples from control trees, and these differences were proved by statistical tests.

During the research, all the aims of the research project set at the beginning were implemented. First of all, the range of trophic preferences was determined for selected species of wood decomposing fungi. The presence in the wood of specific tree species of some substances that seemed to inhibit the growth of fungi was confirmed. These substances were isolated and labeled, then subjected to laboratory tests to confirm the effectiveness of their action. Finally, an attempt was made to develop mixtures of active substances that could be a component of new fungicides for the protection of live wood of trees and usable wood. These mixtures were applied to live tree trunks (injection method), and the effectiveness of this treatment has been confirmed in laboratory.

On the basis of the first stage of the research, the trophic abilities and preferences of selected species of fungi decaying wood against the group of tree species were determined. It turned out that the trophic preferences of particular mushroom species differ quite significantly from the typical range of their hosts observed in the natural environment.

Based on the obtained results, it was found that the trophic abilities of fungi decomposing wood tested in laboratory conditions does not match their preferences in nature and in practically all cases are much wider than it was possible to assume. This phenomenon can be explained by the fact that the wood used in the laboratory tests was dead wood, isolated from the living organism of the tree, and thus deprived of numerous chemical compounds resulting from the physiological process in the living plant organism.

Presumably, the presence of some natural metabolites in wood means that it is not a convenient medium for decomposing fungi. Another explanation may be the lack of a protective layer of bark, which in nature is a barrier difficult to pass for spores and hyphae of mycelium of many species of fungi. Significantly, the decomposition of tree wood of exotic species was relatively weakest. This can be explained both by the fact that as alien species for European species of fungi they do not constitute a good food base for them, as well as suppose that it may contain natural fungus growth inhibitors.

Chemical analysis of wood samples allowed to state that it usually contains small amounts of at least several dozen phenolic compounds. the majority of them occurred in varying amounts in the wood of all studied tree species, while only a relatively small group was appropriate for their specific species. The content of particular compounds in the wood of particular tree species was very different and in at least 25 cases it was possible to determine the existence of mathematical relationships between the amount of a given compound in wood and the degree of its decomposition by a given species of fungus. This allowed to assume that these compounds may be natural fungistatic substances that are able to both suppress and accelerate the development of mycelium.

On the basis of laboratory tests of wood obtained from trees injected with the tested substances, it turned out that all samples were slowerly decomposed by fungi than samples from control trees or only subjected to water injections. This dependence was confirmed by tests on two species of fungi, it concerned both samples taken from parts of stems below and above the injection point.

Based on the above results it can be assumed that in the wood of studied tree species there are no substances with strictly fungistatic activity in the traditional sense of the term (and thus destructive to fungal cells by damaging their cellular membrane, kariokinetic spindles during divisions of cell nuclei, mitochondria or ribosomes). However, because the wood saturated with them is clearly slowerly decomposed by fungi, it can be assumed that some of the phenolic substances identified in it, including eugenol, isoeugenol, resorcinol and 2-furaldehyde are able to 'impregnate' wood in a natural way, making them unsuitable or less useful from the point of view of particular species of fungi. The effectiveness of their operation is so high that it can be assumed with a high probability that, after additional tests, these substances will be able to find practical applications in protecting wood against decomposition by fungi, both in the case of usable wood and live wood, and in in particular, exceptionally valuable old trees – nature monuments.

Conclusions:

- In most cases, wood decaying fungi show in laboratory conditions a much wider range of trophic abilities than is indicated by their occurrence in natural conditions and they are able to use as a substrate the wood of a much larger number of tree species.
- The trophic preferences of fungi decaying wood tested in laboratory conditions are in most cases different than in nature - individual fungi break down the wood of tree species that are not their typical or most common hosts in nature.
- In the wood of each studied tree species, there are at least several dozen organic substances in trace quantities, most of which can be identified as phenolic compounds. A large group of phenolic compounds is present in the wood of each tested tree species, and a smaller group are compounds that are specific only to the wood of some of them.
- The total amount of phenolic compounds in wood is very variable, depends on the species of the tree, and is also positively correlated with the density of wood.

- Individual phenolic compounds occur in the wood of the studied tree species in various amounts and proportions, creating unique chemical sequences, whereas the content of some of the identified phenolic compounds in the wood of particular tree species is significantly lower or significantly higher in relation to the average value.
- There are numerous correlation relationships between the content in wood of individual phenolic compounds and the rate of wood's decomposition by selected species of saprotrophic and parasitic fungi that may indicate the presence of natural substances in the wood being inhibitors or catalysers for mycelium growth. At the stage of settling the wood by fungi and its initial decomposition, substances with a potential effect accelerating the growth of mycelium of particular fungi species seem to be more important, while in the later stages of decomposition the effects of substances with potential inhibiting abilities of mycelium appear.
- Potential inhibitors of mycelium growth in wood might be: 3',5'-Dimethoxyacethophenone, isoeugenol, 2-Cyclopentene-1-on-2-hydroxy-3-methyl; furanone (2-furanon); 1,4-buthanodiamine-2,3-dimethoxy N,N,N',N'tetramethyl; resorcinol, Levoglukosan, Acethylobenzoic-2,5-dimethoxy acid; 2,5-Furanodion-3-methyl and syringol.
- Potential catalysers of mycelium growth in wood might be: eugenol, guaiacylo acethone, 2-furanocarboxy-5-(hydroxymethyl) aldehyde, 2-Metoxy-6-winylophenol, metoxybenzenodiol, vanilic acid, 3,4-dimethoxybenzoic acid, syringe aldehyde, 1-(2,4,6-trihydroxyphenyl)-2-pentanone, palmitic acid, Isolapachol, 10-Hphenoxasilin-10,10-dimethyl, alfa Lapachone; 4-hydroxy-3-methoxy acethylobenzoic acid and koniferol.
- Phenolic compounds naturally present in wood in most cases do not exhibit fungistatic abilities that can be observed in vitro on the basis of nutrient tests.
- Despite the lack of the above capabilities, wood originating from trees subjected to hydrostatic injection with selected phenolic compounds is slower decomposed by fungi than wood from trees injected with water or control trees (without injection).
- Probably studied phenolic compounds, in spite of the lack of typical fungistatic abilities in nutrient studies, are able to naturally protect wood from decay by fungi making them inaccessible (or much harder to access) for this group of organisms.

- Natural phenolic compounds found in wood may find application in the future in the protection against the decomposition of fungi by both usable wood and wood of living trees, e.g. especially valuable trees - nature monuments.

6. The description of other scientific achievements

6.1. The description of scientific research not contributing to the habilitation

My research interests are focused on the subject of wood decay by fungi and the possibilities of decreasing this process. Conducting research during doctoral studies, I determined, on the basis of the field inventory, the group of fungi decaying oak and lime wood (I continued these studies in later years), collected mycelial cultures of selected species and subjected them to laboratory tests using artificial systemic fungicides. They included both nutrient tests and using samples of wood saturated with these preparations and subjected to controlled mycelium breakdown. Then I experimentally tested various possibilities of applying these substances to the wood of growing trees. The result of these experiments was the development of an original method of applying liquid substances directly to tree trunks using gravity injection. Using it, I tested several different systemic fungicides in terms of their use to protect the wood of live trees from decay by fungi. In later years, I confirmed the effectiveness of this method as a way of applying liquid substances to trees by conducting a series of experiments using artificial dyes. I also tested its effectiveness depending on the thickness of tree trunks to which it is applied. These studies have confirmed that it has all the basics for practically used to protect the wood of exceptionally impressive, monumental trees. I have also experimentally confirmed the effectiveness of the use of selected natural phenolic substances found in wood as a means of protecting them against degradation by selected species of fungi.

A separate direction of my research interests is the issue of old trees, natural monuments, their inventory and health assessment. In the years 2000-2001, I made an inventory of their documentation and determined the actual number of monumental specimens in Poland with a division into species (a survey method covering voivodships, poviats and communes throughout Poland). In the years 2001-2018, I made an inventory of over 500 of the most impressive monumental trees in Poland and neighboring countries. The result of this work was a series of publications in scientific and popular scientific journals regarding, among others current measurement data of these trees, their health status and issues related to the measurement methodology and determination of their thickness and age. I also published two comprehensive book publications of my co-authorship on nature monuments in Poland.

Currently, these studies are being continued, and one of their further goals is to prepare guidelines and lists of candidate trees, to cover new forms of protection resulting from the categorization of nature monuments (am idea to divide nature monuments into three categories depending on their environmental, historical and social significance).
A side-mainstream of my interests related to forestry is the history of this branch of industry and the discipline of science, especially seen through the prism of the achievements of its characters. I am the author of three books and numerous parts and chapters of monographic studies and independent publications in scientific and popular science journals (including on the history of forest education in Poland). I have developed, among others a historical outline of 'Sylwan' – the oldest European forest magazine, I prepare for publication the lives of subsequent Honorary Members of Polish Forest Society (PTL) (to which I belong since February 2001), for many years I have worked with the Biographical Dictionary of Polish Technicians edited by prof. Józef Piłatowicz where I worked out the biograms of distinguished figures of the Polish forestry. At the request of the PWN, I prepared an extensive chapter on the history of forest science for the needs of the edition of the publication entitled 'History of sciences and natural sciences'.
In addition to the subject of forestry, since 2004 I have been professionally involved with zoology, and especially with aquaristics. I am the author or co-author of over 3000 publications in this field, including 21 books, and further books are currently in preparation or awaiting for printing.

6.2 Other publications

Numerical comparison of publications

Type of publication	**before doctor's thesis**	**after doctor's thesis**	**Total**
Original scientific articles	4	16	20
Review and popularization articles in peer-reviewed journals	6	18	24
Book publications related to forestry	1	4	5
Conference publications	2	1	3
Chapters in books	-	3	3

Publications included in the achievement (habilitation)	-	8	8
Popular publications in non-referenced journals related to forestry	45	190	235
Biographical publications in forest dictionaries	-	26	26
Review and popularizing articles in peer-reviewed papers not related to forestry	-	5	5
Book publications related to zoology	-	21	21
Chapters in book publications related to zoology	-	1	1
Popular publications in non-referenced journals not related to forestry	51	3243	3294
Total	109	3536	3645

In addition to scientific publications, I have large journalistic achievements related to the promotion of forest knowledge including 235 articles published in 19 non-reviewed journals (popular science, popular publications, daily press - including 'Las Polski', 'Łowiec Polski', 'Poznajmy Las', 'Głos Lasu', 'Echa Leśne', 'Przyroda Polska', 'Fauna and Flora', 'Parki Narodowe'). I am also the author or co-author (minimum 50% of the work input in the preparation of the publication) of 21 book publications related to zoology issued in print in a total edition of over 50,000. copies.

I am also the author or co-author of numerous publications not related to forestry in the field of zoology, marketing, sales and sport. In total, I am the author or co-author of 3645 printed publications, which appeared in 72 Polish, Lithuanian, Russian, Hungarian and English periodicals (as of Mar 15th, 2019).

A list of the most important publications can be found in Annex 3.

6.3. The management of research projects

'Identification of fungicides naturally occurring in wood and their application for the protection of monumental trees against the rot of trunks' („Identyfikacja substancji grzybobójczych naturalnie występujących w drewnie oraz zastosowanie ich do ochrony pomnikowych drzew przed zgnilizną pni") – Scientific Research Committee, 2004-2006, research project no 2 P06L 044 27 – the chief of the project.

6.4. Scholarships and scientific awards

- Team Award of the Third Degree for the Didactic Achievements of the Rector of the Main School of Rural Life (for the book publication "The Great Atlas of Aquarium Fish" – Aug 31 2016)

7. Didactic activity

My didactic achievements include conducting in 2000-2004 classes with full-time and extramural students of the Faculty of Forestry on Warsaw University of Life Sciences as part of the forest phytopathology subject (stationary and field exercises) and nature conservation (field exercises). In 2003, I also ran facultative faculties at the Faculty of Forestry: ‘Monumental trees of Poland and the World’.

In the years 2006-2008, I was four times co-host of the original lecture faculty of the university on ‘The basics of freshwater aquarium’, which was very popular among students. Since 2008 I have been regularly conducting analogous classes with lectures in English for participants of foreign studies at the Faculty of Veterinary Medicine at the Warsaw University of Life Sciences. In addition, since 2008 I am a co-host of the original faculty ‘Exotic pets at home’ addressed to the students of the first year of full-time studies at the Faculty of Medicine. Veterinary WULS-SGGW. In 2015-2016 and 2019, I conducted classes for specialty participants in postgraduate studies on ‘Diseases of non-domestic animals’ (specialization No. 10) at the Faculty of Veterinary Medicine at WULS-SGGW. In 2017, in cooperation with the Faculty of Animal Sciences, WULS-SGGW, I conducted original classes for SGGW students entitled ‘Aquarium Academy’ covering a 30-hour theoretical and practical course on setting up and caring for an aquarium. I have also performed many times on the radio and TV talking about fishkeeping and old trees - nature monuments.

In addition to teaching at the Warsaw University of Life Sciences, I have been regularly conducted lectures and seminars in the field of aquaristics and zoology, as well as sales and marketing for hobbyists and zoological business representatives for over 15 years. Such seminars were repeatedly conducted by me, among others in Poland, Russia, Lithuania, Latvia, Ukraine, Belarus, Moldova, Germany, Spain, Romania, the Czech Republic, Slovakia, Sweden, Finland, Italy in Polish, English and Russian.

8. Organizational activity

Since 2001, I have been a member of the Polish Forest Society (PTL). I participated in several PTL Congresses (in Poznań, Zielona Góra, Supraśl). I am the author of two books and a dozen articles about the history of PTL, mainly biographical materials about its members. Another book publication under the working title 'Chronicle of the Polish Forest Society 1882-2019' is currently under preparation - the planned date of its publication - the second half of 2019.

Paweł Rzempiński