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Comparison of Body Size and Wing Type in Beetles Found on Green Roofs and Adjacent Ground Sites in Portland, Oregon

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Table of Contents

Abstract
Green roofs and nearby ground habitats provide an arena to study invasion and compare dispersal ability between beetles. Invasive species can create a host of problems and to better prevent their spread it is vital to understand what traits allow for extensive colonization. In this study, two physical traits of beetles, wing type and body size, were examined and compared to see if there were differences in the beetle communities found on eight green roofs and eight ground sites in Portland, Oregon. No significant difference was found in body size except when comparing roof only species with abundant species, and due to limitations on wing type data, there was no direct correlation found to answer whether wing type corresponded to location. However, green roofs are a useful tool for comparing traits and further research should utilize these increasingly common habitats to better understand why certain species are found on these isolated urban islands.

Introduction

Urban rooftop gardens are an attempt to create more areas habitable for wildlife within cities and to provide economic benefits for the multi-story buildings they are built on (Velazquez 2005). They are most commonly constructed on buildings with relatively flat and accessible areas. To make these green roofs, a shallow layer of soil or other substrate is spread out on top of a barrier that protects the building. Various plants are grown either from seeds or are brought up from nurseries. Two common types of green roofs are sedum and habitat roofs. Sedum green roofs typically have more gravelly substrate and consist of many kinds of succulent species. Habitat green roofs are home to more herbaceous species that are grown in relatively shallow soil.

Once the substrate is added and plants take root, all sorts of animal life can follow. Insects are one of the most abundant groups of organisms found on these roofs. Spiders, ants, flies, bees, beetles, and more cohabitate in these small urban niches (MacIvor and Lundholm 2011). One of the questions that applies to many of the insect species found on these rooftops is how did they get there. Were they brought in with the substrate, or did they manage to migrate to the tops of these concrete multi-story buildings on their own? Could they have hitchhiked a ride on human or animal visitors to the rooftops via the process known as phoresy? Answering these questions may allow us to understand how to design green roofs so they maximize habitat for native species, and to better predict what makes the nonnative or invasive species so adept at colonizing new environments.

These green roofs are also model areas for studying invasion because they function as pseudo-islands assumed to be essentially uncolonized after construction. By monitoring the establishment of various species on these roofs, it may be possible to attribute certain traits or patterns to high dispersal and invasive propensity. So far, urban environments have been found to be more habitable by nonnative species, however green roofs may offer a potential solution for encouraging native species richness (McKinney 2002). Invasive plant species have also been studied on green roofs to see if these locations may create potential reservoirs for invasive plant species (Kinlock et al 2015).In one particular study it was determined that varying the soil depth on the rooftops affects the plant diversity and prevalence of native species. They put also forth the need to question the types of species used to stock the rooftops since many are often non native themselves.

Invasive species are found all over the world, and understanding how these insects spread is important for preventing ecological and economical damage. The ability to disperse and colonize new environments is relevant for assessing the risks posed by specific species (Anderson et al 2004). Human-involved dispersal is especially important to acknowledge because it is likely the only one that can be controlled. Most modes of human transportation are carrying potential invaders, especially in the ballast water of ships (Frazier et al 2013). Plant nurseries are also big stations for transport (Banks 1902). Nursery pests are insect species that are commonly found in the plants and soil sold by many plant nurseries. Once purchased, there is no limit to where the materials will end up (Banks 1902). Knowing the methods of natural and human aided dispersal will be considerably useful for predicting and affecting species invasion. (Mazzi and Dorn 2012).

Beetles in particular are one of most well-studied species on roof tops; they cover a range of trophic levels, and their short generation times allow them to respond quickly to change (McIntyre 2000). Many species are highly mobile and there is a lot of research available on invasive species all over the world. Certain traits may play a role in determining which beetle species will be most suited to dispersal and invasion. Wing size, body size, breeding location, diet, and other traits all play a role in an insect's success, especially in a new environment (Shibuya et al 2014, Yamashita et al 2006, Ogai and Kenta 2015). For example, insects that are generalist predators tend to be more successful at entering new environments because they are able to thrive on whatever food is most available (Crowder and Snyder 2010).

For this study, wing size and body size were the two primary phenotypes compared for determining which species are likely good dispersers. The evolution of wings appears to respond to the dimensionality of an environment and its stability over time (Roff 1990). In certain beetle species, wings have been completely lost because their necessity does not outweigh the cost (Roff 1990). Wing types are typically grouped into three categories for beetles, macropterous (large-winged), dimorphic (either large or reduced), and brachypterous (reduced wings). Those with macropterous or dimorphic wings are considered likely to have flying capabilities in this study (Thayer 1992, Yamashita et al 2006). There appears to be a connection between wing type and environment type, with smaller wings found in more disturbed environments (Shibuya et al 2014).

The same study on wing type found a similar correlation between body size and environment, with a decrease in body size also found after disturbance (Shibuya et al 2014).

Habitat has an effect on not only the size species found, but also size within species (Ogai and Kenta 2015). Because size seems to vary directly in response to location, it was chosen as a way to compare the beetles found on the roofs and at the ground sites.

The purpose of this research is to identify if body size and wing characteristics of certain beetle species differ between those found on ground sites and on green roofs, and discuss if these traits may help understand how green roofs are colonized. Based on the research mentioned above, there should be a difference in body size and wing type between species on the ground and on the rooftops, due to the difference in habitat type. For beetles found in both locations, wings are likely an important mode of transportation, so they should be mostly macropterous. And because the ground habitats are more stable than the relatively new green roofs, the average body mass may be larger than for the species on the roofs.

Methodology

In order to address these questions, I obtained permission to use a dataset generated from a collaboration between PSU and the University of Applied Sciences in Basel Switzerland that eventually became the primary evidence in a Masters Thesis by Sydney Gonsalves (Gonsalves 2016). As a project intern, I was responsible for insect sorting and occasionally pitfall trap collection.

The collection period was from April 2014 to October 2014. The beetles were collected on eight different green roofs and their corresponding ground sites in and around Portland, Oregon. Four green roofs were sedum roofs, and four were habitat roofs. The ground sites were chosen based on proximity to each roof and had little to no development or foot traffic.

Pitfall traps filled with 10% acetic acid were set up at each location and checked regularly (see fig. 1). The traps were flush with the substrate on the roofs, and covered with chicken wire to prevent interference from birds. Once in the lab, the acetic acid was replaced with 80% ethanol for long-term preservation.

The beetles were shipped to the University of Applied Sciences in Basel Switzerland where they were identified to species level. Over the course of seven months, 5402 beetles representing 102 unique species were collected from green roofs and nearby ground sites (Appendix I). Only 23.4% of these species were on the roof, the rest were captured from the ground sites. The twenty most commonly found beetles on the roofs and at the ground sites were used in comparison of body size and wing type. Those found only on the roofs and only on the ground were also compared. Literature was consulted to find values for body size and wing type of the beetles used for comparison.

The collection method used for capturing beetles on the roofs and ground sites provided a lot of data, however some issues did arise over the course of collection. The location of ground sites was very limited around some rooftops so some sites were farther away from the roof than desired. On the rooftops the primary issue was protecting the traps from birds without influencing the accessibility by insects. The other concern was keeping the traps full during the hottest part of summer. Dry traps likely affected the number of insects collected at certain times during collection.

Figure 1. The left photo shows a typical pitfall trap with a small protective roof (Ingles-Le Nobel 2015). The right photo shows an example of the typical contents of a pitfall trap after approximately one week from a Portland OR green roof (Starry 2015).

Results

The average body size of the twenty most abundant species on the rooftops and on the ground was calculated to determine if a significant difference exists between the two groups. The result of a two-tailed t-test showed an insignificant difference ($p=0.1302$) between the two. The difference in average size between the two groups was 2.45mm, with the ground species taking the lead in size. However, the standard deviation for the ground species was much greater than for the roof species (see fig. 2). The roof beetles ranged from 3mm to 12mm, whereas the beetles on the ground ranged from 3mm to 23mm. There are also seven species that are shared between the two groups because they were abundant at both types of sites.

The same comparison of average body size was made between species only on the roof and only on the ground, but this difference was also not significant ($p=0.1409$), in part because of the large variation in sample size (see fig. 3). The roof only group consists of sixteen species, while the ground only group has forty-one. The ground only group is again larger on average, however there are two species, *C. nemoralis* and *Ocypus olens* that are over 9mm larger than any other beetle in the same group. The standard deviation for the ground only beetles is also over twice that of the roof only group.

One more t-test was run to compare the species only found on the rooftops with the twenty most abundant on the ground. There is very strong evidence that these two groups vary in average size consistently (p=0.0024). Because some of the species in the ground grouping were also found on the roof, the smaller size is not a requirement for inhabiting the green roofs but species only found on the rooftops are smaller on average.

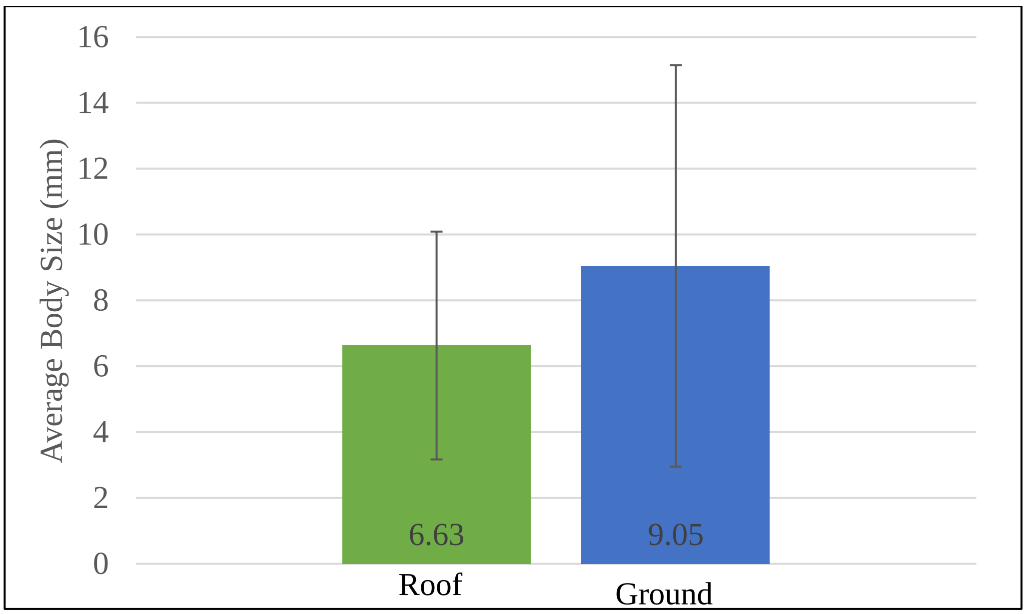

Figure 2: The average body size of the twenty most frequent beetle species from the green roofs (left column) and ground sites (right column) is shown; the error bars represent the standard deviation.

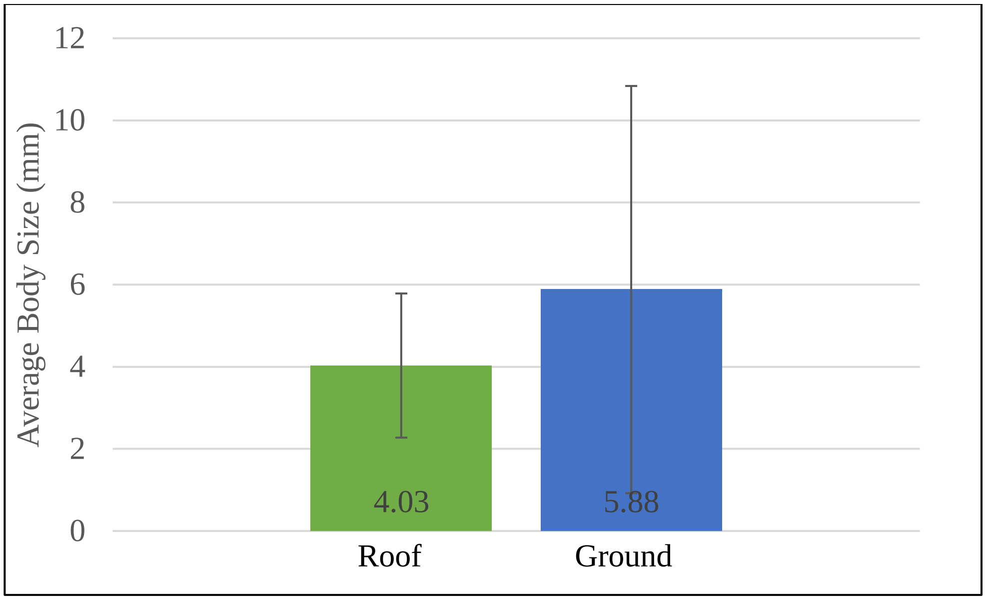

Figure 3: The average body size of the beetles only found on the green roofs (left column) and those only found on the ground (right column) is shown; the error bars represent the standrd deviation.

The comparisons indicate a tendency for larger beetles to be on the ground, and perhaps not be able to make it up to the rooftops. If all the species found on the roofs and ground were compared there may be a more significant difference, or perhaps a smaller one. Size alone though is likely not the only determining factor for a beetle making it to the roof. That is why wing type was also identified for as many species as possible to look at possible differences between the roof and ground species.

Family	**Species**	**Roof**	**Ground**	**Total**	**Size (mm)**	**Wings**
Carabidae	*Carabus nemoralis*	0	84	84	23	B[2,4]
Carabidae	*Calathus fuscipes*	8	56	64	13	B[2,4]
Carabidae	*Notiophilus sylvaticus*	0	40	40	5	D[2]
Carabidae	*Pterostichus melanarius*	2	177	179	16	D[2,4]
Carabidae	*Bembidion lampros*	20	8	28	3.5	D[4]
Carabidae	*Anisodactylus binotatus*	88	74	162	12	M[1]
Carabidae	*Agonum muelleri*	15	21	36	10	M[4]
Carabidae	*Nebria brevicollis*	18	722	740	12	M[1,4]
Carabidae	*Amara aenea*	23	349	372	8	M[1]
Carabidae	*Harpalus affinis*	115	35	150	10	M[3,4]
Carabidae	*Trechus obtusus*	190	73	263	4	M[7]
Staphylinidae	*Tachyporus nitidulus*	18	42	60	3	M[5]

Staphylinidae	*Philonthus carbonarius*	37	241	278	10	M[5]
Staphylinidae	*Philonthus cognatus*	3	1091	1094	12	F[5]
Coccinellidae	*Coccinella septempunctata*	54	25	79	8	F[6]
Staphylinidae	*Xantholinus linearis*	414	162	576	7	F[8]

Table 1: Beetle species that had available data on wing type and that had multiple specimens are shown above. There are three wing types, macropterous (M), brachypterous (B), and dimorphic (D) and a fourth category (F) for beetles that are at least known to be capable of flight. The list of numbered references for wing type can be found in Appendix II. The body size (mm) and number of specimens at each type of location are also included (Gonsalves 2016).

Due to constraints in finding reliable sources for wing type, not all the species from the previous analysis could be compared. For some, flight ability is noted even if wing type is unknown. Only two species were found to have brachypterous wings. One is *C. nemoralis*, a large beetle found only on the ground (Zalewski and Ulrich 2006). The other is *Calathus fuscipes*, a moderately sized beetle that has been found on the ground and on the rooftops (Cole et al 2002).

Beetles with dimorphic wings may have either macropterous or brachypterous wings depending on the individual. The larger winged individuals are able to spread to and colonize new areas, and if these new habitats are suitable, the populations that develop become full of reduced-winged members (Yamashita et al 2006). The three species identified as dimorphic in this data set were found on the rooftops and the ground. The macropterous species were found on both the rooftops and ground sites in large numbers, without being affected by size (Table 1). Due to large quantity of beetles collected and sorted, individuals were not looked at to determine individual wing type. Therefore, further conclusions based on what stage of colonization each species was in are not possible with this data.

Additional, interesting results arise when looking at species origin in terms of body size and wing type. The majority of the species found in the pitfall traps are nonnative, with some known to be invasive (Gonsalves 2016).

Coccinella. septempunctata is an extremely successful ladybug originating out of Asia that is creating considerable competition for native species like *Coccinella californica* (Hodek and Michaud 2008). Both of these have been found, however only one *C. californica* specimen was collected, compared to 79 *C. septempunctata* found on both the roofs and ground sites (Table 1; Appendix I). The dispersal of *C. septempunctata* is thought to be random in terms of oviposition location, and this sort of generalist approach at reproduction may be why is has spread so extensively in North America (Seagraves 2009). It is not surprising that several Coccinellidae were found on the rooftops, since many are very good fliers (Nalepa 2013).

A species with a similar story is *Nebria brevicollis*, a macropterous species. (Mazzei et al 2015). *N. brevicollis* is a very successful nonnative species spreading in the United States. Its expansion has been specially researched in Oregon by James LaBonte, an employee of the Oregon Department of Agriculture. While the immediate detrimental effects of *N. brevicollis*' invasion are not clear, this species is clearly capable of dispersing quickly and effectively, likely due to its eurytopic nature (LaBonte 2011). Interestingly, the vast majority of the specimens trapped for this research were found on the ground. Their larger size of 12mm may affect their ability to fly to the rooftops, or perhaps the ground sites are plenty suitable and there has been no reason to seek out new habitats.

Trechus obtusus is a small beetle equipped with macropterous wings that has been found on both the green roofs and ground sites in this study (Liebherr and Takumi 2002). It is also a nonnative species believed to be introduced by nurseries to the Pacific Northwest region of the United States. The spread of this species has been relatively linear, travelling up and down the west coast. No deleterious effects have been noted from this nonnative species (Kavanaugh and

Erwin 1985). The size and wing type do correlate with high mobility, which is a significant contributor to dispersal.

Pterostichus melanaris is a another species that, while nonnative, has not been found to be particularly harmful to local species and is not considered invasive (Nimela et al 1997). This species has spread globally from Europe due to human-intermediated dispersal, likely traveling in ships or in plants (Nimela and Spence 1991). This species is larger than N. brevicollis, however it is considered dimorphic for wing type (Zalewski and Ulrich 2006). This species was found predominantely on the ground sites, and it would be useful to identify the specific morphs of the species found at each site to see if the reason they are less abundant on the roof is because the nearest ones have reduced wings. A study on this species in Canada found that flight is used for dispersal, but post colonization the reduced wings return and even overtake macropterous individuals in numbers (Bourassa et al 2011).

Simplocaria semistriata is one of two Byrrhidae species we have found. It also likely dispersed via the ballast water of large ships and through nurseries, and was not yet recorded as found in Oregon in a paper published in 1990 (Johnson 1990). Like many byrrhidae species, *S. semistriata* is small, however the wing type was not found (Appendix I)

E. parvulus is likely the most recent to have invaded Oregon, with its first record in the U.S. in the 1950's. The spread and potential impact as an invader for this species is actively being studied (LaBonte 1998). This species is one of the smallest collected on the green roofs, and was also only found on rooftops.

Discussion

The ability to disperse and thrive in new environments facilitates invasion, and by determining which traits lend themselves to dispersal will help us understand more about invasion (Simberloff 2003). The main question this data on size and wing type brings up is if there is an upper size limit to what species have macropterous wings or that are able to fly well enough to make it up multiple stories on their own. The results show a difference in average body size for beetles only found on the rooftops versus those found mostly on the ground, however no strict correlations can be made to answer exactly how size affects location. For wings, macroptery was most common for the species with data available, but there was not enough evidence to show whether some roof species may not be getting to the greenroofs via flight or if flight is required.

Beetles have caused many issues regarding invasion, by outcompeting with native species for resources and destroying local flora (Crowder and Snyder 2010). Some prominent examples include the Colorado potato beetle and the Asian long-horned beetle. (Liu et al 2010; Talbot Trotter III and Hull-Sanders 2015). Much of their success can be attributed to human intermediated dispersal, via ballast water in ships, nursery transport, and many other methods of transportation (Nimela and Spence 1991; Koch et al 2012). Natural dispersal and invasion is less understood and less controllable, however, with more knowledge about the attributes of beetles we may be able to predict or prevent future invasive related damage.

Green roofs provide an opportunity to look at both natural dispersal traits and human influences. Our results are mixed. We did not show a significant difference when comparing the twenty most abundant species on rooftops and at ground sites; however, the beetles that have only found on the rooftops are significantly smaller than the most common beetles on the ground. This may suggest that beetles only on the rooftops are arriving there through mediated transport, but they might also be getting there naturally via flying, and have not been captured at ground sites.

One of the original questions that prompted this analysis of species was what beetles are native to the area, and which ones are not. This information directly correlates with invasion. Some of the species found had only one specimen, and many were nonnative. A possible consideration for their appearance is that they may be brought in on the materials used to start the rooftops. There are companies that solely provide for the creation of green roofs and similar structures, and there is not much research available as to whether these sources are potentially bringing in nonnative species and assisting their dispersal.

There is much work to be done for answering all the questions accumulating around green roofs (Mazzi & Dorn 2011). In this particular study, a small subset of rooftops and ground sites in one city were used to look at two physical traits of beetles. Wing type and body size play a role in the locomotive ability of a beetle, which directly affect how beetles may be moving to the roofs. These two physical traits may not have shown significant difference between rooftops and ground sites, however a potential correlation between locomotion and colonization may be supported with greater samples.

Furthermore, it is important to look more closely at individual species. The invasion of just one species can have a huge effect, and there may only be one characteristic separating an invasive beetle from a noninvasive beetle. Beyond wings and body size, other traits such as diet, reproductive requirements, and habitat preference also play a role in determining where and why a beetle may disperse, and how they might compete with local species (Reitz and Trumble 2002). Combining information from all of these influences is important to truly understand the life history and future of a particular organism.

The process of analyzing data for this particular study raised many ideas for further research using similar methods. In particular, breeding patterns and diet are traits that would be interesting to compare to wings and body size to better create a profile of what types of beetles are successful on green roofs. In one study on feeding habits, the researchers found that the type of predation, generalist or specific, plays a role in successful colonization (Crowder and Snyder 2010). Dispersal is also affected by season and stability of the habitat, which are factors that may differ between green roofs and ground environments (Boivin & Hance 2003).

There are many ways to direct more research on beetle dispersal and colonization tactics in order to better understand invasion. The ultimate goal is to prevent the severe damage caused by nonnative species outcompeting with and destroying local environments. However, this information will also help plan ways to control the spread ongoing invasions by pest species.

Conclusion

This study investigated the average size and wing type for beetle species found on green roof and ground sites in Portland, OR. We did not a show a major difference in wing type between roof and ground species grouped by abundance and location. There was a significant difference however between the most common beetles at the ground sites and the species only found on the rooftops. This might indicate that beetles found on these roofs may be making it there naturally (ie via flight), or that the beetles arriving on the roofs may be more opportunistic. Gaining more information on the full list of identified species may enhance the slight trend toward a larger body size on the ground, and perhaps provide a better picture of how wing type varies. Overall, this study provides a pathway for further research looking at how specific traits may influence the dispersal and invasive capability of beetle and other insect species. Hopefully, by determining how organisms disperse, humans may be able to curb the influence of invasive species on local environments.

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Appendix I.

Family	Species	Roof	Ground	Total
Anthicidae	Anthicus cervinus	17	11	28
Bruchidae	Bruchidius fasciatus	1	0	1
Byrrihidae	Cytilus sericeus	16	0	16
Byrrihidae	Simplocaria semistriata	16	14	30
Carabidae	Trechus obtusus	190	73	263
Carabidae	Harpalus affinis	115	35	150
Carabidae	Anisodactylus binotatus	88	74	162
Carabidae	Amara aenea	23	349	372
Carabidae	Bembidion lampros	20	8	28
Carabidae	Elaphropus parvulus	19	0	19
Carabidae	Nebria brevicollis	18	722	740
Carabidae	Stenolophus conjunctus	17	3	20
Carabidae	Agonum muelleri	15	21	36
Carabidae	Microlestes minutulus	12	106	118
Carabidae	Calathus ruficolis	11	18	29
Carabidae	Calathus fuscipes	8	56	64
Carabidae	Agonum canadense	7	22	29
Carabidae	Amara ovata	4	22	26
Carabidae	Harpalus herbivagus	3	0	3
Carabidae	Pterostichus melanarius	2	177	179
Carabidae	Loricera pilicornis	1	4	5
Carabidae	Loricera foveata	1	11	12
Carabidae	Agonum cupreum	0	1	1
Carabidae	Amara anthobia	0	1	1
Carabidae	Amara familiaris	0	1	1
Carabidae	Amara plebeja	0	8	8
Carabidae	Amphasia sericea	0	2	2
Carabidae	Bembidion doris	0	1	1
Carabidae	Carabus nemoralis	0	84	84
Carabidae	Cicindela purpurea	0	2	2
Carabidae	Clivina fossor	0	1	1
Carabidae	Notiophilus biguttatus	0	21	21
Carabidae	Notiophilus sylvaticus	0	40	40
Carabidae	Syntomus americanus	0	15	15
Carabidae	Amara municipalis	0	3	3
Chrysomelidae	Diabrotica undecimpunctata	1	1	2
Coccinellidae	Coccinella septempunctata	54	25	79
Coccinellidae	Hippodamia convergens	8	1	9

Coccinellidae	Hippodamia variegata	2	7	9
Coccinellidae	Coccinella californica	1	0	1
Coccinellidae	Exochomus quadripustulatus	0	1	1
Coccinellidae	Scymnus rubromaculatus	0	1	1
Corylophidae	Sericoderus lateralis	0	7	7
Cryptophagidae	Atomaria fuscata	0	1	1
Curculionidae	Otiorhynchus sulcatus	19	2	21
Curculionidae	Tychius picirostris	14	18	32
Curculionidae	Hypera zoilus	12	8	20
Curculionidae	Sitona hispidulus	6	80	86
Curculionidae	Otiorhynchus ovatus	3	5	8
Curculionidae	Dryophthorus americanus	2	0	2
Curculionidae	Otiorhynchus rugosostriatus	2	6	8
Curculionidae	Sphenophorus parvulus	1	23	24
Curculionidae	Barypeithes pellucidus	0	57	57
Curculionidae	Hypera nigrirostris	0	8	8
Curculionidae	Hypera postica	0	11	11
Curculionidae	Mecinus pyraster	0	2	2
Curculionidae	Rhinoncus castor	0	1	1
Curculionidae	Sciaphilus asperatus	0	1	1
Curculionidae	Sitona cylindricollis	0	7	7
Curculionidae	Sitona lepidus	0	10	10
Dermestidae	Anthrenus verbasci	0	1	1
Elaturidae	Limonius lanei	1	0	1
Elaturidae	Aeolus mellillus	0	23	23
Languriidae	Cryptophilus integer	0	1	1
Lathridiidae	Melanophthalma distinguenda	0	1	1
Monotomidae	Monotoma longicollis	3	0	3
Mycetophagidae	Mycetophagus quadriguttatus	1	0	1
Nitidulidae	Carpophilus lugubris	4	46	50
Nitidulidae	Colopterus unicolor	0	2	2
Nitidulidae	Epuraea biguttata	0	1	1
Nitidulidae	Epuraea marseuli	0	1	1
Nitidulidae	Glischrochilus quadrisignatus	0	6	6
Nitidulidae	Pocadius fulvipennis	0	1	1
Scarabaeidae	Stentothorax badipes	2	13	15
Scarabaeidae	Onthophagus nuchicornis	0	1	1
Scolytidae	Hylurgops rugipennis	1	0	1
Silvanidae	Silvanus bidentatus	1	0	1
Staphylinidae	Xantholinus linearis	414	162	576
Staphylinidae	Gabrius appendiculatus	112	6	118
Staphylinidae	Philonthus carbonarius	37	241	278
Staphylinidae	Tachyporus dispar	20	27	47
Staphylinidae	Tachyporus nitidulus	18	42	60
Staphylinidae	Oxypoda praecox	13	90	103
Staphylinidae	Aleochara lanuginosa	10	0	10
Staphylinidae	Tachyporus chrysomelinus	5	4	9
Staphylinidae	Tasgius winkleri	4	1	5

Staphylinidae	Philonthus cognatus	3	1091	1094
Staphylinidae	Aloconota gregaria	2	0	2
Staphylinidae	Ocypus aeneocephalus	2	92	94
Staphylinidae	Rugilus orbiculatus	2	5	7
Staphylinidae	Acrotona parens	1	0	1
Staphylinidae	Atheta coriaria	1	0	1
Staphylinidae	Atheta fungi	1	21	22
Staphylinidae	Oxypoda opaca	1	0	1
Staphylinidae	Quedius curtipennis	1	55	56
Staphylinidae	Aleochara diversa	0	1	1
Staphylinidae	Dinaraea angustula	0	5	5
staphylinidae	Gauropterus fulgidus	0	1	1
Staphylinidae	Ocypus olens	0	17	17
Staphylinidae	Omalium rivulare	0	2	2
Staphylinidae	Stenus fulvicornis	0	1	1
Tenebrionidae	Blapstinus moestus	4	413	417

Appendix II.

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