

CONTRIBUTIONS TO THE KNOWLEDGE OF INVERTEBRATES ASSOCIATED WITH DECOMPOSED WOOD FROM THE PLAIUL FAGULUI RESERVE

BUȘMACHIU Galina, BACAL Svetlana, MÎNZAT Cristian, BURDUJA Daniela

Abstract. The paper presents new data about the diversity of invertebrates associated with decomposed wood from the Plaiul Fagului Reserve. A total of 37 invertebrate species belonging to 28 genera, 14 families and two classes Collembola and Insecta (Coleoptera and Hymenoptera) were identified. A rare species - *Carabus intricatus*, included in the third edition of the Red Book was highlighted. Eight new insect species, including three Coleoptera and five ants are quoted for the first time for the reserve, while *Triplax aeneus* and *Lasius neglectus* are cited as new for the country.

Keywords: Collembola, Coleoptera, Hymenoptera: Formicidae, new species, Republic of Moldova, reserve.

Rezumat. Contribuții la cunoașterea nevertebratelor asociate cu lemnul descompus din Rezervația Plaiul Fagului.

Lucrarea prezintă date faunistice noi privind diversitatea nevertebratelor asociate cu lemnul descompus din Rezervația Plaiul Fagului. În total au fost identificate 37 de specii de nevertebrate, ce fac parte din 28 de genuri, aparțin la 14 familii și două clase Collembola și Insecta. A fost identificată o specie rară – *Carabus intricatus* inclusă în a III ediție a Cărții Roșii. Opt specii de insecte, dintre care trei coleoptere și cinci furnici, sunt noi pentru rezervație, iar speciile *Triplax aenea* și *Lasius neglectus* sunt în premieră citate și pentru fauna Republicii Moldova.

Cuvinte cheie: Collembola, Coleoptera, Hymenoptera: Formicidae, specii noi, Republica Moldova, rezervație.

INTRODUCTION

The Plaiul Fagului Reserve is situated in the North – West of the Central Moldavian Hills, 70 km away from Chișinău, at approximately 47°17'28"N 28°3'16"E in the Central Region of the Republic of Moldova. This reserve is an important part of the Moldavian protected areas with a total surface of 5,558.7 sq km. The rare species of plants and vertebrate animals are mentioned here, including some Carpathian elements (Natura Rezervației Plaiul Fagului, 2005).

The invertebrate fauna of the Plaiul Fagului Reserve have been treated until now in several papers and books (Natura Rezervației Plaiul Fagului, 2005; BABAN & NECULISEANU, 2005; DONIȚĂ et al., 2007; BUȘMACHIU, 2021). Notwithstanding the studies presented above, a wide range of insects species has not been studied, and some large groups have not even been mentioned before this research. The diversity of invertebrates associated with decomposed wood from the reserve has not been studied separately.

The aim of this paper is to reveal the invertebrate species associated with dead woods and to increase knowledge of diversity of invertebrate species from the Plaiul Fagului Reserve.

MATERIAL AND METHODS

Sites descriptions. The vegetation of the reserve consists of several types of temperate mixed forests typical for central Europe. The arboreal vegetation is dominated by the oak, lime, ash and hornbeam. 5% of the total forest area is occupied by beech forests, being the largest territory covered by monodominant beech in Moldova (Natura Rezervației Plaiul Fagului, 2005). Several old fallen trees were kept on the territory of the reserve in order to protect rare invertebrate species, whose life cycle is linked to the decomposed wood (Figure 1).

Samples collection. The invertebrates were collected from the decaying wood from the Plaiul Fagului Reserve in October 2008 and 2020 (samples I and II) and in March and April 2021 (samples III and IV). The list of species and number of specimens are included in the Table 1.

Saproxylic beetles and ants were collected manually under the bark or from the dry trees fallen to the ground and from trunks in an advanced degree of decomposition. Supplementary soil and decomposed wood samples were taken for the extraction of small invertebrates (beetles, ants and collembolans).

Collembola, small beetles (Staphylinidae) and some ant specimens were extracted from decomposed wood using modified flotation method (BUȘMACHIU et al., 2015). Specimens of Collembola were treated with lactic acid, discoloured in KOH and mounted in permanent slides.

The taxonomic identification of invertebrate species was performed using MBS-10, Meiji Techno binoculars and microscope Leica. The modern determination keys specific to each group were used: for Collembola - ARBEA & WEINER (1992), SMOLIS (2008), FJELLBERG (2007), POMORSKI, 1998; for Coleoptera - KRYZHANOVSKIY (1965), RUTA et al. (2011) and for ants - site <http://antvid.org>.

Species marked in Table 1 with an asterisk (*) are recorded for the first time for the Plaiul Fagului Reserve; we marked with two asterisks (**) the species that are new for the fauna of the Republic of Moldova.



Figure 1. Decomposing trees in the Plaiul Fagului Reserve - host of invertebrates (original photo).

RESULTS AND DISCUSSION

As a result of the investigation, new data about the invertebrates associated with decomposed wood from the Plaiul Fagului Reserve were obtained. A total of 37 invertebrate species from two classes (Collembola and Insecta) belonging to 28 genera and 14 families were recorded in the microhabitat formed by decomposed wood in the forest ecosystem (Table 1).

For each species a brief information regarding the number of specimens and some data about the ecology are presented.

Eight insect species, including two ladybirds *Propylea quatuordecimpunctata* and *Harmonia axyridis*, four ants *Aphaenogaster subterranea*, *Lasius fuliginosus*, *L. emarginatus* and *L. niger*, are found for the first time in the reserve, while one beetle - *Triplax aenea* and one ant - *Lasius neglectus* are new both for the reserve and for the fauna of the Republic of Moldova.

Table 1. Invertebrates associated with decomposed wood from the Plaiul Fagului Reserve.

| SPECIES | SAMPLE | | | |
|---|--------|----|-----|----|
| | I | II | III | IV |
| COLLEMBOLA | | | | |
| <i>Superodontella lamellifera</i> (AXELSON, 1903) | 1 | - | - | - |
| <i>Superodontella montemaceli</i> ARBEA & WEINER, 1992 | 1 | - | 2 | - |
| <i>Deutonura albella</i> (STACH, 1920) | 1 | - | 1 | - |
| <i>Deutonura stachi</i> (GISIN, 1952) | - | - | 3 | - |
| <i>Thaumanura carolii</i> (STACH, 1920) | 16 | - | - | - |
| <i>Orthonychiurus rectopapillatus</i> (STACH, 1933) | 43 | - | - | - |
| <i>Pogonognathellus flavescens</i> (TULLBERG, 1871) | 24 | - | 3 | - |
| <i>Tomocerus minor</i> (LUBBOCK, 1862) | 7 | - | - | - |
| <i>Tomocerus vulgaris</i> (TULLBERG, 1871) | - | - | 2 | - |
| COLEOPTERA | | | | |
| <i>Amara aenea</i> (DE GEER, 1774) | - | 1 | - | - |
| <i>Carabus cancellatus</i> ILLIGER, 1798 | - | 1 | 4 | - |
| <i>Carabus convexus</i> FABRICIUS, 1775 | - | - | - | 1 |
| <i>Carabus intricatus</i> LINNAEUS, 1761 | - | 6 | 3 | - |
| <i>Platynus assimilis</i> (PAYKULL, 1790) | - | 11 | - | - |
| <i>Coccinella septempunctata</i> (LINNAEUS, 1758) | - | 1 | - | 1 |
| * <i>Propylea quatuordecimpunctata</i> (LINNAEUS, 1758) | - | 1 | - | - |
| * <i>Harmonia axyridis</i> (PALLAS, 1773) | - | 1 | - | - |
| <i>Ampedus pomonae</i> STEPHENS, 1830 | - | 2 | - | - |
| <i>Ampedus sanguineus</i> (LINNAEUS, 1758) | - | - | 3 | - |
| <i>Megapenthes lugens</i> (REDTENBACHER, 1842) | - | 1 | - | - |
| *, ** <i>Triplax aenea</i> (SCHALLER, 1783) | - | - | 2 | - |
| <i>Litargus connexus</i> (GEOFFROY, 1785) | - | - | 2 | - |
| <i>Uleiota planataus</i> (LINNAEUS, 1761) | - | 7 | 5 | - |
| <i>Atrecus affinis</i> (PAYKULL, 1789) | - | - | 2 | - |
| <i>Scaphidium quadrimaculatum</i> OLIVIER, 1790 | - | 2 | - | - |
| <i>Sepedophilus marshami</i> (STEPHENS, 1832) | - | 1 | 2 | - |
| <i>Paederus littoralis</i> GRAVENHORST, 1802 | - | 1 | - | 1 |
| <i>Ocytus nitens</i> (SCHRANK, 1781) | - | 1 | - | - |

| | | | | |
|---|---|---|----|----|
| <i>Tachyporus hypnorum</i> (FABRICIUS, 1775) | - | - | 1 | - |
| <i>Scaphidema metallicum</i> (FABRICIUS, 1792) | - | 3 | - | - |
| <i>Uloma culinaris</i> (LINNAEUS, 1758) | - | 3 | - | - |
| <i>Bitoma crenata</i> (FABRICIUS, 1775) | - | - | 2 | - |
| HYMENOPTERA | | | | |
| * <i>Aphaenogaster subterranea</i> (LATREILLE, 1798) | - | - | - | 39 |
| * <i>Lasius fuliginosus</i> (LATREILLE, 1798) | - | 8 | - | - |
| * <i>Lasius emarginatus</i> (OLIVIER, 1792) | - | - | - | 36 |
| *, ** <i>Lasius neglectus</i> VAN LOON, BOOMSMA & ANDRASFALVY, 1990 | - | - | 39 | - |
| * <i>Lasius niger</i> (LINNAEUS, 1758) | - | - | - | 49 |

Legend: (*) new record for the Plaiul Fagului Reserve; (**) species new for the fauna of the Republic of Moldova

The Collembola presented in the table were extracted only from wood in an advanced state of decomposition, being considered silvicolous and saproxylophagous, very important for the biodiversity of the reserve. An increased preference of the species of the families Neanuridae and Odontellidae (genus *Superodontella*) for secular trees oaks residues was observed, where the unique microhabitats invaded by a rich microflora were formed. The species of these two families can be observed only in natural forest habitats, where dominant trees are oaks. The species *Thaumanura carolii* is an indicator of natural deciduous forests of Central European type detected in litter and decomposed wood (BUȘMACHIU, 2021).

Among 23 species of beetles found in the autumn 2020 in the Plaiul Fagului Reserve, *Harmonia axyridis* is an invasive polyphagous species, without preference for concrete habitats, it has also been recorded in natural ecosystems (under the bark of trees, under leaves), as well as in artificial ecosystems (constructions, beehives). Other 2 species are saprobionts and zoophagous (*Propylea quatuordecimpunctata*, *Coccinella septempunctata*), 3 species are pedobionts, one phytophagous and two zoophagous (*Amara aenea*, *Paederus littoralis*, *Ocypus picipennis*), and 17 species are xylobionts, of which one species is saprophagous (*Sepedophilus marshami*), 5 species (*Triplax aenea*, *Litargus connexus*, *Scaphidium quadrimaculatum*, *Uloma culinaris* and *Scaphidema metallicum*) are mycophagous, and the other 11 species are zoophagous.

We want to mention the presence of several specimens of protected species *Carabus intricatus* (Tab. 1) in at least 4 decomposed logs in autumn of 2020 and in decomposing tree in spring 2021 (Fig. 2). The only specimen of the new species *Triplax aenea* was collected in the spring of 2021 (Fig. 3). Typical habitats for this species are deciduous forests and pastures, where they are associated with fungus-infested wood on a wide variety of trees; it is a rather sporadic European species, extending from Spain into parts of European Russia and to the north of Fennoscandia.



Figure 2. *Carabus intricatus* in the decomposing tree (original).



Figure 3. *Triplax aenea* new species recorded for the reserve (original).

In the Plaiul Fagului Reserve, the species *Carabus convexus convexus* was not listed. The species was first mentioned by BABAN & NECULISEANU, 2005 as being collected from the different types of forests of the Plaiul Fagului Reserve.

In previously published volumes (Natura Rezervației Plaiul Fagului, 2005; DONIȚĂ et al., 2007) no species of ants were cited as being studied in the reserve. Recent research has highlighted the first species of ants associated with decomposed wood. Among them the species *Aphaenogaster subterranea* is a widely distributed Mediterranean ant species, which mainly inhabits moderately wet and warm deciduous forests, nesting in the ground, under stones, in rotten wood, rarely in litter. They form quite numerous colonies (from hundreds to thousands individuals), being active

at night, but also extremely active during the day, exhibiting aggressive behaviour towards common forest species (TĂUȘAN et al., 2011).

Lasius fuliginosus is widely distributed in Europe and Asia, as a zoophagous-xylophagous species, feeding also on the sugars produced by aphids of the species *Chaitophorus populeti*, *Cinara laricis* and *Stomaphis quercus*. Long columns of *L. fuliginosus* can be seen forming a living corridor from the host plants of the aphids to the tree where the ant nest is located. Nests of this ant species are most commonly found in the stems of old trees, especially oaks, sometimes meeting ants under rocks or even in open ground. The ant queen of *L. fuliginosus* can behave as a temporary social parasite, taking the place of the queen of other species *Lasius alienus*, *L. brunneus*, *L. mixtus*, *L. niger* etc. developing in their own colony, by eliminating the hosts over a period of time (NOVGORODOVA, 2015).

Lasius niger is one of the commonest European species, which occurs in deciduous, coniferous and mixed forests, in gardens and in open meadows. He rarely enters houses. In forests it tends to nest in the trunks of rotten trees. It has a varied diet: insects, nectar from aphids or seeds. It is active during both day and night (WILSON, 1955).

Lasius emarginatus is a very common species occurring in central and southern Europe, their nests are most often under stones in dry places, but also in dry wood. It avoids wet places. The diet is similar to *Lasius niger* (WILSON, 1955).

The species *Aphaenogaster subterranea*, *Lasius fuliginosus*, *L. emarginatus* and *L. niger* were first mentioned in bibliographical sources in the Republic of Moldova from the Codrii Tigheci (PODDUBNY et al., 1980).

The originally Asian ant *Lasius neglectus* appeared in Europe in the late 20th century. It expanded its range, affecting and substituting other ant species. The nest can be placed under stones, construction wastes, also under the tree bark or in the ground. The flight does not take place during the breeding period. Coupling takes place directly in the nest. Subsequently, more than one queen is present in the nest, 30-40 active queens have been observed in large nests. This species behaves synanthropically and penetrates even into human homes (ARTOKHIN et al., 2013).

Preserving dead wood in natural ecosystems such as the Plaiul Fagului Reserve has a great significance especially for keeping invertebrate fauna. Not all insects found in dead wood are xylophagous, some of them take shelter during winter, most of them being zoophagous and contributing to the regulation of phytophagous species in the ecosystem.

CONCLUSIONS

In spite of a long term investigation conducted in the Plaiul Fagului Reserve, new invertebrate species can still be recorded.

The maintenance of intact patches of virgin forest, with some quantity of decomposed and covered by moss wood could improve forest biodiversity. The presence of the rare species as well as newly recorded species for the reserve indicate the importance and conservation value of studied microhabitats in the Plaiul Fagului Reserve.

Newly recorded Coleoptera species are on the one hand ecologically and habitat restricted, but at the same time, in recent years, some invasive insect species such as *Lasius neglectus* and *Harmonia axyridis* penetrated in the reserve.

ACKNOWLEDGEMENTS

The study was performed with financial support from the project N. 20.80009.7007.02. The authors would like to thank dr. Tugulea Cristina for the photo of *Carabus intricatus*. The authors want to thank the reviewer dr. Zbyšek Šustek and the editor for the valuable remarks that improved the manuscript.

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Bușmachi Galina

Institute of Zoology, Academiei str. 1, 2028 Chișinău, Republic of Moldova.
Email: bushmakiu@yahoo.com

Received: April 14, 2021

Accepted: July 15, 2021