ИЗУЧЕНИЕ И ОХРАНА ФАУНЫ БЕСПОЗВОНОЧНЫХ НА ООПТ
STUDY AND CONSERVATION OF INVERTEBRATE FAUNA OF PROTECTED AREAS

ON THE USE OF WINE VINEGAR AS AN ATTRACTANT IN CROWN TRAPS

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A variety of baits in simple traps can be very helpful in the study of insect biodiversity. The study was conducted on the possibility of using crown traps with vinegar and beer during their joint exposure. Representatives of 10 insect orders were captured. Vinegar baits are less effective than beer baits. There were more insect speies and individuals in the beer traps. Representatives of the orders Coleoptera, Lepidoptera, Diptera and Hymenoptera were the most numerous in all traps. The only family Formicidae was well lured by vinegar. There were more than 87 species from 31 families in the species diversity of Coleoptera. There were 52 species in wine vinegar traps and 64 species in beer traps. It is better to use traps with vinegar bait in conjunction with beer baits.
Key words: beer traps, insects, fauna, bait traps, biodiversity

Introduction

Insects are the most diverse group of species on Earth. They play crucial roles in the functioning of ecosystems and the global economy. Therefore, the conservation of insect diversity is a topic of global importance. However, researchers of "biodiversity" mostly ignore insects (Kim, 1993; Cardoso et al., 2011; Prather, Laws, 2018). Climate change, human agricultural activities, fires, habitat degradation, and invasive species lead to changes in insect populations and biodiversity and affect the role of insects in our ecosystems (Aleinikov, 2019; Dangles, Casas, 2019; Ruchin et al., 2019; Cicort-Lucaciu, 2020). There is no clear understanding (exact figures) of the total biological diversity of the entomofauna of a particular region or ecosystem in many cases, which complicates the problem (Rozhnov et al., 2019; Silva et al., 2019). A variety of methods is used to study the insects' biodiversity (Jackman, Nelson, 1995; Marques et al., 2006; Fagundes et al., 2011; Egorov, Semishin, 2016; Ruchin, Egorov, 2018; Tomaszewska et al., 2018; Zamotajlov et al., 2019; Bondarenko et al., 2020; Lynov et al., 2020). Crown traps with various baits in the form of fermenting liquids are additional effective methods. Wine, molasses, beer, and various fruits, honey, and sugar are used as such attractants (Williams et al., 1995; MacRae & Rice, 2007; Guarnieri, 2009; Baini et al., 2016; Rukavina et al., 2018; Barros et al., 2020; Dvorak et al., 2020; MacGowan et al., 2021; Ruchin et al., 2021; Ruchin, 2021). Recently, Ruzzier et al. (2021) have reported on the possibility of using cider vinegar as bait. This article discusses the results of our research on the use of vinegar as an attractant in crown traps.

Materials and Methods

The study was conducted on the territory of Temnikov and Krasnoslobodsk districts of the Republic of Mordovia (the center of European Russia). The material was collected using crown

traps, their design was previously described (Ruchin et al., 2020; Fig. 1). Each trap consisted of a plastic 1.5 or 5-liter container with a window cut in it on one side. The trap was installed in the tree crown at a height of 1.5 to 7 m from the soil surface. Six percent cider vinegar was used as an attractant. For comparison, a similar trap was installed next to such a trap, but with beer as an attractant. An equal amount of sugar was added to both traps at the same time. Three pairs of traps were installed in each study spot. A total of 6 traps, three of them were with beer and three with vinegar. Each such pair was suspended from a single tree branch at the distance of less than 1.2 m from each other. The data on traps with different attractants were then averaged. Pairs of traps were exposed in different biotopes. In total, 5 biotopes were studied, 15 pairs of traps were exposed (30 with vinegar and 30 with beer).

A B

Fig. 1. Appearance of experimental traps: A – at a height of 1.5 m; B – at a height of 5 m.

The second author defined Coleoptera. The Coleoptera system, the volume and nomenclature of taxa are accepted according to the "Catalog of Coleoptera of the Palearctic" (Catalogue..., 2007, 2011, 2013, 2015, 2016, 2020a,b).

Results

In general, 4.980 insect specimens from 10 orders were registered during the experiments (Table 1). At the same time, the number of insect specimens caught in beer traps clearly exceeded that in vinegar traps, i.e. beer is the best attraction as bait.

Table 1. Average number of insect specimens recorded in traps with different types of bait

Family	Height – 1.5 m		Height – 5 m		**Total averages**	
	vinegar	beer	vinegar	beer	vinegar	beer
Blattodea	0.2	4.4	0.6	2.6	0.8	7.0
Heteroptera	0.6	0	0.2	0	0.8	0
Rhaphidioptera	0	0.2	0	0	0	0.2
Neuroptera	0	2.0	0.2	10.6	0.2	12.6
Coleoptera	19.6	173.0	23.5	102.3	43.1	275.3
Lepidoptera	9.8	104.0	32.6	243.0	42.4	347.0
Hymenoptera	1.2	5.8	0.8	13.0	2.0	18.8
Formicidae	60.6	43.6	64.0	22.0	124.6	65.6
Diptera	14.6	86.2	22.6	143.0	37.2	229.2
Mecoptera	0	0.8	0.2	4.8	0.2	5.6
Trichoptera	0.2	0	0.2	0.8	0.4	0.8
TOTAL, ind.	**534**	**2100**	**607**	**2199**	**1137**	**3843**

In vinegar traps located at a low altitude, representatives of eight orders were recorded. There were nine orders in beer traps. In traps placed at a height of 4–5 m, representatives of 10 orders were attracted by vinegarb and nine orders by beer. Thus, the variety of insects flying to different baits was similar at the order level.

Representatives of the orders Coleoptera, Lepidoptera, Diptera and Hymenoptera were the most numerous in all traps. At the same time, beer traps, unlike vinegar traps, attracted much more individuals of these orders. However, the family Formicidae was well lured by vinegar (Table 1). It turned out that ants in significant numbers were found both in traps at low and high altitudes.

We studied the species diversity of Coleoptera in details (Table 2). It turned out that in total, more than 87 species from 31 families were registered in all traps (some taxa have not been determined to species). The greatest species diversity is registered in the families Cerambycidae (18 species), Nitidulidae (9), Elateridae (8) and Scarabaeidae (7). A small number of species represented the remaining families.

Table 2. Species diversity of Coleoptera recorded in traps with different bait

Family/species	vinegar	beer
Histeridae		
Gnathoncus buyssoni Auzat, 1917	1	2
Platysoma deplanatum (Gyllenhal, 1808)	3	
Platysoma elongatum (Thunberg, 1787)	11	
Leiodidae		
Agathidium sp.		1
Silphidae		
Nicrophorus vespilloides Herbst, 1783		4
Oiceoptoma thoracicum (Linnaeus, 1758)		2
Staphylinidae sp.	7	28
Scydmaenidae		
Scydmaenus hellwigii (Herbst, 1791)	1	
Scarabaeidae		
Cetonia aurata (Linnaeus, 1758)		1
Gnorimus variabilis (Linnaeus, 1758)		19
Phyllopertha horticola (Linnaeus, 1758)		2
Protaetia fieberi boldyrevi Jakobson, 1909		3
Protaetia marmorata (Fabricus, 1792)	2	61
Protaetia cuprea volhyniensis (Gory & Percheron, 1833)	1	7
Trichius fasciatus (Linnaeus, 1758)	1	
Scirtidae		
Contacyphon ochraceus (Stephens, 1830)	1	
Microcara testacea (Linnaeus,1767)	1	
Buprestidae		
Anthaxia quadripunctata (Linnaeus, 1758)	1	1
Throscidae		
Trixagus sp.	2	2
Elateridae		
Agrypnus murinus (Linnaeus, 1758)		2
Ampedus balteatus (Linnaeus, 1758)	1	
Ampedus cinnabarinus (Eschscholtz, 1829)		9
Ampedus pomonae (Stephens, 1830)		2
Ampedus pomorum (Herbst, 1784)	2	7

Continuation of Table 2

Ampedus praeustus (Fabricius, 1792)		2
Dalopius marginatus (Linnaeus, 1758)	2	
Prosternon tesselatum (Linnaeus, 1758)	7	22
Lycidae		
Lygistopterus sanguineus (Linnaeus, 1758)	1	1
Xylobanellus erythropterus (Baudi di Selve, 1872)	1	
Lampyridae		
Lampyris noctiluca (Linnaeus, 1758)	1	
Cantharidae		
Cantharis figurata Mannerheim, 1843	3	
Cantharis nigricans O.F. Müller, 1776	1	2
Rhagonycha nigripes (W. Redtenbacher, 1842)		1
Dermestidae		
Globicornis emarginata (Gyllenhal, 1808)	1	2
Trogoderma glabrum (Herbst, 1783)	6	6
Cleridae		
Thanasimus formicarius (Linnaeus, 1758)		1
Tillus elongatus (Linnaeus, 1758)	1	
Melyridae		
Cordylepherus viridis (Fabricius, 1787)	1	
Dasytes niger (Linnaeus, 1761)		1
Erotylidae		
Triplax lepida (Faldermann, 1837)	1	
Monotomidae		
Rhizophagus fenestralis (Linnaeus, 1758)	1	2
Nitidulidae		
Cryptarcha strigata (Fabricius, 1787)	42	244
Cryptarcha undata (G.-A. Olivier, 1790)	15	13
Cyllodes ater (Herbst, 1792)	1	
Epuraea guttata (G.-A. Olivier, 1811)	1	8
Epuraea sp.	1	21
Glischrochilus hortensis (Geoffroy, 1785)	4	42
Glischrochilus grandis (Tournier, 1872)	7	81
Glischrochilus quadripunctatus (Linnaeus, 1758)		8
Glischrochilus quadriguttatus (Fabricius, 1777)		1
Soronia grisea (Linnaeus, 1758)	10	107
Cucujidae		
Pediacus depressus (Herbst, 1797)	13	18
Coccinellidae		
Calvia quatuordecimguttata (Linnaeus, 1758)	2	1
Halyzia sedecimguttata (Linnaeus, 1758)	1	2
Psyllobora vigintiduopunctata (Linnaeus, 1758)	2	1
Scymnus frontalis (Fabricius, 1787)		1
Mycetophagidae		
Litargus connexus (Geoffroy, 1785)	2	3
Zopheridae		

End of Table 2

Synchita humeralis (Fabricius, 1792)	1	
Mordellidae		
Mordella sp.	1	
Mordellistena humeralis (Linnaeus, 1758)	2	
Tomoxia bucephala A. Costa, 1854	3	1
Tenebrionidae		
Lagria hirta (Linnaeus, 1758)		1
Mycetochara flavipes (Fabricius, 1792)	3	
Oedemeridae		
Oedemera femorata (Scopoli, 1763)	1	
Chrysanthia viridissima (Linnaeus, 1758)	1	3
Scraptiidae		
Anaspis frontalis (Linnaeus, 1758)		2
Cyrtanaspis phalerata (Germar, 1847)		1
Cerambycidae		
Aegomorphus clavipes (Schrank, 1781)		1
Anoplodera sexguttata (Fabricius, 1775)		1
Dinoptera collaris (Linnaeus, 1758)	1	2
Leptura quadrifasciata Linnaeus, 1758	7	333
Leptura thoracica Creutzer, 1799	1	83
Lepturalia nigripes (DeGeer, 1775)	2	28
Mesosa myops (Dalman, 1817)	1	
Necydalis major Linnaeus, 1758		3
Purpuricenus globulicollis Dejean, 1839		1
Rhagium inquisitor (Linnaeus, 1758)		9
Rhagium mordax (DeGeer, 1775)	1	40
Rutpela maculata (Poda von Neuhaus, 1761)		2
Spondylis buprestoides (Linnaeus, 1758)		1
Stenurella bifasciata (O.F. Müller, 1776)		3
Stenurella melanura (Linnaeus, 1758)		1
Stictoleptura maculicornis (DeGeer, 1775)	1	3
Stictoleptura rubra (Linnaeus, 1758)		1
Xylotrechus rusticus (Linnaeus, 1758)		1
Chrysomelidae		
Altica sp.	1	
Plagiodera versicolora (Laicharting, 1781)		2
Brentidae		
Oxystoma cerdo (Gerstaecker, 1854)		1
Curculionidae		
Anisandrus dispar (Fabricius, 1792)		4
Archarius pyrrhoceras (Marsham, 1802)		1
Hylobius abietis (Linnaeus, 1758)		1
Miarus ajugae (Herbst, 1795)	1	
Phyllobius argentatus (Linnaeus, 1758)	1	
TOTAL, species	**52**	**64**
TOTAL, ind.	**192**	**1274**

The number of species accounted for 52 in vinegar traps and for 64 species in beer traps. The four above-mentioned families accounted for almost half of the total species diversity, and there were 21 species from those families found in vinegar traps (Cerambycidae – 7, Nitidulidae – 7, Elateridae – 4, Scarabaeidae – 3), and 37 species in beer traps (Cerambycidae – 17, Nitidulidae – 8, Elateridae – 6, Scarabaeidae – 6).

Almost all taxa were previously indicated for the Mordovia State Nature Reserve (Egorov et al., 2020, 2021). However, one species – *Contacyphon ochraceus* – was discovered in this territory for the first time.

Discussion

There is data that acetic acid baits effectively trap several taxa from different orders, including Lepidoptera (Lan-dolt, Higbee, 2002; Toth et al., 2010), Diptera (Cha et al., 2012), Coleoptera (Baini et al., 2016; Piccini et al., 2021) and Hymenoptera (Landolt et al., 2000; Landolt, Zhang, 2016).

Many researchers use vinegar as a bait in traps set on the different branches (Rastegar et al., 2013; Powell, 2015; Vorst, Heijerman, 2015; Piccini et al., 2021). Along with formalin, vinegar is often used as a preservative in soil traps (Brandmayr et al., 1996; Assmann, 1999; Ilić, Čurčić, 2013; Brigić et al., 2016; Pizzolotto et al., 2018). Allegro and Dulla (2008) used wine vinegar to catch ground beetles. It turned out that some groups and species of Carabidae (for example, tribe Sphodrini, including the species of the genus *Calathus*) are more likely to fall into traps with the vinegar. On the other hand, the genus *Amara* was not attracted by vinegar and was represented equally in terms of numbers in all traps.

Our results show that beer traps more effectively attract all insect groups except ants. This is especially noticeable in the example of Coleoptera. The number of species and numerical abundance of this order in beer traps significantly exceeded similar indicators in vinegar traps. We point out that when the difference in the number of species in traps with different attractants was not so large, the number of species and families of Coleoptera differed significantly. There were a lot of representatives of Cerambycidae and Scarabaeidae in of beer traps. Well-attracted species from the families Cerambycidae, Nitidulidae, Elateridae, Scarabaeidae (for example, *Cryptarcha strigata, Soronia grisea, Leptura quadrifasciata, Leptura thoracica* and others) have always numerically prevailed in beer traps. According to Ruzzier et al. (2021), only 13 species from three families were caught in vinegar traps. However, our data indicate a more significant species diversity of species attracted by such baits.

Apparently, a significant amount of various chemical compounds (aldehydes, alcohols, ketones, etc.) appears in beer traps during fermentation, which attract a variety of insects. In vinegar, the number of chemical compounds is limited. The only family that was actively falling in vinegar traps were ants. According to Tăuşan et al. (2012), vinegar is a good attractant for this group.

Conclusion

Crown simple traps with baits such as vinegar and beer are effective for studying the species diversity of insects. Representatives of 10 insect orders are caught on such baits. However, baits with vinegar are less effective than baits with beer. There were more insect speies and individuals in the beer traps. Representatives of the orders Coleoptera, Lepidoptera, Diptera and Hymenoptera were the most numerous in all traps. At the same time, beer traps, unlike vinegar traps, attracted much more individuals of these orders. The only family Formicidae was well lured by vinegar. There were more than 87 species from 31 families in the species diversity of Coleoptera. There were 52 species in wine vinegar traps and 64 species in beer traps. The four above-mentioned families accounted for almost half of the total species diversity, 21 species belonging to these families were identified in vinegar traps (Cerambycidae – 7, Nitidulidae – 7, Elateridae – 4, Scarabaeidae – 3) and 37 species in beer traps (Cerambycidae – 17, Nitidulidae – 8, Elateridae – 6, Scarabaeidae – 6). Thus, it is better to use traps with vinegar bait in conjunction with beer baits.

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О ПРИМЕНЕНИИ ВИННОГО УКСУСА В КАЧЕСТВЕ АТТРАКТАНТА В КРОНОВЫХ ЛОВУШКАХ

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Разнообразные приманки в простых по конструкции ловушках могут оказать значительную помощь в изучении биоразнообразия насекомых. Изучена возможность применения кроновых ловушек с уксусом и пивом при их совместной экспозиции. Отлавлены представители 10 отрядов насекомых. При этом приманки с уксусом менее эффективны, чем приманки с пивом. В пивные ловушки попало большее число видов при их большей численности. Наибольшей численностью во всех ловушках отличались представители отрядов Coleoptera, Lepidoptera, Diptera и Hymenoptera. Единственной группой, которая хорошо приманивалась уксусом, является семейство Formicidae. Видовое разнообразие Coleoptera было представлено более 87 видами из 31 семейства. Число видов в ловушках с уксусом составляло 52, в пивных – 64 вида. Ловушки с приманкой из уксуса лучше применять совместно с пивными приманками.
Ключевые слова: пивные ловушки, насекомые, фауна, ловушки с приманкой, видовое разнообразие