Proceedings of the Tenth International Conference on Urban Pests
Rubén Bueno-Marí, Tomas Montalvo, and Wm. H Robinson (editors) 2022
CDM Creador de Motius S.L., Mare de Deu de Montserrat 53-59,
08930 Sant Adrià de Besòs, Barcelona, Spain

CLERIDS AS A POTENTIAL APPROACH FOR BIOLOGICAL CONTROL – FAUNISTIC INVESTIGATION IN BUILDINGS INFESTED WITH WOOD DESTROYING INSECTS

[1,2]CHRISTOPHER BAAR, [1]CLAUDIA VON LAAR, AND [2]HENNING BOMBECK
[1]Hochschule Wismar, Univ. of Applied Sciences, Tech., Business and Design,
Philipp-Müller-Str. 14, 23952 Wismar, Germany
[2] Universität Rostock, Agrar- und Umweltwissenschaftliche Fakultät, Justus-von-Liebig-Weg 6, 18059 Rostock

Abstract The clerids *Korynetes caeruleus* (Coleoptera: Cleridae) and *Opilo domesticus* (Coleoptera: Cleridae) naturally occur in buildings where they feed on the wood pest *Anobium punctatum* (Coleoptera, Ptinidea). Another prey of *K. caeruleus* in buildings is the wood-destroying insect *Xestobium rufovillosum* (Coleoptera, Ptinidae). The larvae of these two species of checkered beetles live polyphagously and hunt the larvae of wood-destroying insects in their tunnels. However, for the establishment and mass reproduction of these beneficial insects for biological control of wood-destroying insects, the factors influencing their occurrence in buildings, as well as their prey range and predatory potential, need to be investigated in more detail. In 2020 and 2021, faunistic and climatic monitoring was installed in 16 buildings from Mecklenburg with active infestation of *A. punctatum* and *X. rufovillosum*. The results show that the adult *K. caeruleus* and *O. domesticus* have differences in their way of life. *Korynetes caeruleus* has not been observed chasing or feeding on adult wood-destroying insects on the wood surface. Adult *K. caeruleus* entered the boreholes of the prey. *K. caeruleus*, adult *O. domesticus* simultaneously occurred with their adult prey *A. punctatum* and actively hunted them outside the wood. During the reproductive phase of *O. domesticus*, a large number of killed adult *A. punctatum* were found in some buildings. Adult *O. domesticus* are not able to hunt in the boring tunnels of their prey *A. punctatum* due to their body size.The study showed, that one of the two clerid species always dominated the buildings surveyed, which could indicate mutual displacement competition.

Key Words *Anobium punctatum, Xestobium rufovillosum, Korynetes caeruleus, Opilo domesticus*, predatory antagonists

INTRODUCTION

Biological control of wood-destroying insects as part of Integrated Pest Management is becoming important. Biological control involves the targeted mass release of beneficial insects to reduce the population density of pests to an economically acceptable level (Auer et al., 2021, Dettner and Zwölfer, 2003).

Figure 1. Adult *Korynetes caeruleus*

Only the parasitoid wasp *Spathius exarator* is commercially available for biological control of *Anobium punctatum* (Coleoptera, Ptinidea) larvae in Germany. The effect is limited by the length of the wasp's ovipositor (Haustein, 2019). Another approach for biological control could be synanthropic, predatory checkered beetles (Cleridae). *Korynetes caeruleus* (Figure 1) and *Opilo domesticus* (Coleoptera: Cleridae) are natural enemies of wood-destroying anobial species in wooden structures (Freude et al., 1979; Pospischil, 2000). They are considered beneficial insects.

The wood pests *Xestobium rufovillosum* (Coleoptera, Ptinidea) and *A. punctatum* are widespread throughout most of Europe (Kutnik et al., 2020). In addition, *A. punctatum* is found in Australia, New Zealand, North Africa, South Africa, the east coast of North America and Asia (Child and Pinniger, 2014).
Korynetes caeruleus is distributed in Central and Southern Europe (Pospischil, 2000) and North Asia (Kim and Jung, 2006b). The larvae of *K. caeruleus* can attack larvae of wood-destroying insects deep in the wood (Belmain et al.,

1999b, Haustein, 2019). In this context, *A. punctatum* (Becker, 1942, Haustein and von Laar, 2007, Pospischil, 2000, Ott, 2007) and *X. rufovillosum* (Belmain et al., 1999a, Noldt, 2007, Huckfeldt et al., 2019) are included in the prey spectrum. Haustein (2010) mentions a polyphagous disposition of *K. caeruleus*. Furthermore, in breeding studies at the Bundesanstalt für Materialforschung und -prüfung (BAM) and various partners, the first *K. caeruleus* has already been bred under laboratory conditions, defining the minimal requirements for breeding this antagonist (Haustein et al., 2019). *Korynetes caeruleus* is 4 to 5.5 mm long and about 1.8 to 2.2 mm wide. The larvae of *K. caeruleus* are up to 14 mm long (Ott, 2007).*Opilo domesticus* is found across central Europe including southern Sweden, the Iberian Peninsula, North Africa and the southeastern Caucasus (Gerstmeier, 1987). In addition, Korea, southern Europe, North America and Mexico are mentioned as distribution areas (Kim and Jung, 2006a). The adults of *O. domesticus* captured in this study were between 7 to 10 mm long and about 2.5 to 3 mm wide. The collected larvae were between 10 and 12 mm long. The prey of *O. domesticus* is primarily *A. punctatum* (Haustein and von Laar, 2007, Pospischil, 2000), but also *X. rufovillosum* (Huckfeldt et al., 2019) is reported in some cases. Becker (1954), Freude et al. (1979) and Gerstmeier (1987) mention anobial species as prey.

In this study, historic buildings in Mecklenburg-Western Pomerania were investigated with faunistic monitoring for the occurrence of wood-destroying insects and their natural enemies. The measures employed during the monitoring in this study have been tested numerous times (Belmain, 1999a, Haustein et al., 2007, Noldt, 2006 and 2007). Despite an intensification of research (Haustein et al., 2019, Baar et al., 2021, von Laar et al., 2021) on the building-inhabiting clerids *K. caeruleus* and *O. domesticus*, much research on their lifestyle, prey spectrum and predatory efficiency is still needed.

MATERIAL AND METHODS

Buildings. In 2020, faunistic monitoring was installed in 13 buildings in Mecklenburg-Western Pomerania (north-east Germany) (Figure 2). Churches, hall houses and a warehouse building were investigated. The buildings are of timber-framed or brickwork construction. Some of the buildings were empty, used for storage or as open-air museums. In 2021, monitoring continued in nine buildings and was extended by a further 11 buildings to a total of 20 properties. The floors affected by wood-destroying insects ranged from the basement to the attic.

Figure 2: Locations of the buildings investigated. Locations marked in orange were equipped with monitoring in 2020 and those marked in purple only in the following year 2021

Faunistic monitoring. The monitoring measures included paper covers, sticky traps and collections. Paper covers and white sticky traps (Dr. Elkmann) were placed in the buildings until the beginning of April and remained there until mid-September. The paper stickers (83 g/m²) were attached to visually identifiable infestation points using reversible Tylose glue. Every two to four weeks, the paper covers and sticky traps were checked for newly created exit holes and newly trapped insects. In addition, insects were collected from the infested wooden structures.

Climate monitoring. To measure relative humidity and temperature, at least one data logger (Scanntronik Hygrofox Mini) was positioned at the focus of infestation in each building. In buildings with an intensive infestation over several floors or rooms, several data loggers were used. Measurements started from May 2020 respectively March 2021, depending on the start of the monitoring. The measurement interval was one measurement per hour.

RESULTS

The results of the investigations showed that four buildings from 2020 and 2021 were either not infested or only infested to a very low degree by wood-destroying insects. In addition, no species of checkered beetles were detected in these buildings. As a result, only 9 buildings from 2020 and 16 buildings from 2021 are considered in the following results.

Based on the results of the sticky traps, collections and paper covers, Table 1 shows the number of buildings with an occurrence of adult pest and beneficial insect species. *Anobium punctatum* occurred in all nine examined buildings in 2020, and this was confirmed in the following year 2021, supplemented by seven new building occurrences (Σ n = 16). *Xestobium rufovillosum* was detected in four buildings in 2020 and twice that number in 2021 (Σ n = 8) (Table 1). In these cases, it was a co-occurrence with *A. punctatum*. *Korynetes caeruleus* was the most common species of checkered beetles in this study, with 67% in the first year and 88% in 2021. The occurrence of *O. domesticus* was 33% (2020) and 38% (2021).

	2020 Σ n = 9	**2021** Σ n = 16
X. rufovillosum	4 (44 %)	8 (50 %)
A. punctatum	9 (100 %)	16 (100 %)
K. caeruleus	6 (67 %)	14 (88 %)
O. domesticus	3 (33 %)	6 (38 %)

Table 1: Number of buildings (n) with detection of adult pests and beneficial insects by year

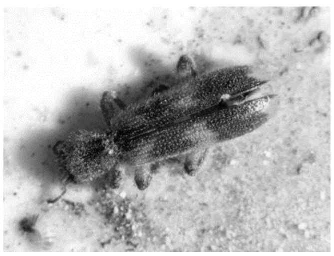

Figure 3: Adult *O. domesticus*

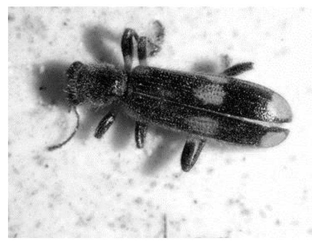

Figure 3: Adult O. domesticus

Time of occurrence of adult pests and beneficial insects

Assignment of the exit holes to the selected insect species in the paper covers was based on the characteristics of the diameter and degree of fraying of the exit holes tested and described by Haustein (2010). A reliable differentiation of the exit holes for the species *O. domesticus* (Figure 3) and *O. mollis* (Figure 4) is not possible due to the almost similar body shape and size. Only the exit holes of *K. caeruleus* could be clearly determined. Therefore, in the further discussion, the results of all investigated checkered beetle species from the paper covers have not been included. An unambiguous identification of pest exit holes was possible according to Haustein (2010). The number of detected exit holes is listed in parentheses by month in Table 2.

For adult pest and clerid species collected from sticky traps and collections, a clear species identification was made according to macroscopic characteristics based on identification literature (Freude et al., 1979, Klausnitzer, 1999 and Klausnitzer et al., 2011). The checkered beetles captured in sticky traps and during collections were outside the wood and in their reproductive phase (Table 2). During this phase, adult checkered beetles hunt for their prey, fly, search for mates and reproduce.

	2020 (9 Buildings)						**2021 (16 Buildings)**					
	Apr	May	Jun	Jul	Aug	Sep	Apr	May	Jun	Jul	Aug	Sep
X. rufovillosum	31 (89)	96 (48)	34 (3)	2 (0)	0 (0)	0 (0)	23 (48)	173 (107)	104 (1)	0 (8)	0 (0)	0 (0)
A. punctatum	0 (3)	2 (20)	14 (13)	154 (559)	12 (23)	14 (4)	0 (30)	2 (20)	18 (66)	360 (940)	39 (35)	5 (12)
K. caeruleus	0	162	57	0	0	0	0	83	74	0	0	0
O. domesticus	0	0	0	71	5	5	0	0	0	86	6	0

Table 2. Number of adult pests and beneficial insects trapped in sticky traps collected by month, and number of exit holes in paper covers for pests by month in parentheses

As the first wood-destroying insect, *X. rufovillosum* hatched beginning in early April (Table 2). The main hatch was in April or May, depending on the year, which allowed most adult beetles to be caught in the sticky traps and collections shortly thereafter. The hatching of *A. punctatum* was detected by the paper covers during a period from April to September. During the two years of monitoring, 1499 exit holes, 86.9 % of the total number were detected in the month of July. This result was also confirmed with 514 beetles from the sticky traps and collections. Here the maximum of 82,9 % was also in the month of July.

Korynetes caeruleus was detectable as an adult beetle in the buildings in May and June. Most imagines occurred at the end of May to the beginning of June and thus shortly after *X. rufovillosum* and this regardless of whether *X. rufovillosum* was detected in these buildings. Only 36 adult *A. punctatum*, representing 5.8 % of the total catch, were observed during the reproductive period of *K. caeruleus*.

Opilo domesticus was detected from July to September with a peak of 157 beetles and 90.8 % of the total beetles in July.
To further examine the prey spectrum of the two predators, *K. caeruleus* and *O. domesticus*, trap counts for predators and prey from sticky traps and collections are compared in Table 3 for all 16 buildings from 2021.

Buildings (no.)	*X. rufovillosum Xr*	*A. punctatum Ap*	*K. caeruleus Kc*	*O. domesticus Od*	Most found pests	Most found predators
1	35	42	0	75	*Ap*	***Od***
2	0	35	80	0	*Ap*	*Kc*
3	18	25	8	1	*Ap*	*Kc*
4	0	19	1	0	*Ap*	*Kc*
5	1	46	13	6	*Ap*	*Kc*
6	8	30	2	4	*Ap*	***Od***
7	5	15	4	1	*Ap*	*Kc*
8	0	2	2	0	*Ap*	*Kc*
9	0	10	14	0	*Ap*	*Kc*
10	30	16	5	0	***Xr***	*Kc*
11	0	4	2	0	*Ap*	*Kc*
12	28	61	10	0	*Ap*	*Kc*
13	0	12	1	0	*Ap*	*Kc*
14	0	8	2	0	*Ap*	*Kc*
15	0	74	0	7	*Ap*	***Od***
16	175	21	16	0	***Xr***	*Kc*

Table 3: Total adult insects caught in sticky traps and collections from 2021

Korynetes caeruleus
In 63% of the examined buildings, *K. caeruleus* occurred as the only species of checkered beetle. *Korynetes caeruleus* is found in buildings infested with both *A. punctatum* and *X. rufovillosum* (Table 3). In two buildings without detection of *K. caeruleus* (2021), *O. domesticus* was present in large numbers in sticky traps.

Opilo domesticus
In two buildings (Table 3, no. 1 and 15; marked red) *O. domesticus* could be detected as the only species of checkered beetles. In these two buildings *A. punctatum* represents the main part of the pest infestation. This becomes clear for building no. 1 only when looking at the paper covers. In 2021, 298 *A. punctatum* and only 17 *X. rufovillosum* exit holes were counted in this building.

Common occurrence of *K. caeruleus* and *O. domesticus*
In buildings no. 3, 5, 6, and 7 *K. caeruleus* and *O. domesticus* were detected together, with *K. caeruleus* always present in greater numbers except for building no. 6. Building no. 6 had monitoring in both 2020 and 2021. In 2020, building no. 6 (Table 3; marked red), still had 19 adult *K. caeruleus* and three *O. domesticus* imagines detected via sticky traps and collections. In the following year (Table 3), more adult *O. domesticus* (n = 4) than *K. caeruleus* (n = 2) were caught in this building for the first time among all the investigated buildings.

Observations on prey supply
Some collected *K. caeruleus* and *O. domesticus* were used for breeding at the Bundesanstalt für Materialforschung und -prüfung (BAM) and Wismar University of Applied Sciences, Technology, Business and Design. *Anobium punctatum* and *X. rufovillosum* used for feeding observations at Wismar University were collected from buildings under investigation or, with relation to *A. punctatum*, partly from breeding at BAM. In 2020 and 2021, 333 alive adult *K. caeruleus* were collected from the buildings. Of these, the most *K. caeruleus* were collected in building no. 2, with 162 in 2020 and 67 in 2021 (Table 3).*K. caeruleus* imagines were offered dead adult *X. rufovillosum* as food. Further experiments were made with alive and dead adult *A. punctatum*, as well as *A. punctatum* larvae. The offered insects remained unharmed until the death of the *K. caeruleus* imagines. Moreover, no cannibalism of the imagines was observed. Thus, no feeding by the adult *K. caeruleus* was observed in this study.

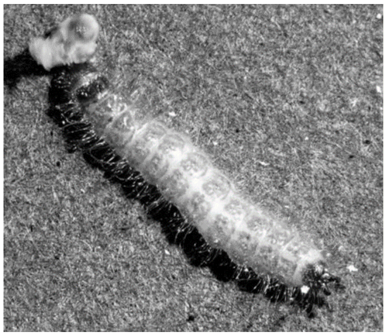

Figure 5: Collected *O. domesticus* larva eating dead *A. punctatum* larva in the laboratory.

In 2021, four *O. domesticus* larvae were collected. These *O. domesticus* larvae were offered dead and alive *A. punctatum* larvae, as well as dead adult *A. punctatum* as food which they accepted as a food source (Figure 5). Dead adult *K. caeruleus* and *X. rufovillosum* were not accepted as food by the larvae.

Microclimate during the reproductive phase:

By measuring relative humidity and temperature in 2020, it is possible to assign the results from the sticky traps and collections to the microclimates during insect occurrence. This was not possible for 19 of 163 adult *X. rufovillosum*, as they were detected in sticky traps prior to the installation of the data loggers. In Figure 6, the mean value of all measurements (air temperature and relative humidity) between two control intervals of the sticky traps was assigned to the imagines originating from sticky traps. For collected insects, the daily mean (air temperature and relative humidity) was assigned to them.

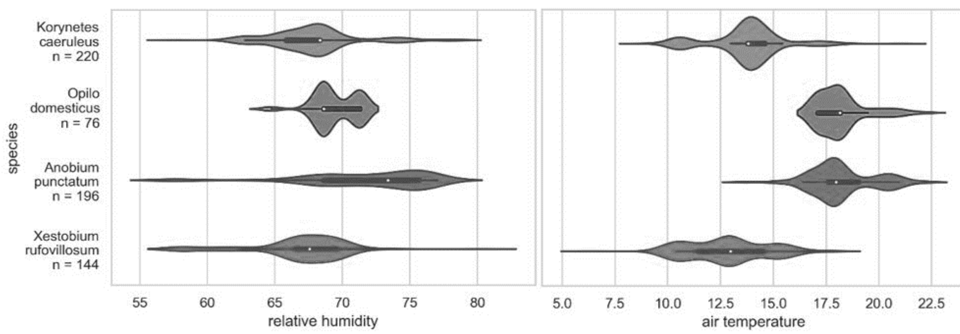

Figure 6. Relative humidity and temperature during the reproductive phase in 2020 based on sticky traps and collections.

Xestobium rufovillosum occurred at cold temperatures from 5 to 19°C and abundantly between 11 and 14°C (Figure 6). The relative humidity interval ranged from 55 to 84%, with most insects detected from 65 to 72% in the buildings. *Anobium punctatum* was detected between 55 and 80% relative humidity and from 12.5 to 23°C air temperature. Increased occurrence of imagines was between 16 and 18°C air temperature and at a relative wide range of relative humidity from 65 to 78%.Adult *K. caeruleus* occurred at relative humidity of 55 to 80% and air temperature of 7.5 to 22.5 °C, thus exhibiting the widest climatic range of the examined checkered beetle species. *Opilo domesticus* has the smallest interval of air temperature and relative humidity of all examined species, during the reproductive phase. Relative humidity and air temperature during this phase range from 64 to 73% and 16.5 to 23°C, respectively.

DISCUSSION

Possible prey during the reproductive phase of *Korynetes caeruleus*

Korynetes caeruleus occurred both in buildings predominantly infested by *A. punctatum* and *X. rufovillosum*. Hickin (Hickin, 1969 cited in Niehuis, 2013) considers it possible that *K. caeruleus* adapts to its prey and hatches with either the *A. punctatum* or *X. rufovillosum* prey in each case. The adult species *X. rufovillosum* occurs more often from April to early June, while *A. punctatum* appears from July to August (Table 2 and Figure 7). The reproductive phase of *K. caeruleus* occurred in May and June (Table 2 and Figure 7) and is consistent with the monitoring results of Noldt (2006, 2007) and Haustein (2010). A temporal shift and adaptation of the reproductive phase of *K. caeruleus* to *A. punctatum* and *X. rufovillosum* could not be observed in this study, as the reproductive phase always occurred in the months of May and June, regardless of pest infestation. The reproductive phase of *K. caeruleus* took place shortly after the maximum occurrence of adult *X. rufovillosum*. This is also noticeable in the comparison of the measured relative humidities and air temperatures (Figure 6). While the occurrence of *X. rufovillosum* is mostly within an interval of air temperature of 11 to 14°C, *K. caeruleus* could be detected in a larger number between 13 and 15°C.

During the reproductive phase of *K. caeruleus*, only 5.8% of the total catch of *A. punctatum* was detected in the buildings. For this reason, Haustein (2010) already suspected that adult *A. punctatum* probably do not prey on adult *K. caeruleus*. This is also illustrated by the measured temperatures while *K. caeruleus* was already present in large numbers between 13 and 15°C in the buildings, the reproductive phase of *A. punctatum* occurred only between 16 and 18°C in the majority. Furthermore, no feeding activity of adult *K. caeruleus* could be observed in this study, although adult *X. rufovillosum*, *A. punctatum* imagines, as well as *A. punctatum* larvae were offered as food. However, Haustein (2010) concludes that the imagines are feeding, as he was able to observe fecal excretions. It is possible for adult *K. caeruleus* to enter and exit feeding tunnels of both *A. punctatum* and *X. rufovillosum* based on their body size (Baar et al., 2021). Whether egg deposits of *X. rufovillosum* or *A. punctatum* serve for the presumed mature feeding (Niehuis, 2013) or a feeding according to Haustein (2010) has to be clarified in later experiments.

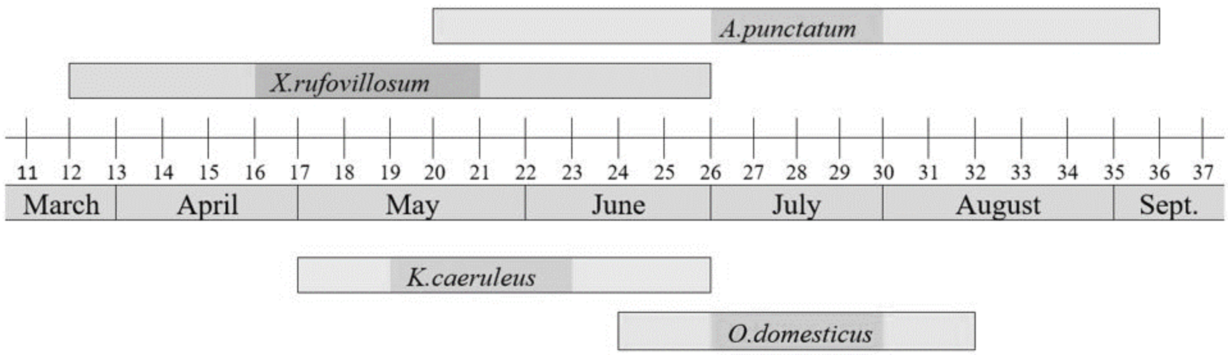

Figure 7. Timeline of adult pests and clerids caught in sticky traps and during collections; darker coloration indicates main occurrence of insect species

Possible prey during the reproductive phase of *Opilo domesticus*

The majority of *O. domesticus* hatching occurred in the month of July (Table 2) and is therefore consistent with the assumptions of Haustein (2010), although the phenogram of Niehuis (2013) indicates a main hatching in June. With the reproductive phase occurring in July, a large number of adult *A. punctatum* were available to *O. domesticus* as prey for the mature feeding presumed by Becker (1942) and Pospischil (2000), as 86.9% of the adult *A. punctatum* occurred in this month. There was also a very large overlap in the air temperatures measured as imagines, so that both species largely occurred in parallel at 16 to 18°C in the buildings (Figure 6). During the reproductive phase of *O. domesticus*, a large number of killed adult *A. punctatum* were found in some buildings, presumably cut up and eaten by O. domesticus. Hunting within the bore tunnels of *A. punctatum* is not possible for adult *O. domesticus* due to their body size (Baar et al., 2021).

In contrast to Haustein's (2010) monitoring, *O. domesticus* was detected in buildings infested with *X. rufovillosum* in this study, but a larger population of *A. punctatum* (Table 3) was additionally always present. In the only building where *X. rufovillosum* is the main infestation, no occurrence of *O. domesticus* was detected during two years of monitoring (Table 3, Building no. 16). Due to the different timing of the reproductive phase of *X. rufovillosum* and *O. domesticus*, adult *X. rufovillosum* are unlikely to prey on *O. domesticus* imagines (Table 3 and Figure 7). In addition, their climatic requirements differ most among all insect species studied (Figure 6). In contrast to *A. punctatum* imagines, adult *X. rufovillosum* were not observed to prey on *O. domesticus* larvae. The *O. domesticus* larvae must sometimes have a great capacity for starvation, as one larva continued to live trapped on a sticky trap from the day of discovery on 6/21/2021 to 12/15/2021. From mid-September, the sticky trap with the captured larva was kept in a refrigerator at about 10°C. A large starvation ability was described by Becker (1942). Cannibalism among adult *O. domesticus* was described by Becker (1942) and observed on the sticky traps examined in this study.

Observations on the population density of beneficial insects in buildings

In the two years of monitoring, more imagines of *O. domesticus* (Σ n = 169) than of *K. caeruleus* (Σ n = 51) were found in the sticky traps, although *K. caeruleus* occurred in 88 % and *O. domesticus* only in 38% of the buildings. In building no. 2, it was possible to collect 162 *K. caeruleus* in 2020 and 67 *K. caeruleus* in 2021. However, only 27 adult *K. caeruleus* were captured in the sticky traps in both years combined. As Haustein (2010) concluded, the *K. caeruleus* imagines captured in sticky traps do not represent the existing population density.

For adult *O. domesticus*, an opposite phenomenon is observed. In all buildings combined, only three imagines were collected over both years of monitoring. However, in building no. 1 alone, 73 adult *O. domesticus* were detected in sticky traps in 2020 and 72 in the following year. The night activity described by Freude et al. (1979), Pospischil (2000) and Franke (2001) could be a reason for this. Franke (2001) already suspected nocturnal activity to be the reason why they are rarely sighted. The checkered beetles *K. caeruleus* and *O. domesticus* did not occur in equal numbers in any building (Table 3). One of the two clerid species always dominated the buildings surveyed, which could indicate mutual displacement competition.

REFERENCES CITED

Auer, J. Opitz, C. Kassel, A. 2021. A new biological method to control Anobium punctatum, by using the parasitoid wasp *Spathius ex*arator. In: Journal of Applied Entomology, 145, p.78-81.

Baar, C. von Laar, C. Willert, M. Bombeck, H. 2021. Occurrence of synanthropic wood-boring beetles (Coleoptera Ptinidae) and predatory checkered beetles (Coleoptera Cleridae) in relation to climatic factors in historical buildings. Proceedings IRG Annual Meeting, IRG/WP 21-10980

Becker, G. 1942. Ökologische und physiologische Untersuchungen über die holzzerstörenden Larven von *Anobium punctatum* De Geer. Zeitschrift für Morphologie und Ökologie der Tiere 39: 98-152.

Becker, G. 1954. Räuber und Parasiten holzzerstörender Insekten in Gebäuden. – Verhandlungen der Deutschen Gesellschaft für angewandte Entomologie 1954: 76-86.

Belmain, S.R. Simmonds, M.S.J. and Blaney W.M. 1999a. Deathwatch beetle, *Xestobium rufovillosum*, in historical buildings: monitoring the pest and its predators. Entomologia Experimentalis et Applicata 93: 97–104.

Belmain, S.R. Simmonds, M.S.J. and Blaney W.M. 1999b. The Deathwatch beetle, *Xestobium rufovillosum*, accommodated in all the best places. In: Robinson, W.H. Rettich, F. and Rambo G.W. (eds): Proceedings of the 3rd International Conference on Urban Pests, pp 407-414.

Child, R. and Pinniger, D. 2014. Current status and treatments for *anobium punctatum*. In: Müller, G. Pospischil, R. and Robinson, W.H. (eds): Proceedings of the Eighth International Conference on Urban Pests

Cymorek, S. 1968. Hylotrupes bajulus - Verpuppung und Flug, deren Klimaabhängigkeit und Beziehung zur Artverbreiterung. In: Zeitschrift angewandte Entomologie 62 (3), p. 316-344.

Dettner, K and Zwölfer, H 2003. Biologische, chemische und biotechnische Schädlingsbekämpfung. In: Lehrbuch der Entomologie, Dettner, K and Zwölfer, H. (eds.) München,Elsevier GmbH, p. 671-699.

Franke, P. 2001. Holzwurmbefall tot oder lebend? Der Praktische Schädlingsbekämpfer 6/2001:1 5-21.

Freude, H. Harde, K.W. Lohse, G.A. 1979. Die Käfer Mitteleuropas. Band 6: Disicornia. Goecke & Evers Verlag, pp 84-99.

Gerstmeier, R. 1987. Biologie und Verbreitung der Buntkafer in Bayern (Coleoptera, Cleridae). In: Schriftenreihe Bayerisches Landesamt für Umweltschutz 77/1987, p. 7‑16

Haustein, T. 2010. Zur Diagnose und integrierten Bekämpfung Holz zerstörender Insekten unter Berücksichtigung der Buntkäfer (Coleoptera: Cleridae) als deren natürliche Gegenspieler in historischen Gebäuden. Fraunhofer IRB Verlag.

Haustein, T. and von Laar, C. 2007. Vorkommen von synanthropen Buntkäfern (Coleoptera: Cleridae) in Mecklenburg-Vorpommern. Entomologische Nachrichten und Berichte 51: 225-229.

Haustein, T. von Laar, C. and Noldt U. 2007. Situation of wood-destroying pests in historical buildings of Mecklenburg – insect monitoring. In: Noldt, U. and Michels, H. (eds): Wood-destroying Organisms in Focus – Alternative Measures for Preservation of Historic Buildings, pp 73-81.

Haustein, T. 2019. Biologische Bekämpfung mit Nützlingen - Wohin geht die Reise im Holzschutz? In: Proceedings EIPOS-Sachverständigentages Holzschutz 2019. Beiträge aus Praxis, Forschung und Weiterbildung. Stuttgart: Fraunhofer IRB Verlag, 2019, S. 37-46

Haustein, T. Busweiler, S. Haustein, V. von Laar, C. and Plarre, R. 2019. Laboratory breeding of *Korynetes caeruleus* (Coleoptera: Cleridae) for the biological of *Anobium punctatum*) (Coleoptera, Ptinidae). European Journal of Entomology 116: 362-371.

Huckfeldt, T. Höpken, M. Noldt, U. 2019. Gescheckter Nagekäfer - *Xestobium rufovillosum* (De Geer, 1774) - Monitoring und Biologie des Käfers am Beispiel einer norddeutschen Kirche. ed. Schönherr, S. In: Tagungsband Holzschutz 2019; Beiträge aus der Praxis, Forschung und Weiterbildung. Eipos, Fraunhofer IRB, Stuttgart, p. 109-139.

Kim, J. and Jung, B.H. 2006 a. Taxonomic review of the Cleridae (Coleoptera) in Korea (Part 1): Clerinae Latreille, 1802. In: Entomological Research 36, p. 6-16.

Kim, J. and Jung, B.H. 2006 b. Taxonomic review of the Cleridae (Coleoptera) in Korea (Part 3): Korynetinae, Tarsosteninae and Tillinae. In: Entomological Research 36, p. 245-252.

Klausnitzer, B. 1999. In: Die Larven der Buntkäfer Mitteleuropas 3. Band Teil 2. Springer-Verlag Berlin Heidelberg, 325 p.

Klausnitzer, B. Schmidt, J. Hieke, F. Uhlig, M. Behne, L. 2011. In: Stresemann, Exkursionsfauna von Deutschland, ed. Hannemann, H.-J., Klausnitzer, B. & Senglaub, K., Band 2. Wirbellose: Insekten. 9. neu bearbeitete Auflage, Heidelberg & Berlin: Spektrum Akademischer Verlag, 959 p.

Kutnik, M. Paulmier, I. Ansard, D. Montibus, M. Lucas, C. 2020. Update on the Distribution of Termites and other Wood-boring Insects in Europe. Proceedings IRG Annual Meeting, IRG/WP 20--10960, 1-15

von Laar, C. Baar, C. Plarre, R. McMahon, D. P. 2021. Genetic relationships of local infestations by *Anobium punctatum*, *Xestobium rufovillosum* and their associated predator *Korynetes caeruleus* from buildings in North-Eastern Germany. Proceedings IRG Annual Meeting, IRG/WP 21-10982

Niehuis, M. 2013. Die Buntkäfer in Rheinland-Pfalz und im Saarland. GNOR, Mainz

Noldt, U. 2006. Holzzerstorende Insekten ‑ Befallsmerkmale, Monitoring, Langzeituntersuchungen und Begleitung von Bekampfungsmasnahmen in historischen Gebauden. In: Forschungsreport 2/2006, S. 33‑37

Noldt, U. 2007. Monitoring of wood-destroying insects – requirements and first results. In: Noldt, U. and Michels, H. (eds): Wood-destroying Organisms in Focus – Alternative Measures for Preservation of Historic Buildings, pp 41-57

Ott, R. 2007. Spurensuche – Untersuchungen über die Entstehung von Bohrmehlhäufchen an Schlupflöchern des Gemeinen Nagekäfers. Nachrichtenblatt der Landesdenkmalpflege Baden-Württemberg 36: 164-167.

Pospischil, R. 2000. Buntkäfer Teil I and II. In: Der praktische Schädlingsbekämpfer 1/2000, pp. 4-6 and 2/2000, p. 4-6.