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Hermit beetle's (*Osmoderma eremita* Scopoli, 1763) occurrence in roadside double row of willows

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Abstract The aim of the research presented in this paper was to assess the state of trees' health in roadside double row of aged white willows regarding the possibility of the protected species of hermit beetle's occurrence. The study was conducted in years 2013 and 2014 on a double row of trees located along the roadside of unpaved local road connecting two farms in the Kuyavian-Pomeranian Voivodeship (town Jarantowiczki, Wąbrzeźno district, municipality of Wąbrzeźno). Detailed study included 500 m long section of double row topped tree formation of aged white willows Salix alba, on which the presence of hermit beetle *Osmoderma eremita* was observed. The most serious threat to the hermit beetle is tree-felling in aged tree rows, which are their natural habitat and at the same time ecological corridor that allows connectivity with other populations of this species in the area. Therefore, it is important to preserve in the agricultural landscape as many cavity trees as possible. Especially important within this matter is to conduct local research on small areas, and provide detailed inventories of natural areas for investment.

Występowanie pachnicy dębowej *Osmoderma Eremita Scopoli*, 1763 w przydrożnym szpalerze wierzbowym

Słowa kluczowe *Osmoderma eremita*, *Salix alba*, szpaler drzew, przydroże

Streszczenie Celem badań przedstawionych w niniejszym artykule jest ocena stanu zdrowotnego drzew przydrożnego szpaleru wiekowych wierzb białych pod kątem możliwości wystąpienia chronionego chrząszcza – pachnicy dębowej. Badania przeprowadzono w latach 2013–2014 na szpalerze drzew przydrożnych zlokalizowanym wzdłuż nieutwardzonej drogi gminnej łączącej dwa gospodarstwa rolne w województwie kujawsko-pomorskim (miejscowość Jarantowiczki, powiat wąbrzeski, gmina Wąbrzeźno). Badaniami szczegółowymi objęto 500 m odcinek zadrzewienia szpalerowego zdominowany przez ogłowione, stare wierzby białe *Salix alba*, na którym obserwowano obecność pachnicy dębowej *Osmoderma eremita*.
Najpoważniejszym zagrożeniem dla pachnicy dębowej jest wycinka starych alei drzew, które są ich siedliskiem i jednocześnie korytarzem ekologicznym umożliwiającym łączność z pozostałymi populacjami tego gatunku na danym terenie. Dlatego tak ważne jest zachowanie

w krajobrazie rolniczym starych dziuplastych drzew. Szczególnie istotnym w tym zakresie staje się prowadzenie badań lokalnych, na niewielkich obszarach oraz szczegółowe inwentaryzacje przyrodnicze obszarów przeznaczonych do zainwestowania.

Introduction

The most common, outstanding area of natural beauty is the one characterized by significant natural values, sensitive to anthropogenic perturbations that can lower its rank. However, not all areas rich in terms of the characteristics of the natural environment are and may in the future be covered by the legal forms of protection. Very often these are small areas (the position of the protected plant) or they have a linear form (piece of roadside plantings). However, it is important to preserve this type of areas, because they are characterized by huge biodiversity, especially valuable in a monotonous agricultural landscape (Liżewska & Zwierowicz 2009; Gamrat et al. 2011; Bardgett & van der Putten 2014; Gonthier et al. 2014). Forestation of open areas, as for example fields, serve as refuges for all kinds of living organisms, which found their ecological niche in the anthropogenic landscape. With regard to midfield woodlots having the form of the avenues or tree rows, especially important is their function of ecological corridors, which means areas to facilitate the movement of organisms for long distances (Ranius & Hedin 2001; Kosmala & Rosłon-Szeryńska 2012). One of the insects, whose further preservation in rural areas is dependent on the occurrence of rows of trees, is hermit beetle *Osmoderma eremita* (Oleksa et al. 2013; Barnosky et al. 2011).

Hermit beetle is a brownish-olive large beetle (up to 3 cm), belonging to the order of *Coleoptera*, subfamily of *Cetoniidae* Oleksa 2010; Zauli et al. 2016). In Poland, it is considered as species of "high risk exposed to extinction," or the species "particularly important." Under the Regulation of the Minister of the Environment (Journal of Laws, 2014) it was covered by strict species protection and as a priority species of the EU it was covered by Habitats Directive 92/43/EEC. This weakly flying insect owes its Polish name (pachnica dębowa) to alluring females secreted pheromones, which reminds a scent of plum and apricot (Larsson et al. 2003).

In Poland, the hermit beetle occurs throughout the country, but especially in large numbers in Warmian-Masurian Voivodeship, Lubusz Voivodeship, Greater Poland, Opole Voivodeship, Lower Silesian Voivodeship and Świętokrzyskie Voivodeship (Kadej et al. 2007; Bernacki & Karg 2008). As habitat it selects the aged, cavity grouped species of trees, mainly oak, beech – species of hardwood, with extensive touchwood formations. Currently, such tree formations are rare, and therefore it was observed that it colonizes replacement habitat, such as aged, rotten species of willows and lindens – species with soft wood, formed as roadside avenues (Oleksa et al. 2007).

The aim of the research was to assess the state of trees' health in roadside double row of aged white willows regarding the possibility of the protected species of hermit beetle's occurrence.

Material and Methods

In years 2013 and 2014 there were carried out the dendrological and faunological studies of the roadside double row located along the unpaved local road connecting the two farms in the Kuyavian-Pomeranian Voivodeship (town Jarantowiczki, Wąbrzeźno district, municipality of Wąbrzeźno) – Figure 1. Detailed study included 500 m long section of double row topped tree formation of aged white willows Salix alba, on which the presence of hermit beetle *Osmoderma eremita* was observed.

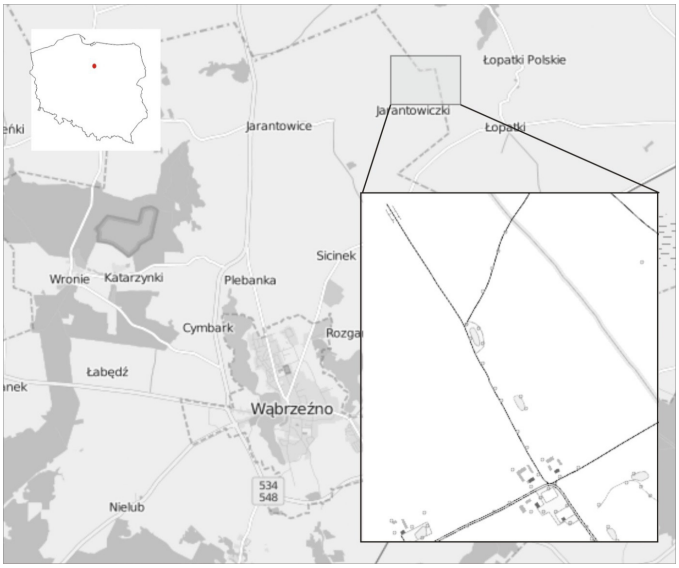

Figure 1. Location of the research area (own work)

The presence of a protected beetle was found by observation: of adult specimens or feces of larvae in the months of July–August during sunny weather with the air temperature above 24°C (Oleksa 2010; Larsson & Svensson 2011). There has also been analyzed the composition of tree species and conducted basic dendrometric measurements: trunk circumference, height of the specimen and the crown diameter. Additionally, the state of the trees' health was stated (modification Liżewska & Zwierowicz 2009 – table 1). Tree sizes were compared to the size of trees of monumental dimensions, adopting the criterion of 3m trunk circumference at a height of 1.30 m (Pietrzak-Zawadka 2015).

Table 1. The condition of trees in the study area (own work)

The condition of trees in the study area	Description of the health status of trees
very good	very good health condition, without breakdown, correct sort
good	good health condition, few surface and deep losses, formed crown, small deadwood, single hidey-holes
satisfactory	good health condition, numerous surface and deep losses, branches and twigs broken off, hidey-holes about significant sizes, cracks of the trunk from the base until the crown
weak	bad state of health (partly dying), numerous surface and deep losses, branches and twigs broken off, cracks of the trunk from the base until the crown, shaken statics of the tree
bad	very bad state of health (dead, isn't promising for surviving)

Results and Discussion

While carrying out various investments, for example, roads modernization, preservation of valuable areas of nature takes on a new meaning. Midfield woodlots are not just a diversity of monotonous agricultural landscape, biodiversity refuges, but also measurable value to people (Bulak et al. 2010; Kędziora & Karg 2010). The preservation of the principles of sustainable development makes the investment planning to focus on assessing the ecological value of the area and to carry out proper investment process aimed at respecting the rights of nature (Staniak 2009; Smith et al. 2015).

Polish landscapes preserved its natural values in an incomparably greater extent than the neighboring Western countries. However, also here changes in the characteristic features of the landscape in different regions can be recognized. In the area of Eastern and Central Poland double rows of willows, planted next to the ditches, midfield roads in the form of wind protecting lanes were common until World War II. Today, however, they are less and less common (Witusińska et al. 2009; Kuszewska & Fenyk 2010).

In the researched roadside area there were three tree species (28 specimens): *Salix alba, Pirus communis* and *Alnus glutinosa* (Figure 2). Among the identified species of trees 20 specimens of *Salix alba* were topped. Other specimens of willows and other species have unthinned branches.

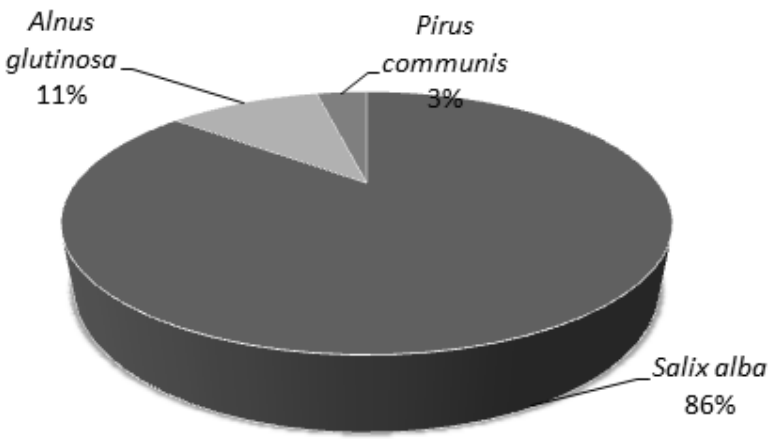

Figure 2. Species composition of trees of the studied area (own work)

Analysis of the state of trees' health showed that 64% of trees are in good health condition, although it was found that they have numerous defects and broken branches, but it can be considered as characteristic for the white willow species, especially those specimens that were subject of successive topping treatments. These trees are in good health and it is not expected any deterioration of their condition in the near future. Five specimens of trees were classified into the group of sufficient state of preservation. They were topped, had broken branches and boughs, scars from cuts, surface defects, small cavities, were partially rotten (from the top).

Also, five specimens of trees were classified to the group of poor preservation status. Trees were characterized by lost of their branches and boughs, had numerous scars from cuts, defects

on the surface and small holes, cavities and rotting wood formations inside the trunk, and sometimes they had partially rotten or hollow trunk. Despite such unfavorable changes all the trees have survived alive and during the observation no trees completely dead were found.

Topping treatments performed by a too vast cuts or in the wrong year period cause disturbances in the biological balance of plants, which leads to the rapid invasion of all fungal diseases. Drastic reduction of branches, deprives from the tree such number of leaves that it goes into hunger mode and becomes prone to extensive wounds, and ultimately it may lead to its death (2008 Suchocka; Gamrat et al. 2011). However, the species with soft wood, such as white willow or linden may be subjected to systematic topping from the earliest stages of development. As a result trunk grows, creating a unique shape called a willow head. In such modified form, they are a characteristic part of the natural landscape in many regions of Poland (Dolatowski 2000).

On trees of roadside avenue that was the base of the study, there was observed the occurrence of species covered by strict protection – hermit beetle *Osmoderma eremita* (Journal of Laws, 2014), in the form of adult specimens and feces of larvae (Photo 1). It was present on eight of topped aged specimens of white willows *Salix alba*. The adult specimens (imago) has been recognized on the trunks of researched trees, and in several internal touchwood formations feces of hermit beetle and two dead adults specimens were identified (Table 2).

Photography 1. The adult specimen of the beetle and the position of *Osmoderma eremita* (photo E. Dusza)

Habitat of the hermit beetle is associated with anthropogenic cultural landscapes with a sufficiently high density of trees, which often are roadside plantings. This insect during almost whole of his life resides inside cavities of aged trees. Therefore, detection of this species in the area is very difficult, because only 2% of the duration of the entire life cycle of these insects can be found outside cavities – time an adult specimen life. This species prefers primarily large cavity trees growing in a sunny spots. Shaded locations are inhabited by hermit beetle much less often, mainly due to unfavorable thermal conditions (Lindhe et al. 2005). Species normally inhabit aged trees having more than 100 years. They are usually cavity trees, but still alive and standing (Zauli et al. 2016). Protection of this species provides simultaneous protection of biodiversity associated with cavity trees, because it is scientifically proved that the trees inhabited by the hermit beetle are characterized by a high diversity of life represented by the numerous groups of organisms, plants, fungi, invertebrates and vertebrates (Barnosky et al. 2011).

Table 2. Biometric measurements of trees along with the assessment of medical condition and appearing of *Osmoderma eremita*

Lp.	Name of the species	circumference of the trunk [cm]	Diameter of the crown [m]	Height [m]	State of health	Appearing of *Osmoderma eremita*
1	*Salix alba*	328*	6	4	good	
2	*Salix alba*	353*	10	6	good	
3	*Salix alba*	408*	8	6	good	
4	*Salix alba*	413*	10	7	satisfactory	
5	*Salix alba*	409*	8	6	satisfactory	
6	*Salix alba*	323*	8	6	good	imago
7	*Salix alba*	412*	8	6	satisfactory	
8	*Salix alba*	205	8	7	good	imago
9	*Salix alba*	438*	9	8	good	
10	*Salix alba*	407*	8	6	good	
11	*Salix alba*	404*	9	7	good	
12	*Pyrus communis*	16; 18; 21	2	3	good	
13	*Salix alba*	307*	10	7	good	
14	*Salix alba*	336*	6	4	good	
15	*Salix alba*	282	18	10	good	
16	*Salix alba*	357*	20	10	good	
17	*Salix alba*	354*	8	6	satisfactory	
18	*Alnus glutinosa*	82	7	6	good	
19	*Alnus glutinosa*	57	6	6	good	
20	*Alnus glutinosa*	37	7	6	good	
21	*Salix alba*	376*	20	10	good	imago, koprolity
22	*Salix alba*	265	15	9	good	imago, koprolity
23	*Salix alba*	350*	6	5	weak	
24	*Salix alba*	353*	13	8	weak	
25	*Salix alba*	248	14	9	weak	koprolity
26	*Salix alba*	318*	14	9	satisfactory	imago, koprolity, martwe imago
27	*Salix alba*	452*	10	8	weak	imago, koprolity
28	*Salix alba*	269	10	8	weak	imago, koprolity

Explanations: * – trees having sizes of monumental trees.

According to the monitoring data (Oleksa 2012) it can be stated that the hermit beetle is relatively widely represented in the Kuyavian-Pomeranian Voivodeship, and the state of species preservation can be considered as appropriate. It is connected with the occurrence in Pomerania of characteristics cultural landscapes, which include historically shaped green roadside rows of trees along the roads and avenues, and quite frequently occuring post-manorial and post-palace parks.

Hermit beetle researches in Lower Silesia pointed its 745 habitats, 88% of which are single locations of inhabited trees. Other habitats include groups of trees formed as an avenue or woodlots. Most of the hermit beetles' habitats in the area of study (59%) are located in forest areas. Out of the 443 forest habitats 78% are located in commercial forests. In the avenues and parks there is respectively 24% and 11.5% of the habitats. The rest are biotopes such as: linear plantings at riversides, cemeteries or lone standing trees (Kadej et al. 2014).

Of the assessed 28 specimens forming roadside plantings or tree rows along the unpaved roads, 19 can be considered as a potential natural monuments. Trunks circumference was ranged from 3.1 to 4.5 m, with an average value within listed specimens of 3.8 m. The height of these trees depended on the topping. It ranges from 6 to 20 m. Other tree from the white willow species occurring in the area, that are forming the dominant species in this midfield avenue, despite the smaller trunk circumference, also deserve the absolute preservation.

The researched roadside area, on a section of 500 m, is a valuable natural object, since the distance between the individual specimens of trees is small and ranges from 6 to 8.5 m in several clusters. Also the distance between the clusters of individual trees is not more than 20 m (Figure 3). Thanks to that, such conditions seem to be an ideal place of hermit beetles' living, because it does not move for long distances and rather is devoted to one area. The small distance between the individual specimens of trees, their sizes and species (significant touchwood formations) creates an ideal habitat for the development of this rare beetle. This is particularly important considering the fact that the crucial for protection of hermit beetles is the problem of increasing isolation of its habitats.

Trees-felling during roads modernization, enhances isolation and reduces the chances of survival of the hermit beetles, especially since this insect has slight opportunity to move – up to 300 m (Svensson et al. 2004; Chiari 2012). Two-year monitoring study carried out by Chiari et al. (2013), regarding the spreading of hermit beetles in the forests of cork oak in central Italy showed that 39% of the population of this species dispersed only to 250 m. The longest migration observed was 1504 m. On a single tree was found only a few specimens in imago form. Most adults leave their tree. In order to preserve the population of that species, it is desirable that the respective tree are grouped in the field of maximum several hundred meters. Studies of Dubois et al. (2010) on the size of the hermit beetles' spreading carried out for more than 30 specimens in different regions of France, indicated on several parameters (gender, number of specimens) affecting the degree of migration. There was stated a higher ability to fly within females than within males, though they were in worse condition. A single maximum flight of the specimen was 1,6-fold faster than a group (respectively 1.5 m and 2.4 m). Flight speed within females depended on the health condition. Investigated factors indicated that males and females have different policies and thus the different possibility of spreading.

As an organism with the small capacity of dispersion hermit beetle is not able to colonize distant and heavily isolated habitats. Therefore, using the knowledge of its migration, it is worth to plan (by planting trees) and keep (by protecting) any linear tree plantings (e.g. avenues, rows) that may be useful to connect local small populations. Outside observers or people not aware of relationships of biological processes rarely know that tree-felling in any place of aged avenues or rows and cavity (often monumental) trees can cause loss of communication and consequently isolate specimens from each animal subpopulations (Ranius & Hedin 2001).

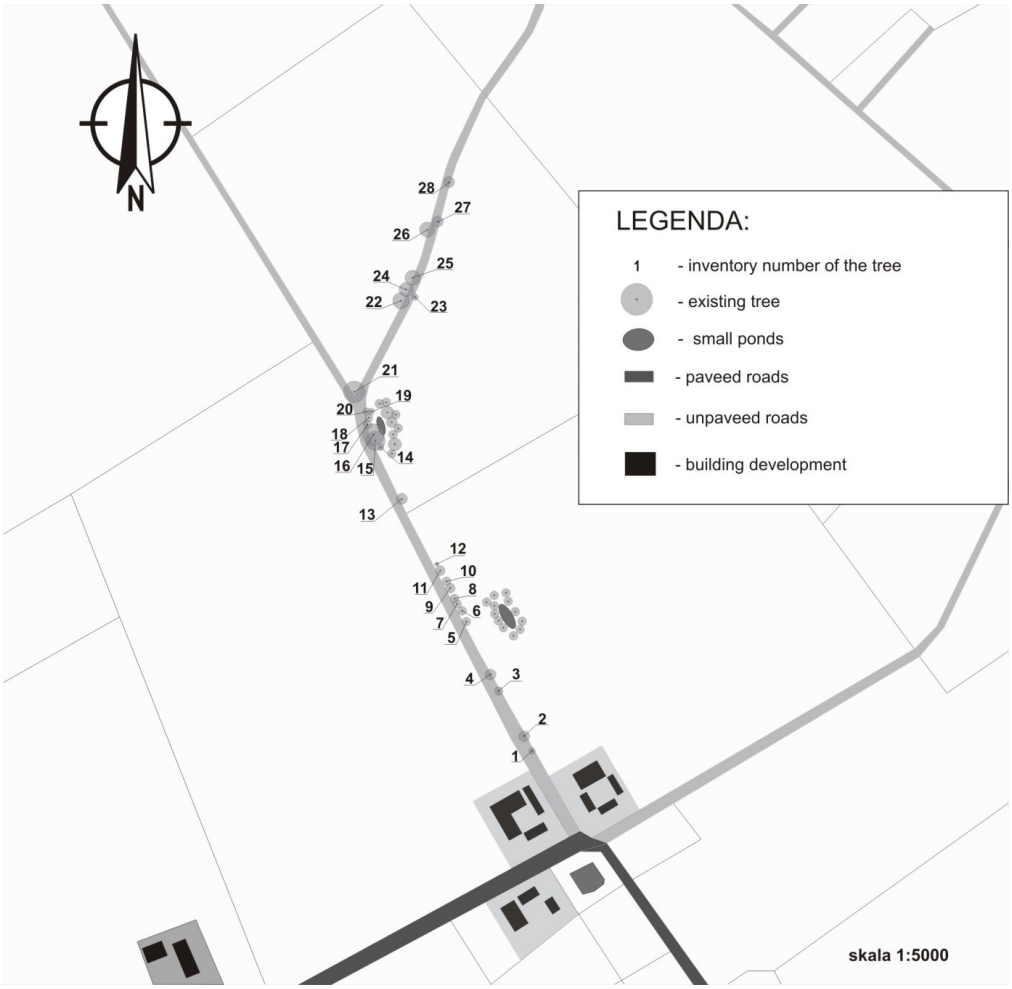

Figure 3. The location of individual trees of the study area

In order to preserve the population of hermit beetle *Osmoderma eremita*, management actions should be aimed at increasing the density of cavity trees and volume of tree cavities by fostering the natural aging of trees and the creation of artificial habitats in live trees (Chiari et al. 2014). Giangregorio et al. (2015) believed that in order to keep hermit beetle *Osmoderma eremita* it should be allowed to it. Ten years of experience in the forest dominated by aged beech next to Sant 'Antonio created habitats for this species. During the tree-felling (specimens > 30 m in height and circumference of > 4 m) and during forestation, some of the older specimens of common beech were topped.

This led to the creation at the trunks top of vast callus surface (made of callus tissue) accelerating the decay process – providing the optimal environment for hermit beetle. Rocca et al. (2014) showed that the density and small diameter of breast height of trees in the forests have a negative impact on species diversity. In order to increase the presence of saproxylic organisms in extensively developed areas it should be used regular cuttings to provide cutting stumps and secure the continuity of the dead wood. Logging combined with controlled burning o wood particles with downtimes, increases the number of threatened species (Hilszczański 2016).

Monumental size trees, even after their physiological death deserves preservation. They can be used in numerous purposes: educational, historical, historic, commemorative, patriotic. It is a valuable didactic object (Pietrzak 2011).

"there are many examples to show that any activity or treatments aimed to promote biodiversity of saproxylic species in developed forests require, «a multi-scale approach», e.g. local treatments should be performed in a much greater extent than it is now" (Sverdrup-Thygeson et al. 2014).

Conclusion

The most serious threat to the hermit beetles is a tree-felling of aged rows of trees which are their natural habitat and at the same time ecological corridor that allows connectivity with other populations of this species in the area. Therefore, it is important to preserve the agricultural landscape of aged cavity trees. Especially important, in this regard, it is to conduct local research on small areas, and to provide detailed inventories of natural areas for investment. The results of field studies should determine the trends and opportunities for investment processes while maintaining landscape features that are unique. Nowadays, investors are accommodating environment-friendly solutions, but they must be supported by field studies. Valuable natural areas, which undoubtedly the discussed double row of white willows is, should also get legal protection as monuments or another natural monument (group - in the form of a row). Such number of powerful and aged trees which are the habitats of protected species of beetle is extremely important both for learning, and certainly raises the tourist values of the area.

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