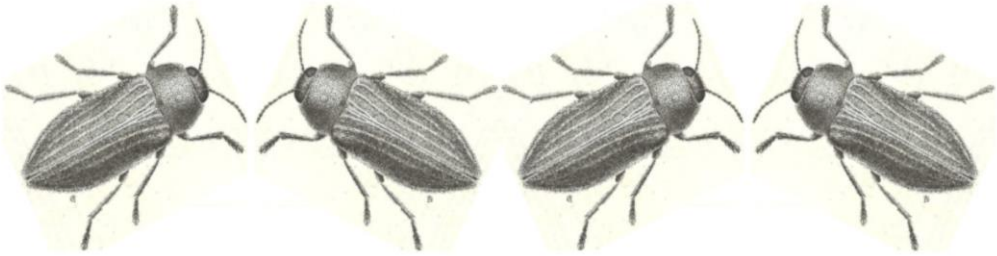
# 11th Symposium on the Conservation of Saproxylic Beetles



## Aranjuez, 14-16 September 2023

Organizing committee:

Marcos Méndez - Universidad Rey Juan Carlos (Madrid, Spain)

Tomasz Jaworski - Forest Research Institute (Raszyn, Poland)

Funding by:

Universidad Rey Juan Carlos

Photo credits: Pollarded poplars in river Alfambra, near Aguilar del Alfambra (Teruel, Spain) by Marcos Méndez.

Drawing of *Buprestis splendens* Fabricius, 1774 by Antonio Cobos, originally published in Cobos, A. (1953). *Boll. Assoc. Rom. Entomol.* 8: 27-33.

**Short program**

***Wednesday 13th September***

18:00-20:00 - Early reception of attendants

20:00 - Informal dinner

***Thursday 14th September***

9:00-9:30 Reception of attendants

9:30-10:00 Opening words

10:00-11:00 Invited talk

11:00-11:30 Coffe break

11:30-13:00 1st Session of talks

13:00-14:30 Lunch break

14:30-16:00 2nd Session of talks

16:00-16:30 Coffe break

16:30-17:30 3rd Session of talks

17:30-18:30 Poster session

20:30 Meeting dinner at *El Rana Verde* restaurant

***Friday 15th September***

9:30-10:30 Invited talk

10:30-11:30 4th Session of talks

11:30-12:00 Coffe break

12:00-13:00 5th Session of talks

13:00-14:30 Lunch break

14:30-16:00 6th Session of talks

16:00-16:30 Coffe break

16:30-17:30 Poster session

17:30-18:00 Assembly: organization of next meeting

18:00-18:30 Parting words

***Saturday 16th September***

9:00-18:00 Excursion to pine forests in the Serranía de Cuenca

## DETAILED PROGRAM

***Thursday 14th September***

9:00-9:30 Reception of attendants

9:30-10:00 Opening words

10:00-11:00 Key note speech (chairperson: Marcos Méndez)

**Tone Birkemoe** - *Saproxylic insect communities: importance, detection and conservation*

11:00-11:30 Coffe break

11:30-13:00 1st Session - Actions at the species level (chairperson: Koen Smets)

11:30-11:50 **Sylvie Barbalat** - *Promoting* Rosalia alpina *in the Swiss Jura*

11:50-12:10 **Nicklas Jansson** & Claud Youssif - *Not only stag beetle like constructed log piles*

12:10-12:30 **Indra Saenen** et al. - *Capture-mark-recapture across threatened stag beetle populations in Belgium: insights in population size and functional morphology along an urbanisation gradient*

12:30-12:50 **Arno Thomaes** et al. - *Evaluating log piles as stag beetle conservation measure*

13:00-14:30 Lunch break

14:30-16:00 2nd Session - Actions at the species level / Outreach (chair person: Estefanía Micó)

14:30-14:50 **Lukas Drag** et al. - *Large trees as the key habitat for endangered beetle: movement strategy of the great capricorn beetle* Cerambyx cerdo

14:50-15:10 **Marcos Méndez** - *Conservation status of* Buprestis splendens*: an update*

15:10-15:30 **Silvia Gisondi** et al. - *Results and perspectives from an Italian long-term citizen science initiative focused on protected saproxylic beetles*

15:30-15:50 **Dmitry Schigel** - *Stitching the field together through education: the dead wood courses*

16:00-16:30 Coffe break

16:30-17:30 3rd Session - Ecological insights (chair person: Sylvie Barbalat)

16:30-16:50 **Alice Lenzi** et al. - *On how the ecosystem engineering* Cetonia aurataeformis *(Coleoptera: Scarabaeidae: Cetoniinae) responds to climate change*

16:50-17:10 **Lisa F. Lunde** et al. - *Beetles disperse viable spores of a keystone wood decay fungus*

17:10-17:30 **Sandra Martínez Pérez** et al. - *The decline of saproxylic beetles in a time window: Who and how much?*

17:30-18:30 Poster session

20:30 Meeting dinner at *El Rana Verde* restaurant

***Friday 15th September***

9:30-10:30 Key note speech (chair person: Tomasz Jaworski)

Alessandro Campanaro [et al.]- *One species to rule them all, one species to find them, one species to bring them all: do umbrella species still offer new scientific insights? The case of the big protected saproxylic beetles*

10:30-11:30 4th Session - Monitoring and assessment (chair person: Tone Birkemoe)

- 10-30-10:50 **Aoife Crowe** et al. - *Sampling for saproxylic beetles in an important ancient woodland setting - an Irish context*
- 10:50-11:10 **Stephanie Skipp** et al. - *Saproxylic Stepping Stones: Supporting deadwood beetle diversity through tree age gaps*
- 11:10-11:30 **Dmitry Telnov** - *The first Latvian red list of saproxylic Coleoptera – «LIFE FOR SPECIES» project*

11:30-12:00 Coffe break

12:00-13:00 5th Session - Techniques (chairperson: Javier Quinto)

- 12:00-12:20 **Rick Buesink** - *Investigating invertebrates in Dutch tree hollows; can environmental DNA contribute?*
- 12:20-12:40 **Dmitry Telnov** - «*smarTrap*» ® *– a technologically advanced tool for monitoring and collecting insects*
- 12:40-13:00 **Petr Kozel** et al. - *Stable isotopes of saproxylic beetles reveal low differences among trophic guilds and suggest a high dependence on fungi*

13:00-14:30 Lunch break

## DETAILED PROGRAM

14:30-16:00 6th Session - Actions at the community level (chairperson: Jakub Horak)

14:30-14:50 Tomasz Grzegorczyk et al. (presented by **Lukáš Čížek**) - *The effect of coppicing on availability of tree related microhabitats and communities of saproxylic beetles in oak woodlands*

14:50-15:10 **Milda Norkute** et al. - *Effect of clearcut forestry on beetles in boreal spruce forests in Southeastern Norway*

15:10-15:30 **Jiří Schlaghamerský** et al. - *Saproxylic beetle assemblages before and after the restoration of coppicing in several forest stands in southern Moravia (Czech Republic)*

15:30-15:50 **Michal Perlík** et al. - *Response of saproxylic bees and wasps to different levels of post-disturbance logging – canopy openness more important than deadwood amount*

16:00-16:30 Coffe break

16:30-17:30 Poster session

17:30-18:00 Assembly: organization of the next meeting

18:00-18:30 Parting words

## KEY NOTE SPEECH

### Saproxylic insect communities: importance, detection and conservation

Tone Birkemoe

*Norwegian University of Life Sciences, Ås, Norway*

Insects represent the most species rich group in boreal forests, closely followed by fungi, and a large number of forests insect species depend on dead wood. Despite their high numbers, the importance of saproxylic insects in the forest ecosystem is only partly understood, as is the structure of their communities and the community's importance to maximize their functions. Novel methods for insect collection and identification is emerging and may potentially enable cost-efficient monitoring and surveys. However, even catches by well-established trapping methods are difficult to interpret. Forest products are an important part of a sustainable future and create pressure on harvesting and intensive management. Recently, the United Nations Biodiversity Conference (COP15) in Canada ended with a global agreement to halt and reverse nature loss, including putting 30 per cent of the planet and 30 per cent of degraded ecosystems, under protection by 2030. Thus, given the large areas covered by forests and the need for wood harvesting, this ecosystem will need particular attention. Knowledge of saproxylic insect communities is essential in order to make the best conservation measures. In my talk I will focus on challenges and knowledge needs to approach this goal.

## Promoting *Rosalia alpina* in the Swiss Jura

Sylvie Barbalat
*Consultant, Neuchâtel, Switzerland*

Pro Natura, a major NGO for nature conservation in Switzerland, actively promotes keeping dead wood in forests. *Rosalia alpina* was chosen as an ambassador species to highlight the importance of dead wood for biodiversity. The goal of this project was to enhance a population of *R. alpina* in the foothills of the Swiss Jura. We selected a forest where a few specimens of *R. alpina* had recently been observed (2005). The selected site is a beech-dominated stand about 700 m a.s.l. In 2013, a band of bark 50 cm high was removed around the circumference of healthy beeches (hereafter «ringed») between 25 and 55 cm in diameter. In 2014, we observed that young tree growth was rapid, which caused two problems. First, the young trees shaded the ringed trees, making them less attractive for *R. alpina*. Second, the presence of the young trees made it impossible for observers to see the exit holes at certain heights on standing trunks. Hence young trees were removed. In 2018, trees were controlled and thirteen exit holes of *R. alpina* on five dead beeches were counted: ten on lying trees and three on standing trees. The project was effective at promoting *R. alpina* in a managed forest. In a country such as Switzerland with a high density of forest paths and roads, it is difficult to find places where creating artificially dangerous trees by ringing them does not generate conflicts with public security. Collaborating with foresters in order to keep high stumps and dead trees in sunny places in managed forests is to be encouraged in order to conserve *R. alpina,* as well as less spectacular beetle species.

## Not only stag beetles like constructed log piles

Nicklas Jansson & Claud Youssif
*County Administration Board of Östergötland, Linköping, Sweden*

The tradition of burying wood in the ground to benefit the stag beetle (*Lucanus cervus*) is several hundred years old and originate from Germany. Starting again in UK for 25 years ago and in Sweden 10 years later we have learnt it work fine for the stag beetle. In a EU financed LIFE project a lot of log piles were constructed in 2018. The colonizing saproxylic beetle fauna were studied on 31 log piles three years later, in 2021. In total 3720 individuals from 220 species were collected. Many of them are very rare and on the Swedish redlist. The study also indicated the best results are obtained when constructed on sandy soils. The log piles can be used to boost the microhabitats in an area but can also act as bridges between areas of high conservation value to ease the dispersal of saproxylic beetles.

## Capture-mark-recapture across threatened stag beetle populations in Belgium: insights in population size and functional morphology along an urbanisation gradient

Indra Saenen[1, 2], Francesca Della Rocca[3], Elke Horemans[4], Sara Jafari[1], Arianna Tagliani[3], Karen Vancampenhout[4], Thomas Merckx[1]* & Arno Thomaes[2]*

*[1] Vrije Universiteit Brussel, Elsene, Belgium; [2] Research Institute for Nature and Forest, Brussels, Belgium; [3] University of Pavia, Pavia, Italy; [4] Catholic University of Leuven, Geel, Belgium*

*Shared senior authorship

The European stag beetle (*Lucanus cervus*) is a flagship species that declined due to habitat loss. Within Northern Belgium the species is listed as «Endangered», with few geographically and genetically isolated populations remaining in Flanders and Brussels. In order to assess the status of these populations, we conducted five capture-mark-recapture (CMR) surveys at three different sites in Flanders and Brussels along an urbanisation gradient. Our aim was to (i) quantify population dynamics by using Jolly-Seber models, (ii) compare functional morphology and male dimorphism, and (iii) assess mobility. We found male population sizes ranging from 69 to 220 males/year/ha habitat, with the lowest density for the urban population. No evidence of male dimorphism was found and overall body size for all monitored populations was small compared to other European populations, with a male body length range of only 30-66 mm. Males were smallest in the urban environment, while the mean size of both sexes was larger in the rural population. The apparent absence of major morphs in the monitored populations is possibly explained by the urban-heat-island effect that shortens larval development and/or by the fragmentation of suitable habitat patches. Regarding observed mobility, 60% of recaptures occurred within 50 m of the original capture, while only 17% showed a displacement between 100-525 m. With this study we confirmed that CMR is a useful tool for monitoring fragmented populations, allowing easy comparison across sites. We found that all the monitored populations are characterised by small population size and small body size. Additional conservation efforts need to be implemented, providing landscape heterogeneity and connectivity necessary for sustaining stag beetle populations. Based on the habitat map for Flanders and Brussels we can upscale our CMR population estimates to estimate a yearly total population size.

## Evaluating log piles as stag beetle conservation measure

Arno Thomaes[1], Bart Christiaens[1], Stefaan Goessens[1] & Arianna Tagliani[2]

*[1] Research Institute for Nature and Forest, Geraardsbergen, Belgium; [2] University of Pavia, Pavia, Italy*

Log piles are mainly built in urban areas as a species specific conservation measure for the European stag beetle (*Lucanus cervus*). As little is known about the success of this measure, we aim to study their success and longevity based on 100 small log piles that were followed up with emergence traps. Log piles were colonised the first year of building and beetles emerged up to 13 years later, although most beetles emerged after eight years. Overall, 67% of the log piles had emerging beetles: *Quercus robur* log piles (80%) were more successful, followed by *Fagus sylvatica* (58%) and *Populus* x *canadensis* (50%). Overall, 177 ± 5, 131 ± 5 and 89 ± 5 beetles emerged per m³ wood used in the log pile for oak, beech and poplar respectively but tree species had no effect on the size of the beetles. The emergence phenology was explained by a degree-day model with 6.6°C as baseline temperature, predicting start and end of the emergence around 620 and 810 accumulated degree-days. We conclude that log piles are a successful conservation measure for the European stag beetle but distance to populations and abiotic characteristics need to be taken into account. For conserving this species in urban areas, we propose to build a network of log piles and to build new log piles about every ten years while retaining the old log piles. As the log piles are used by several species, they can also be useful for the conservation of other saproxylic species.

## Large trees as the key habitat for endangered beetle: movement strategy of the great capricorn beetle *Cerambyx cerdo*

Lukas Drag[1], Fran Kostanjsek[1], Jana Ruzickova[2], Lukáš Čížek[1]

*[1] Biology Centre of the Czech Academy of Sciences, České Budějovice, Czech Republic; [2] Eötvös Loránd University, Budapest, Hungary*

Habitat structure and quality are the major determinants of site occupancy in insects. As a consequence, species' movement may be also driven by specific site conditions. The Great Capricorn Beetle (*Cerambyx cerdo*), a species with high conservation and ecological value, inhabits open woodlands with large veteran trees, although populations from closed forests with oaks of a much smaller diameter are also known. Using a radio-tracking approach, we investigated if the beetles' movements were habitat related. Over three seasons, we tracked 76 individuals in various forest types in the Czech Republic, Slovakia and Hungary resulting in almost 1000 fixed positions. We found that the probability of beetle movement for both sexes highly decreased with increasing DBH (diameter at breast height) of the tree the individual was spotted on. We assume that large trees can harbour a larger population of the beetle on a smaller spatial scale compared to woodlands of smaller diameter. As a consequence, large trees can represent a more stable environment in which the species has a lower need for dispersal to find a suitable food source, shelter or mating partner. Our results thus stress the important role of veteran trees in the landscape for saproxylic insects as well as they bring evidence that movement can be site-induced and that the landscape context for species-specific works needs to be considered.

## Conservation status of *Buprestis splendens*: an update

Marcos Méndez
*Universidad Rey Juan Carlos, Móstoles, Spain*

*Buprestis splendens* has been considered as a relict and vanishing saproxylic beetle already in the early 20th century. It is rated as «Endangered» by the IUCN assessment performed in 2010. As a part of a reassessment of its IUCN category, all the classic literature and new references were checked and an updated distribution and conservation status were suggested. The general distribution of *B. splendens*, as summarized in the literature before 1974, included cites from 14 countries: Sweden, Finland, Russian Federation, Belarus, Ukraine, Poland, Slovakia, Romania, Germany, Austria, Croatia, Bosnia-Herzegovina, Greece, and Spain. However, recent (2000 or later) findings are available only for Ukraine (around Kiev), Poland (at Białowieża National Park), Romania (Cerna Valley National Park) and Austria (a small area in Carinthia). In the remaining countries, no new cites have been reported since the 1970s or earlier, although cites from Greece in the 1980s seem to exist. In addition, a literature search identified cites for five additional countries: Albania, Bulgaria, Hungary, Italy and Slovenia. Only in Italy, recent cites exist, from the Pollino National Park. Overall, six sites seem to remain occupied in Europe, giving the benefit of doubt to the Greek populations. These sites are mainly in protected areas with ancient pine forest. However, not all of them seem to be safe, e.g. Kiev due to the ongoing political conflict and Białowieża due to the management issues. This reduction of occupancy area with respect the 2010 assessment suggests that this species is neither currently safer than it was in the past nor invites an optimistic future prospect.

## Results and perspectives from an Italian long-term citizen science initiative focused on protected saproxylic beetles

Silvia Gisondi[1, 2], Alice Lenzi[1, 2, 3], Marco Bardiani[4], Sönke Hardersen[4], Vincenzo Andriani[4], Pio Federico Roversi[1, 2] & Alessandro Campanaro[1, 2]

*[1] Council for Agricultural Research and Economics, Florence, Italy; [2] National Biodiversity Future Center, Palermo, Italy; [3] University of Siena, Siena, Italy; [4] Reparto Carabinieri Biodiversità, Verona, Italy*

Recent projects and initiatives aimed at monitoring species and habitats have confirmed that citizen science is a valuable tool to collect data and gather information at large spatial and long temporal scales. This approach can be particularly important if it helps to meet the obligations of the Habitats Directive. In Italy, only few citizen science projects are dedicated to the collection of data on insect species, and these mainly focus on butterflies, pollinators, or invasive alien species while protected saproxylic beetles, and protected insects more generally, are rarely targeted by citizen science projects. Here, we present the results from a long-term citizen science initiative which started as the «LIFE MIPP» project (LIFE11NAT/IT/000252) and continued afterwards thanks to funding from the Italian Ministry of the Environment. This initiative focuses on protected insect species, including the 'big five' saproxylic beetles (i.e. *Cerambyx cerdo*, *Lucanus cervus*, *Morimus asper*/*funereus*, *Osmoderma eremita*, *Rosalia alpina*), and so far more than 1400 volunteers participated and collected almost 7000 records. Analyses of these data show a clear increase in the number of records over the years as well as greater spatial coverage than previously known for the target species, based on UTM grids and α hulls. Another important finding is that the majority of records fall outside protected areas. As this initiative has been ongoing for ten years, we decided to evaluate the results achieved by the project, and to investigate whether the project has reached its maximum potential, thus revealing the importance of long-term projects in collecting data on the distribution of the target species. In conclusion, the data collected during this initiative not only confirmed and strengthened the current knowledge, but also added new spatial information, resulting in a better assessment of the species conservation status as required by the Habitats Directive.

## Stitching the field together through education: the dead wood courses

Dmitry S. Schigel
*University of Helsinki, Helsinki, Finland*

How scientific disciplines are formed and remain valid is one of the world's mysteries. When an aspiring scholar becomes attracted to a certain science, professional lifestyle, or a community, often educational and professional paths available are often square and rigid. While there is obvious value in taking classic courses of the well-carved disciplines in the beginning of your studies, a more mature researcher may find labelling herself by set professional keywords counterproductive and limiting. The field of dead wood or saproxylic ecology does not exist in any formal catalogue of disciplines or subjects, yet in the scientific worlds, the job market, the legal and policy fronts of exploring the dead wood systems have been growing in importance since the 1989 paper by Speight (and a few hundred years of natural history studies on saproxylic organisms). The lack of the recognized field can translate to funding and policy invisibility and is already now manifest the isolation of the entomology and of the mycology oriented dead wood ecologists. Why should it be so, while species share hollows, logs, and stumps? The publication of the *Biodiversity in Dead Wood* book by Stokland, Siitonen, and Jonsson in 2012 have opened an opportunity of broader and formal training of the future scholars of the dead wood systems and taxa. I have organized the first of five Dead Wood Courses in 2013 in Finland, aiming at the master and PhD students, and the course took place four more times in Finland, Russia, and Norway since then: *adlignum.com/teaching*. My presentation will illuminate the evolution of the course and will provide tips and recommendation to anyone willing to collaborate or to independently run future Dead Wood Courses. Let your dead wood be always full of life!

## On how the ecosystem engineering *Cetonia aurataeformis* (Coleoptera: Scarabaeidae: Cetoniinae) responds to climate change

Alice Lenzi[1, 2, 3], Javier Quinto[4], Alessandro Campanaro[1, 2] & Estefanía Micó[4]

*[1] Council for Agricultural Research Economics, Florence, Italy; [2] National Biodiversity Future Center, Palermo, Italy; [3] University of Siena, Siena, Italy; [4] Universidad de Alicante, San Vicente del Raspeig, Spain*

Saproxylic beetles include rare species to which conservation interest is usually mostly addressed in terms of study, monitoring and conservation measures. However, recently, remarkable climate changes (i.e., temperatures/drought increasing) and habitat loss seem to impact even species usually considered «common» and not «worthy of concern», especially in critical areas, such as Mediterranean forests. Moreover, studies highlighted that species not always show the same response patterns to disturbances. Thus, it is important understanding not only who is disadvantaged and who is favoured by these environmental changes, but also which are the main effects (e.g., variation in phenology, abundance, morphology) and what are the influencing drivers (e.g., temperature, humidity, food availability). Here, we present results from a study aimed at assessing changes over time in *Cetonia aurataeformis* (Coleoptera: Scarabaeidae: Cetoniinae) inhabiting Cabañeros National Park (Spain), by comparing data collected in two one-year sampling campaigns carried out in 2009-2010 and in 2021-2022, respectively. *C. aurataeformis* is a Spanish widespread showy beetle, with key ecological roles as ecosystem engineer in tree hollows at larval stages and pollinator as adult. Cabañeros is a conservation area in which forestry and other human activities are excluded, however a strong increase in temperatures over time has been recorded,recently. Data show that *C. aurataeformis,* in 12 years, has undergone a sharp decline in abundance; its intra-annual phenology seems to be changing, and a slight trend is also detectable in terms of body size. These results suggest an effective ongoing shift in several biological traits, but further insights are required to obtain a better overview. Indeed, C. *aurataeformis* was used as a model to evaluate preliminary results of a larger study in which the effects of climate change in Cabañeros are assessed on 40 saproxylic beetles, focusing both on species and on community level.

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## Beetles disperse viable spores of a keystone wood decay fungus

Lisa Fagerli Lunde[1], Anne Sverdrup-Thygeson[1], Lynne Boddy[2], Håvard Kauserud[3], Rannveig Jacobsen[1] & Tone Birkemoe[1]

*[1] Norwegian University of Life Sciences, Ås, Norway; [2] Cardiff University, Cardiff, UK; [3] University of Oslo, Oslo, Norway*

Wood- decay fungi disperse by wind, but targeted insect dispersal may also be of importance, particularly in managed forests where dead wood is scarce. To study the potential for insect dispersal, we used *Fomitopsis pinicola*, a keystone wood-decay fungus in boreal forests, as a model species. We investigated 1) the invertebrate community visiting fruit bodies by use of time-lapse cameras, 2) whether viable spores of *F. pinicola* could be found in the faeces or exoskeleton of beetles collected on the fruit bodies, and 3) whether viable spores of *F. pinicola* could be found on beetles collected on fresh spruce logs, a favourable habitat for spore deposition. We found that beetles were the most numerous invertebrate order occurring on *F. pinicola* fruit bodies, followed by flies and spiders. Viable spores were on the exoskeleton and in the faeces of all beetle species collected at the sporulating fruit bodies. On fresh spruce logs, nine beetle species transported viable spores, of which several bore into the bark. Our results demonstrate that beetles can provide directed dispersal of wood-decay fungi and also that a larger group of invertebrates might have the potential to do so.

## The decline of saproxylic beetles in a time window: Who and how much?

Sandra Martínez-Pérez, Javier Quinto, Eduardo Galante & Estefanía Micó
*Universidad de Alicante, San Vicente del Raspeig, Spain*

Populations of saproxylic beetles are vulnerable to the consequences of climate change, fragmentation and habitat loss. These changes may threat not only populations of rare and vulnerable species but also common species. Here we analyze the changes in the abundance and richness of the saproxylic beetle community living in tree hollows in a time window of 11 years in the Cabañeros National Park (Spain). Since declining numbers of individuals can be the first step towards local extinction of a species, our aim was to analyse the response of each species in terms of abundance to detect potential «winners» and «losers» of global change. Data of two one-year samplings carried out in 2009-2010 ($t_1$) and 2021-2022 ($t_2$) was used to analyze patterns of temporal changes in the richness and abundance of the saproxylic community, we used the iNEXT package of the R software. To identify possible changes in the abundance of each species between $t_1$ and $t_2$, we used parametric or non-parametric tests depending on the Shapiro-Wilk normality results. Results showed no significant temporal differences in the richness of the saproxylic beetle community in the tree hollows. However, the results of the abundance of each species showed that out of a total of 152 species collected, 11% of the species experienced notable changes in abundance, mostly a decline of more than 80% of their populations, and three of them were not detected in the current sampling ($t_2$). Climate change could explain the patterns observed; however, further studies are needed to better understand the patterns obtained, including longer time series and the analysis of morphological traits of «loser» versus «winner» species.

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**KEY NOTE SPEECH**

## *One species to rule them all, one species to find them, one species to bring them all*: do umbrella species still offer new scientific insights? The case of the big protected saproxylic beetles

Alessandro Campanaro[1, 2], Alice Lenzi[1, 2, 3], Pio Federico Roversi[1, 2] & Silvia Gisondi[1, 2]

*[1] Council for Agricultural Research Economics, Florence, Italy; [2] National Biodiversity Future Center, Palermo, Italy; [3] University of Siena, Siena, Italy*

Research focus on flagship and umbrella species is still valuable in terms of scientific insights. In the past years, the Laboratory for Protection of Functional Biodiversity in Forest Ecosystems at CREA, and its scientific partners, have continued to study different aspects related to the ecology and biology of the protected saproxylic beetles. In this scenario, the aim of the present contribution is to highlight the main outcomes of these studies. The state of knowledge for protected saproxylic beetles is diverse. In fact, while for *Osmoderma eremita* complex, the actual distribution is, surprisingly, still partially unknown as highlighted by the discovery of a new population in Central Italy (Lenzi et al. 2022), the distribution of *Rosalia alpina* is nationally well known, allowing research on other biological information. For example, the study of genetic variability has assessed the presence of exclusive mitochondrial DNA haplotypes, suggesting that Apennine populations in Italy are highly differentiated from those of Central and South-eastern Europe (Molfini et al. 2018). Moreover, *Lucanus cervus* represent the most studied species, enabling more focused research on population size, effects of deadwood and allometric variation, all recently investigated in a capture-mark-recapture study carried out through a citizen science approach (Giannetti et al. 2023). In this context, the cooperation of volunteers generated important results also at European level concerning the species phenology and temperature adaptations, as demonstrated by the European Stag Beetle Monitoring Scheme (Thomaes et al. 2021). If correlated with climate and environmental variables, citizen science data can also be applied to the characterization of niche space, as demonstrated by Redolfi de Zan et al. (2023), producing habitat suitability maps for the “big five” species (*L. cervus. R. alpina, Morimus asper/funereus, Cerambyx cerdo, O. eremita*). This kind of studies reveal a rather patchy situation, yet highlighting many research opportunities for the future.

## Sampling for saproxylic beetles in an important ancient woodland setting - an Irish context

Aoife Crowe[1], Aidan O' Hanlon[2], Caitriona Carlin[1], Christopher Williams[3] & Michael Gormally[1]

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Current predications indicate that within a few decades, 40% of insects and their ecosystem services will have disappeared, often due to habitat loss. Saproxylic beetles, the focus of this research project, are insects that depend on dead, decaying, and live wood, and mirror this decline with 17.9% of European species already threatened with extinction. This is of particular concern given that these beetles are important components of healthy woody habitats on which better-known iconic animals depend. In addition, saproxylic beetles deliver essential ecosystem services including pollination, decomposition, and nutrient cycling. Despite this, knowledge gaps still pertain to the ecology of this insect group in Europe and there is a particular paucity of information in Ireland regarding the ecological requirements, ecosystem functioning and conservation status of saproxylic beetles. This talk will outline the study of saproxylic beetles in an important Irish ancient woodland called «St. John's Wood». I will discuss how the project evolved from sampling for one particular beetle family, the longhorn beetles (Cerambycidae), to the sampling of a full suite of saproxylic beetles that use different microhabitats within the woodland. I will give insights into the broad findings of the study i.e., the various insect orders and their abundances collected, before delving into more detail on the results of beetles collected from one specific trapping method i.e., emergence trapping (Fig. 1). The effectiveness of this trapping method and a brief comparison with the other trapping methods used will be discussed. I will also outline details such as interesting species collected and the various trophic guilds found, whilst also noting differences in trap collections from across the woodland. I am currently in the second year of a four-year PhD project. This talk references the results from the summer sampling season in year one (June–September 2022).

*Figure 1. Emergence trap.*

## Saproxylic Stepping Stones: Supporting deadwood beetle diversity through tree age gaps

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The UK's ancient pasture woodlands are key resources in supporting threatened saproxylic beetle communities. However, these landscapes suffer from tree age-gaps caused by extensive historical tree felling. As a result, as veteran trees reach the end of their lives and their saproxylic habitats are lost, there is a lack of trees of a lower age category developing new deadwood features to support beetle populations. It is essential that solutions are developed to mitigate the age-gap problem for saproxylic beetles, and that these are implemented using strong foundations in landscape ecology. This presentation outlines research addressing scales of saproxylic beetle habitat use in pasture woodlands, and the potential to artificially supplement deadwood habitats over these scales in the future. The habitat density scales relevant to saproxylic beetle communities were investigated through flight interception trapping in two UK oak pasture woodlands. Results showed that higher veteran tree densities over 250 m radii positively correlated with saproxylic beetle diversity in veteran trees. The diversity of rare species was also strongly influenced by tree density over smaller scales of 25 and 50 m. We used this information to identify locations where the introduction of additional deadwood habitat would be most valuable for the conservation of saproxylic beetles. One method of creating such deadwood resources is through artificial habitat reservoirs («beetle boxes») which are designed to replicate the conditions inside tree hollows, providing refuges for hollow-dwelling beetles. We address research into a novel beetle box design, which is partially buried in the ground to mimic basal tree hollows. The boxes studied were found to host rare, hollow specialist beetle species, proving their potential as a conservation tool. The construction material and wood mould contents of the beetle boxes also influenced the saproxylic beetle communities inhabiting them.

**Figure 1**. A flight interception trap (left) in an ancient tree and a beetle box installed in a pasture woodland.

## The first Latvian red list of saproxylic Coleoptera – «LIFE FOR SPECIES» project

Dmitry Telnov

*University of Latvia, Rīga, Latvia; Natural History Museum, London, UK*

The present Latvian national list of protected species was issued over 20 years ago under very different socio-economical circumstances. The species were selected for the current list based on non-transparent criteria, without performing extinction risk assessments. The EU LIFE programme-funded project «Threatened species in Latvia: improved knowledge, capacity, data and awareness» (LIFE FOR SPECIES, LIFE19 GIE/LV/000857) is aimed to update the list of protected species based on scientific criteria, to prepare proposals for changes in the national legislation, as well as to increase public and stakeholder awareness on species protection in Latvia. Within the project, national experts were trained to apply IUCN methodology and criteria for assessing extinction risk. For the first time we assessed 114 saproxylic taxa of Latvian Coleoptera against IUCN criteria, including all EU Habitat directive species which occur in Latvia. 38% of the assessed taxa are threatened (Endangered or Vulnerable), 11% Near Threatened, 11% Data Deficient and 38% Least Concern.

## Investigating invertebrates in Dutch tree hollows; can environmental DNA contribute?

Rick Buesink

*Wageningen University and Research Centre, Wageningen, Netherlands - In collaboration with Datura Molecular Solutions (Wageningen) and European Invertebrate Survey, Leiden*

Despite the recognized significance of tree hollow habitats in Europe, this habitat has been largely overlooked in the Netherlands. Prompted by the rediscovery of tree-hollow habitat umbrella species *Osmoderma eremita* within Dutch borders, a study has been conducted to explore the potential of additional populations and test new environmental DNA monitoring methods. The comprehensive survey didn't result in the discovery of further populations. eDNA extraction from wood mould from hollow trees led to the detection of several taxa that remained undetected using traditional methods. Single-species detection of *Osmoderma eremita* was tested using wood mould from a several European populations, but with varying results. Although the use of these eDNA monitoring techniques seems promising, the methods still have not fulfilled the anticipated expectations. Monitoring using Cross Window Interception Traps (CWFT) demonstrated much higher effectiveness of detecting taxa compared to both pitfall traps and eDNA metabarcoding, even resulted in the first records of *Crepidophorus mutilatus* and several hard-to-monitor species in the Netherlands. Only few taxa, belonging to only four families, were detected with all methods. These findings suggest that no single method can successfully detect all taxa, hence, a combination of methods is necessary for optimal monitoring. For optimal efficiency, CWFT's are proved again to be the most potent tool for detecting saproxylic taxa. However, refining of metabarcoding-techniques, especially DNA extraction, could enhance its effectiveness, making it a more viable tool for future applications.

## «smarTrap» ® – a technologically advanced tool for monitoring and collecting insects

Dmitry Telnov

*Natural History Museum, London, UK; Daugavpils university, Daugavpils, Latvia*

An innovative, technologically advanced, and field-tested trap for monitoring and recording saproxylic insects developed and produced by Daugavpils university is presented. The trap is Linux controller managed and equipped with temperature and humidity sensors, movement sensor, photo camera, SIM card and internet connection. Every specimen trapped is automatically photographed and data being uploaded to a web portal, supplemented with an information on air temperature, humidity, and time of record. An automatic release option is considered. The traps have been tested within EU LIFE+ programme project «Ecological network for *Osmoderma eremita* and other species dependent on veteran trees», LIFE16 NAT/LT/000701.

## Stable isotopes of saproxylic beetles reveal low differences among trophic guilds and suggest a high dependence on fungi

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Deadwood-dependent beetles are crucial agents in deadwood decomposition and they act as an important model group in forest ecology. They are often classified into trophic guilds which describe species' niche position on the deadwood decomposition gradient or trophic level, generally dividing them into xylophages, saproxylophages, mycetophages, or zoophages. Assignment to the trophic guilds, however, may be more dependent on microhabitat preference rather than on actual diet of particular species. Carbon ($\delta^{13}C$) and nitrogen ($\delta^{15}N$) stable isotope ratios reflect the degree of deadwood decomposition and they can thus be used to infer the feeding habits of the beetles independently. We carried out stable isotope analysis on 121 saproxylic beetle species sampled in a mixed-deciduous forest in order to test for the effect of phylogeny and body size on stable isotope ratios, and to assess how the isotope ratios match with two trophic guild classifications commonly used in literature. We found that both phylogenetic relationships and body size affected $\delta^{13}C$ values of saproxylic beetles, with species from some families having similar values, and larger species having lower values than smaller ones. After filtering out these effects, only the species classified as mycetophages were relatively well-distinguished based on their isotopic composition from species belonging to other trophic guilds, which relates to higher $\delta^{13}C$ values of fungi – their food source. Other saproxylic guilds share isotopic niche space to a great extent and cannot be well discriminated according to $\delta^{13}C$ and $\delta^{15}N$ isotope composition. Isotopic niche location and important intra-guild variation suggest that species from different guilds may also depend on fungi to a great extent and that mixed trophic strategies may be more common across saproxylic beetles than currently acknowledged. Alternatively, a high degree of omnivory, opportunistic zoophagy in feeding habits, or current misclassification of some species into guilds may explain the observed pattern.

## The effect of coppicing on availability of tree related microhabitats and communities of saproxylic beetles in oak woodlands

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Abandonment of traditional forest managements has led to homogenisation of vegetation structure of European woodlands and triggered decline of their biodiversity. Coppicing has long been advocated as a tool to support the threatened light-demanding biodiversity of European woodlands. Its effect on saproxylic organisms, however, has been considered potentially negative due to low dead wood volumes in active coppices. Coppices, on the other hand, are known to support populations of some high specialised saproxylic species. We thus decided to evaluate how coppicing contributes to the formation of dead wood microhabitats and what effect it has on the biodiversity of organisms associated with deadwood. We compared (i) the offer of deadwood microhabitats between bases of 232 maiden trees and 324 coppice stools, and (ii) species richness, abundance, and functional diversity of saproxylic beetles emerging from ten coppice stools and ten stumps of maiden trees. We found that basal hollows and exposed wood were substantially more common in coppice stools. Communities of saproxylic beetles emerging from coppice stools were also substantially more species rich and abundant, they were characterised by species with larger body size and preferring wood in more advanced stages of decay. Xylophages, xylosaprophages, and xylozoophages, as well as species exploiting bark, wood and mould were more abundant in the coppice stools. No functional/ecological trait showed a tendency to increase towards the stumps of maiden trees. We conclude that coppicing sustains saproxylic biodiversity by increasing the frequency of rare deadwood microhabitats such as basal hollows and exposed dead wood.

## Effect of clearcut forestry on beetles in boreal spruce forests in Southeastern Norway

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Nearly 70% of the forests in Norway is productive with Norway spruce (*Picea abies*) being the dominant and economically most important tree species. Clearcutting was introduced ca 70 years ago and is the dominant forestry practice, resulting in homogenous and even aged forest stands. At present, only 30% of the productive forest have not been clearcut (hereafter defined as near-natural), while as little as 1.7% can be defined as old growth with the main characteristics of a true natural forest. In our study we aim to investigate if clearcut forestry has changed beetle diversity and abundance by comparing mature clear-cut forests with near-natural forests. We further explore how the forest stands differ in structural characteristics, such as tree density and deadwood volume, and diversity. We established 10 study sites in Southeastern Norway, each including one former clear-cut and one near-natural forest stand. We collected insects by flight interception traps during eight weeks in the summer of 2023 and all beetles were determined morphologically to species level. The volume of large diameter and late decay deadwood was higher in near-natural than former clearcut forests. Based on preliminary data (six weeks of trapping), we caught over 31046 beetles, representing 468 species, of which 16455 individuals and 292 species were saproxylic. Both forest types shared 298 beetle species, while we captured 103 unique species in the near natural sites and 67 unique species in the former clear-cut sites. We found no significant effect of forest type on overall beetle abundance and species richness, but when analyzing saproxylic insects only, the richness remained unaffected whereas the abundance was highest in the near-natural forests. We also found increasing species richness with increasing volume of deadwood both when analyzing all beetles and saproxylic species alone.

## Saproxylic beetle assemblages before and after the restoration of coppicing in several forest stands in southern Moravia (Czech Republic)

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Coppicing is the oldest method of managing forests for sustainable wood production. In the lower vegetation tiers of Central Europe, with tree species suitable for coppicing (e.g., oak, hornbeam, lime), it remained in wide use until WW II. After that, most coppices or low forests were transformed into high forests – mostly even-aged and with much higher canopy-closure. At less productive or less accessible sites (often newly established nature reserves), management often just ceased, leading to neglected coppices with shadier conditions. Later it became apparent that the loss of the former mosaic of asynchronously coppiced stands (creating gradients of stands in different stages of the coppicing cycle), had led to a decline in many species of plants and animals (often considered forest species, but preferring more open and insolated conditions). This led to attempts to restore the practise of coppicing for conservation purposes. Since 2013, we have studied the effect of the restoration of coppicing on saproxylic beetles in neglected coppices within southern Moravia (south-eastern Czechia). From 2013, we studied their assemblages, using flight interception traps, in two close-by forest stands (dominated by lime and hornbeam) in the White Carpathians on the border to Slovakia. This covered two years before the logging (in winter 2014/2015), the two subsequent years (2015, 2016) and then 2019 and 2022 *(i.e.*, the 5th and 8th year after logging). Since 2015 we have studied by the same method two stands (dominated by sessile oak) in the Podyjí (Dyje/Thaya valley) region at the border to Austria. Beetles were trapped during one year (2015) before the logging, two years directly after it (2016, 2017) and again in 2020 (5th year after logging). So far, only selected families (or saproxylic subsets within) were have been analysed. In Elateridae and Staphylinidae all species, including non-saproxylic ones, were considered. Floricolous and heliophilous species (in general, in particular, Buprestidae and Cerambycidae), increased after the logging (sap flow from stumps surely played a role in the first year), whereas adapted to shadier conditions and more decomposed, moist wood (e.g. Eucnemidae) decreased. Both groups included threatened species.

## Response of saproxylic bees and wasps to different levels of post-disturbance logging – canopy openness more important than deadwood amount

Michal Perlík[1,2], Pavel Sebek[1] & Simon Thorn[1,3]

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Saproxylic insects are an important component of forest biodiversity. However, the relationships between habitat characteristics and ecology of saproxylic insects are mostly based on beetles as a model group, while other groups are underrepresented in the literature. We studied the effect of salvage logging in windthrown forests of Steigerwald, Germany, on richness and species composition of saproxylic aculeate Hymenoptera two years after the disturbance event using two different sampling methods, flight-interception traps and trap-nests. While flight-interception traps catch species passively, including individuals passing through habitats, the traps-nests are designed to test which habitats are utilised by bees and wasps for nesting. We compared undisturbed plots with disturbed plots under different levels of salvage logging (i.e. different amounts of deadwood removed) to assess the effects of deadwood amount and canopy openness on bees and wasps. Results from our short-term study suggest that canopy openness is the principal factor driving richness and community assembly mechanisms with deadwood amount having little to no effect. The patterns suggest that in comparison to beetles, saproxylic Hymenoptera may be affected much more by local microbiotope quality or by broader landscape properties, as they are very good fliers being able to locate newly established nesting and foraging sites very efficiently. We conclude that at short term scale, immediate effects various disturbances have on diversity of saproxylic bees and wasps are mainly driven by change in canopy openness. However, long-term studies are needed to fully understand the impact of disturbances and post-disturbance management actions on the biodiversity of bees and wasps.

## Concept for creating an algorithm to quantify the abundance of the flat bark beetle C*ucujus cinnaberinus*

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The flat bark beetle *Cucujus cinnaberinus*, listed in Annex II of the Habitats Directive, requires strict protection as a species of Community interest. Latvia, as a Member State, reported on the conservation status of EU-important habitats and species for the 2013-2018 period, finding that the population and development prospects of *C. cinnaberinus* were uncertain. The existing monitoring approach was inadequate for assessing population data. To rectify this, a comprehensive study was conducted in Latvia to evaluate the species' occurrence in different forest stands. The aim of the study was to identify key factors influencing the presence of *C. cinnaberinus*. Three Natura 2000 sites were surveyed, each with 90 polygons grouped by suitability. The survey involved examining three logs and five 30 cm wide sections per site, resulting in 4050 count units surveyed. Based on the data obtained, a specialised algorithm was developed to estimate the population size of the flat bark beetle, which is a significant advance in abundance estimation. This research was part of the LVAF-funded project «Development and monitoring of an algorithm for estimating the abundance of the flat bark beetle *Cucujus cinnaberinus*» (project registration number 1-08/62/2022). The project contributes to understanding and conserving the species, aligning with Latvia's commitment to fulfilling obligations under the Habitats Directive and protecting biodiversity within its territory.

## Habitat requirements of the critically endangered jewel beetle *Eurythyrea quercus* (Herbst, 1780) in the Czech Republic

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The jewel beetle *Eurythyrea quercus* (Herbst, 1780) is considered as «critically endangered» species according to the Red List of endangered species of the Czech Republic. Its larvae develop in the wood of old-grown oaks (*Quercus* sp.), rarely of chestnuts (*Castanea* sp.). The species usually occur in the areas with the presence of solitary trees or where the host trees grow in low canopy closure. These areas, however, rapidly decrease. Therefore, the populations of the beetle become isolated and survive only in the areas where the old oaks still grow. The aim of the study is to assess the habitat requirements of *Eurythyrea quercus* which are crucial for its preservation. We collected environmental data from four localities in the Czech Republic. The localities are characterised as lowland forests, steep rocky forests, and a pond dam. We recorded the number of exit holes of the beetle at each potential tree in all localities. We further recorded the basic parameters of each tree, for instance, the diameter of the stem, canopy closure, habitus, surface of bare wood, etc. In total, we sampled 896 trees occupied by the beetle, and 1861 trees unoccupied. We visualised the relationship among the variables using recursive partitioning. Using inference trees combined with bootstrapping, we obtained thresholds with confidence intervals signifying suitable habitat for *E. quercus*. Our results indicate that even small areas of a bare surface and a tree diameter are crucial for the occupation of the tree by *E. quercus*. Our results also provide background information for managers of forest or protected areas. The essential for populations of *E. quercus* is to preserve the old-grown solitary oaks, avoid increasing canopy closure and support the creation of deadwood microhabitats, such as bare surfaces on the bark.

## Assessing the effects of forest composition and structure to taxonomic and functional diversity of saproxylic beetlesaspart of a multi-taxonomic study in Italian forests

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In the last decades, the alarming scenario of biodiversity loss encourages for increasing the studies on insect assemblages, with a focus on their conservation status assessment and responses to environmental changes. Recently such studies have also embraced Italian forest ecosystems. In this context, the present research is developed as part of a PhD project performed in Italy at the University of Siena and in collaboration with CREA-Research Centre for Plant Protection and Certification.The aim is to investigate how forest composition and structure influence diversity and abundance (both taxonomic and functional) of saproxylic beetle assemblages within a multi-taxonomic study in Italian forests. Indeed, a number of other taxonomic groups are considered and included, as well as vascular plants, lichens and soil arthropods. Multi-taxonomic data will be matched with forest structure indices, dead wood abundance, canopy cover and tree-related microhabitat, all collected at forest plot level. Surveys are performed by a multidisciplinary team of experts in the framework of «MultiForM», an Italian research network for multi-taxon forest biodiversity monitoring. Areas selected for sampling are in Tuscany Region, namely: the State Reserve «Belagaio», characterised mainly by a holm oak and an abyssal beech forest (350-270 meters a.s.l.) both located on the same slope, and «Alpe di Catenaia», a forest compartment dominated by beech under different management treatments over the last 100 years. In the first area, we aim at characterising and comparing the different environments and forest composition and the consequent variations in beetle assemblages; in the second area we investigate which forest structure and management influence the saproxylic community and how. The study began in 2023 and will be carried out over the next few years with the first results expected by the end of 2024.

## Saproxylic beetles in pollarded poplars of river Huerva (Zaragoza, Spain)

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The diversity of saproxylic beetles has been increasedly documented in Iberian forests. However, riparian forests have been relatively neglected. Here, we report the diversity of saproxylic beetles in riparian forests of pollarded poplars, typical from the river Huerva area in Zaragoza (Spain). We studied four sites from May to October 2019. We found 10116 saproxylic beetles, corresponding to 217 species and 37 families. In Molino, we found 116 species belonging to 29 familias; in Paridera, 107 species belonging to 27 families; in Badules 1, 120 species belonging to 28 families; and in Badules 2, 119 species belonging to 29 families. Twelve species were indicator of habitats of high temporal continuity. The three kinds of traps used showed a low overlap in the species captured. From the 217 species collected, only 38 (17,5%) were captured by the three kinds of traps and 120 (55,3%) were captured only by one kind of trap. Funnel traps captured the highest percentage of unique species (45,2%), followed by bottle traps (29,5%) and window traps (18,7%). Most of the species and individuals were collected in June and July. This study highlights the value of riparian forests for saproxylic beetles, in particular, when they have been managed in a traditional way (pollarding) that creates large, veteran trees in an agricultural o silvicultural matrix.

## Predicting chemical composition of downed deadwood in traditionally managed Mediterranean forests

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Deadwood serves as a crucial substrate within forest ecosystems, playing an important role in enhancing fertility and productivity. The importance of deadwood quantity for saproxylic diversity is widely documented, but deadwood quality also has relevance. However, in traditionally managed forests like Mediterranean *dehesas*, the presence of deadwood is limited. We assessed deadwood quantity and quality in *dehesa*-like Mediterranean *Q. pyrenaica* forests in the western Iberian Peninsula. We also analyzed the decomposition processes of *Q. pyrenaica* deadwood in nature by chemically characterizing three decomposition stages based on physical properties and relating them to fungal activity through ergosterol content. Chemical analyses included elemental composition determination, thermogravimetry and infrared spectroscopy. Our findings revealed that both the physical decomposition stage and ergosterol content served as robust predictors of the chemical changes occurring during the decay of *Q. pyrenaica* deadwood in field conditions. In addition, the relationship between ergosterol content and chemical composition varied depending on the physical stage and environmental local factors. The assessment of the relationship of decomposition processes of deadwood with chemical composition and fungal activity under field conditions can help to understand the contribution of deadwood to ecosystem services in forest ecosystems.

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## Abiotic and biotic factors shaping saproxylic beetle communities in central Europe: an experimental approach

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The biodiversity of saproxylic beetles is affected by multiple environmental drivers, with sun exposure as the most prominent. In fact, deadwood's microclimatic conditions, both when exposed to sunlight and when shaded from the tree's canopy, are crucial for the survival of beetles. Another driver of biodiversity is the interactions among locally co-occurring species. The chemistry of different tree species and interactions among wood-inhabiting fungi might play an important role in the colonization of deadwood by saproxylic beetles (i.e., the priority effect). Yet, the complex interplay between different drivers remains largely unexplored. To test the impact of tree species, sun exposure, and priority effects on saproxylic beetle assemblages, we developed a new experimental design. Freshly cut branch bundles of four different tree species (oak, beech, spruce, and pine) and four different experimental treatments were exposed at ten experimental plots across Germany and the Czech Republic covering a wide range of forest types. Branch bundles were first sterilized and then inoculated by either brown- or white-rot wood-inhabiting fungi to predetermine assembly history. In total, 320 bundles were hung in experimental plots at sun-exposed sites as well as under the canopy from May to October 2022. To collect saproxylic beetles attracted to bundles we installed on each bundle a plastic panel (12 x 20 cm) coated with insect glue («sticky trap»). As expected, the diversity of saproxylic beetles varied substantially among tree species. Further, sun-exposed deadwood hosted higher species richness of saproxylic beetles compared to shaded deadwood. This effect was further mediated by the inoculated wood-inhabiting fungi. This is the first study focusing on the complex interplay of sun exposure and priority effects in determining saproxylic biodiversity. Our well-designed experimental approach enables us to shed new light on biotic and abiotic interactions, factors that are otherwise often correlated.

## Beetle mania at Copenhagen Zoo

Signe Ellegaard, Eddie Bach & Martin Schwarz
*Copenhagen Zoo, Copenhagen, Denmark*

On a warm Tuesday night in June 2023, many years of excitement culminated when beetle experts from Copenhagen Zoo found the first European stag beetles *Lucanus cervus* in Jægersborg Dyrehave just north of Copenhagen, Denmark. More than 10 years ago, a political decision was made to attempt to reintroduce the stag beetle in Denmark from where it was considered extinct since the 1970s and not reliably recorded in the country since the 1950s. The Danish Nature Authorities' (Naturstyrelsen) protected areas in Jægersborg Dyrehave north of Copenhagen was chosen as the most suitable location for the reintroduction of this forest-dwelling, dead wood dependent beetle. The areas where prepared and stag beetle larvae and imagoes collected from wild populations in Sweden, Germany, and Poland were released in 2013. The hope was that the larvae would thrive and develop into adult beetles that could reproduce and disperse so that Denmark again would have a stable population of this amazing species. Although the development cycle is less than three years no evidence of success of these efforts has been recorded since. This year, the Danish Nature Authorities has commissioned the Copenhagen Zoo to design and conduct a survey to assess the population. The survey was conducted in the same areas, where the founder animals were originally released a decade ago and the adult beetles now found in 2023 is evidence that not only beetles survived in Jægersborg Dyrehave, but they have also successfully reproduced in at least two generations since.

## History of the Copenhagen Zoo in working with saproxylic beetles

Signe Ellegaard, Simon Brusland & Martin Schwarz
*Copenhagen Zoo, Copenhagen, Denmark*

Aside of stag beetle, in the Copenhagen Zoo we work with three other beetle species: noble chafer, variable chafer, and hermit beetle. These three species are under tremendous pressure in Denmark, primarily due to lack of available dead wood in the landscape, related to intensive modern forestry. These three Danish native beetles are currently being held in the zoo's breeding center for the purpose of conservation breeding, translocation to restored habitats, and research. All three beetle species lay their eggs in more or less decomposed tree hollows where the larvae, depending on species and environmental factors, spend 1-3 years developing until the imagoes emerge during summer.

## Introducing a novel approach for estimating the abundance of the hermit beetle *Osmoderma barnabita* in habitat complexes of Latvia

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The hermit beetle *Osmoderma barnabita* holds significance as a species listed in Annex II of the Habitats Directive, entailing strict protection under the European Council Directive 92/43/EEC on the Conservation of Natural Habitats, Wild Flora, and Fauna. Consequently, Member States, including Latvia, are obligated to report on the status of EU-important species to the European Commission every six years (Article 17). For the hermit beetle, the conservation status in Latvia during 2013-2018 remains unknown. Prior abundance estimates were varied, using different units to indicate occurrence or approximate abundance without precise count data. This study aims to determine the importance of diverse habitat types for hermit beetle populations by exploring the relationship between suitable tree availability, individual movement, and concentration. Additionally, the impact of weather conditions on their activity is assessed. Three regions with significant populations and extensive habitat complexes, representing both continental and seaside climates, are selected for the study. In each area, forty-three traps are strategically placed in habitats of varying quality, including well-maintained wooded meadows and forest habitats. Extra traps are positioned in suitable habitats between the main trap concentrations. Population size and individual movement are estimated using the mark and recapture method. The research was carried out as part of the European Social fund financed project Strengthening of the professional competence of the academic staff of Daugavpils University in the areas of strategic specialization, 3rd round (project registration number 8.2.2.0/20/I/003). This project grants a financial support to students for studying a doctoral study program and obtaining a scientific degree.

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