The xylobiontic beetle fauna of old oaks colonised by the endangered longhorn beetle *Cerambyx cerdo* Linnaeus, 1758 (Coleoptera: Cerambycidae)

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Abstract: Xylobionte Käferfauna alter Eichen, die von dem gefährdeten Bockkäfer *Cerambyx cerdo* besiedelt sind (Coleoptera: Cerambycidae)

Der Große Eichenbock (*Cerambyx cerdo* Linnaeus, 1758) hat in Mitteleuropa in den letzten 100 Jahren einen dramatischen Rückgang in der Zahl der Vorkommen und in den Populationsgrößen erfahren. Als Frischholzbesiedler von Eichen beeinflusst die Art durch larvale Fraßtätigkeit die physiologischen Eigenschaften dieser Bäume sowie deren Beschaffenheit als Habitat für andere Organismen. Wir haben die Auswirkungen dieser Veränderungen auf die Zusammensetzung der holzbewohnenden Käferfauna bei verschiedenen taxonomischen und funktionalen Gruppen untersucht. Dabei vergleichen wir die mit Lufteklektoren erzielten Fänge an 10 besiedelten und 10 unbesiedelten Eichen aus einem Untersuchungsgebiet in Niedersachsen. Insbesondere viele seltene Bewohner von Baumhöhlen und Holzmulm profitieren von der Anwesenheit dieser Bockkäferart und den dadurch entstehenden Mikrohabitaten. Besiedelte Bäume beherbergen auch signifikant mehr Arten der Roten Liste. Wir diskutieren die Eigenschaft von *C. cerdo* als Substratbereiter sowie die davon partizipierenden Arten. Freilich lässt nur ein Teil des Artenspektrums engere Zusammenhänge mit Besiedlung durch den Großen Eichenbock erkennen. Allerdings gehören auch Arten mit loser Beziehung zu *Cerambyx cerdo* über weite Strecken einer hochgradig bedrohten Käfergemeinschaft alternder Eichen an. Vor diesem Hintergrund sehen wir die unverzichtbare Rolle des Großen Eichenbockes in von Eichen geprägten Ökosystemen, wenn es um die Erhaltung der Artenvielfalt holzbewohnender Insekten geht.

Key words: biodiversity, FFH, saproxylic beetles, oak, Quercus, endangered species, nature conservation

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In our present-day landscape in Central Europe major parts of the xylobiontic especially of the saproxylic beetle fauna belong to the group of endangered species assemblages (Speight 1989, Geiser 1994). Oaks, in Central Europe mainly *Quercus robur* and *Q. petraea*, are well known for their large number of associated insect species and harbour the highest beetle diversity, especially for dead wood inhabiting species, of all broadleaved tree species in this region (e.g. Palm 1959). A characteristic species associated with oaks in its life-cycle is the endangered Great Capricorn *Cerambyx cerdo*. *C. cerdo* is one of the protected species explicitly named in the Habitats Directive of the European Union with the goal of maintaining existing populations and establishing long-term survival (Council of the European Communities 1992). The last remaining colonised areas of this longhorn beetle in Central Europe are well known for the enormous number of very rare xylobiontic beetle species. Thus, we are interested in the following research questions:

1) Are there typical species associated with *C. cerdo*?
2) If so, what kind of relationship do these associated species have to *C. cerdo* from a nature conservation point of view?

Material and methods

We used interception traps to survey the flight-active beetle fauna of the oak trees. Individual trees used for trapping were randomly selected from the pool of oaks investigated in habitat modelling of *Cerambyx cerdo* (see Buse & al. 2007). This group of oak trees is divided into colonised and uncolonised ones. In total, we analysed

10 colonised and 10 uncolonised trees for their xylobiontic beetle fauna with one trap per tree. Uncolonised trees had a minimum distance of 30 metres to colonised ones. We used a mixture after RENNER (1980) to preserve the catches and we emptied the traps every three weeks. The single traps were placed in the lower canopy about 4-5 metres above ground from May 10 to August 28 in 2006.

The study area was located in the 'Gartower Elbmarsch' (53° 1' N, 11° 27' E) where the last population of the longhorn beetle *Cerambyx cerdo* in Lower Saxony (Germany) is found. The 'Gartower Elbmarsch' is characterised by large areas of pastures interspersed with groups of trees and small woodlands. Most trees on which *C. cerdo* occurs are located in a narrow strip of pasture between a dike and the river. Another important location is a three kilometre long avenue with a mixture of oak trees of different ages on both sides. Our research area is part of the MAB (Man-and-Biosphere)-reserve "River Landscape Elbe".

We identified all beetles on species level following the nomenclature of FREUDE & al. (1964-83) and later supplements and included those species in our analysis which have been listed as xylobiontic species in SCHMIDL & BUSSLER (2004) and occur on oaks. Additionally we included some species which were regarded to be xylobiontic according to PALM (1959). Details on the red-list classification were taken from the national Red List of Germany (GEISER 1998). Fisher's exact test was used to compare the number of locations where the single species were caught. Differences in the number of red-listed species between colonised and uncolonised trees were tested with the Wilcoxon-rank-sum-test. For this purpose we pooled the red-listed species numbers for each tree. We carried out the statistical analyses with R 2.2.0 (R Core Development Team 2005).

Results

In total, we found about 7,225 individuals from 181 xylobiontic beetle species. 69 of these beetle species are listed in the national Red List of Germany. More than half of the sample is represented by *Xyleborus saxeseni*, a very common bark beetle. There is great variance in the distribution of individuals per species. 49 species are recorded as single individuals. Oaks colonised by *C. cerdo* harbour significantly more threatened xylobiontic beetle species than uncolonised oaks (Wilcoxon-rank-sum-test, $p < 0.017$).

We arranged each species according to their habitat and food preferences as known from the literature (e.g. PALM 1959, SCHMIDL & BUSSLER 2004). Figure 1 shows that more species live on rotten wood and in tree-hollows when oaks are colonised by *C. cerdo*. We observed six feeding guilds the xylophagous, necrophagous, mycetophagous, polyphagous and zoophagous guilds of which are richer in species on oaks that are colonised by *C. cerdo*. These trees harbour nearly twice the species of the necrophagous and polyphagous guild. Both groups of trees host the same number of beetle species feeding on sap streams. Xylophagous and zoophagous species represent nearly half of the overall species number. Most species which were more frequent on colonised oaks are inhabitants of tree hollows (Table 1). Many of them are exclusively recorded from those trees with remarkable signs of *Cerambyx*'s presence in this study. Four beetle species are significantly more frequent on colonised oaks.

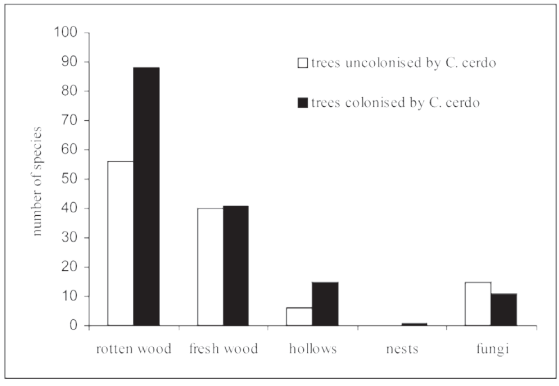

Figure 1: Observed number of species living in different habitats

Discussion

Relationships between species can show various forms. Theoretically, there is a wide range of patterns from symbiosis or predation to different degrees and kinds of competition.

Attention should be paid to such cases where *C. cerdo* prepares the wood quality for other xylobiontic species. For example, the darkling beetles *Uloma culinaris* and *Corticeus bicoloroides* find suitable conditions inside the larval galleries of *C. cerdo* as well as other large longhorn beetles e.g. *Megopis scabricornis* (cf. ZABRANSKY 1991). Besides certain decay stages and wood conditions itself, the dimensions of the galleries may play a certain role. They are big enough to provide free moving space for secondary inhabitants and concurrently

allow the beetles to reach the interior of the trunk or branch. On the other hand, these holes and galleries are narrow enough to offer protection against potential predators and allocate a constant microclimate.

The relationship of some Cetonidae e.g. *Protaetia aeruginosa* or the hermit beetle (*Osmoderma eremita*) to *C. cerdo* is probably similar to the one discussed before. The entrance of the afore mentioned species into the interior of the wood is also fasciliated by the larvae of *C. cerdo*. Prepared hollows are enlarged by the larval feedings of the scarab species, the tree hollow is filled up with faeces of the scarab larvae and dead wood remnants. A new habitat for other species is created, e.g. *Elater ferrugineus* and *Brachygonus megerlei* (Elateridae), which are predators of at least the larval stages of the scarabs (cf. Husler & Husler 1940, Svensson & al. 2004).

Table 1: Xylobiontic beetle species exclusively or predominantly found on oak trees colonised by *C. cerdo*; the number of trees where the single species were present is shown according to the colonisation status of *Cerambyx cerdo*. RL = red list status according to the national Red List of Germany (Geiser 1998): 1 = critically endangered, 2 = endangered, 3 = vulnerable. Fisher's exact test: ** $p < 0.01$; . $p < 0.1$; n.s. = not significant at the species level

Family	Genus	Species	Presence of *C. cerdo*	Absence of *C. cerdo*	p	RL
Aderidae	*Euglenes*	*oculatus*	6	0	**	2
	Euglenes	*pygmaeus*	2	0	n.s.	1
Alleculidae	*Mycetochara*	*axillaris*	1	0	n.s.	2
	Mycetochara	*linearis*	9	5	n.s.	
	Pseudocistela	*ceramboides*	1	0	n.s.	2
Anobiidae	*Dorcatoma*	*chrysomelina*	3	0	n.s.	3
	Dorcatoma	*flavicornis*	9	2	**	3
Cerambycidae	*Cerambyx*	*scopolii*	4	0	.	3
	Rhagium	*sycophanta*	4	1	n.s.	3
	Stenocorus	*quercus*	1	0	n.s.	2
Cleridae	*Korynetes*	*coeruleus*	1	0	n.s.	
	Dermestoides	*sanguinicollis*	2	0	n.s.	1
	Thanasimus	*formicarius*	1	0	n.s.	
	Tillus	*elongatus*	2	0	n.s.	3
Colydiidae	*Colydium*	*elongatum*	1	0	n.s.	3
	Colydium	*filiforme*	4	0	.	2
Curculionidae	*Brachytemnus*	*porcatus*	1	0	n.s.	2
Dermestidae	*Attagenus*	*punctatus*	5	1	n.s.	2
	Ctesias	*serra*	3	0	n.s.	
	Globicornis	*nigripes*	10	3	**	3
	Trogoderma	*glabrum*	3	0	n.s.	
Elateridae	*Ampedus*	*cardinalis*	3	0	n.s.	1
	Ampedus	*hjorti*	5	1	n.s.	2
	Brachygonus	*megerlei*	2	0	n.s.	2
	Cardiophorus	*gramineus*	4	0	.	2
	Lacon	*querceus*	1	0	n.s.	1
	Procraerus	*tibialis*	6	0	**	2
Tenebrionidae	*Corticeus*	*bicolor*	1	0	n.s.	3
	Corticeus	*bicoloroides*	1	0	n.s.	1
	Corticeus	*fasciatus*	1	0	n.s.	2
	Tenebrio	*molitor*	4	0	.	
	Uloma	*culinaris*	1	0	n.s.	2

Our results indicate that oaks colonised by *C. cerdo* contain more beetle species associated with tree hollows or wood mould like *Ampedus cardinalis*, *Ampedus hjorti*, *Lacon querceus*, *Procraerus tibialis*, *Corticeus bicoloroides* and *Uloma culinaris*. Also several species caught from the families Aderidae and Alleculidae live in or on top of wood mould inside those trees. These beetle species have different life traits and belong to distinct feeding guilds. The first group with species like *Allecula morio* feed on fungi-infested wood parts and sometimes on remnants from other insects or their nests (Palm 1959). The second ecological group living in wood mould are predators like the larvae of some click beetles. Typical inhabitants of insect and animal nests belong to the third group of beetles which were more abundant on trees colonised by *C. cerdo*. Classical members of this group are *Globicornis nigripes* and *Cryptophagus micaceus* whose larvae feed on dead insects and related natural remnants in dead trees (Palm 1959).

In general, predatory species benefit from the increased number of insect species and their larvae in dead and rotten wood. Most specimens from the predatory family of Cleridae were caught on oak trees which were strongly influenced by the larval feedings of *C. cerdo*. Especially the huge number of scolytid and anobiid beetles created favourable conditions for some checkered beetles (cf. KENIS & al. 2004; ULYSHEN & al. 2004). According to KOLIBÁC & al. (2005) the larval stage of *Dermestoides sanguinicollis*, a species which is very rare in his whole distribution area, lives mainly on oaks as a predator in the galleries of *Lymexylon navale* (Lymexylonidae), occasionally also in galleries of *Xestobium rufovillosum*, *Oligomerus* sp. (both Anobiidae) and perhaps also of *Acmaeodera degener* (Buprestidae). Other inhabitants of holes and galleries are *Corticeus* species, which were recorded only as single individuals exclusively from the oaks colonised by *C. cerdo*. *Corticeus fasciatus* moves typically on barkless dry wood and is mainly found on trunks colonised by *Lymexylon navale* (e.g. PALM 1959). But there is uncertainty about the feeding ecology of *Corticeus*.

We summarise that trees colonised by *Cerambyx cerdo* offer a habitat for numerous endangered xylobiontic beetle species. Especially many saproxylic species, e.g. inhabitants of tree hollows and rotten wood, do colonise the same trees. Therefore, efforts to improve habitat conditions for *C. cerdo* have a positive effect on an entire threatened assemblage of insects.

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