

SPECIES STRUCTURE OF THE SAPROXYLIC BEETLES ASSEMBLAGES IN THE PROTECTED TERRITORIES OF BELARUS

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Abstract. The studies of insects inhabiting of the dead wood were carried out on the specially protected territories in Belarus: Berezinsky Biosphere Reserve, National Parks “Belovezhskaya Pushcha” and “Pripyatsky” in 2008. Insects were collected by hand under the bark of dead trees and snags, as well as damaged rotten wood. All insects were fixed in 70% ethanol. Totally more than 1,000 specimens of insects belonging to 130 species were collected.

Keywords: Coleoptera, saproxilic species, dead wood.

Rezumat. Structura specifică a comunităților de coleoptere saproxilice în ariile protejate din Belarus. Studiul insectelor care populează arborii căzuți au fost efectuate cu precădere în arealele protejate din Belarus: Rezervația Biosferei Berezinsky, Parcurile Naționale “Belovezhskaya Pushcha” și “Pripyatsky” în 2008. Insectele au fost colectate cu mâna de sub scoarța copacilor aflați în putrefacție și a cioturilor, precum și din putregai. Toate insectele au fost păstrate în etanol 70%. Per total, au fost colectate mai mult de 1.000 de exemplare de insecte din 130 specii.

Cuvinte cheie: Coleoptera, specii saproxilice, lemn putred.

INTRODUCTION

Coarse woody debris (CWD) is a significant part of the total stock of stemwood in forests and presented by fallen trees, dried trees, their fragments, and by dead parts of living trees and stumps. CWD serves many ecological functions, one of which is to maintain biological diversity topical and (or) trophically associated with CWD animals, plants and fungi in forest ecosystems. Woody debris is an important habitat for invertebrate animals because it has a number of specific features. CWD is comprised almost entirely of organic matter and represents a powerful source of energy. These organic materials are mainly cellulose and lignin, very resistant to destruction. As result, decaying trunks are long-term source of energy, but the wood is extremely poor in nitrogen, which is a limiting factor for the development of most groups of saproxilic insects.

The long process of wood destruction is accompanied by a gradual change in its structure, physical properties and chemical composition. These changes largely determine its accessibility to diet of the different groups of invertebrates. It leads to successive changes of insect communities especially beetles inhabiting of large wood detritus. The study of the regularities of formation and dynamics of this complex of insects in undisturbed forest ecosystems can help to solve many practical problems concerning biodiversity conservation, pest control, and forestry monitoring in the forest ecosystems (MAMAEV et al., 1977).

MATERIAL AND METHODS

The studies of insects inhabiting of CWD were carried out on specially protected territories in Belarus: Berezinsky Biosphere Reserve (BBR), National Parks “Belovezhskaya Pushcha” (BP) and “Pripyatsky” (PNP) in 2008. CWD was studied in the forests excluded from the economic activity with natural level of CWD resource on temporary sample plots. In this paper, a CWD included: fallen trees and dried trees, their fragments, dead parts of living trees with a base diameter of 8 cm or more and a length (height) not less than 1 m, and stumps with an upper diameter of 15 cm or more.

All CWD was divided into 5 stages of decomposition on the base of the visual features (PUGACHEVSKY & ZHDANOVICH, 2007).

Insects were collected by hand under the bark of dead trees and snags, as well as damaged rotten wood. The 100 cm, 50 cm and 25 cm long circular pallets were laid on the bark covered CWD logs (depending on the diameter of the trunk and the opportunity to lay the pallet) (MOZOLEVSKAYA et al., 1984). The dust from the logs of the late stages of decomposition was sifted by soil sieves. All insects were fixed in 70% ethanol. Totally more than 1,000 specimens of 130 insect species were collected (Table 1).

RESULTS AND DISCUSSIONS

The beetles of the family Carabidae were found practically on all stages of decomposition, but preferred the 3rd and the later stages. On the territory of the PNP, 6 species of ground beetles were collected, in the BBR and BP only one species was found in each territory. Most species of the genus *Carabus* was found in early spring and late autumn, and the others occurred under the bark during all field season. The observed distribution can be explained by the following reasons: firstly, the use of CWD as a refuge and secondly as land for hunting.

Table 1. The distribution of saproxylic insects on the different stages of CWD decomposition in BBR, BP and PNP.
 Tabel 1. Distribuția insectelor saproxilice în diferite stadii de descompunere ale resturilor grosiere de lemn în RBB, BP și PNP.

Taxon	Stages of decomposition					BBR	BP	PNP
	1	2	3	4	5			
Carabidae								
<i>Agonum duftschmidi</i> J. SCHMIDT 1994			+					+
<i>A. fuliginosum</i> (PANZER 1809)			+					+
<i>A. krynickii</i> (SPERK 1835)		+	+					+
<i>Bembidion varium</i> (OLIVIER 1795)		+						+
<i>Carabus granulatus</i> LINNAEUS 1758	+	+	+	+				+
<i>C. hortensis</i> LINNAEUS 1758	+					+		
<i>Notiophilus palustris</i> (DUFTSCHMID 1812)			+				+	
<i>Pterostichus oblongopunctatus</i> (FABRICIUS 1787)		+						+
Histeridae								
<i>Plegaderus vulneratus</i> (PANZER 1797)	+	+				+		
Staphylinidae								
<i>Acrulia inflata</i> (GYLLENHAL 1813)		+					+	
<i>Anomognathus cuspidatus</i> ERICHSON 1839		+				+		+
<i>Anthobium atrocephalum</i> (GYLLENHAL 1827)		+				+		
<i>Atheta fungi</i> (GRAVENHORST 1806)		+					+	
<i>A. graminicola</i> (GRAVENHORST 1806)				+				+
<i>A. picipes</i> (THOMSON 1856)		+				+		
<i>Atrecus longiceps</i> (FAUVEL 1873)		+					+	
<i>Bolitochara obliqua</i> ERICHSON 1837	+	+				+		+
<i>Cyphaea curtula</i> (ERICHSON 1837)		+	+			+		+
<i>Dadobia immersa</i> (ERICHSON 1837)		+				+		
<i>Dexiogyia corticina</i> (ERICHSON 1837)		+						+
<i>Dinaraea aequata</i> (ERICHSON 1837)	+	+				+		+
<i>D. linearis</i> GRAVENHORST 1802		+	+			+		+
<i>Gabrius splendidulus</i> (GRAVENHORST 1802)	+	+	+	+		+	+	+
<i>Homalota plana</i> (GYLLENHAL 1810)	+	+	+			+		+
<i>Lathrobium brunnipes</i> (FABRICIUS 1793)	+							+
<i>L. geminum</i> KRAATZ 1857	+							+
<i>L. impressum</i> HEER 1841				+				+
<i>Leptusa pulchella</i> (MANNERHEIM 1831)	+	+				+		
<i>L. ruficollis</i> (ERICHSON 1839)	+					+		
<i>Myllaena dubia</i> (GRAVENHORST 1806)	+							+
<i>Nudobius lentus</i> (GRAVENHORST 1806)	+	+				+	+	+
<i>Ochtheophilum fracticorne</i> (PAYKULL 1800)		+						+
<i>Ocypus nitens</i> (SCHRANK 1781)				+				+
<i>Olophrum fuscum</i> (GRAVENHORST 1806)		+						+
<i>Paederus riparius</i> (LINNAEUS 1758)	+	+	+					+
<i>Phloeocharis subtilissima</i> MANNERHEIM 1830		+				+		
<i>Phloeonomus punctipennis</i> THOMSON 1866	+		+				+	
<i>P. pusillus</i> (GRAVENHORST 1806)	+	+					+	
<i>Phloeopora concolor</i> KRAATZ 1856	+						+	
<i>P. corticalis</i> GRAVENHORST 1802		+					+	
<i>P. testacea</i> (MANNERHEIM 1830)	+	+					+	+
<i>Placusa atrata</i> (MANNERHEIM 1830)		+				+		
<i>Quedius maurus</i> (C. SAHLBERG 1830)				+				+
<i>Q. mesomelinus</i> (MARSHAM 1802)			+			+		
<i>Q. plagiatus</i> MANNERHEIM 1843	+	+				+	+	
<i>Q. scitus</i> (GRAVENHORST 1806)		+	+	+		+	+	
<i>Q. xanthopus</i> ERICHSON 1839	+	+	+	+		+	+	+
<i>Sepedophilus bipustulatus</i> (GRAVENHORST 1802)		+	+	+		+	+	+
<i>S. marshami</i> (STEPHENS 1832)		+				+	+	
<i>S. testaceus</i> (FABRICIUS 1793)	+	+	+	+		+	+	+

<i>Stenus europaeus</i> PUTHZ 1966		+						+
<i>S. humilis</i> ERICHSON 1839	+	+	+					+
<i>S. palustris</i> ERICHSON 1839	+							+
<i>Xantholinus longiventris</i> HEER 1839		+						+
Pselaphidae								
<i>Tyrus mucronatus</i> (PANZER 1805)	+							+
Lucanidae								
<i>Ceruchus chrysomelinus</i> (HOCHENWART 1785)			+	+			+	
<i>Dorcus parallelepipedus</i> (LINNAEUS 1785)		+						+
<i>Sinodendron cylindricum</i> (LINNAEUS 1758) L.		+						+
Dermestidae								
<i>Megatoma undata</i> (LINNAEUS 1758)			+				+	
Lymexylidae								
<i>Elateroides dermestoides</i> (LINNAEUS 1761) L.	+					+		+
Cantharidae								
<i>Cantharis livida</i> LINNAEUS 1758	+	+						+
<i>Malthodes marginatus</i> (LATREILLE 1806)			+			+		
Cleridae								
<i>Thanasimus formicarius</i> (LINNAEUS 1758)	+						+	
Trogositidae								
<i>Grynocharis oblonga</i> (LINNAEUS 1758)		+						+
<i>Tenebroides mauritanicus</i> (LINNAEUS 1758)	+	+						+
<i>Thymalus limbatus</i> (FABRICIUS 1787)		+					+	
Peltidae								
<i>Ostoma ferrugineum</i> (LINNAEUS 1758)	+	+	+	+	+		+	+
<i>Peltis grossa</i> (LINNAEUS 1758)			+					+
Lycidae								
<i>Lygistopterus sanguineus</i> (LINNAEUS 1758)	+	+	+				+	+
Elateridae								
<i>Ampedus balteatus</i> (LINNAEUS 1758)		+	+	+			+	+
<i>A. elongatulus</i> (FABRICIUS 1787)			+					+
<i>A. erythrogonus</i> (P.W. MULLER 1821)		+					+	
<i>A. nigerrimus</i> (BOISDUVAL & LACORDAIRE 1835)				+	+	+	+	
<i>A. pomonae</i> (STEPHENS 1830)	+	+	+	+		+	+	+
<i>A. pomorum</i> (HERBST 1784)	+	+	+	+	+	+	+	+
<i>A. praeustus</i> (FABRICIUS 1792)				+			+	
<i>A. sanguineus</i> (LINNAEUS 1758)			+	+			+	
<i>A. sanguinolentus</i> (SCHRANK 1776)		+	+	+		+	+	+
<i>A. tristis</i> (LINNAEUS 1758)			+				+	
<i>Calambus bipustulatus</i> (LINNAEUS 1767)	+						+	
<i>Denticollis linearis</i> (LINNAEUS 1758)	+							+
<i>Diacanthous undulatus</i> (DE GEER 1774)	+	+				+	+	
<i>Melanotus villosus</i> (FOURCROY 1785)		+	+	+		+	+	+
<i>Stenagostus rufus</i> (DE GEER 1774)	+						+	
Buprestidae								
<i>Agrius biguttatus</i> (FABRICIUS 1776)		+					+	
Monotomidae								
<i>Rhizophagus dispar</i> (PAYKULL 1800)		+						+
<i>R. nitidulus</i> (FABRICIUS 1798)		+					+	
<i>R. bipustulatus</i> (FABRICIUS 1792)		+				+	+	
Cucujidae								
<i>Cucujus cinnaberinus</i> (SCOPOLI 1763)	+	+	+			+	+	+
<i>C. haematodes</i> ERICHSON 1845	+	+	+			+	+	+
Laemophloeidae								
<i>Cryptolestes duplicatus</i> (WALTL 1834)	+							+
Silvanidae								
<i>Dendrophagus crenatus</i> (PAYKULL 1799)	+	+	+			+	+	

<i>Uleiota planata</i> (LINNAEUS 1761)		+						+
Cerylonidae								
<i>Cerylon deplanatum</i> GYLLENHAL 1827	+							+
<i>C. ferrugineum</i> STEPHENS 1830		+	+			+		+
<i>C. histeroides</i> (FABRICIUS, 1792)	+	+						+
<i>C. impressum</i> ERICHSON 1845			+					+
Coccinellidae								
<i>Adalia bipunctata</i> (LINNAEUS 1758)			+					+
Zopheridae								
<i>Colydium elongatum</i> (FABRICIUS 1787)		+						+
<i>Synchita mediolanensis</i> VILLA & VILLA 1833	+	+				+		
Pythidae								
<i>Pytho depressus</i> LINNAEUS 1767	+						+	
Pyrochroidae								
<i>Pyrochroa coccinea</i> (LINNAEUS 1761)	+	+	+				+	+
<i>P. serraticornis</i> (SCOPOLI 1763)	+						+	
<i>Schizotus pectinicornis</i> (LINNAEUS 1758)	+	+	+	+		+	+	+
Mordellidae								
<i>Tomoxia bucephala</i> (COSTA 1854)		+				+		+
<i>Variimorda villosa</i> (SCHRANK 1781)		+						+
Melandryidae								
<i>Orchesia undulata</i> KRAATZ 1853		+						+
Tenebrionidae								
<i>Hypophloeus unicolor</i> (PILLER & MITTERPACHER 1783)	+	+				+		+
<i>Pseudocistela ceramboides</i> (LINNAEUS 1761)		+					+	
<i>Scaphidema metallicum</i> (FABRICIUS 1792)			+				+	
<i>Uloma culinaris</i> (LINNAEUS 1758)			+	+	+			+
Salpingidae								
<i>Salpingus ruficollis</i> (LINNAEUS 1761)	+					+		
Boridae								
<i>Boros schneideri</i> (PANZER 1795)	+	+				+	+	+
Cerambycidae								
<i>Acanthoderes clavipes</i> (SCHRANK, 1781)			+					+
<i>Leiopus nebulosus</i> (LINNAEUS 1758)	+	+					+	+
<i>Mesosa curculionoides</i> (LINNAEUS 1761)	+							+
<i>Monochamus galloprovincialis</i> (OLIVIER 1795)	+					+		
<i>Oplosia cinerea</i> (MULSANT 1839)	+	+						+
<i>Phymatodes testaceus</i> (LINNAEUS 1758)		+					+	
<i>Plagionotus arcuatus</i> (LINNAEUS 1758)	+	+					+	
<i>Rhagium inquisitor</i> LINNAEUS 1758	+	+	+			+	+	
<i>R. mordax</i> (DE GEER 1775)	+	+	+			+	+	+
<i>R. sycophanta</i> (SCHRANK 1781)		+					+	
<i>Saperda carcharias</i> (LINNAEUS 1758)	+	+				+	+	
<i>S. perforata</i> (PALLAS 1773)	+	+				+		
<i>S. scalaris</i> (LINNAEUS 1758)	+	+				+	+	+
<i>Semanotus undatus</i> (LINNAEUS 1758)		+				+		
<i>Spondylis buprestoides</i> (LINNAEUS 1758)	+					+		
<i>Tetropium castaneum</i> (LINNAEUS 1758)	+	+					+	
Chrysomelidae								
<i>Chrysolina polita</i> (LINNAEUS 1758)		+						+

Family Histeridae was represented by one species, collected on the 1st and 2nd stages of decomposition of CWD in BP. The presence of these beetles on the early stages of decomposition was due to the large number of other insect larvae, on which they feed.

One of the most abundant families on the CWD was rove beetles (Staphylinidae). They were found on the first four stages of CWD decomposition. Basically, they occurred on the 1st and 2nd stages of decomposition, rarely on the 3rd and 4th. On the territory of BBR, 21 species were found, BP-16 species, and PNP-24 species of rove beetle. The

distribution of different genera and species in various stages of decomposition can be caused by their trophic specialization, which remains for many species of this family debatable.

The beetles of the family Pselaphidae were collected in PNP under the bark on the 1st stage of CWD decomposition. Larvae and adult observed under the bark, where they likely prey.

Totally 3 species of the family Lucanidae were found, *Ceruchus chrysomelinus* in BP, *Dorcus parallelipipedus* and *Sinodendron cylindricum* in PNP. Distribution along the stages of decomposition is connected to the fact that the larvae of *C. chrysomelinus* prefer the brown rot, more common the later stages of decomposition (the 3rd and 4th), and larvae *D. parallelipipedus*, *S. cylindricum* prefer white rot, which are characteristic for the second stage of decomposition.

The beetles of the family Dermestidae were found in BP under the bark of CWD on the second and third stages of decomposition. The optimal conditions for carpet beetles larvae are on the 2nd and 3rd stages of decomposition, because a large amount of remainders, like larval skins, dead adults etc., accumulated under the bark.

On the first stage of CWD decomposition *Elateroides dermestoides* (Lymexylidae) was found in the PNP and BBR. The beetles of this family occupy only weakened or wind-broken trees.

The beetles of the family Cantharidae were found on the first three stages of CWD decomposition in BBR. The larvae of *Cantharis livida* were collected on the 1st and 2nd stages of decomposition, and larvae *Malthodes marginatus* on the third. Larvae of both species were observed under the bark, where they likely prey.

In our collection, the family Cleridae includes only one species *Thanasimus formicarius*, collected in PB. Its larvae were found in galleries of bark beetles, where they prey on the larvae.

The beetles of the family Trogositidae were found on the 1st and 2nd stages of CWD decomposition in BP and PNP. *Grynocharis oblonga*, *Tenebroides mauritanicus* are collected on the earlier stages of decomposition because they are mostly predators. *Thymalus limbatus* was found in BP under the bark on the third stage, where it feeds on fungi mycelium.

The beetles of the family Peltidae were found on all 5 stages of CWD decomposition: *Ostoma ferrugineum* in BP and *O. ferrugineum* and *Peltis grossa* in PNP. Both species are xylomycetophagous therefore larvae and adults occur on all stages of decomposition.

On the 1st, 2nd, and 3rd stages of CWD decomposition in BP and PNP, *Lygisterus sanguineus* (Lycidae) was found. Larvae develop under the bark and wood rests on the soil surface. Such distribution along the stages of decomposition is characteristic for non-specialized predators with elements of saprophagy.

The beetles of the family Elateridae were found on all 5 stages of decomposition of CWD in the BBR, BP, and the PNP. The larvae of the beetles of the genus *Ampedus* and *Melanotus* were observed on all stages of decomposition, because they are saprophages with elements of predation. At the same time, the species of the genus *Calambus*, *Denticollis*, *Diacanthous*, and *Stenagostus* were collected on the early stages of decomposition because they are predators.

The family Buprestidae was represented by one species *Agrilus biguttatus*, which was found on the 2nd stages of CWD decomposition in BP. Jewel beetles are wood borer insect therefore characterized by the development of their larvae in the early stages of CWD decomposition.

The beetles of the family Monotomidae were found in the BBR, BP, and the PNP. Larvae of the genus *Rhizophagus* are predators. They were found under the bark on the 2nd stage of CWD decomposition.

The beetles of the family Cucujidae were found in the BBR, BP, and the PNP. Larvae and adults of the genus *Cucujus* occur mainly on the second stage of decomposition, but were found on the 1st and 3rd stages of decomposition. Larvae are saprophages with elements of predation, adult are predators.

Species *Cryptolestes duplicatus* (Laemophloeidae) was found in BP. Its larvae are found under the bark on the 1st stage of CWD decomposition, where they feed on fungi.

The beetles of the family Silvanidae were found under the bark on the 1st, 2nd, and 3rd stages of decomposition of CWD in the BBR, and BP. Larvae feed on fungi developing on the early stages of decomposition.

The beetles of the family Cerilonidae were found on the 1st, 2nd, and 3rd stages of decomposition of CWD in the BBR and the PNP. Larvae and adults are mycetophages developing on the early stages of CWD decomposition.

The beetles of the family Coccinellidae were found on the 3rd stage of CWD decomposition in the PNP. Species of *Adalia bipunctata* was found under the bark in late autumn and early spring. It is associated with woody debris only topically because it uses it for the overwintering.

The beetles of the family Zopheridae were found on the 1st and 2nd stages of CWD decomposition in BP and BBR. Larvae and adults are mycetophages and facultative predators. They were found in galleries of bark beetles.

Species *Pytho depressus* (Pythidae) was found on the 1st stage of CWD decomposition on the pine in BP. Larvae feed on organic rests of both animal and vegetable origin, they are facultative predator.

The beetles of the family Pyrochroidae were found on the 1st, 2nd, and 3rd stages of CWD decomposition in the BBR, BP, and PNP. They occur mainly on the second stage of decomposition, less on the 1st and 3rd, where they feed on various organic rests.

The beetles of the family Mordellidae were found on the 2nd stages of CWD decomposition only in the BBR and the PNP. They feed on the wood damaged by white rot on the second stage of decomposition.

The beetles of the family Melandryidae were found on the 2nd stage of CWD decomposition only in BP. Larvae develop under the bark, where they feed on fungi.

The beetles of the family Tenebrionidae were found on all 5 stages of CWD decomposition in the BBR, BP, and PNP. The species *Hypophloeus unicolor* and *Pseudocistela ceramboides* were collected on early stages of decomposition under the bark, where they prey. The species *Scaphidema metallicum* and *Uloma culinaris* occur on the later stages of decomposition, where they feed on woody detritus with fungi mycelium.

The beetles of the family Salpingidae were found on the 1st stage of decomposition of CWD in the BBR. Larvae develop under the bark where they feed on fungi.

The beetles of the family Boridae were found on the 1st and 2nd stage decomposition of CWD in BP, BBR, and the PNP. Larvae feed on organic rests of both animal and vegetal origin, facultative predator.

The beetles of the family Cerambycidae were found on the 1st, 2nd, and less on the 3rd stages decomposition of CWD in BP, BBR, and the PNP. As true wood borer, long-horned beetles are found only in the early stages of decomposition.

The beetles of the family Chrysomelidae were found on the 3rd stage of decomposition of CWD in the PNP. The species *Chrysolina polita* occurs under the bark in late autumn and early spring; it is associated with woody debris only topical because uses them for the overwintering.

CONCLUSIONS

Thus, 130 species of saproxylic beetles were collected within specially protected natural areas (51 species in BBR, 58 species in BP, and 76 species in PNP). The saproxylic insect distribution along the stages of CWD decomposition is of all related to trophic specialization of the larvae and adults, and secondly to an opportunity to find refuge over for wintering.

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