

***Phosphaenus hemipterus* (Goeze, 1777) (Coleoptera: Lampyridae): the First Record in Bulgaria, with Data on its Habitat Preferences and Feeding**

Teodora M. Teofilova^{1*}, Denis Gradinarov² & Nikolay D. Kodzhabashev³

¹ Institute of Biodiversity and Ecosystem Research, Bulgarian Academy of Sciences, 1 Tsar Osvoboditel Blvd., 1000 Sofia, Bulgaria; E-mail: oberon_zoo@abv.bg

² Faculty of Biology, St. Kliment Ohridski Sofia University, 8 Dragan Tzankov Blvd., 1164 Sofia, Bulgaria;
E-mail: dgradinarov@abv.bg

³ Department of Hunting and Game Management, Faculty of Forestry, Forestry University, 10 Kliment Ohridski Blvd., 1756 Sofia, Bulgaria; E-mail: ndkodjak@abv.bg

Abstract. The genus *Phosphaenus* Laporte de Castelnau, 1833 and its species *P. hemipterus* (Goeze, 1777) (Coleoptera: Lampyridae: Lampyrinae) are recorded for the first time from Bulgaria. The material was collected in the Sarnena Sredna Gora Mts., central Bulgaria, with pitfall traps. The new locality of the lesser glow-worm is the most southeastern point known in the European mainland range of the species. Considering its current distributional range, we may suggest that the lesser glow-worm is to be found in whole Europe but probably its peculiar way of life has impeded its records. The present study gives new information about the habitat preferences and the potential preys of the species.

Key words: glow-worms, new record, Sarnena Sredna Gora Mts., prey, habitat

Introduction

The family Lampyridae is still little studied in the Western Palaearctic. The genus *Phosphaenus* Laporte de Castelnau, 1833 (Lampyrinae) is represented by a single European species (KAZANTSEV 2011, NOVÁK 2018). *Phosphaenus hemipterus* (Goeze, 1777) is a small species, unique amongst the 2,000 or so firefly species described by its morphology and biology. It is remarkable as being the only known lampyrid, in which the male is brachelytral, the female is larviform, and both adult sexes are flightless, diurnal and faintly luminous, although they appear only to glow in response to disturbance

(McDERMOTT 1964, DE COCK 2000, DE COCK et al. 2009, MAJKA & MACÍVOR 2009, NOVÁK 2018). The behaviour and morphology of males, with their long, broad antennae and small eyes, and the fact that they appear to be attracted to and assemble on places where females are hiding, strongly suggest that this species uses pheromones rather than light signals in sexual communication (DE COCK & MATTHYSEN 2005, DE COCK et al. 2009). The larvae are predominantly nocturnal and seem to be specialised in feeding on earthworms (DE COCK 2000, DE COCK et al. 2009).

The species is considered a rare and poorly known but DE COCK (2000) has presumed that the reason for this is the fact that this firefly can be found

* Corresponding author: oberon_zoo@abv.bg

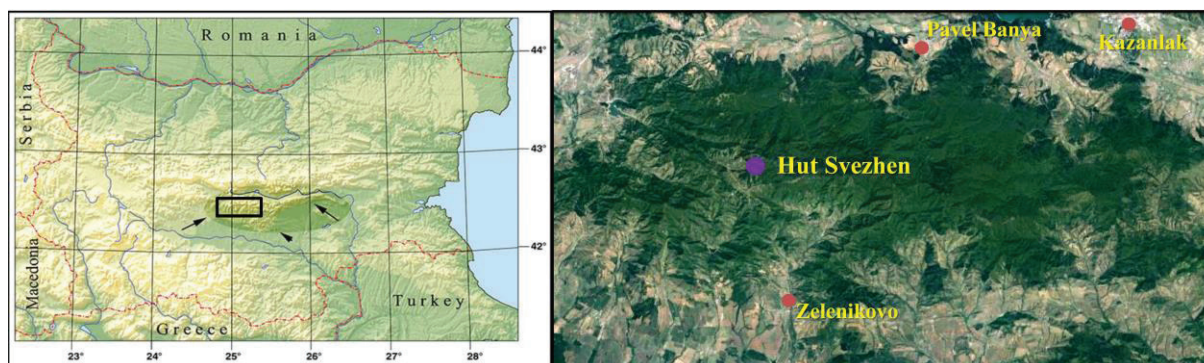


Fig. 1. Locality in the Sarnena Sredna Gora Mts. where the *Phosphaenus hemipterus* was collected.

mainly in areas with high levels of human disturbance (NOVÁK 2018). It is uncommon in many areas of Europe where it occurs, and is Red Listed in Germany as an endangered species (GEISER 1998). It is also included in the British Insect Red Data Book (SHIRT 1987).

The aim of this study is to present the first records of *Phosphaenus hemipterus* in Bulgaria and to add new data to the knowledge of its distribution and ecology.

Materials and Methods

The specimens were collected in the period 8 July – 10 November 2019 via pitfall trapping in five sampling sites in the Sarnena Sredna Gora Mts. (easternmost part of the Sredna Gora Mts.), in the region of the Svezhen Hut (Fig. 1). Formaldehyde was used as a fixative. The identified specimens are pinned and deposited in the zoological collections of Sofia University, Faculty of Biology (BFUS) and Institute of Biodiversity and Ecosystem Research (IBER-BAS).

Results

Ten male specimens and four larvae of the lesser glow-worm *Phosphaenus hemipterus* (Goeze, 1777) (Lampyridae: Lampyrinae) were collected and photographed for the first time in Bulgaria (Fig. 2). Material examined: Central Bulgaria, Sarnena Sredna Gora Mts., 8.VII–10.XI.2019, leg. T. Teofilova & N. Kodzhabashev. Localities: (1) East to Svezhen Hut, 42°30'35"N, 25°03'51"E, 1100 m a.s.l., mesophilous beech forest at the ridge of the mountain, 4♂, 3 larvae; (2) E Svezhen Hut, 42°30'36"N, 25°04'26"E, 975 m a.s.l., old mesophilous beech forest, 1♂, 1 larva; (3) 1 km NW Svezhen Hut, 42°31'03"N, 25°02'40"E, 1022 m a.s.l., old mesophilous beech forest, 3♂; (4) 1.5 km NW Svezhen Hut, 42°30'60"N, 25°02'38"E, 1015

m a.s.l., mixed forest with Scots pine, Douglas fir, spruce and solitary beech trees, 1♂; (5) 5 km NW to Svezhen Hut, 42°31'59"N, 25°02'05"E, 898 m a.s.l., mixed deciduous forest with beech, oak and hornbeam, 1♂. Habitats where *P. hemipterus* was collected are shown on Fig. 3.

Discussion

So far, five lampyrid species of four genera are known from Bulgaria: *Lampyrus noctiluca* (L., 1767), *L. zenkeri* Germar, 1817, *Lamprohiza splendidula* (L., 1767), *Lampyroidea dispar* (Fairmaire, 1857) and *Luciola lusitanica* (Charpentier, 1825) (ANGELOV 1960, ANGELOV 1989, GEISTHARDT & SATÔ 2007). Our new finding adds the genus *Phosphaenus* Laporte de Castelnau, 1833 and the lesser glow-worm to the Bulgarian fauna. Adult males of this species measure about 7 mm in length and the females are only slightly larger – about 10 mm. Wings of both males and females are rudimentary or entirely absent and their elytra are reduced to small, rucksack-like stubs in the male and are lacking altogether in the female (DE COCK et al. 2009).

Phosphaenus hemipterus, among glow-worm species, has the second largest distribution range in Europe after *Lampyrus noctiluca*. It is a European species recorded in Austria, western Balkans, Belgium, Crete, Czech Republic, Denmark, Estonia, Finland, France, Germany, northern Italy, Latvia, Lichtenstein, Lithuania, Luxembourg, Netherlands, North Macedonia, Poland, Portugal, Romania, central, western and north-western Russia, Slovakia, Slovenia, Spain, Sweden, and Switzerland (DE COCK 2000, MAJKA & MACIVOR 2009, KAZANTSEV 2011, GEISTHARDT & SATÔ 2007, GEISTHARDT 2019). It has been collected at several sites in England but it is still not confirmed if the species is native or introduced there (DE COCK et al. 2009, MAJKA & MACIVOR 2009). It seems to be the only



Fig. 2. General view (dorsal) of two male specimens found at the sampling site 3. Scale bar 1 mm.

European firefly that has been imported into another continent (North America). The unintentional introduction in Canada was probably facilitated by its high tolerance of, or even preference for, human-altered environments (MCDERMOTT 1964, MAJKA & MACIVOR 2009, NOVÁK 2018). Our new locality in Bulgaria fills a gap in the distribution of the species, representing the most south-eastern point known in the European mainland range of the species.

Phosphaenus hemipterus inhabits various types of biotopes. In most cases, these are highly urbanised and artificial habitats (gardens, orchards, field edges, mixed patches of shrubs, hedgerows, roads, etc.). Often considerable numbers of males have been found on or beside stones and some form of wall or paving (MULLER 1805, JENNER 1883, BUTLER 1880, MORRIS 1893, WEBER 1909, AIRY-SHAW 1961, MAGIS 1977, CRIBB 1991, DE COCK 2000, DE COCK et al. 2009, MAJKA & MACIVOR 2009). In the same time, it was found in a beech forest and in a frequently-pruned afforestation of ash (*Fraxinus excelsior*) near Brussels (DE COCK 2000). According to DE COCK (2000), preferred habitats are on compact, loamy or clayey soils and a recurring feature is an abrupt transition from dense vegetation or humus layer towards open, bare terrain, e.g. pavement, roads, walls and

fields. Larvae were mostly found on leaf litter in the more wooded or densely vegetated areas but also crawling over bare moist surfaces (DE COCK 2000). Males have been found on bare spots or on loamy soil with a thin leaf litter cover (DE COCK 2000). In our case, such thin leaf litter occurred only in the mixed coniferous forest (sampling site 4). The leaf litter covers in the beech and mixed deciduous forests were quite thick.

Currently the species is known from low altitudes: Baltic countries, Karelia, vicinity of Brussels (DE COCK 2000), Lednice in Czech Republic (NOVÁK 2018), Nova Scotia (MAJKA & MACIVOR 2009), etc. In Portugal, the species is known from 40 to 440 m a.s.l. (GEISTHARDT et al. 2008). We found the lesser glow-worm in natural mountain habitats from about 900 (at the beginning of the beech belt) to 1100 m a.s.l. (at the ridge of the mountain), which brings new data about species ecology, since it seems that *P. hemipterus* has not been found in mountain belts and has been considered a suburban and rural species. The statement that the conclusions about the rarity of the species may be the result of the lack of interest of today's entomologists in habitats favoured by *P. hemipterus*, e.g. (sub)urban habitats (DE COCK 2000), is probably not quite correct. In Bulgaria, the species apparently occurs in natural mountain habitats and its distribution is not tied to



Fig. 3. Habitats in the Sarnena Sredna Gora Mts. where *Phosphaenus hemipterus* was collected. A. Sampling site 1, spring. B. Sampling site 1, autumn. C. Sampling site 2, summer. D. Sampling site 3, spring. E. Sampling site 4, autumn. F. Sampling site 5, autumn.

settlements. In fact, we have found it only in this particular part of the Sarnena Sredna Gora, although we have studied many more localities and other similar habitats in other mountains, too. The apparent rarity of the species more likely can be a result from its hidden lifestyle.

The life cycle of the species lasts two or three years (NOVÁK 2018). The adults are most abundant

from June till the beginning of July. Occasionally, a few males can still be found in August and even September (MAGIS 1977, DE COCK 2000). Larvae can be found throughout the year, except in winter when they hibernate, probably in the soil (DE COCK 2000). Our findings are in accordance with these observations, since we caught the beetles in the period 8 July – 10 November, and there were no catches in

the previous period of sampling (22 March – 8 July). The absence of lesser glow-worms in the first catch (until 8 July) could be explained with the higher altitudes of our sampling sites and the influence of the mountain climate.

As in other European glow-worm species, the adults do not seem to feed (MIKŠIĆ 1981, DE COCK 2000). Larvae are known to feed on earthworms (Lumbricidae: *Lumbricus terrestris* L., 1758) and it seems that *P. hemipterus* specialises on this type of prey (DE COCK 2000, MAJKA & MACIVOR 2009). *Lumbricus terrestris* is widespread in the lowland regions of Bulgaria but it does not occur in the habitats of *P. hemipterus* in the present study. In the same traps, where the *P. hemipterus* specimens have been captured, we have found ten species of earthworms, which can probably be used as food by the *P. hemipterus* larvae: *Aporrectodea rosea* (Savigny, 1826), *A. longa* (Ude, 1895), *Bimastos eiseni* (Levinson, 1884), *Cernosvitovia rebeli* (Rosa, 1897), *Dendrobaena alpina* (Rosa, 1884), *D. balcanica* (Černosvitov, 1937), *Eisenia fetida* (Savigny, 1826), *Lumbricus meliboeus* Rosa, 1884 and *L. rubellus* Hoffmeister, 1843.

The fact that we have found both larvae (in different stages) and adults of the species only after the beginning of July, suggests that oviposition probably takes place in August and September in the studied habitats. In the spring, larvae are weakly mobile given the plenty food resources in the soil and as well the cooler mountain climate of the habitats. Activation probably occurs in summer when the larvae come out to the ground surface and feed on the available worms (not *L. terrestris* in our case).

In spite of its relatively large geographical range, knowledge about the lesser glow-worm remains limited because of its assumed rarity (DE COCK 2000) or its peculiar biology. Males can easily be confused with staphylinid beetles as they bear shortened wing cases (DE COCK 2000), which could lead to their misidentification. Females are extremely rarely found and very difficult to record since they seem to hide most of the time in the soil or under stones (WEBER 1909, BURAKOWSKI 2003, NOVÁK 2018). They have been found in front of very thin fissures at the base of a wall and in an excavation of a wooden log (DE COCK 2000). Their lower mobility also explains the absence of females in our catches.

Another reason for the scarcity of the knowledge about the *P. hemipterus* may be its assumed diurnal behaviour (JENNER 1883, WEBER 1909, AIRY-SHAW 1961, MAGIS 1977, DE COCK 2000, BURAKOWSKI 2003). By using pheromones to attract males, the female is able to operate during the day

and can remain hidden below ground or in crevices, where she is less likely to also attract predators (DE COCK et al. 2009). Therefore, it cannot be discovered by its glowing at night. The species may also just be overlooked because of its small size (DE COCK 2000).

The fact that both sexes are flightless restricts their dispersal and in turn may result in a species more localised distribution. Further studies may provide more comprehensive information on the biology of the species and its distribution in Bulgaria.

Acknowledgements: This study was funded by the National Science Fund via the Project № KII-06-M21/2 H-18-TTEO-010 “Study of the faunistic diversity and assessment of the condition and ecosystems services in different types of model ecosystems in the Sarnena Sredna Gora Mts.”. We thank Elena Zdravkova, Kalina Kotseva, Georgi Boevski and Stilian Stefanov (Forestry University, Sofia) for their help with collecting and processing samples.

References

- AIRY-SHAW H. K. 1961. Untitled. Entomologist's Monthly Magazine 97: 182.
- ANGELOV P. 1960. Etudes sur l'entomofaune de parc „Delasement et Culture” (L'île au milieu de Maritza) pres de Plovdiv, avec quelques notes faunologiques. Godishnik na muzeite v Plovdiv. Prirodonauchen Muzey, 3: 7–40. (In Bulgarian, French summary).
- ANGELOV P. 1960. Beitrag zur Kenntniss der Familien Cantharidae (Coleoptera) Bulgariens. Travaux scientifiques de l'Ecole Normale Supérieure “Paisii Hilendarski”, 27 (6): 111–114. (In Bulgarian, German summary).
- BURAKOWSKI B. 2003. Klucze do oznaczania owadów Polski, Część XIX Chaszcze —Coleoptera, Zeszyt 29, 30 Karnazynkowate—Lycidae, Swietlikowate—Lampyridae. Torun: Polskie Towarzystwo Entomologiczne. 39 p.
- BUTLER E. A. 1880. Untitled. Entomologist's Monthly Magazine 17: 116.
- CRIBB P. 1991. Cemetery and crematorium grounds. In: CRIBB P. (Ed.): Habitat Conservation for Insects – Neglected Green Issue. The Amateur Entomologist Volume 21. Essex: Cravitz Printing Company Ltd., pp. 187–189.
- DE COCK R. 2000. Rare, or simply overlooked? Practical notes for survey and monitoring of the small glow-worm *Phosphaenus hemipterus* (Coleoptera: Lampyridae). Belgian Journal of Zoology 130 (2): 93–101.
- DE COCK R. & MATTHYSEN E. 2005. Sexual communication by pheromones in a firefly, *Phosphaenus hemipterus* (Coleoptera: Lampyridae). Animal Behaviour 70 (4): 807–818.
- DE COCK R., HORNE J. & TYLER J. 2009. The Lesser Glow-worm in Britain: native or newcomer? British Wildlife 39:43.
- GEISER R. 1998. Rote Liste der Kafer (Coleoptera). In: BINOT M., BLESS R., BOYE P., GRUTTKKE H. & PRETSCHER P. (Eds.): Rote liste gefährdeter Tiere Deutschlands. Schriftenreihe für Landschaftspflege und Naturschutz 55: 168–230.
- GEISTHARDT M. 2019. Fauna Europaea: Coleoptera, Lampyridae. Fauna Europaea. https://fauna-eu.org/cdm_dataportal/

- taxon/207dce2b-56c1-4db0-8336-b3b2a324937c [accessed 18.XII.2019].
- GEISTHARDT M. & SATÔ M. 2007. Lampyridae. In: LÖBL I. & SMETANA A. (Eds): Catalogue of Palaearctic Coleoptera, Vol.4: Elateroidea – Cucujoidea. Denmark, Stenstrup: Apollo Books, pp. 225–234.
- JENNER J. H. A. 1883. Reappearance of *Phosphaenus hemipterus* Geoff., at Lewes. The Entomologist 16: 216.
- KAZANTSEV S. V. 2011. An annotated checklist of Cantharoidea (Coleoptera) of Russia and adjacent territories. Russian Entomological Journal 20 (4): 387–410.
- MAGIS N. 1977. Catalogue raisonnee des Cantharoidea, premiere partie, Homalidae, Drilidae, Lampyridae et Lycidae. Catalogue des Coleopteres de Belgique VI. Brussels: Societe royale belge d'Entomologie. 60 p.
- MAJKA C. G. & MACIVOR J. S. 2009. The European lesser glow worm, *Phosphaenus hemipterus* (Goeze), in North America (Coleoptera, Lampyridae). ZooKeys 29: 35–47.
- MCDERMOTT F.A. 1964. The taxonomy of the Lampyridae (Coleoptera). Transactions of the American Entomological Society (1890-) 90 (1): 1–72.
- MIKŠIĆ R. 1981. Die Lampyriden Europas (Coleoptera, Malacodermata). Acta Entomologica Jugoslavica 17: 19–26.
- MORRIS C. H. 1893. Untitled. Entomologist's Monthly Magazine 29: 162.
- MULLER P. W. J. 1805. Beitrage zur naturgeschichte des Halbedekkigen Leuchtkafers, *Lampyris hemiptera* Fabr. Illiger's Magazine IV: 175–196.
- NOVÁK M. 2018. Redescription of immature stages of central European fireflies, Part 3: *Phosphaenus hemipterus* (Goeze, 1777) larva, and notes on its life cycle and behaviour, with a key to three central European lampyrid larvae (Coleoptera: Lampyridae). Zootaxa 4382 (3): 450–464.
- SHIRT D. B. 1987. British Red Data Book, 2: Insects, pp 194–195.
- WEBER L. 1909. Über den Leuchtkafer *Phosphaenus hemipterus* Lap., speziell dessen manlichen Geschlechtsapparat. Deutsche Entomologische Zeitschrift 1909: 784–788.

Received: 16.01.2020

Accepted: 10.04.2020