University of Sopron

Faculty of Forestry

Thesis of PhD dissertation

EXAMINATION OF BEETLE COMMUNITY IN TINDER FUNGUS

Réka Andrési

Sopron

2022

Doctoral school: Roth Gyula Doctoral School of Forestry and Wildlife Management Sciences

Head of Doctoral School: Prof. Dr. Sándor Faragó

Program: Biological Basis of Forest Management (E2)

Program Leader: Prof. Dr. Ferenc Lakatos

PhD Supervisor: Dr. habil Katalin Tuba

Introduction

We posses lesser knowledge about species, which are indirectly connected to deadwood (e.g.: deadwood decomposing tinder fungi), than about those communities which are directly connected to deadwood. In Hungary, the research of insect communities belonging to tinder fungi is lacking. After studying the relevant European scientific literature, I came to the conclusion that this topic is most frequently occurs in the studies of Scandinavian countries.

The decomposition of deadwood is a fundamental biological process. The majority of tinder is decomposed by fungi, however bacteria also partake in this process. Fungi are unable to decompose completely intact tinder, so the role of insects is equally important in this process, which begins with the activity of xylophage insects and followed by the tinder fungi. During their activity, the tinder becomes available for other decomposer organisms. The process of complete decomposition includes the decomposition of the tinder fungi, which is carried out by tinder fungi beetles.

Aims

During my research, my aim was to explore the insect communities of Hungarian tinder fungi. During the evaluation of the study results, the huge amount of data forced me to narrow my scope and only examine the beetle communities of tinder fungi. As I also mentioned in the introduction, there were only a few research conducted in this topic in Hungary, so I considered an important task to also set up an appropriate methodology.

During my research, I aimed to answer the following questions:

1. In Hungary, few people have previously studied the beetle community of tinder fungi. Thus, the aim of my research was to expand this knowledge. Based on my hypothesis, a rare or possibly new species may occur in association with tinder fungi.

    - Which species are connected to the fruiting bodies collected during the examinations?

- Which tinder fungi species has the most species-rich beetle community?

- Which are the dominant beetle species?

- Regarding the Hungarian beetle fauna, could a new species be found in the fruiting bodies of tinder fungi?

2. According my hypothesis, by comparing my results and the scientific literature, I can get a more accurate picture of the life cycle and relationship systems of beetle species.

   - What kind of life cycle can the cultivated species suggest?

   - Regarding their lifestyle, only specifically tinder fungi associated species can be cultivated from the samples?

3. Examining the beetle assemblage of the same tinder fungus, *Fomes fomentarius*, within a year, I hypothesized that there may be a difference in the date of the different seasons of collection. In my opinion, it was important to collect the samples from the same area and, if possible, from the same dead tree.

   - Is there a seasonal difference in the beetle species composition and abundance conditions of the *Fomes fomentarius* fruiting bodies collected from the same host plant?

   - What is the season when the largest number of species and the largest number of individuals can be found in *Fomes fomentarius*? Which seasons are most similar or different in terms of species and number of individuals?

   - How does the collection time of fruiting bodies affect community ecological indicators?

4. I hypothesize that a comparative study of the same fungus species, *F. fomentarius*, collected from several parts of the country there are differences in the species composition of tinder fungi species according to the forestry region.

- What differences can be observed between the beetle assemblages of *Fomes fomentarius* bodies from different collection sites?

- Are the dominance conditions of beetle assemblages different in the case of fruiting bodies collected in different forestry regions?

- In the case of fruiting bodies from different collection sites, how do the typical ecological indicators develop?

5. In my assumption, the age, size, and collection season of the fungus all affect the composition and quantity of species that can be cultivated from the fruiting bodies. Based on my hypothesis, the higher the weight and volume of the fruiting body, the more beetles can be cultivated. My hypothesis is that the older the fungus, the numbers of cultivated species and individuals are also higher.

    - What relationship can be discovered between the age of the fungus, the size of the beetle and the season of fruiting body collection?

    - Is there a correlation between the increase in the volume and weight of fungi and the number of species and individuals cultivated from them?

6. I also assumed a correlation between the extra information (e.g.: the designation of the host plant, the quality of the host plant, the exposure of the fruiting body, the vertical location of the fungus, the number of individuals of the fungi located near the collected fruiting body and the cultivated beetle assemblage) recorded when collecting the tinder fungi.

    - How does exposure of the location of the fruiting body affect the number of species and individuals?

    - Does the quality of the host plant and the host plant itself affect the beetle community of the tinder fungi?

- Does the height of the fruiting body from the ground affect the beetle fauna of the tinder fungus?

- Can the same or different species of fungi in the vicinity of the collected fruiting body result in a higher number of species and individuals?

Materials and methods

The process of sample collection, rearing, and data processing consisted of three main parts. During the research, there were continuous improvements in the methodology. First, I studied what kind of beetle community is bound to different tinder fungi. The tinder fungi were collected from the different parts of Hungary. The study was performed not systematically between April and October 2013. In the second study, I chose to investigate beetle community of *Fomes fomentarius*, which is a common tinder fungus in Hungary. Every month for a year, between October 2015 and October 2016, *F. fomentarius* fruiting bodies were collected from the same lying deadwood host in the same place. The aim of the study was to compare the beetle community of *F. fomentarius* fruiting bodies collecting in different seasons. In the first study, the rearing cycle was eight weeks long and in the second it was six weeks long, I placed the collected fruiting bodies in paper bags, which have been recorded the place and time of the collection, and the age of the fungus, the designation of the host plant, the quality of the host plant. In the third study, I examined the beetle community of *F. fomentarius* fruiting bodies which were gathered from different parts of the country 2017 spring and autumn. Rearing was even more frequent than in previous studies, twice a week for two months, once a week for four months, and every two weeks for six months. During the third examination however, I placed them in plastic buckets already equipped with ventilating material. The information recorded during the sample collections was also constantly expanding, in the third phase, the exposure of the location of the fruiting body, the height of the placement of the tinder fungi from the ground and the names and quantities

of fruiting bodies located within a radius of 1 meter and 10 meters have also been recorded.

Results and conclusions

I conducted my research in several parts of the country from spring of 2013 to autumn of 2017. During this time, out of 345 fruiting bodies of 28 tinder fungi species, a total of 28,950 individuals of 75 insect species were cultivated. Of these beetles, 48 species and 28,736 individuals were accurately identified. 99% of the identified species have a lifestyle that is specifically associated with tinder fungi, but there have also been species such as predators, herbivores and bark-dwelling species. In my studies, most of the species and individuals were identified from the Ciidae family.

In the primary, general studies, I dealt with one-year-old and multi-year-old fruiting bodied tinder fungi separately. In the case of one-year-old fruiting bodies, the *Trametes gibbosa* had the most diverse beetle assemblages, of which *Cis boleti* was the most abundant species. Meanwhile in the case of multi-year-old fruiting bodies, *Fomes fomentarius* had the most diverse beetle community, from which *Rhopalodontus perforatus* hatched with the largest numbers. As a result of the study, I came to the conclusion that the life cycle of beetles is presumably fast, they can mate within a short time after hatching.

For the second stage of the research, I chose *F. fomentarius*, I examined the yearly changes of the tinder fungi's beetle assemblages. In terms of species numbers, the samples collected in the spring showed uniformity, while the samples collected in September showed outstanding values. Examining the number of individuals, the samples collected in the spring showed the higher beetle numbers. Overall, the number of species and individuals is also higher in younger fruiting bodies. To compare the diversity, I used Rényi's diversity profiles. The obtained profile shows a higher diversity value in the case of autumn samples, while the lowest diversity was observed in the summer samples, which is caused by the decrease in activity at the end of the summer. Correlation studies show a significant positive relationship between beetle body size and number of individuals, and beetle body size and species number.

In the third stage of the study, *F. fomentarius* fruiting bodies were collected from several parts of the country. The species numbers were the highest in the samples from the Great Plane and Northern Central Mountain, the specimen number was highest in the samples from Sothern Transdanubia, but in this case the data can only be considered as informative, since the least number of fruiting bodies was collected from here. In terms of dominance, *Rhopalodontus perforatus* was the most dominant species, except in the Transdanubian Central Mountains. The community ecological results were firstly examined via dominance and diversity values. Comparing spring-autumn collected tinder fungi in Mátra, the autumn samples have the higher diversity and equitability values. In my case, the higher equitability was caused by lower species numbers. The greatest similarity was found in the results of the forestry regions of the Northern Central Mountains and the Great Plain. In the dendrogramed hierarchical cluster analysis based on the number of individuals – due to the different number of samples – I re-proportioned the numbers of individuals of the beetle species with the number of fruiting bodies collected from the given forestry region from which successful rearing took place. Based on the Jaccard species identity index, the beetle assamblages of the Transdanubian Mountains and the Great Plain showed the greatest similarity. While in the case of the Bray-Curtis species identity index, the beetle assemblages collected from the forestry region of the Great Plain and Western Transdanubia showed the greatest similarity. Based on these, it can be assumed that tinder fungi have similar species stock in Hungary, regardless of their location. The analysis between the beetle assamblage of the tinder fungi and the exposure of the fungi was performed by canonical correlation analysis, which results showed a significant positive relationship can be read in the theses. Correlation studies show a significantly positive relationship between the weight of fruiting bodies and the number of beetle species cultivated, as well as between the volume of fruiting bodies and the number of beetle species. So, the larger the size (weight, volume) of the tinder fungi, the more species-rich assemblage is associated with them. A significant positive correlation is also observed between the number of tinder fungi in the radius of 1 m and 10 m of the collected fungal bodies and the age of the fungi. There is a positive relationship between the number of beetles and other fungal species in their environment. So the beetles might spread while walking on the ground. Based on the correlation, a positive relationship can also be observed between the number of tinder fungi in the 1 m radius of the collected tinder fungi and the number of tinder fungi in the 10 m radius. Studying the beetle

community, there is a significantly positive correlation between *Bolitophagus reticulatus* and *Neomida haemorrhoidalis*.

Theses

1. According to the studies, *Cis jacquemartii* is a species with a sporadic occurrence in Hungary in the case of *Fomes fomentarius*. In *Fomes fomentarius*, the beetle species with the highest dominance value was *Rhopalodontus perforatus*.

2. In tinder fungi not only fungi-consuming species can occur, but according to the results of my studies, 99% of the cultivated beetle species were mycophagous. 1% of the identified beetle species (66 individuals of 15 species) occurred in fungi through indirect connections. For example, tinder fungi can also be used as habitats, feeding grounds, and hiding places for predatory species (*Paromalus flavicornis*), herbivores (*Hydrothassa marginella*) and bark-dwelling beetles (*Litargus connexus*).

3. The species with the highest dominance value of the tinder fungi (*Fomes fomentarius*) collected in different seasons are different. The most dominant species of tinder fungi collected in autumn were *Neomida haemorrhoidalis*, while *Dorcatoma robusta* in winter-collected fungi, *Bolitophagus reticulatus* in spring-collected samples, and *Rhopalodontus perforatus* in summer-collected fungi.

4. Regarding the collection seasons, the highest abundance value was given by the results of spring sampling. In the spring, due to the onset of vegetation, the moisture content of the tree species and thus of the tinder fungi is also higher, which presumably also provides a more valuable nutrient for the fungal beetles. The lowest abundance value was given by fruiting bodies collected in summer as a result of the decrease in beetle activity.

5. There is no significant positive relationship between the *Fomes fomentarius* fungal beetle assemblages and the age of the fruiting bodies, the seasonal collection of the tinder fungi and the fungal beetle assemblages, and the collection site of fruiting bodies and the fungal beetle assemblages. This suggests that the domestic beetle community of *Fomes fomentarius* may have a similar species stock, regardless of collection the time, collection place, and age of the fungus.

6. A significantly positive relationship can be observed between the number of individuals of the following species:
   - Between *Neomida haemorrhoidalis* and *Dorcatoma robusta*, *Cis castaneus*, *Bolitophagus reticulatus*.
   - Between *Bolitophagus reticulatus* and *Rhopalodontus perforatus*.

   The significantly positive relationship may be due to the fact that the above-mentioned species can use each other's passages and divide food properly.

7. Examined by canonical correspondence analysis, there is a significantly positive relationship between exposure and some beetle species:
   - Between Northern exposure and *Rhopalodontus baudueri*, *Rh. perforatus*, *Sulcacis fronticornis*, *Dorcatoma minor* and *Cis boleti*.
   - Between North-Eastern exposure and *Cerylon ferrugineum* and *C. histeroides*, furthermore *Neomida haemorrhoidalis*, a species that did not prefer southern exposure in Hungary, contrary to the literature. The average temperature in Hungary is higher than the average temperature in the Scandinavian areas, so in Hungary the cooler exposure is preferred, while in the colder place the warmer exposure is preferred. Its temperature optimum may be between Hungary and the Scandinavian areas.

- Between South-Eastern exposure and *Xylographus bostrichoides* and *Litargus connexus* species.

8. Based on the correlation analysis, there is a significantly positive relationship between the weight of the fruiting bodies and the species numbers of beetles cultivated from them, and between the volume of fruiting bodies and the species numbers of cultivated beetles. The larger the fruiting body, the greater the amount of food available for mycophagous species, as a result of which not only is there a possibility of a higher number of individuals, but the food may be distributed among several species.

9. There was a significantly positive correlation between the number of *Fomes fomentarius* fruiting bodies in the radius of 1 m and 10 m of the harvested fruiting bodies and the age of the harvested *Fomes fomentarius*. The more vegetation cycles a tinder fungus has in the area, the more spores can it spread, resulting in a greater number of fruiting bodies appearing within a 10 m radius.

10. Other tinder fungal species present in their environment have a significant positive effect on the number of beetles cultivated from the harvested fruiting body, thus, they are not necessarily required to fly for food, but are more likely to expand on the ground.

Publications

Scientific essays

Andrési R. (2018): Különböző korosztályú kultúrfenyvesek erdészeti károsítói és kórokozói hazánkban. Soproni Egyetem, Erdőmérnöki Kar. Szigorlati dolgozat, Sopron. 29 p.

Andrési R. (2016): Bükktapló (*Fomes fomentarius* L.) rovarközösségének éven belüli változása. Nyugat-magyarországi Egyetem, Erdőmérnöki Kar. Szakdolgozat, Sopron. 61 p.

Andrési R (2015): Taplógombák rovarközösségének vizsgálata. Nyugat-magyarországi Egyetem, Erdőmérnöki Kar, Diplomamunka, Sopron. 68 p.

Andrési R. (2014): Taplógombák rovarközösségének vizsgálata. Nyugat-magyarországi Egyetem, Erdőmérnöki Kar, TDK dolgozat, Sopron. 43 p.

Book chapters

Andrési R. és Tuba K. (2021): A Tanulmányi erdő taplóiban előforduló bogarak. In: Andrési P. (szerk.): Az ásotthalmi Tanulmányi erdő állatvilága. pp. 191-204.

Andrési R. és Tuba K. (2017): A lombos fák taplógombáinak mikofág bogárvilága. In: Szabó P. (szerk.): Kutatás-fejlesztés- innováció az agrárium szolgálatában. pp. 111-118. (ISBN 978-963-286-726-7)

Peer reviewed scientific journal articles

Andrési, R. and Tuba, K. (2018): Comparative study of the *Fomes fomentarius* and *Trametes gibbosa* beetle communities in Hidegvíz Valley, Sopron Mts., Hungary. *Community Ecology*. 19(2): 141-147.

Andrési R., Janik G., Fürjes-Mikó Á., Eötvös Cs. B. és Tuba K. (2018): A bükkfatapló [*Fomes fomentarius* (L. ex. Fr.) Kickx.] bogárfaunisztikai vizsgálata Magyarországon. *Erdészettudományi Közlemények* 8(2): 71-82.

Proceedings, studies, conference-publications

Andrési R. és Tuba K. (2018): Bükkfatapló rovarközösségének összehasonlítása irodalmi adatok alapján. In: Bidló A. & Facskó F. (szerk.): VI. Kari Tudományos Konferencia. Konferencia kiadvány. Soproni Egyetem Kiadó, Sopron. pp. 158-163. (ISBN 978-963-359-088-1)

Andrési, R. and Tuba, K. (2017): Comparative study of the *Fomes fomentarius* and *Trametes gibbosa* beetle community in Hidegvízvölgy. In: 1st International Conference on Community Ecology. Book of abstracts. Akadémiai Kiadó, Budapest, 2017. pp. 99-100. (ISBN 978-963-454-170-7)

Andrési R., Tuba K., Andrésiné Ambrus I. és Andrési P. (2017): Az ásotthalmi Bedő-liget bükkfatapló közösségének több szempontú összehasonlítása. In: Csiha I., Kamandiné Végh Á. & Nagy A. (szerk.): Alföldi Erdőkért Egyesület Kutatói Nap: Tudományos Eredmények a Gyakorlatban. pp. 106-115. (ISBN:978-615-80594-1-1)

Andrési, R. and Tuba, K. (2016): Diversity of beetle communities in tinder fungus (*Fomes fomentarius*). In: Ács K., Bencze N., Bódog F., Haffner T., Hegyi D., Horváth O. M., Hüber G. M., Kis K. B., Lajkó A., Mátyás M., Szendi A. & Szilágyi T. G. (szerk.): V. Interdiszciplináris Doktorandusz Konferencia Konferenciakötet: 5th Interdisciplinary Doctoral Conference Conference Book. Pécsi Tudományegyetem Doktorandusz Önkormányzat, Pécs. pp. 4-12. (ISBN:978-963-429-039-1)

Andrési R., Tuba K., Andrésiné Ambrus I. és Andrési P. (2016): Az ásotthalmi Bedő-liget bükkfataplóinak (*Fomes fomentarius* (L.) FR.) bogárközössége. In: Lipák L. (szerk.): Alföldi Erdőkért Egyesület Kutatói Nap XXVI.: Tudományos Eredmények a Gyakorlatban. pp. 49-53. (ISBN:978-615-80594-0-4)

Andrési R. és Tuba K. (2015): A taplók szerepe az erdei életközösségben. In: Lipák L. (szerk.): Alföldi Erdőkért Egyesület Kutatói Nap XXIII. Tudományos eredmények a gyakorlatban. pp. 96-103. (ISBN: 978-963-12-3841-9)

Andrési, R. and Tuba, K. (2014): Examination of beetle community in tinder fungus. IX. International Euroasian Symposion. ЛЕСА РОССИИ И ХОЗЯЙСТВО В НИХ 50: 26-28. Ekaterinburg.

Articles published in a professional promotional journal

Andrési R. és Tuba K. (2019): Bükkfatapló (*Fomes fomentarius*) bogárközösségének éven belüli változása. *Erdészeti Lapok*. 154(4): 119-120.

Oral presentations

Andrési R. és Tuba K. (2017): A bükkfatapló bogárközösségének éves változása az ásotthalmi Bedő-ligetben. XII. Regionális Természettudományi Konferencia. Szóbeli előadás. Szombathely, 2017.01.25.

Andrési R. és Tuba K. (2017): A taplógombák lebontását végző mikofág bogarak bemutatása. Herman Ottó Szakkollégium. Szóbeli előadás. Sopron, 2017.04.27.

Posters

Andrési R., Tuba K., Andrésiné Ambrus I. és Andrési P. (2017): Az ásotthalmi Bedő-liget bükkfatapló közösségének több szempontú összehasonlítása. Alföldi Erdőkért Egyesület Kutatói Nap: Tudományos Eredmények a Gyakorlatban. Lakitelek, 2017. november 2.

Andrési R. és Tuba K. (2017): Bükkfatapló rovarközösségének összehasonlítása irodalmi adatok alapján. VI. Kari Tudományos Konferencia. Soproni Egyetem Kiadó, Sopron, 2017. október 24.

Andrési, R. and Tuba, K. (2017): Comparative study of the *Fomes fomentarius* and *Trametes gibbosa* beetle community in Hidegvízvölgy. 1st International Conference on Community Ecology. Budapest, 2017. szeptember 28-29.

Andrési R. és Tuba K. (2017): A taplógombákat lebontó leggyakoribb bogárfajok bemutatása. Élő Erdő Konferencia, Erdőgazdálkodásról és Erdőkezelésről Natura 2000 területeken. Sopron, 2017. március 21-22.

Andrési R., Tuba K., Andrésiné Ambrus I. és Andrési P. (2016): Az ásotthalmi Bedő-liget bükkfataplóinak (*Fomes fomentarius* (L.) FR.) bogárközössége. Alföldi Erdőkért Egyesület Kutatói Nap XXVI.: Tudományos Eredmények a Gyakorlatban. Lakitelek, 2016. november 3.

Andrési, R. and Tuba, K. (2016): Diversity of beetle communities in tinder fungus (*Fomes fomentarius*). V. Interdiszciplináris Doktorandusz Konferencia Konferencia. Pécs, 2016. május 27-28.

Andrési R. és Tuba K. (2015): A taplók szerepe az erdei életközösségben. Alföldi Erdőkért Egyesület Kutatói Nap XXIII. Tudományos eredmények a gyakorlatban. Kecskemét, 2015. november 5.

Andrési, R. and Tuba, K. (2014): Examination of beetle community in tinder fungus. IX. International Euroasian Symposion, Russia, Ekaterinburg, 2014. szeptember 23.