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Potential effects of box elder control measures and vertical stratification of xylobiontic beetles in floodplain forests of the Donau-Auen National Park, Lower Austria

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Abstract

Xylobiontic beetles represent a substantial fraction of the biodiversity of forest ecosystems and are useful bioindicators for evaluating effects of forest management measures. This study was conducted in the Donau-Auen National Park in Lower Austria, one of the largest remaining semi-natural floodplain forests in Central Europe. There, for five months in summer 2012, beetles were sampled using flight interception traps, a widely used method for inventorying the fauna of wood inhabiting beetles. The aims of the study were to investigate the differences of xylobiontic beetle assemblages between two forest strata (understory and canopy) and the possible effects of an abruptly increased volume of fresh dead wood on them. The dead wood originated from the neophytic Box Elder (*Acer negundo*), that is becoming more and more widespread in riparian landscapes, and was girdled or felled at several locations in the national park to prevent a further dispersal. At five sites where such control measures had been applied beetles were sampled with one flight interception trap in the understorey and one in the canopy, the same was done at five reference sites without management. In total, 267 species of xylobiontic beetles (of 49 families) were recorded. Species richness, total abundance and also the composition of beetle assemblages differed significantly between forest strata. Total abundance was higher in the understorey, whereas species richness was higher in the canopy. There is no evidence however for an effect of the control measures on box elder on either total abundance, species richness or the composition of assemblages. The distribution of the functional groups of xylobiontic beetles seems to correlate neither with stratum nor with site type. The complete lack of an influence of the newly available dead wood material on xylobiontic beetle assemblages can be accounted for by the following factors: for one thing the time lag between implementation of control measures and sampling (less than one year) may have been too short for beetles to react, or the neophytic origin of the dead wood made it unsuitable for autochthonous beetle species.

Keywords

Zusammenfassung

Xylobionte Käfer machen einen wesentlichen Anteil der Biodiversität von Waldökosystemen aus und sind nützliche Bioindikatoren um die Auswirkungen forstwirtschaftlicher Maßnahmen zu ermessen. Diese Studie wurde im Nationalpark Donau-Auen in Niederösterreich durchgeführt, einem der letzten verbliebenen naturnahen Auwälder in Mitteleuropa. Im Sommer 2012 wurden dort für 5 Monate Käfer mittels Flugfensterfallen gesammelt, einer weit verbreiteten Methode um den Bestand der holzbewohnenden Käferfauna aufzunehmen. Die in der Studie verfolgten Ziele waren zum einen die Untersuchung der Unterschiede von xylobionten Käfergesellschaften in verschiedenen Vegetationsschichten (Baumkrone und Unterwuchs) und zum anderen der Nachweis eines möglichen Einflusses von plötzlich erhöhtem Volumen an frischem Totholz auf diese. Das Totholz stammte von Eschen-Ahorn (*Acer negundo*), einem Neophyten, der sich in Flusslandschaften mehr und mehr ausbreitet, und der an mehreren Stellen im Nationalpark geringelt oder gefällt wurde um dessen weitere Verbreitung zu unterbinden. An fünf Standorten, an welchen solche Kontrollmaßnahmen durchgeführt worden waren, wurden Käfer mit je einer Flugfensterfalle im Unterwuchs und einer in der Baumkrone gesammelt. Fünf Referenzstandorte ohne Kontrollmaßnahmen wurden auf gleiche Weise besammelt. Insgesamt wurden 267 xylobionte Käferarten (aus 49 Familien) aufgenommen. Artenreichtum, Abundanz und die Zusammensetzung der Käfergesellschaften unterschieden sich signifikant zwischen den Vegetationsstrata. Die Baumkronen wiesen einen höheren Artenreichtum auf, während die Abundanz der Arten im Unterwuchs größer war. Keinen Hinweis hingegen gibt es auf einen Einfluss der Kontrollmaßnahmen an Eschen-Ahorn auf Abundanz, Artenreichtum und Zusammensetzung der untersuchten Käfergemeinschaften. Die Verteilung der funktionellen Gruppen der Totholzkäfer scheint weder mit der Vegetationsschicht noch mit den Standorttypen zusammenzuhängen. Das Fehlen einer Beeinflussung der Käfergemeinschaften durch das neu verfügbare frische Totholz kann in folgenden Faktoren begründet sein: Einerseits könnte der verstrichene Zeitraum von weniger als einem Jahr zwischen der Durchführung der Kontrollmaßnahmen und dem Besammeln der Standorte zu kurz für eine entsprechende Reaktion der Käfergesellschaften gewesen sein, andererseits war das Totholz durch seine neophytische Herkunft vielleicht ungeeignet für autochthone Käferarten.

Introduction

Big rivers are one of the factors that have most influenced and altered the surface of the Earth in the course of geological history. The flowing water is the driving force that shapes rock and soil by abrading material at one point and depositing it at another, thus forming landscapes that are variable and ever changing. River floodplains are created and maintained by these dynamic interactions between land and water (Bayley 1995). The regular disturbance by the periodically changing water discharge requires special adaptations of all biota inhabiting a floodplain (Junk *et al.* 1989). The extent and frequency of flooding strongly influences the vegetation cover. In floodplains of the temperate regions of the northern hemisphere regularly flooded areas are dominated by poplar, willow and alder (soft-wooded floodplain forest) whereas at sites that are usually not affected by inundation oak, ash and elm prevail (hard-wooded floodplain forest) (Mucina *et al.* 1993).

Floodplain forests are characterized by a high level of productivity and high biodiversity, due to the large number and structural heterogeneity of habitats. Additionally, they protect watercourses against pollution and erosion, provide retention space for water during flooding periods and are also of great recreational value to the human populations living in their vicinity (Klimo & Hager 2001). Notably, these qualities can only be maintained if human impact is minimized (Brown *et al.* 1997), a situation which is currently only rarely fulfilled. Through the last century, most of the world's floodplain ecosystems have been heavily transformed due to anthropogenic influence, including the majority of floodplain forests in Europe. River regulation measures aiming to protect inhabited land from flooding caused a significant decline of the hydrological dynamic of most floodplains and also led to a decrease of the groundwater level. Furthermore, Europe's floodplain forests have become fragmented due to the clearing of woodland and the draining of swampy areas for agricultural use (Klimo & Hager 2001).

Although Austria has not been spared from this development, the floodplain system along the Danube River between Vienna and the Slovakian border represents one of the largest remaining semi-natural alluvial landscapes in Central Europe (Tockner *et al.* 1998). Floodplain forests typically contain a high amount of dead wood, representing an important microhabitat for xylobiontic insects (Gentry & Whitford 1982; Polit & Brown 1996). Especially xylobiontic beetles have in the past years been more and more in the focus of researchers around the globe (e.g. Martikainen *et al.* 2000, Wu *et al.* 2008, Nitu *et al.* 2009). For the temperate zone authors emphasized the ecological value and the importance of the protection of particular xylobiontic flagship species (e.g. Ranius *et al.* 2005 about *Osmoderma eremita*, or Buse *et al.* 2008 about *Cerambyx cerdo*), studied the horizontal and vertical distribution of xylobiontic Coleoptera (e.g. Schmidt *et al.* 2007, Bouget *et al,* 2011, Ulyshen 2011) and quantified the effect of forest management measures (Müller *et al.* 2008, Ulyshen *et al.* 2010). Studies from Central

Europe have found a very high diversity of xylobiontic beetles especially in floodplain forests (e.g. Bense *et al.* 2000; Bail 2007).

In this study we sampled xylobiontic beetles in the understory and canopy of a floodplain forest in the Donau-Auen National Park, Eastern Austria. Our study provides the first estimate of the species richness of this ecologically important group for the national park. Besides collecting beetles in two different vegetation strata, we studied effects of measures aiming to control box elder (*Acer negundo*). The box elder represents a neophyte native to North America, which was introduced to Europe as a garden tree in the late 17th century (Saccone *et al.* 2010). It has spread in riparian communities and already contributes significantly to the vegetation cover of floodplain forests in our study area (Walter *et al.* 2005). Consequently, management measures (girdling, felling) aiming to control this neophyte produce a significant amount of additional dead wood.

In particular, our study addressed the following questions:
(1.) How does the community of xylobiontic beetles differ between understorey and canopy in floodplain forests of the Donau-Auen National Park? Studies from tropical forests reported a distinct vertical stratification in forest insect assemblages (e.g. Schulze *et al.* 2001), including beetles (e.g. Charles & Basset 2005, Stork & Grimbacher 2006, Bouget *et al.* 2011, Davis *et al.* 2011). We expect that xylobiontic beetles are more abundant and show a higher species richness at lower vegetation levels due to their naturally higher amount of available dead wood.
(2.) How do box elder control measures affect xylobiontic beetles? We expect that the abundance of xylobiontic beetles is higher at forest sites where such measures (girdling and felling of box elder trees) have been implemented due to an increased amount of dead wood as has been shown in previous studies (Ulyshen *et al.* 2010, Gossner *et al.* 2013). Because the sampling was conducted less than a year after the control measures were applied, we expect that particularly beetles feeding on fresh dead wood will benefit.

Material and Methods

Study area

The study was conducted in the Lower Austrian part of the Donau-Auen National Park, south-east of Vienna. The region's floodplain forests are characterized by an especially high biodiversity (Tockner *et al.* 1998) and are therefore considered as areas of major conservation concern.

In 1978 already a small part of the area (Lobau) was declared a nature reserve. Then in 1984 a long free-flowing section of the Danube and the adjacent woodlands were in danger of being destroyed by

the construction of a new power plant near Hainburg. Massive protesting in the population however led to a reinvestigation of the natural conditions in the floodplain, which came to the conclusion that the area was worth being protected. In 1996 finally the Donau Auen National Park was established (National Park Donau Auen 2013a).

In the area of the national park the average slope of the Danube is 0.04% and the average discharge is 1500-1900m³·s⁻¹ (Nationalpark Donau-Auen 2013b). The amplitude of the fluctuations of the water level can add up to 6 to 8 m in the course of a year. These inundations, that usually occur in summer, and the many lateral branches still linked to the main river channel cause a high level of interconnectedness between the Danube and the adjacent floodplain (Lazowski 1997). In the late 19th century a dyke was constructed to protect the surrounding farmland from flooding. It allows the natural water dynamics only up to dyke-level, thus forming an artificial borderline between regularly flooded soft-wooded forest and usually dry hard-wooded forest. The mean annual temperature of the study area is 9.5°C with relatively hot summers (mean July: 19.5°C) and cold winters (mean January: -0.8°C), which is typical for the Pannonian climate zone. The mean annual precipitation is $525\ l\ m^{-2}$ (averages of years 1971-2000; ZAMG 2013).

Our study area "Stopfenreuther Au" is located in the eastern part of the national park at the northern banks of the Danube River, in the regularly flooded part of the forest (dominated by *Populus*, *Salix* and *Alnus* trees). There, about a year prior to beetle sampling, numerous box elder (*Acer negundo*) trees had been girdled or felled in various places to prevent an excessive dispersion of this neophyte in the fragile floodplain ecosystem (see Figure 1 for examples of managed and unmanaged forest sites).

Assemblages of xylobiontic beetles were compared between forest sites where management measures had been applied to control box elder (AC sites) and reference forest sites which remained unaffected (R sites) (see Figure 2 for an overview map of the national park and the locations of the sampling sites).
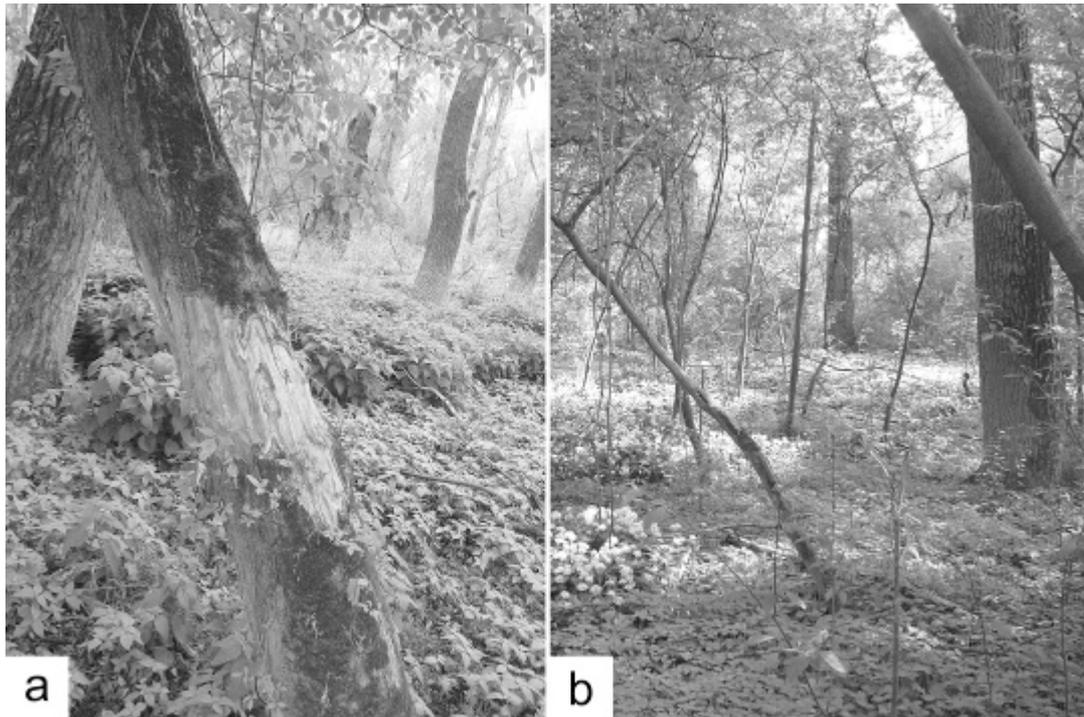
Figure 1. (a) A girdled box elder (*Acer negundo*) tree at a forest site where management measures had been taken, and (b) an example for an unmanaged forest site.
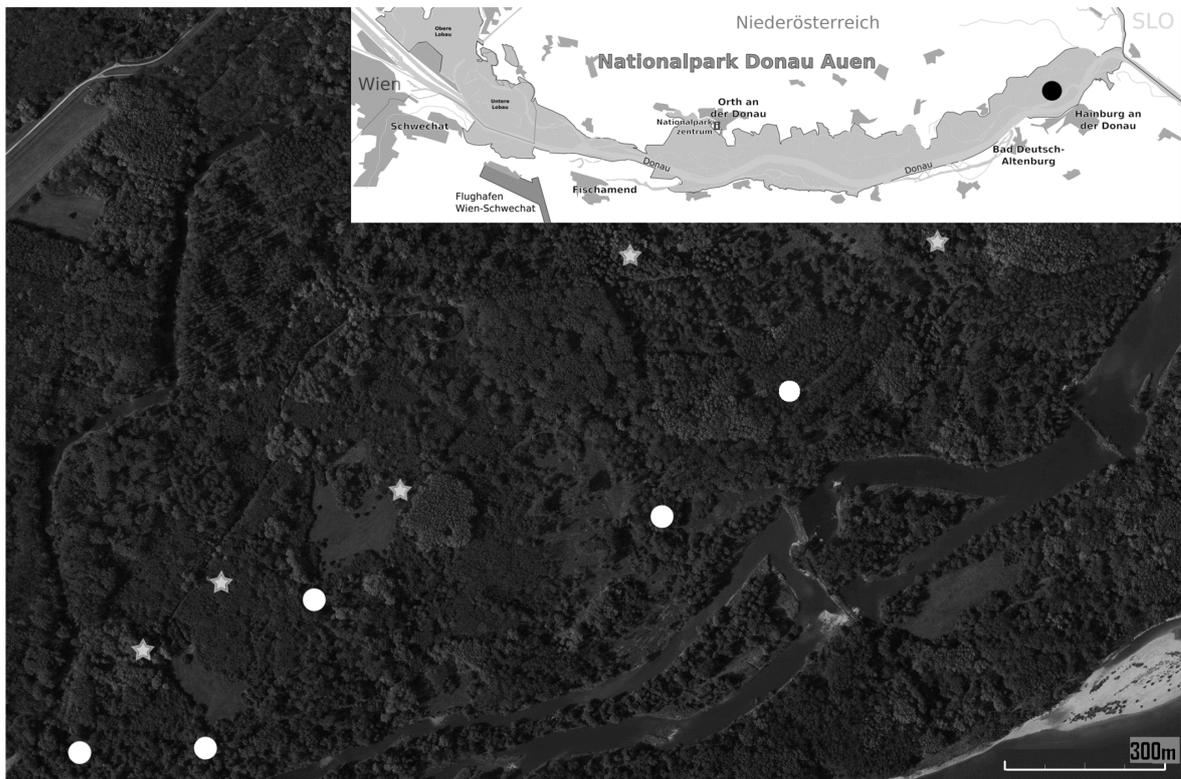

Figure 2. Aerial photograph of the study area. White circles indicate managed sampling sites, grey stars are reference sites. The black dot in the overview map of the National Park marks the location of the study area.

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A total of five replicate sites per forest type were selected. All sampling sites were located between E 016°54'31''–016°56'12'' and N 48°09'03''–48°09'38''. The minimum and maximum distance between two sampling sites was 200 and 1900 m respectively.

Sampling and identification of beetles

At each study site beetles were sampled with two flight interception traps (e.g. Bail 2007; see also Fig. 3), one placed in the understorey (at ca. 1.5 m height above ground) and one in the canopy (at 10 to 15 m height). All traps were suspended on ropes fixed on branches of trees. Since trees at the respective sampling sites did usually not provide the possibility to position understorey and canopy trap exactly above one another, suitable branches were chosen about 1 to 3 m apart. The used traps consisted of two panes of acrylic glass (dimensions 40 x 60 cm) fixed at right angles to one another, a plastic cone underneath (diameter: 40 cm) and a plastic bottle (volume 0.5 l) screwed to it. Each bottle contained 95% Ethanol to kill and preserve caught individuals and a rinsing agent to lower the surface tension of the alcohol.

Figure 3. Photo of one of the used flight interception traps (the plastic bottle underneath the cone is missing in the picture).

The traps were controlled every 2 to 3 weeks between May and September 2012 resulting in a total of 8 samples per trap. Beetles were identified to species level according to Freude *et al.* (1964-1983). Classification of xylobiontic beetles in substrate-guilds was done according to Schmidl & Bussler (2004, Table 1).

Table 1. Substrate-guilds of xylobiontic beetles (Schmidl & Bussler 2004).

Guild code	Substrate preferences
F	living or freshly dying wood
A	old dead wood, at different states of decay
P	fungi growing on dead wood or fungi-infested dead wood
M	rotholes (rotting wood in living trees)
S	special habitats, species with other ways of living in dead wood

Environmental parameters

In order to estimate canopy closure, a photo of the canopy was taken from underneath each trap towards the sky (two photos per site). With the software ImageJ (Rasband 1997-2012) these pictures were converted into black and white monochromes and subsequently the percentage of black and white pixels was calculated. Canopy closure is given as the fraction of black pixels in the respective picture. For each site, the average of both measurements was used to quantify canopy cover.

To calculate the dead wood volume for each site, all standing and lying dead wood within a radius of 8 m around the center point between understorey and canopy trap was measured and assigned to 4 degrees of decay (1 being freshly dead and 4 totally rotten). Only stems above 20 cm diameter at breast height (DBH) were included in the calculation.

For the calculation of volume the following formulas were used, according to Oehmichen (2007).

Smalian's formula was used for lying dead wood: $v = \frac{g_o + g_u}{2} \cdot l$

Huber's formula for standing dead wood: $v = g_m \cdot l$

(g_o – surface area at the top, g_u – surface area at the bottom, g_m – surface area in the middle, l – length)

Data analysis

Species accumulation curves and estimates of total species richness were calculated for the total sample of xylobiontic beetles using the software EstimateS vers. 9 (Colwell 2013). In order to estimate the total number of xylobiontic species occurring in the study area the Chao 2 species richness estimator was used. This extrapolation method is specifically suitable for datasets with many "rare" species, because it upweights classes with an abundance of only 1 or 2 individuals (Chao 1987).

Samples of individual traps from one sampling round represent the sampling units. Furthermore, abundance-based species accumulation curves (± 95 % CI) were calculated with the software Past (Hammer *et al.* 2001) for xylobiontic beetles sampled in canopy and understorey layer by pooling all AC and R sites, respectively. To evaluate the effect of box elder control measures on species richness, abundance-based species accumulation curves (± 95 % CI) were also calculated separately for forest sites with and without applied control measures (by pooling canopy and understorey sites).

To test for effects of forest type (AC vs. R sites) and vegetation stratum (canopy vs. understorey) on the total abundance of xylobiontic beetles caught per trap, the total and relative abundance of beetles feeding on fresh dead wood ("F-beetles") and the species richness of all xylobiontic beetles and all F-beetles, a two-way ANOVA was calculated with the software Statistica 7.1 (StatSoft, Inc. 2005). To quantify species richness, all samples were rarefied to a largest shared sample size.

Bray-Curtis similarities were calculated (using $\sqrt{x}$ transformed abundances) for all combinations of traps to evaluate effects of forest stratum and box elder control measures on species composition of xylobiontic beetles. The effects of stratum and site type on the guild composition of xylobiontic beetles were assessed in the same way using Bray-Curtis similarities. Subsequently, similarity relationships were visualized with a non-metric multidimensional scaling (NMDS) ordination. An associated stress value of <0.20 for both similarity matrices was considered as reliably displaying the similarity relationships in the resulting two-dimensional ordination (Clarke 1993). Analyses of similarity (ANOSIMs; with 999 permutations) were calculated with the program Primer v5 (Clarke & Gorley 2001) to test for differences in xylobiontic beetle composition and substrate-guild composition between forest types (AC vs. R sites) and vegetation strata (understory vs. canopy).

To test for effects of the composition of dead wood decay classes and the composition of species assemblages and functional guilds, Spearman matrix rank correlations were calculated with Primer v5.

To evaluate effects of canopy closure and the volume of standing and lying dead wood on species richness and abundance of xylobiontic beetle assemblages (understorey and canopy trap samples were pooled for each site) Generalized Linear Models (GLMs) with a normal error distribution and a log-link function were calculated. A GLM with a normal error distribution and a log-link funtion was also used to test for effects of canopy closure and dead wood volume of the decay classes I and II on the relative abundance of F-beetles. All GLMs were calculated using Statistica 7.1.

Results

Abundance and species richness

A total number of 10 978 beetle individuals were caught with the deployed flight interception traps. These individuals could be assigned to 454 species in 60 families. Xylobiontic beetles made up the majority of sampled Coleoptera, representing 59 % (267 species) of all sampled species and 81 % (8848 specimens) of all trapped individuals. The calculated species accumulation curve for the total sample of xylobiontic beetles indicates a still very incomplete species inventory. The total richness of beetles feeding on dead wood predicted by the richness estimator Chao2 is nearly 450 species (Figure 4).
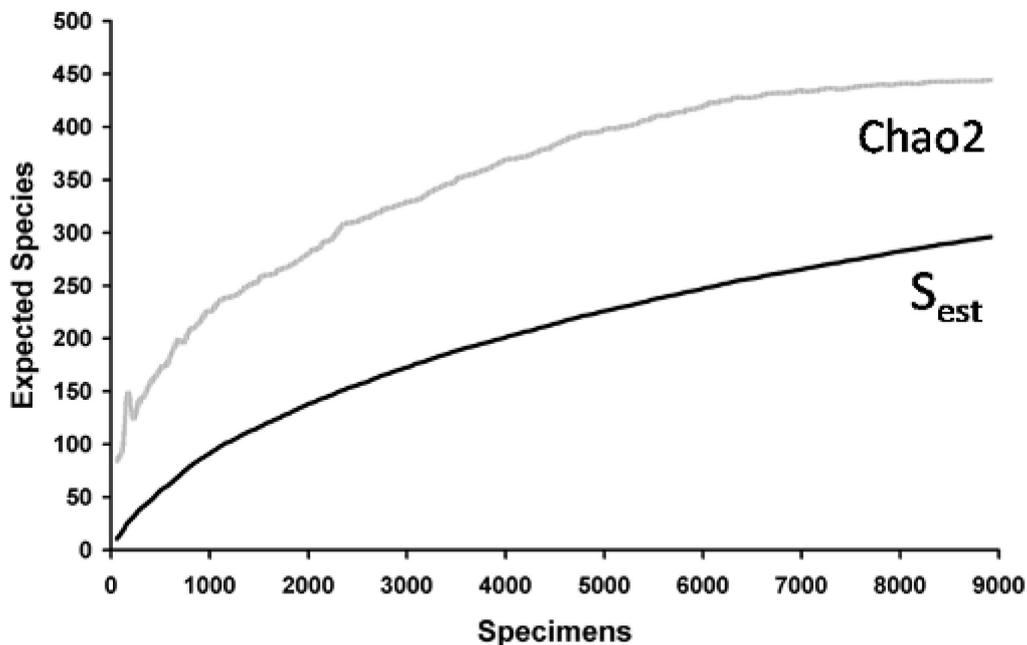

Figure 4. Species accumulation curve for xylobiontic beetles caught in the National Park Donau Auen. Estimation of total species richness by estimator Chao 2.

The total abundance of xylobiontic beetles per trap did not differ between forest types (AC vs. R sites) (two-way ANOVA; $F_1 = 0.975$, $p = 0.338$), but between vegetation strata (understorey vs. canopy traps; $F_1 = 4.849$, $p = 0.043$). The abundance was significantly higher in the understorey (Figure 5a).

A similar effect was found on total species richness of xylobiontic beetles estimated for a largest shared sample size of 494 individuals, which did not differ between site types (two-way ANOVA: $F_1=0.441$, $p=0.516$), whereas regarding strata species richness was significantly higher in the canopy ($F_1=6.454$, $p=0.022$) (Figure 5b).
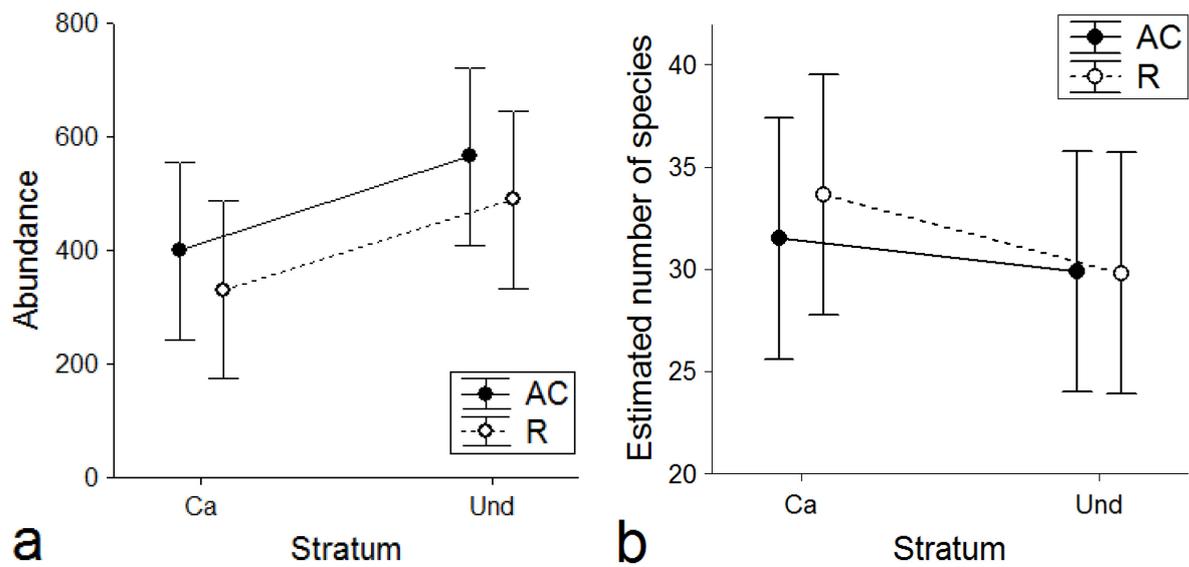
Figure 5. (a) Mean abundance and (b) species richness of xylobyontic beetles per interception trap ± 95 % CI in canopy (Ca) and understorey (Und) at forest sites with (AC) and without (R) box elder control measures.

This is also pointed out by the respective species accumulation curves. The 95% confidence intervals of species accumulation curves for both forest types show a strong overlap (Figure 6a), whereas they indicate a significantly higher richness in the canopy compared to the understorey (Figure 6b).
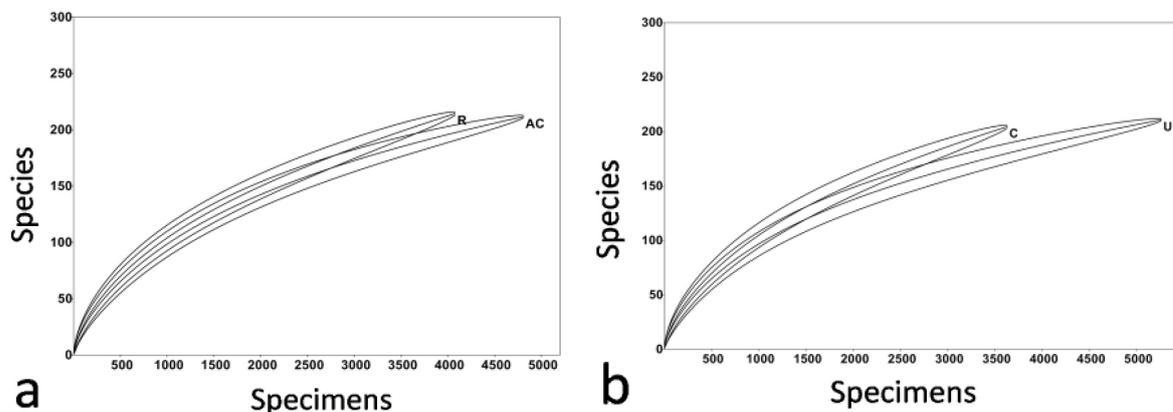
Figure 6. Species accumulation curves ± 95% CI for xylobiontic beetles sampled at (a) sites with (AC) and without box elder control measures (R) and in (b) different vegetation layers (C – canopy, U – understory layer).

Species composition

The NMDS ordination (based on Bray-Curtis similarities) visualizing similarity relationships between all xylobiontic beetles sampled by flight interception traps does not indicate an obvious effect of box elder control measures on species composition. However, a notable difference exists between

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understory and canopy traps (Figure 8). Indeed, the calculated two-way ANOSIM indicated a significant effect of vegetation stratum on species composition (global $R = 0.36$, $p = 0.002$), though no effect of site type (global $R = -0.006$, $p = 0.482$).

Figure 7. Similarity relationships between xylobiontic beetle assemblages collected with flight interception traps at canopy and understorey layer of sites affected by box elder control measures (AC) and sites without any forest management 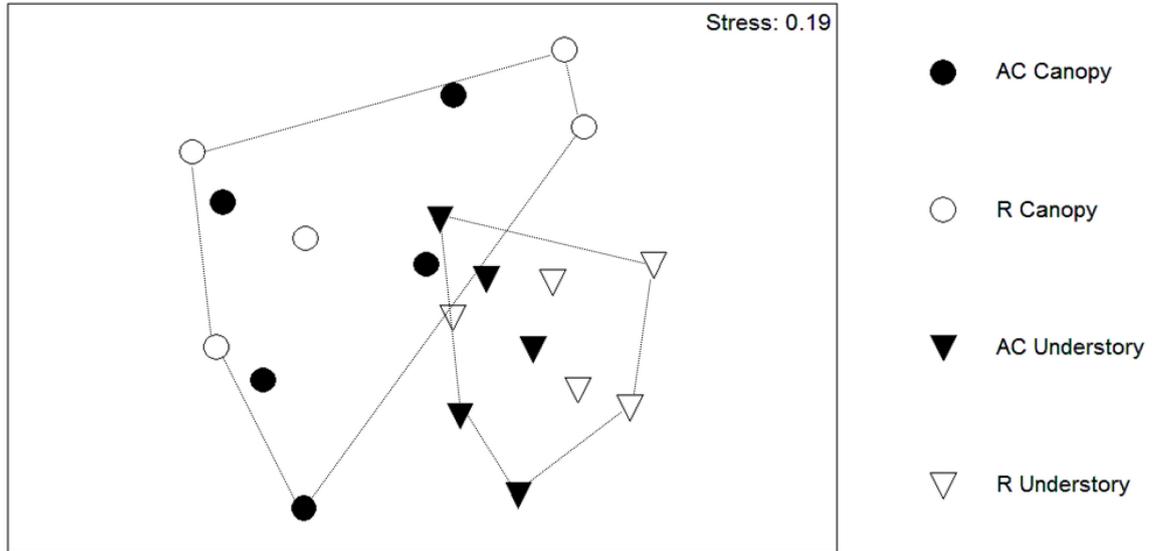measures (R). Similarities quantified as Bray-Curtis index values (calculated using √x transformed abundances) are visualized by a non-metric multidimensional scaling ordination. Understory and canopy sites are connected by lines to visualize the difference in species composition between both vegetation layers.

Functional groups

A two-way ANOVA testing for effects of vegetation stratum (understory vs. canopy) and forest type (AC vs. R sites) on the total abundance of xylobiontic beetles colonizing fresh dead wood did not indicate any significant effect (Stratum: $F_1 = 3.358$, $p = 0.086$; forest type: $F_1 = 1.435$, $p = 0.248$). Neither did a two-way ANOVA show any effects of forest type ($F_1 = 1.740$, $p = 0.206$) or stratum ($F_1 = 0.036$, $p = 0.851$) on the relative abundance of F-beetles.

Likewise, Bray-Curtis similarities for feeding guild composition and the subsequently calculated NMDS ordination do not provide evidence for any effect of vegetation stratum or forest type (Figure 8). Also the two-way ANOSIM calculated from the data did not reveal any significant effects of box elder control measures and strata on the substrate-guild composition (Site type: global $R = -0.03$, $p = 0.54$; Stratum: global $R = 0.09$, $p = 0.197$).
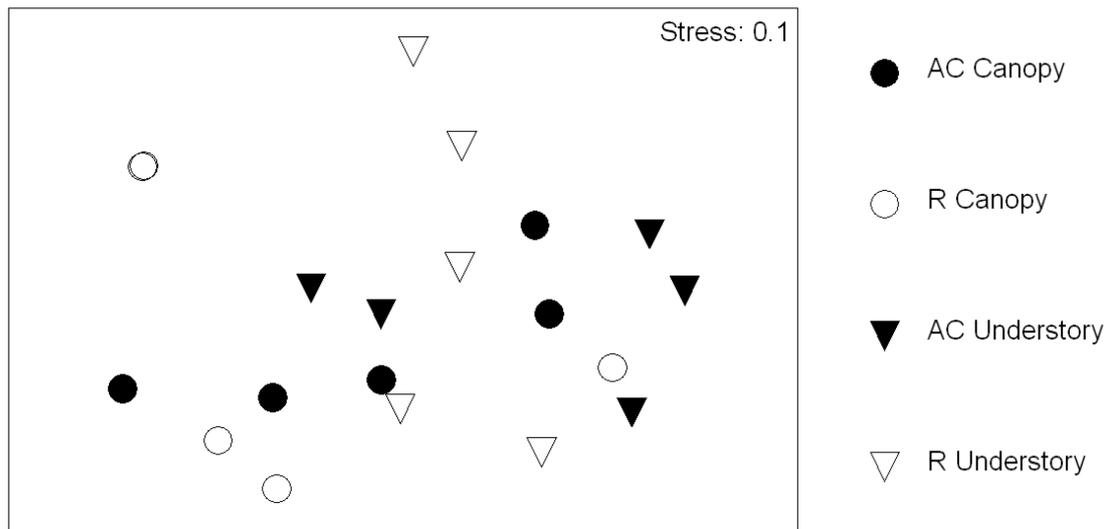
Figure 8. Similarity relationships between xylobiontic beetle guilds (as specified in Table 1) collected in understorey and canopy of managed (AC) and reference sites (R).

Environmental parameters

Canopy closure was relatively similar at all sites ranging from 70 to 82.5% (the only exception is site AC 07 with only 64.2% mean canopy closure) (Table 2) and did not differ significantly between AC sites and R sites (t-test: $t = -1.36$, $p = 0.210$).

The volume of standing dead wood was significantly higher at AC sites (*t*-test:, *t*-value = 2.81, $p = 0.023$). Volume of lying dead wood did not differ between site types (*t*-test: $t = -1.15$, $p = 0.283$).

At AC sites most of the existing dead wood was assigned to the degree of decay category 1 (fresh dead wood) (Table 2), although this difference did not prove to be significant (Mann-Whitney U-test: $U = 3.500$, $p = 0.076$). All other decomposition classes did not differ between forest types (Mann-Whitney U-tests; decay degree 2: $U = 10.00$, $p = 0.676$; decay degree 3: $U = 12.00$, $p = 1.000$; decay degree 4: $U = 4.00$, $p = 0.095$).

Table 2. Environmental Parameters: Left half of table shows canopy cover above understorey and canopy trap, and the mean value of both. On the right, volume of lying and standing dead wood (DBH >20 cm) is listed, as well as dead wood volume (DBH > 20 cm) broken down into degrees of decomposition (1= freshly dead, 2 = beginning decomposition, 3 = advanced state of decay, 4 = totally rotten) and the total dead wood volume at each sampling site.

Site code	Canopy cover (%)			Deadwood volume (m^3)							
	Understory trap	Canopy trap	mean	Standing	Lying	Degree of decay				Total
						1	2	3	4	
AC05	77.92	69.43	73.67	0	2.25	0	1.36	0.89	0	2.25
AC07	61.80	66.59	64.19	6.95	0.43	6.95	0	0.43	0	7.38
AC11	71.00	70.44	70.72	13.85	0	13.85	0	0	0	13.85
AC13	80.36	77.55	78.96	12.19	0	12.19	0	0	0	12.19
AC14	79.76	83.95	81.85	4.88	3.85	4.88	1.63	0.56	2.06	8.73
R02	83.03	81.31	82.17	0	20.05	0	0	15.81	4.23	20.05
R09	80.54	84.30	82.42	0	2.76	2.67	0	0	0.09	2.76
R17	81.03	74.70	77.86	0	1.63	0	0	0	1.66	1.63
R20	81.32	79.00	80.16	0.97	0.12	0	1.40	0	0.12	1.09
R22	71.23	72.34	71.78	1.47	3.47	1.47	0	3.03	0.44	4.94

Spearman matrix rank correlations between similarity in dead wood composition decay classes and species composition of xylobiontic beetles and feeding guild composition, respectively, indicate a significant relationship for species composition (Rho = 0.483, p = 0.004), but not for feeding guild composition (Rho = 0.103, p = 0.247).

The GLM testing for possible effects of canopy closure, standing and lying dead wood volume on species richness estimated for a largest sample size of 494 individual only indicated a significant positive effect of canopy cover on species richness. In contradiction, no significant effect of canopy closure as well as standing and lying deadwood on the abundance was indicated (GLM: $r_{multiple}$ = 0.46, $r^2_{multiple}$ = 0.21, $F_{3,6}$ = 0.53, p = 0.6795). Also a GLM testing for effects of canopy cover and the dead wood volume of the decay classes I and II did not prove to affect the relative abundance of xylobiontic beetles specialized on fresh dead wood ($r_{multiple}$ = 0.30, $r^2_{multiple}$ = 0.089, $F_{3,6}$ = 0.12, p = 0.8958).

Table 3. Results of GLM ($r_{multiple}$ = 0.85, $r^2_{multiple}$ = 0.73, $F_{3,6}$ = 5.33, p = 0.0396) testing for effects of mean canopy closure (%), standing and laying dead wood volume (m^3) on species richness estimated for a largest sample size of 494 individuals.

Effect	SS	FG	MQ	*F*	*p*	*Beta*	+95% CI	-95% CI
Constant	5.56	1	5.56	0.41	0.5457			
Canopy cover	202.40	1	202.40	14.93	0.0083	0.928	0.340	1.515
Standing dead wood volume	5.41	1	5.41	0.40	0.5509	0.151	-0.435	0.738
Lying dead wood volume	60.24	1	60.24	4.44	0.0796	-0.511	-1.103	0.082
Error	81.32	6	13.55					

Discussion

Abundance and species richness

In comparison to other studies on xylobiontic beetles in Central European floodplain ecosystems, our results from a floodplain forest in Donau-Auen National Park indicate an exceptionally high richness of this beetle group with so far nearly 300 recorded species. Other studies conducted in floodplain forests in Central Europe recorded a less diverse community of xylobiontic beetles. For example, Bail & Schmidl (2008) found 219 xylobiontic species at seven sites along the Danube in Southern Germany, Austria and the Czech Republic, though using fogging as an additional sampling technique to flight eclectors. Schmidt *et al.* (2007) found 175 species in the "Burgaue" near Leipzig in Germany (using flight eclectors). To our knowledge, in Europe similar species numbers of xylobiontic beetles

were only found in other forest types, e.g. in a deciduous forests with a high proportion of oaks in Northern France (280 species; Bouget *et al.* 2011). Calculated species accumulation curves and the Chao 2 richness estimator both indicate an even higher richness of xylobiontic beetles for our study area, with an estimation of a total of about 450 xylobiontic beetles in the surveyed area. This unusually high diversity indicates that the National Park Donau Auen is one of the most species rich areas for xylobiontic beetles in Central Europe. A furthermore remarkable fact is that more than 30 of the recorded species are red-listed for Austria (Jäch 1994).

Contrary to our expectations the implemented control measures aiming to reduce box elder trees had no effect on total abundance nor on species richness of xylobiontic beetles. A study conducted in a deciduous forest in Canada did find a significant increase in abundance of saproxylic species already one year after artificially depositing freshly cut wood, and after two years also species richness had augmented notably (Hammond *et al.* 2001). However, the therein used dead wood originated from old trees (40 - >100 years), that already contained rot holes and were infected by fungi, a crucial fact, that very likely facilitated colonization by xylobionts. In our study the box elder control measures only increased the amount of fresh dead wood. Many of the girdled trees were not even dead yet. So the time it must take to be suitable for wood boring beetles should accordingly be longer. Our sampling period was less than one year after the control measures and apparently beetle assemblages had not yet been able to respond to the abruptly increased availability of dead wood. A very recent study from Germany (Gossner *et al.* 2013) also measured effects of artificially increased dead wood volume on xylobiontic beetles and found that both abundance and species diversity almost immediately increased. There dead wood from the dominating autochthonous tree species in the respective forest stands was used for dead wood enrichment, while in our study the additional dead wood originated from the neophytic box elder. Since the genus of the host tree plays an important role for many xylobiontic beetles (Jacobs *et al.* 2007), and even more so for beetles preferring fresh dead wood (Wu *et al.* 2008), xylobiontic beetle species native to Eastern Austria may not be able to benefit much from wood of a tree species native to North America. This theory is supported by Schmidt *et al.* (2007) who found the xylobiontic beetle fauna much poorer on introduced tree species than on autochthonous ones. Moreover, the above mentioned study by Gossner *et al.* (2013) was conducted in a managed forest with a previously low amount of dead wood, where even slight increases in dead wood volume are more apt to show than in the semi-natural surroundings of our national park.

The factor that does influenced total abundance and species richness of xylobiontic beetles in our study was the forest stratum at which they were caught. Vertical stratification is generally common in forest arthropods due to strongly differing habitat conditions in understory and canopy layer (Su & Woods 2001, Ulyshen 2011). Since in our study area most dead wood was on or near the forest floor, we had anticipated both abundance and species richness to be higher in the understorey. This

assumption was confirmed by our results. Previous research has basically come to the same conclusion, finding species richness and abundance to be higher in lower vegetation strata (Vodka *et al.* 2009, Bouget *et al.* 2011, Gossner *et al.* 2013). In only one study, conducted in North America and using flight interception traps suspended at two different heights in a deciduous forest like we did, neither species richness nor total abundance differed between the chosen strata (Ulyshen & Hanula 2007). The understory there was dominated by an invasive neophyte, which probably lowered beetle numbers in that stratum. Also the tree species dominating the canopy there (e.g. oak) may provide more habitats for xylobiontic beetles than the trees in our study area.

Species composition and functional groups

The species composition of xylobiontic beetle assemblages was not influenced by the box elder control measures, and accordingly the substrate-guild composition did not show any measurable change. We had expected beetle species belonging to different guilds to react differently to the newly available dead wood. Particularly species colonizing fresh dead wood (F-beetles) could have benefit by the recently implemented control measures. Gossner *et al.* (2013) found beetle communities considerably changed after artificially depositing dead wood in a forest and Johansson *et al.* (2007) observed that the deposition of different kinds of logs affected the functional groups of saproxylic beetles. Ulyshen *et al.* (2010) found that the removal of an invasive shrub from a floodplain forest in Georgia (USA) had far reaching consequences on richness and species composition of beetles. The lack of a notable effect in our study may again be explained by the neophytic origin of the available dead wood. Schmidt *et al.* (2007) already noticed in their work, that wood of introduced species is not equally used by the native arthropod fauna.

However, our data indicate distinct species assemblages of xylobiontic beetles in the understorey and canopy layer of the sampled floodplain forest. Also other studies documented that species composition of forest beetles differs considerably between vegetation strata, even though species richness and total abundance is similar (Ulyshen & Hanula 2007). Also Bouget *et al.* (2011) found a high percentage of taxa restricted to either canopy or understorey of an oak forest in France. Interestingly, the composition of the functional groups of xylobiontic beetles did not change with strata. It has been stated that in temperate forests stratification can never be as pronounced as it is in tropical forests (Basset et al. 2003, Ulyshen 2011). This is for example due to the angle of incidence of sunlight, that at higher latitudes produces crown shapes that allow fewer vegetation strata, which influences the stratification of other organisms as well (Tanabe et al. 2001). Moreover, the dramatic seasonality in the temperate zone with cold winters and the hence resulting leaf loss of trees forbid a strict specialization of species on a life the canopy, because they must return to the ground to overwinter (Ulyshen 2011). Possibly the stratification effect detected in our study is not pronounced enough to

show also in a variation of the functional groups. In understorey and canopy are living different species, but are belonging to the same feeding guilds and probably fulfilling similar roles in the ecosystem.

Environmental parameters

Canopy closure was quite similar at all sampling sites, and did not differ between R sites and AC sites. This leads us to the conclusion that the sites were well chosen and no misleading effect could have been measured that was caused by differing light conditions instead of the implemented box elder control measures.

Canopy closure and hence insolation are generally considered important factors for wood inhabiting insects. Vodka et al. (2009) state insolation to be the most important factor affecting the composition of assemblages of Jewel Beetles (Buprestidae) and Longhorn Beetles (Cerambycidae) and Ranius & Jansson (2000) noted much higher abundances of saproxylic beetles at sites with lower canopy cover. Our study however did not show any connection between canopy closure and the abundance of xylobiontic beetles. Moreover, a positive relationship exists between canopy cover and species richness, an effect quite opposite to that shown by Ranius & Jansson (2000). The reason why our results are so opposed to those of other researchers might be accounted for by the similarity with respect to canopy closure between our study sites that probably had just been too high to allow for any measurable effect on xylobiontic beetle assemblages.

Also in opposition to our expectations was that overall dead wood volume did not have any influence on xylobiontic Coleoptera. The total amount of dead wood did not make a difference, nor did the amount of standing dead wood have an effect on beetle assemblages in the canopy or that of lying dead wood on beetles in the understory. This stands in contrast to the results of previous work: Bail & Schmidl (2008) in their study conducted in an oak forest in Germany found a correlation between canopy dead wood and the species richness of beetles in canopies, and also Müller *et al.* (2008) state that the amount of dead wood had a positive influence on saproxylic beetles. The findings of other researchers however, support our seemingly unusual results. Vodka *et al.* (2009) and Gossner *et al.* (2013) both state the available amount of dead wood not to be a factor influencing saproxylic beetles in species richness or abundance, and found other aspects like insolation, precipitation or temperature to be more important.

Our results suggest a significant effect on species composition, if the available dead wood at sites differs in composition regarding state of decay, but unexpectedly no effect of decay classes could be verified for the composition of substrate guilds of beetles. The volume of dead wood of decay classes I

and II did not influence the abundance of F-beetles. In contradiction, Gossner *et al.* (2013) reported a change in guild composition as a consequence of an artificial increase of dead wood volume. A study from Norway (Sverdrup-Thygeson & Ims 2001) found more saproxylic beetles on snags (decaying trees, stranding upright) than on logs, whereas in our study, although the amount of standing deadwood was drastically higher at AC sites than at reference sites, no influence on xylobiontic beetles was evident. The reason why in our study beetles were apparently not influenced by the available dead wood may again be that most of the fresh and standing dead wood originated from a neophytic species and was still too fresh to be of interest to xylobiontic beetles.

Conclusions

Arthropods depending on dead wood represent an exceptionally diverse ecological group. By returning nutrients into the ecological cycle of a forest, they play an invaluable role in these complex ecosystems (Speight 1989). Unfortunately, they also belong to one of the most rapidly declining groups in Europe (Nieto & Alexander 2010). Although much work has been done, especially in the past few years, in order to study and protect these organisms so essential to forests worldwide, even more thorough human efforts will be necessary to ensure their survival.

The high species richness documented by our data underlines the conservation value of the floodplain forests in the Donau-Auen National Park. The diversity in xylobiontic beetles might even be one of the highest ever recorded for floodplain forests in Central Europe. Therefore, further studies on the ecology of this highly interesting group are urgently needed, for example to evaluate possible negative effects of neophytic trees like box elder. Also a complete faunistic inventory of xylobiontic beetles in the Danube floodplain forests and the floodplains of nearby rivers with the use of additional sampling methods would be desirable.

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Appendix

List of captured species

1 = xylobiontic, 0 = not xylobiontic, f = guild inhabiting fresh dead wood, a = guild inhabiting old, decaying dead wood, p = beetles depending on fungi, m = guild inhabiting rotholes, s = beetles with special habitats

Species	Family	Xylobiontic	Guild
Acalyptus carpini	Curculionidae	0	
Adalia bipunctata	Coccinellidae	0	
Adalia decempunctata	Coccinellidae	0	
Adrastus pallens	Elateridae	0	
Adrastus rachifer	Elateridae	0	
Agathidium nigripenne	Leiodidae	1	P
Agathidium varians	Leiodidae	1	P
Agrilus convexicollis	Buprestidae	1	F
Agriotes acuminatus	Elateridae	0	
Agrypnus murinus	Elateridae	0	
Aleochara brevipennis	Staphylinidae	0	
Aleochara haematoptera	Staphylinidae	0	
Aleochara lanuginosa	Staphylinidae	0	
Aleochara puberula	Staphylinidae	0	
Aleochara sanguinea	Staphylinidae	0	
Aleochara sparsa	Staphylinidae	0	
Aleochara stichai	Staphylinidae	0	
Amara aulica	Carabidae	0	
Amarochara umbrosa	Staphylinidae	0	
Ampedus elegantulus	Elateridae	1	A
Ampedus nigerrimus	Elateridae	1	A
Ampedus nigrinus	Elateridae	1	A
Ampedus pomorum	Elateridae	1	A
Amphicyllis globus	Leiodidae	1	P
Anaspis flava	Scraptiidae	1	A
Anaspis frontalis	Scraptiidae	1	A
Anaspis humeralis	Scraptiidae	1	A
Anaspis thoracica	Scraptiidae	1	A
Anobium fulvicorne	Anobiidae	1	A
Anobium nitidum	Anobiidae	1	A
Anobium pertinax	Anobiidae	1	A
Anobium punctatum	Anobiidae	1	A
Anobium rufipenne	Anobiidae	1	A
Anobium rufipes	Anobiidae	1	A

Anomala dubia	Scarabaeidae	0	
Anoplus setulosus	Curculionidae	0	
Anotylus nitidulus	Staphylinidae	0	
Anotylus sculpturatus	Staphylinidae	0	
Antherophagus nigricornis	Cryptophagidae	0	
Anthonomus pinivorax	Curculionidae	0	
Anthophagus caraboides	Staphylinidae	0	
Aphodius prodromus	Scarabaeidae	0	
Aphodius rufipes	Scarabaeidae	0	
Aphthona coerulea	Chrysomelidae	0	
Aphthona cyanella	Chrysomelidae	0	
Aphthona cyparissiae	Chrysomelidae	0	
Aphthona euphorbiae	Chrysomelidae	0	
Aphthona lacertosa	Chrysomelidae	0	
Aphthona pygmaea	Chrysomelidae	0	
Aphthona venustula	Chrysomelidae	0	
Archarius crux	Curculionidae	0	
Archarius salicivorus	Curculionidae	0	
Aromia moschata	Cerambycidae	1	A
Arthrolips nana	Arthrolips nana	1	P
Atheta fungi	Staphylinidae	0	
Atheta triangulum	Staphylinidae	0	
Athous bicolor	Elateridae	0	
Athous haemorrhoidalis	Elateridae	0	
Athous vittatus	Elateridae	0	
Atomaria atricapilla	Cryptophagidae	1	P
Atomaria fuscata	Cryptophagidae	1	P
Atomaria linearis	Cryptophagidae	1	P
Attagenus schaefferi	Dermestidae	1	A
Aulonothroscus brevicollis	Throscidae	1	A
Batrisodes buqueti	Staphylinidae	1	A
Betarmon ferrugineus	Elateridae	0	
Bitoma crenata	Zopheridae	1	A
Boragogethes symphyti	Nitidulidae	0	
Brachygonus megerlei	Elateridae	1	A
Brassicogethes aeneus	Nitidulidae	0	
Brassicogethes coracinus	Nitidulidae	0	
Brassicogethes longulus	Nitidulidae	0	
Brassicogethes viridescens	Nitidulidae	0	
Bruchidius varius	Bruchidae	0	
Bythinus macropalpus	Staphylinidae	0	
Calodera rufescens	Staphylinidae	0	

Calvia quattuordecimguttata	Coccinellidae	0	
Cantharis decipiens	Cantharidae	0	
Cantharis fusca	Cantharidae	0	
Cantharis gemina	Cantharidae	0	
Cantharis nigricans	Cantharidae	0	
Cantharis rufa	Cantharidae	0	
Cantharis rustica	Cantharidae	0	
Carpelimus similis	Staphylinidae	0	
Carpophilus sp.	Nitidulidae	0	
Cartodere nodifer	Latridiidae	0	
Cerylon deplanatum	Cerylonidae	1	F
Cerylon ferrugineum	Cerylonidae	1	A
Cerylon histeroides	Cerylonidae	1	A
Chaetocnema mannerheimi	Chrysomelidae	0	
Chaetocnema obesa	Chrysomelidae	0	
Chilochorus renipustulatus	Coccinellidae	0	
Choragus sp.	Anthribidae	1	A
Cis bidentatus	Ciidae	1	P
Cis boleti	Ciidae	1	P
Cis comptus	Ciidae	1	P
Cis micans	Ciidae	1	P
Cis setiger	Ciidae	1	P
Clanoptilus strangulatus	Malachiidae	1	A
Clytus arietis	Cerambycidae	1	F
Coccinella septempunctata	Coccinellidae	0	
Colenis immunda	Leiodidae	1	P
Colydium elongatum	Colydiidae	1	F
Cordalia obscura	Staphylinidae	0	
Corticaria bella	Latridiidae	1	A
Corticaria longicollis	Latridiidae	1	A
Corticaria serrata	Latridiidae	1	A
Corticarina fuscula	Latridiidae	1	P
Corticarina similata	Latridiidae	1	P
Corticeus unicolor	Tenebrionidae	1	F
Cortinicara gibbosa	Latridiidae	1	P
Cortodera aurata	Chrysomelidae	0	
Cossonus cylindricus	Curculionidae	1	A
Cossonus linearis	Curculionidae	1	A
Cossonus parallelepipedus	Curculionidae	1	A
Crepidodera aurata	Chrysomelidae	0	
Crepidodera aurea	Chrysomelidae	0	
Crepidodera fulvicornis	Chrysomelidae	0	

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Cryphalus intermedius	Curculionidae	1	F
Cryphalus saltuarius	Curculionidae	1	F
Cryptolestes duplicatus	Laemophloeidae	1	F
Cryptophagus fuscicornis	Cryptophagidae	1	M
Cryptophagus labilis	Cryptophagidae	1	M
Cryptophagus postpositus	Cryptophagidae	1	M
Cryptophagus pubescens	Cryptophagidae	1	M
Cryptophagus scanicus	Cryptophagidae	1	M
Cryptophagus subfumatus	Cryptophagidae	1	M
Cryptophilus integer	Erotylidae	0	
Cucujus cinnaberinus	Cucujidae	1	A
Cylister angustatum	Histeridae	1	F
Cyphea curtula	Staphylinidae	1	F
Cyphon pubescens	Scirtidae	1	S
Cyphon variabilis	Scirtidae	1	S
Dacne bipustulata	Erotylidae	1	P
Dasytes aeratus	Dasytidae	1	A
Dasytes fusculus	Dasytidae	1	A
Dasytes niger	Dasytidae	1	A
Dasytes plumbeus	Dasytidae	1	A
Dasytes subaeneus	Dasytidae	1	A
Dasytes virens	Dasytidae	1	A
Denticollis linearis	Elateridae	1	A
Dermestes murinus	Dermestidae	0	
Dexiogya corticina	Staphylinidae	1	F
Dinoptera collaris	Cerambycidae	1	A
Dirhagus lepidus	Eucnemidae	1	A
Dirhagus pygmaeus	Eucnemidae	1	A
Dissoleucas niveirostris	Anthribidae	1	A
Dorcatoma dresdensis	Anobiidae	1	P
Dorcus parallelepipedus	Lucanidae	1	A
Dorytomus dejeani	Curculionidae	0	
Dorytomus edoughensis	Curculionidae	0	
Dorytomus filirostris	Curculionidae	0	
Dorytomus ictor	Curculionidae	0	
Dorytomus longimanus	Curculionidae	0	
Dorytomus majalis	Curculionidae	0	
Dorytomus melanophthalmus	Curculionidae	0	
Dorytomus minutus	Curculionidae	0	
Dorytomus nebulosus	Curculionidae	0	
Dorytomus occallescens	Curculionidae	0	
Dorytomus puberulus	Curculionidae	0	

Dorytomus rufatus	Curculionidae	0	
Dorytomus salicis	Curculionidae	0	
Dorytomus suratus	Curculionidae	0	
Dorytomus taeniatus	Curculionidae	0	
Dorytomus tortrix	Curculionidae	0	
Dorytomus tremulae	Curculionidae	0	
Dorytomus villosulus	Curculionidae	0	
Dromaeolus barnabita	Eucnemidae	1	A
Dromius quadrimaculatus	Carabidae	0	
Dryocoetes autographus	Curculionidae	1	F
Dryophthorus corticalis	Curculionidae	0	
Ellescus bipunctatus	Curculionidae	0	
Ellescus infirmus	Curculionidae	0	
Ellescus scanicus	Curculionidae	0	
Enicmus atriceps	Latridiidae	1	P
Enicmus brevicornis	Latridiidae	1	P
Enicmus fungicola	Latridiidae	1	P
Enicmus histrio	Latridiidae	1	P
Enicmus rugosus	Latridiidae	1	P
Enicmus testaceus	Latridiidae	1	P
Enicmus transversus	Latridiidae	1	P
Epitrix pubescens	Chrysomelidae	0	
Epuraea aestiva	Nitidulidae	1	F
Epuraea distincta	Nitidulidae	1	F
Epuraea fageticola	Nitidulidae	1	F
Epuraea longula	Nitidulidae	1	F
Epuraea pallescens	Nitidulidae	1	F
Epuraea unicolor	Nitidulidae	1	F
Euaesthetus bipunctatus	Staphylinidae	0	
Eucnemis capucina	Eucnemidae	1	A
Euplectus punctatus	Staphylinidae	1	A
Euryusa pipitzi	Staphylinidae	1	S
Eusphalerum luteum	Staphylinidae	0	
Exocentrus lusitanus	Cerambycidae	1	F
Exochomus quadripustulatus	Coccinellidae	0	
Fabogethes nigrescens	Nitidulidae	0	
Gastrallus laevigatus	Anobiidae	1	A
Genistogethes carinulatus	Nitidulidae	0	
Glaphyra umbellatarum	Cerambycidae	1	P
Glischrochilus quadriguttatus	Nitidulidae	1	F
Glischrochilus quadrisignatus	Nitidulidae	1	F
Gnathoncus buyssoni	Histeridae	1	A

Gnathoncus nanus	Histeridae	1	A
Gnathoncus nidorum	Histeridae	1	A
Grammoptera ruficornis	Cerambycidae	1	A
Gyrohypnus angustatus	Staphylinidae	0	
Habrocerus capillaricornis	Staphylinidae	0	
Halyzia sedecimguttata	Coccinellidae	0	
Haploglossa marginalis	Staphylinidae	1	A
Hedobia imperialis	Anobiidae	1	A
Hemicrepidius hirtus	Elateridae	0	
Hesperus rufipennis	Staphylinidae	1	A
Hister unicolor	Histeridae	0	
Hololepta plana	Histeridae	1	F
Homalota plana	Staphylinidae	1	F
Hylesinus oleiperda	Curculionidae	1	F
Hylis foveicollis	Eucnemidae	1	A
Hypocyphtus pulicarius	Staphylinidae	0	
Ilyobates benneti	Staphylinidae	0	
Ischnomera cyanea	Oedemeridae	1	A
Isorhipis marmottani	Eucnemidae	1	A
Isorhipis melasoides	Eucnemidae	1	A
Lamiogethes ochropus	Nitidulidae	0	
Lamiogethes persicus	Nitidulidae	0	
Lamprinodes saginatus	Staphylinidae	0	
Latridius hirtus	Latridiidae	1	P
Latridius minutus	Latridiidae	1	P
Leiopus nebulosus	Cerambycidae	1	F
Leperisinus varius	Curculionidae	1	F
Leptophloeus clematidis	Laemophloeidae	1	F
Leptura quadrifasciata	Cerambycidae	1	A
Leptusa fumida	Staphylinidae	1	A
Limodoromus assimilis	Carabidae	0	
Liogluta microptera	Staphylinidae	0	
Lissodema cursor	Salpingidae	1	F
Lissodema denticolle	Salpingidae	1	F
Litargus balteatus	Mycetophagidae	1	P
Litargus connexus	Mycetophagidae	1	P
Lucanus cervus	Lucanidae	1	A
Lyctus pubescens	Lyctidae	1	F
Lymantor coryli	Curculionidae	1	F
Lythraria salicariae	Chrysomelidae	0	
Magdalis armigera	Curculionidae	1	F
Magdalis cerasi	Curculionidae	1	F

Malachius bipustulatus	Malachiidae	1	A
Malthodes marginatus	Cantharidae	1	A
Megatoma undata	Dermestidae	1	S
Melandrya barbata	Melandryidae	1	A
Melanophthalma transversalis	Latridiidae	1	P
Melanotus niger	Elateridae	1	A
Meligethes flavimanus	Nitidulidae	0	
Melolontha hippocastani	Scarabaeidae	0	
Mesosa curculionides	Cerambycidae	1	F
Mesosa nebulosa	Cerambycidae	1	A
Microrhagus emyi	Eucnemidae	1	A
Microrhagus lepidus	Eucnemidae	1	A
Microrhagus pygmaeus	Eucnemidae	1	A
Mniusa incrassata	Staphylinidae	0	
Monotoma picipes	Monotomidae	0	
Mordella sp.	Mordellidae	1	A
Mordellaria aurofasciata	Mordellidae	1	A
Mordellistena variegata	Mordellidae	1	A
Mycetophagus fulvicollis	Mycetophagidae	1	P
Mycetophagus piceus	Mycetophagidae	1	P
Mycetophagus populi	Mycetophagidae	1	P
Mycetophagus quadripustulatus	Mycetophagidae	1	P
Nacerdes carniolica	Oedemeridae	1	A
Necrophorus fossor	Silphidae	0	
Necrophorus humator	Silphidae	0	
Necrophorus interruptus	Silphidae	0	
Necrophorus investigator	Silphidae	0	
Necrophorus vespillo	Silphidae	0	
Necrophorus vespilloides	Silphidae	0	
Nematodes filum	Eucnemidae	1	A
Nemozoma elongatum	Trogositidae	1	F
Neuraphes angulatus	Staphylinidae	0	
Notolaemus unifasciatus	Laemophloeidae	1	F
Obrium cantharinum	Cerambycidae	1	F
Oedostethus quadripustulatus	Elateridae	0	
Oligomerus brunneus	Anobiidae	1	A
Omalium excavatum	Staphylinidae	0	
Omalium rugatum	Staphylinidae	0	
Onthophagus verticicornis	Scarabaeidae	0	
Onychophilonthus marginatus	Staphylinidae	0	
Opanthribus tesselatus	Anthribidae	1	A
Opilo pallidus	Cleridae	1	A

Orchestes testaceus	Curculionidae	0	
Orthocis alni	Ciidae	1	P
Orthocis festivus	Ciidae	1	P
Orthocis vestitus	Ciidae	1	P
Oulema melanopus	Chrysomelidae	0	
Oxypoda sp.	Staphylinidae	0	
Oxytelus laqueatus	Staphylinidae	0	
Oxytelus piceus	Staphylinidae	0	
Oxythyrea funesta	Scarabaeidae	0	
Paromalus flavicornis	Histeridae		
Pediacus depressus	Cucujidae	1	A
Pelecotoma fennica	Rhipiphoridae	1	A
Phalacrus corruscus	Phalacridae	0	
Philonthus sp.	Staphylinidae	0	
Phloeocharis subtilissima	Staphylinidae	1	A
Phloeonomus punctipennis	Staphylinidae	1	F
Phloeophagus thomsoni	Curculionidae	1	A
Phloeopora angustiformis	Staphylinidae	1	F
Phloeopora corticalis	Staphylinidae	1	F
Phloeopora scribae	Staphylinidae	1	F
Phloeopora teres	Staphylinidae	1	F
Phloeopora testacea	Staphylinidae	1	F
Phloeostiba planus	Staphylinidae	1	F
Phosphuga atrata	Silphidae	0	
Phyllobius calcaratus	Curculionidae	0	
Phyllobius glaucus	Curculionidae	0	
Phyllobius oblongus	Curculionidae	0	
Phyllotreta atra	Chrysomelidae	0	
Phyllotreta christinae	Chrysomelidae	0	
Phyllotreta cruciferae	Chrysomelidae	0	
Phyllotreta nemorum	Chrysomelidae	0	
Phyllotreta nigripes	Chrysomelidae	0	
Phyllotreta procera	Chrysomelidae	0	
Phyllotreta undulata	Chrysomelidae	0	
Phyllotreta vittula	Chrysomelidae	0	
Phymatodes testaceus	Cerambycidae	1	F
Placonotus testaceus	Laemophloeidae	1	F
Placusa depressa	Staphylinidae	1	F
Placusa pumilio	Staphylinidae	1	F
Placusa tachyporoides	Staphylinidae	1	F
Platydema violaceum	Tenebrionidae	1	P
Platypus cylindrus	Platypodidae	1	F

Platystethus nodifrons	Staphylinidae	0	
Platystomos albinus	Anthribidae	1	P
Polydrusus corruscus	Curculionidae	0	
Polydrusus formosus	Curculionidae	0	
Polydrusus pterygomalis	Curculionidae	0	
Polydrusus sericeus	Curculionidae	0	
Priobium carpini	Anobiidae	1	A
Prionus coriarius	Cerambycidae	1	F
Propylea quatuordecimpunctata	Coccinellidae	0	
Protaetia aeruginosa	Scarabaeidae	1	M
Protaetia fieberi	Scarabaeidae	1	A
Pseudapion rufirostre	Apionidae	0	
Ptilinus fuscus	Anobiidae	1	A
Ptilinus pectinicornis	Anobiidae	1	A
Ptinus rufipes	Ptinidae	1	A
Ptinus sexpunctatus	Ptinidae	1	A
Pycnomerus terebrans	Zopheridae	1	A
Quedius (Microsaurus) tenellus	Staphylinidae	1	A
Quedius (Microsaurus) xanthopus	Staphylinidae	1	A
Quedius cruentus	Staphylinidae	0	
Quedius scitus	Staphylinidae	1	A
Rhacopus attenuatus	Eucnemidae	1	A
Rhacopus sahlbergi	Eucnemidae	1	A
Rhagium mordax	Cerambycidae	1	F
Rhagonycha fulva	Cantharidae	0	
Rhagonycha limbata	Cantharidae	0	
Rheochara spadicea	Staphylinidae	0	
Rhizophagus bipustulatus	Monotomidae	1	F
Rhizophagus parvulus	Monotomidae	1	F
Rhizophagus perforatus	Monotomidae	1	F
Rhopalocerina clavigera	Staphylinidae	0	
Rhyncolus punctatulus	Curculionidae	1	A
Ropalopus macropus	Cerambycidae	1	F
Rybaxis longicornis	Staphylinidae	1	A
Sacium pusillum	Corylophidae	1	P
Saggitogethes ater	Nitidulidae	0	
Sagittogethes ovatus	Nitidulidae	0	
Sagittogethes umbrosus	Nitidulidae	0	
Salpingus planirostris	Salpingidae	1	F
Salpingus ruficollis	Salpingidae	1	F
Saperda scalaris	Cerambycidae	1	F
Scaphisoma agaricinum	Scaphidiidae	1	P

Scolytus ensifer	Curculionidae	1	F
Scolytus intricatus	Curculionidae	1	F
Scolytus kirschii	Curculionidae	1	F
Scolytus mali	Curculionidae	1	F
Scolytus multistriatus	Curculionidae	1	F
Scolytus rugulosus	Curculionidae	1	F
Scolytus scolytus	Curculionidae	1	F
Scraptia fuscula	Scraptiidae	1	A
Scymnus frontalis	Coccinellidae	0	
Sepedophilus binotatus	Staphylinidae	1	A
Sepedophilus bipunctatus	Staphylinidae	1	A
Sepedophilus bipustulatus	Staphylinidae	1	A
Sepedophilus lividus	Staphylinidae	1	A
Sericoderus lateralis	Corylophidae	0	
Siagonium quadricorne	Staphylinidae	1	F
Silvanus bidentatus	Silvanidae	1	A
Silvanus unidentatus	Silvanidae	1	A
Simo hirticornis	Curculionidae	0	
Sitona humeralis	Curculionidae	0	
Sphaerosoma pilosum	Alexiidae	0	
Stachygethes ruficornis	Nitidulidae	0	
Stelidota geminata	Nitidulidae	0	
Stenagostus rhombeus	Elateridae	1	A
Stenagostus rufus	Elateridae	1	A
Stenhomalus bicolor	Cerambycidae	1	F
Stenocarus ruficornis	Curculionidae	0	
Stenocorus meridianus	Cerambycidae	1	A
Stenomax aeneus	Tenebrionidae	1	A
Stenostola dubia	Cerambycidae	1	F
Stephostethus angusticollis	Latridiidae	1	P
Stephostethus caucasicus	Latridiidae	1	P
Stethorus punctillum	Coccinellidae	0	
Stilbus testaceus	Phalacridae	0	
Symbiotes gibberosus	Endomychidae	1	M
Synaptus filiformis	Elateridae	0	
Synchita humeralis	Zopheridae	1	A
Tachinus fimetarius	Staphylinidae	0	
Tachinus laticollis	Staphylinidae	0	
Tachinus lignorum	Staphylinidae	0	
Tachinus signatus	Staphylinidae	0	
Tachyporus nitidulus	Staphylinidae	0	
Taphrorychus bicolor	Curculionidae	1	F

Telmatophilus typhae	Cryptophagidae	1	M
Tenebroides fuscus	Trogositidae	1	A
Thanasimus formicarius	Cleridae	1	F
Tilloidea unifasciata	Cleridae	1	A
Tomoxia biguttata	Mordellidae	1	A
Trechus quadristriatus	Carabidae	0	
Tribolium castaneum	Tenebrionidae	0	
Tribolium confusum	Tenebrionidae	0	
Trichonyx sulcicollis	Staphylinidae	1	A
Triplax aenea	Erotylidae	1	P
Trixagus dermestoides	Throscidae	1	A
Trixagus elateroides	Throscidae	1	A
Trixagus leseigneuri	Throscidae	1	A
Trixagus meybohmi	Throscidae	1	A
Trixagus obtusus	Throscidae	1	A
Trox scaber	Trogidae	0	
Trypodendron domesticus	Curculionidae	1	F
Trypophloeus alni	Curculionidae	1	F
Trypophloeus asperatus	Curculionidae	1	F
Trypophloeus bispinulus	Curculionidae	1	F
Trypophloeus granulatus	Curculionidae	1	F
Trypophloeus rybinskii	Curculionidae	1	F
Trypophloeus spiculatus	Curculionidae	1	F
Tychius picirostris	Curculionidae	0	
Tychius tibialis	Curculionidae	0	
Variimorda fasciata	Mordellidae	1	A
Velleius dilatatus	Staphylinidae	0	
Vibidia duodecimguttata	Coccinellidae	0	
Xantholinus linearis	Staphylinidae	0	
Xerogethes sp.	Nitidulidae	0	
Xyleborinus saxeseni	Curculionidae	1	F
Xyleborus cryptographus	Curculionidae	1	F
Xyleborus dispar	Curculionidae	1	F
Xyleborus dryographus	Curculionidae	1	F
Xyleborus monographus	Curculionidae	1	F
Xyleborus saxeseni	Curculionidae	1	F
Xylocleptes bispinus	Curculionidae	1	F
Xylophilus corticalis	Eucnemidae	1	A
Xylophilus testaceus	Eucnemidae	1	A
Xylosandrus germanus	Curculionidae	1	F
Xylostiba bosnica	Staphylinidae	1	F

Lebenslauf

Kathrin Stürzenbaum

Ausbildung

1994-1998	Volksschule Obdorf, Bludenz
1998-2006	Bundesgymnasium Bludenz (Matura mit ausgezeichnetem Erfolg)
2006-2013	Studium der Biologie an der Universität Wien, Studienrichtung Zoologie
2012-2013	Diplomarbeit am Department für Tropenökologie und Biodiversität der Tiere

Zusätzliche Qualifikationen

Sprachkenntnisse	Deutsch (Muttersprache), Englisch (ausgezeichnet), Französisch (Diplôme d'Etudes en Langue Française, B 1)

Sonstige Tätigkeiten im Bereich der Biologie

06/2013	Teilnahme am 5. Forschungssymposium der Nationalparks in Österreich, Mittersill; Posterpräsentation
2013	Teilnahme an „Geo-Tagen der Artenvielfalt": in Maria-Anzbach (Biosphärenpark Wienerwald) und in Molln (Nationalpark Kalkalpen)