Saproxylic insect fauna – *Dasycera oliviella* (Lepidoptera: Oecophoridae) seen as a meaningful habitat quality indicator

Radoslav Valkov

Abstract. Saproxylic insects are inextricably associated with woodland habitats, often with assigned conservation designations. The presence of rare saproxylic insects that are characteristic to a given habitat type emphasises the ecological importance of the naturally occurring process of wood decay. This is the first record of the diurnal micro-moth *Dasycera oliviella* (Fabricius, 1794) in North-West Bulgaria that includes field notes on the behaviour and feeding preferences of the adult moth, seen in nature. Other rare European insect species, found in the same sampling site where *D. oliviella* was recorded, are mentioned to reinforce the importance of perceiving any habitat as a potentially vulnerable ecologically interconnected entity. The paper also emphasizes the irreparable damage to insect populations brought about by anthropogenic activity in sensitive habitats, the establishment of which requires many years of undisturbed plant-insect interaction. Problems connected with the deficiency of research data when studying Microlepidoptera are also discussed.

Samenvatting. Saproxyle insecten zijn onlosmakelijk verbonden met boshabitats, vaak met toegewezen beschermingsaanduidingen. Het detecteren van de aanwezigheid van zeldzame saproxyle insecten die kenmerkend zijn voor een bepaald habitattype, benadrukt het ecologische belang van het natuurlijk voorkomende proces van rottend hout. Dit is het eerste record van de dag-actieve micro-mot *Dasycera oliviella* (Fabricius, 1794) voor Noordwest-Bulgarije, met aantekeningen over het gedrag en de voedingsvoorkeuren van het imago, zoals waargenomen in de natuur. Andere zeldzame Europese insectensoorten, gevonden op dezelfde locatie waar *Dasycera oliviella* werd aangetroffen, worden opgesomd om het belang van zulk een habitat als een potentieel kwetsbare, ecologisch onderling verbonden, entiteit verder te onderbouwen. Het artikel benadrukt ook dat antropogene activiteit in gevoelige habitats onherstelbare schade tot gevolg heeft voor insecten wiens vestiging vele jaren van ongestoorde plant-insect-interacties vereist. Ook problematische aspecten van tekortkomingen in onderzoeksdata bij het bestuderen van Microlepidoptera worden besproken.

Résumé. Les insectes saproxyliques sont inextricablement associés aux habitats forestiers, souvent avec des désignations de conservation assignées. La détection de la présence d'insectes saproxyliques rares, caractéristiques d'un type d'habitat donné, souligne l'importance écologique du processus naturel de dégradation du bois. Il s'agit du premier signalement du micro-papillon diurne *Dasycera oliviella* (Fabricius, 1794) pour le nord-ouest de la Bulgarie qui comprend des notes sur le comportement et les préférences alimentaires de la forme adulte, observées dans la nature. D'autres espèces d'insectes européennes rares, trouvées dans le même site d'échantillonnage où *Dasycera oliviella* a été enregistrée, sont mentionnées pour étayer davantage l'importance de percevoir tout habitat comme une entité écologiquement interconnectée et potentiellement vulnérable. L'article insiste également sur le préjudice irréparable pour les insectes résultant de la difficulté de compenser les dommages anthropiques dans les habitats sensibles, dont l'établissement nécessite de nombreuses années d'interactions plantes-insectes non perturbées. Les aspects problématiques des manque de données de recherche lors de l'étude des microlépidoptères sont également abordés.

Key words: Bioindicators – *Dasycera oliviella* – Saproxylic insects – Woodland conservation.

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"Destroying one of the very sources of life on Earth, a tree, takes a couple of minutes; this will most certainly obliterate beneficial insect fauna that has been around for many centuries – vital, unnoticed and underappreciated."

Radoslav Valkov

Introduction

Human-induced deterioration of an environment produces habitats unsuitable for colonization by saproxylic organisms. Establishment of a particular species at a new site can take decades, and once a small population is established, it is very fragile. Certain saproxylic insect species are intolerant of apparently insignificant habitat-related changes and have fairly limited dispersal capabilities; survival may be restricted to a very narrow ecological niche and geographical perimeter. Removal of a specific larval food source will result in the exclusion of dependent insect species from an otherwise suitable habitat. This is why the forest management practice of removal of dead wood poses a serious threat to saproxylic insects (Seibold *et al.* 2015). Roth *et al.* 2020 and Haeler *et al.* 2021 demonstrate that increasing the amount of dead wood in European temperate forests is a beneficial restoration practice, both to saproxylic beetles and fungal communities.

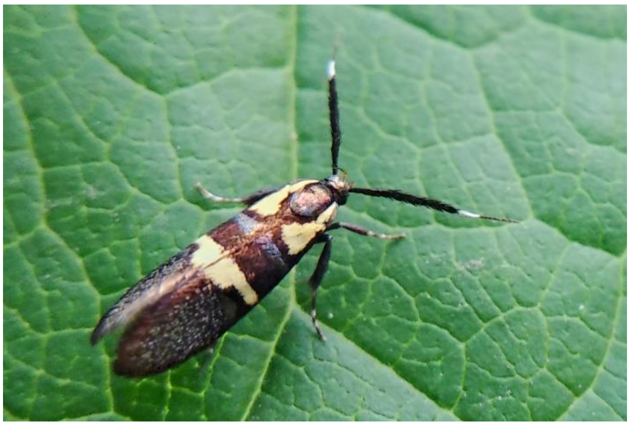

Fig. 1. *Dasycera oliviella,* resting on *Campsis radicans*, 22.vii.2020, 19:07. © Radoslav Valkov.

In regard to the interactions between saproxylic organisms and their habitats, little is known about the role of Microlepidoptera, apart from the general fact that their larvae feed on decaying or dead wood (Jaworski 2018). The presence of rare species as habitat indicators, as well as the ecological implications of such records, have not been sufficiently addressed in scientific literature. Right across Europe and the UK, there are but few records of the occurrence of rare saproxylic Microlepidoptera, and these simply define certain species as local and scarce, without answering questions about their modes of colonisation and their habitat requirements. Observations on saproxylic insects that could be of practical conservation value still remain poorly researched (Jaworski *et al.* 2016).

First observation of *Dasycera oliviella* in NW Bulgaria

One specimen of *Dasycera oliviella* (Fabricius, 1794) was observed in the author's garden in the town of Byala Slatina, Bulgaria on 22 July 2020. This is the second scientifically verified record of *Dasycera oliviella* for Bulgaria more than half a century after its first discovery for the country. The most recent mention of *D. oliviella* in Bulgaria dates back from 1957–1969, described by Tuleschkov & Slivov (1975). Interestingly, the specimens are reported from regions and biotopes that greatly differ from the region and habitat of the current find. This is an unmistakable saproxylic member of the family Oecophoridae. Most records are from ancient broad-leaved woodland; the larva feeds under bark of decaying wood of *Quercus*, *Corylus* and *Prunus*; pupation occurs in dead wood adjacent to the feeding place (Harper *et al*., 2002; Tokár 2005; Palm 1989). *Dasycera oliviella* is an appropriate example of an organism that is exclusively restricted to its preferred habitat. Although diurnal, it is one of those elusive micro-moths that are very difficult to find and observe; its flight is difficult to follow with the naked eye–quick, energetic, with high frequency beats. The predominantly dark wing colouration also hinders observation when the moth is in flight (pers. observ.).

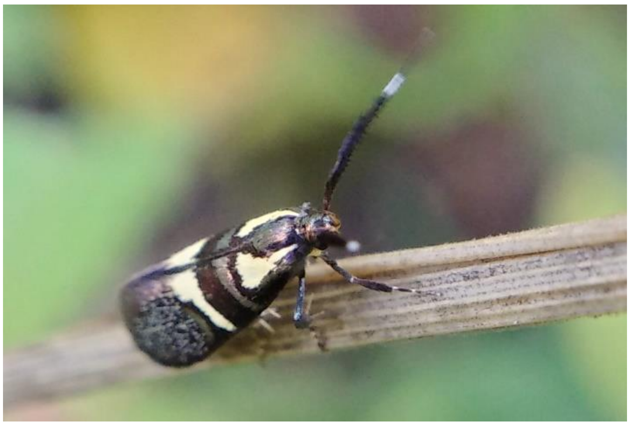

Fig. 2. *Dasycera oliviella,* crawling up on low vegetation, 22.vii.2020, 19:17. © Radoslav Valkov.

The individual reported was spotted flying above *Campsis radicans* (L.) Seem. ex Bureau (Trumpet-creeper) after a hot and sunny afternoon, performing a vertical movement when flying, as described by Harper *et al.* 2002. In less than 20 seconds it settled on a leaf to rest at 7:06 PM (Fig. 1). It allowed about 10 minutes to be documented at rest, took flight towards the main garden space and remained settled in an area of low vegetation, but its precise location was temporarily lost. Following a 10-minute search, it was found crawling up a dry plant stem, performing a sensing movement with its antennae, as if it was “probing” (Fig. 2). Then it took flight and landed in the foliage of the Persian silk tree located about 1m away from the spot where it had left. Following a short search, it was found and immediately photographed with a digital SLR camera (Nikon D70s), used with macro extension tubes, lens Zoom Nikkor 28-80mm f/3.3–5.6 and photographic flash Nikon SB-R200. The resulting photographs show the moth had actually detected a food source (Fig. 3). The Persian silk tree foliage was covered with honeydew of unknown origin, on which it was feeding. It showed no interest in any wildflowers or flowering garden plants as a food source. This observation suggests that the moth relied on olfactory perception to sense food, rather than using visual cues. When uncoiled, the proboscis looks flat and short (Fig. 3), with rough structure, better visible when the proboscis is coiled at rest (Fig. 4). Following this observation, the moth took flight and was not seen again, even after subsequent prolonged inspections of the whole garden area the following day.

Fig. 3. *Dasycera oliviella,* feeding on sticky honeydew among Persian Silk tree (*Albizia julibrissin*), 22.vii.2020, 19:21. © Radoslav Valkov.

Fig. 4. *Dasycera oliviella,* resting among Persian silk tree (*Albizia julibrissin*), 22.vii.2020, 19:23. © Radoslav Valkov.

Discussion
Source of the adult form

Corylus, *Salix* and *Prunus*, genera often stated to be food sources of the larvae of *D. oliviella*, all known to benefit wildlife and saproxylic invertebrates in particular (Alexander *et al.* 2006), are all present. The wood decay process had started in *Corylus* and *Salix*. *Corylus* forms a 25 years old woody cluster of trees (4x5m) (Fig. 5) that had undergone highly selective coppicing; the assemblage had been left intact for about 7 years with no maintenance applied. *Salix fragilis* L. is 30 years old, 15m tall (Fig. 6). *Prunus spinosa* L. is excluded as a possible source, because the plants are young (4 years old) and have yet to show any signs of decay.

Fig. 5. *Corylus* assemblage. © Radoslav Valkov.

Hypotheses on dispersal capacity

Significant differences in soil quality, plant and insect diversity, artificial chemical input and overall habitat quality between the place of record and the surrounding neighbouring gardens are observed. The two neighbouring gardens are without ecologically meaningful vegetation and lack a visible insect fauna; the tree species cited above as a potential source of decaying wood for the development of larvae are also absent. This suggests the possibility that *D. oliviella* might be resident in the small area where the record was made, but hitherto un-noticed.

Fig. 6. *Salix fragilis.* © Radoslav Valkov.

Although its dispersal range remains uncertain, an extremely rare saproxylic fly, *Rainieria calceata* (Fallén, 1820) (Micropezidae), strictly associated with ancient woodland, was recorded from the same garden on 18 June 2020 (Fig. 7). This suggests the habitat offers favourable conditions for the larval development of both *D. oliviella* and *R. calceata*, although *R. calceata* could have a broader mobility range (Sumner 2019). The surrounding areas restrict the preferred habitat to the garden. This is the very first record of this rare fly to be reported from a garden property in Bulgaria. The exceptional rarity of *R. calceata* is further confirmed by map data for the UK and France, reported by the European Microprezids & Tanypezids recording scheme.

In accordance with the appropriate vernacular name of the family Oecophoridae (concealer moths), when settled on the Persian silk tree to feed on honeydew, *D. oliviella* remained inconspicuous among foliage. This increases the likelihood of it having been overlooked. Nevertheless, the moth proved approachable, and all the photographs were taken from a distance less than 20 cm. Since no explicit data is available on *D. oliviella* as a strictly woodland inhabitant, it is hypothesised that dispersal constraints are imposed on it because of the high degree of habitat fragmentation, as evident from the description of the sampling site and the surrounding areas (Wölfling *et al.* 2019).

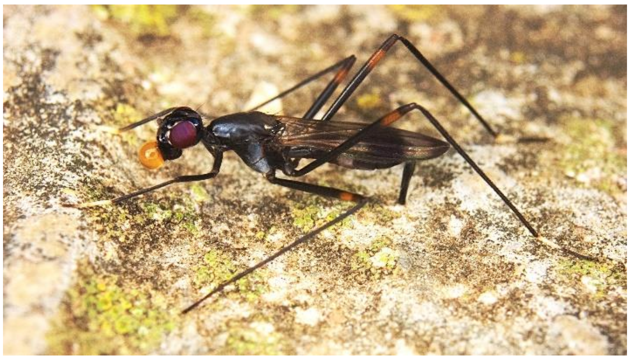

Fig. 7. *Rainieria calceata,* at rest, 18.vi.2020, 10:00. © Radoslav Valkov.

Ethical and conservation considerations

The specimen recorded was not collected for preparation, although there was such an opportunity. Even without keeping it as a voucher specimen, the moth was considered to be unmistakable, and verifiable on the photographic evidence. This record was startling and new to the lepidopteran fauna of the area, in which there is also a small population of another significantly rare moth species across Europe and the UK, the diurnal *Nemophora fasciella* (Fabricius, 1775), first recorded in the area on 16 June 2007 (Fig. 8); Fig. 9 illustrates the species resting on *Ballota nigra* on 08 June 2020. This population has gradually expanded over the years due to the intentional increase in the density of its larval food plant, *Ballota nigra* L. Adelidae is a poorly researched family, especially in respect to its ecological role in the ecosystem. The rarity of *N. fasciella* is hypothesised to originate from its low dispersal capacity and strong dependence on the larval foodplant, which in most cases is treated as unwanted vegetation, hence populations cannot be established (pers. observ.). Thus, it would be reasonable that extra notice should be taken when unexpected records are encountered for this particular site.

Interception with artificial light in the context of ethological observations

Many Microlepidoptera are very small, and there is an overwhelming diversity of species worldwide which are difficult to observe and document in the wild. When microlepidopteran species are attracted to light, there is often a mixture of nocturnal and diurnal species. Visits to a moth trap increase the activity of many micro-moth species, which could yield truly intriguing data on Microlepidoptera (pers. observ.). However, when studying micro-moths that are known to be strictly diurnal, a moth trap may introduce bias when collecting behavioural data. Two other saproxylic Oecophoridae, *Crassa unitella* (Hübner, 1796) (Fig. 10) and *Epicallima formosella* (Denis & Schiffermüller, 1775) (Fig. 11) are present at the same site as *Dasycera oliviella* and are frequently attracted by MV moth traps. All three species of Oecophoridae have characteristic curved labial palps (Hannemann 1997). In addition, another intriguing saproxylic find was recorded on 20.vi.2020 – *Neurothaumasia ankerella* (Mann, 1867), family Tineidae (Fig. 12). Its larvae are described to utilise the galleries made by *Cermabyx cerdo* L. (Great capricorn beetle) according to Spuler, 1910. The only known mention of *N. ankerella* in Bulgarian microlepidopteran fauna is provided by Tuleschkov & Slivov 1975, where the species is reported twice in 1967 and 1969.

Fig. 8. *Nemophora fasciella,* ♀ nectaring on *Rudbeckia* sp., 16.vi.2007, 11:13. © Radoslav Valkov.

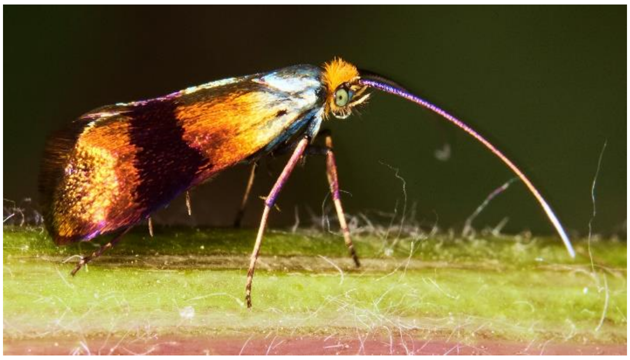

Fig. 9. *Nemophora fasciella,* ♀ at rest following oviposition on *Ballota nigra*, 08.vi.2020, 15:27. © Radoslav Valkov.

Special attention should be paid to the relationship between morphological features, environmental variables and behaviour (Wölfling *et al.* 2016), a poorly explored perspective when researching Microlepidoptera. Account on direct observations *in situ*, without light sources used would require a substantial investment of time and vigilance.

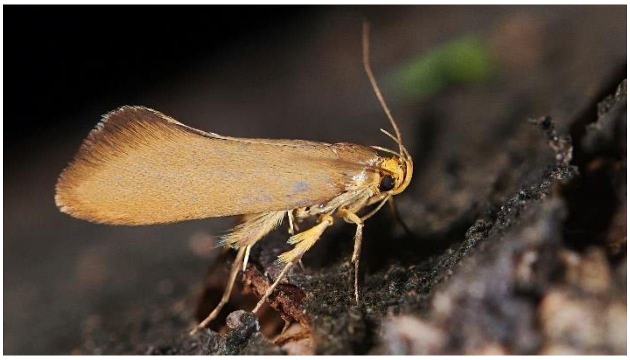

Fig. 10. *Crassa unitella* on apple tree *(Malus domestica)* bark – 125W MV moth trap, 17.vi.2013, 22:51. © Radoslav Valkov.

Studying Microlepidoptera is important: an evidence-based summary

Despite being enormously diverse, the microlepidopteran fauna deserves much closer attention to its relationship with more subtle processes in nature, as seen with *Dasycera oliviella;* the record confirms the presence of naturally occurring wood decay. This shows that any habitat, big or small, can provide favourable conditions to sustain rare insect species in the absence of negative anthropogenic impact, as here, an old garden. Furthermore, habitat fragmentation has been found to play a important role in the decreased colonisation rate amongst other Microlepidoptera in urban areas (Kozlov 1996). It is important to include saproxylic species, as well as others, as indicators of the nature and potential of diverse habitats.

Fig. 11. *Epicallima formosella,* at rest – 125W MV moth trap, 26.vi.2020, 01:38. © Radoslav Valkov.

Urbanisation is highlighted as a major factor negatively affecting saproxylic insects (Meyer *et al.* 2021). While long-term distribution data answers many questions about population dynamics, and facilitates implementation of targeted conservation measures, the depth of observations is a major determinant for the overall quality of the scientific value and practical significance of a record that could be used, for instance, in other priority areas such as improving planning criteria for certain sites. However, inferences based solely on indicator species should be made with great caution (Fleishman & Murphy 2009); research insights on species-specific evidence and knowledge about the microlepidopteran fauna are still very limited. This paper presents some qualitative evidence on species from different taxa, affirming Man's responsibilities towards the ecological integrity of any habitat, and suggesting the potential of *D. oliviella* as a useful habitat quality indicator (Gerlach *et al.* 2013), along with its value to facilitate measuring conservation significance of a given site (Speight 1989).

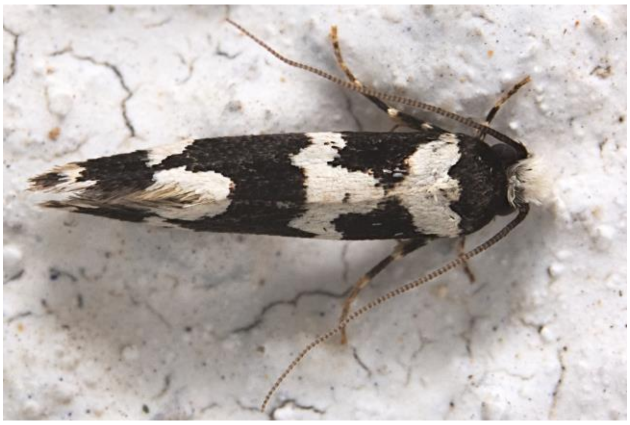

Fig. 12. *Neurothaumasia ankerella* – 125W MV moth trap, 20.vi.2020, 00:57. © Radoslav Valkov.

Conclusions

Dasycera oliviella, together with examples of the presence of other saproxylic Oecophoridae and rare Diptera in the same garden habitat, allude to the irreversibility of ecological damage arising from habitat loss. The understanding that small moths are an important constituent of nutrient cycles and are hence largely beneficial, is generally correct. However, deficiency of data may lead to faulty assumptions, rather than inferences that are based strictly on field observation and in-depth analysis. What really matters to understand the contribution made by Microlepidoptera in the ecosystem, is to explore, for example, possible adverse effects on their populations by techniques developed for natural pest control, and their role as beneficial pollinators. This highlights the need to consider any tiny detail revealed in the study of poorly researched taxa.

The functional role of Microlepidoptera remains neglected in various fields of ecology, despite dead wood decomposition being an essential insect-mediated feature of the ecosystem. The part played by Lepidoptera and Diptera receive little scientific attention in this respect, either at order level or in regard to a direct quantification and experimental studies (Noriega *et al.* 2018). Through a literature review reflecting long-term trends in scientific output (1956–2016), the authors highlight that the commercially important research aspects of ecosystem services, mediated by insects, largely suppress areas of research that could be practically significant. For instance, pollination is rarely quantitatively analysed, let alone its mediation by organisms that have not received adequate research attention, such as Microlepidoptera. For example, Fig. 8 clearly demonstrates the importance of *Nemophora fasciella* as a pollinator. Many other diurnal microlepidopteran generalists exhibit the same capacity. Such research requires knowledge, both at species-specific and population level, in order to conduct unbiased quantitative experiments in the field.

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