



## Contents

- Nia Toshkova, Vladimir Todorov, Stanimira Deleva, Ilya Acosta-Pankov, Rostislav Bekchiev,  
Mario Langourov, Nikolay Simov, Venislava Spasova, Nedko Nedyalkov  
Beyond bats: hidden mammalian biodiversity in Bulgarian caves 165
- Borislav Naumov, Simeon Lukanov, Emiliya Vacheva, Maria Naumova, Deyan Duhalov, Andrey Kolev  
On the abundance of *Triturus ivanbureschi* Arntzen & Wielstra, 2013 (Amphibia: Salamandridae):  
a case study in three Natura 2000 sites in Bulgaria 179
- Botond Balogh, Balázs Tóth, Áron Horváth, Stoyan Beshkov, Nimród Varga  
Two autumn collecting expeditions highlight the under-researched Lepidoptera fauna of Albania:  
new records and notes on related literature with additions to the fauna of the country (Lepidoptera:  
Macroheterocera) 189

Historia naturalis bulgarica  
<https://www.nmnhs.com/historia-naturalis-bulgarica/>  
Editorial office e-mail: hnb@nmnhs.com

Publisher: National Museum of Natural History, Bulgarian Academy of Sciences, 1 Tsar Osvoboditel Blvd,  
1000 Sofia, Bulgaria

Editorial board

Editor-in-chief  
Stanislav Abadjiev

Subject editors

Ilya Fabian Acosta, Zsolt Bálint, Christo Deltshev, Snejana Grozeva, Kal Ivanov, Larissa Ivanova, Peter Jäger,  
Mihail Kechev, Fedor V. Konstantinov, Yurii V. Kornilev, Yordan Koshev, Mario Langourov, Georgi N. Markov,  
Boris Nikolov, Jozef Oboňa, Teddy German Angarita Sierra, Nikolay Simov, Giancarlo Statti, Rossen Tzonev,  
Dimitar Uzunov



Distributed under the Creative Commons Attribution 4.0 International License (CC BY 4.0)



Research article

## Beyond bats: hidden mammalian biodiversity in Bulgarian caves

Nia Toshkova<sup>1</sup>, Vladimir Todorov<sup>2</sup>, Stanimira Deleva<sup>3,4</sup>, Ilya Acosta-Pankov<sup>5</sup>,  
Rostislav Bekchiev<sup>6</sup>, Mario Langourov<sup>7</sup>, Nikolay Simov<sup>8</sup>, Venislava Spasova<sup>9</sup>,  
Nedko Nedyalkov<sup>10</sup>

- (1) [Corresponding author] National Museum of Natural History, Bulgarian Academy of Sciences, 1 Tsar Osvoboditel Blvd, 1000 Sofia, Bulgaria, [niatoshkova@nmnhs.com](mailto:niatoshkova@nmnhs.com) ; <https://orcid.org/0000-0003-4217-5653> 
- (2) Institute of Biodiversity and Ecosystem Research, Bulgarian Academy of Sciences, 1 Tsar Osvoboditel Blvd, 1000 Sofia, Bulgaria, [vladimirtodorov.r@gmail.com](mailto:vladimirtodorov.r@gmail.com) ; <https://orcid.org/0000-0001-9974-842X> 
- (3) [Corresponding author] National Museum of Natural History, Bulgarian Academy of Sciences, 1 Tsar Osvoboditel Blvd, 1000 Sofia, Bulgaria, [stanimira.deleva@gmail.com](mailto:stanimira.deleva@gmail.com) ; <https://orcid.org/0000-0002-2964-8607> 
- (4) Scientific Research and Education Centre, Plovdiv Zoo, Yasna Polyana Street, 4002 Plovdiv, Bulgaria
- (5) [Corresponding author] National Museum of Natural History, Bulgarian Academy of Sciences, 1 Tsar Osvoboditel Blvd, 1000 Sofia, Bulgaria, [ilya.acosta@nmnhs.com](mailto:ilya.acosta@nmnhs.com) ; <https://orcid.org/0000-0001-7275-0482> 
- (6) National Museum of Natural History, Bulgarian Academy of Sciences, 1 Tsar Osvoboditel Blvd, 1000 Sofia, Bulgaria, [bekchiev@nmnhs.com](mailto:bekchiev@nmnhs.com) ; <https://orcid.org/0000-0001-6143-0184> 
- (7) National Museum of Natural History, Bulgarian Academy of Sciences, 1 Tsar Osvoboditel Blvd, 1000 Sofia, Bulgaria, [langourov@nmnhs.com](mailto:langourov@nmnhs.com) ; <https://orcid.org/0000-0001-6756-3420> 
- (8) National Museum of Natural History, Bulgarian Academy of Sciences, 1 Tsar Osvoboditel Blvd, 1000 Sofia, Bulgaria, [simov@nmnhs.com](mailto:simov@nmnhs.com) ; <https://orcid.org/0000-0003-1626-2964> 
- (9) Department of Ecology and Environmental Protection, Faculty of Biology, Sofia University “St. Kliment Ohridski”, 8 Dragan Tsankov Blvd, 1164 Sofia, Bulgaria, [v\\_spasova@biofac.uni-sofia.bg](mailto:v_spasova@biofac.uni-sofia.bg) ; <https://orcid.org/0000-0002-7421-973X> 
- (10) [Corresponding author] National Museum of Natural History, Bulgarian Academy of Sciences, 1 Tsar Osvoboditel Blvd, 1000 Sofia, Bulgaria, [nnedko@gmail.com](mailto:nnedko@gmail.com) ; <https://orcid.org/0000-0003-4586-3224> 

**Abstract:** Caves in Bulgaria have been studied primarily for their bat fauna, and the occurrence of other mammals in subterranean environments has remained largely unsynthesised. Here we compile and analyse records of non-volant mammals obtained during cave surveys and bat-monitoring activities conducted between 1993 and 2026. The dataset comprises 214 records of 14 taxa from 29 caves, based on direct observations, pitfall trapping, camera trapping, tracks and scats. Most records originate from the entrance and twilight zones, whereas deeper cave sectors were only rarely used. The assemblage is dominated by facultative cave visitors: two species *Glis glis* (Linnaeus, 1766) and *Martes foina* (Erxleben, 1777), both of which were classified as common, while most taxa were rare or accidental. Visiting caves for shelters and roosting by *Rupicapra rupicapra balcanica* (Bolkay, 1925) is a rarely documented phenomenon. Data from camera traps in a small cave in the Rhodope Mountains indicate that different chamois individuals frequently visit underground cavities, using them as shelter and resting sites. Pitfall data indicate strong seasonality in small-mammal detections, with captures concentrated in the warmer months and very limited winter representation, whereas winter surveys more frequently revealed the presence of medium and large mammals. Several records, including direct observations and feeding evidence, indicate opportunistic predation on bats by carnivores. These results show that the contemporary diversity of non-chiropteran mammals using Bulgarian caves has been underestimated. The concentration of records in ecotonal cave zones indicates consistent spatial overlap with bat roosts, highlighting the need to consider the broader mammalian assemblage in cave conservation and assessments of zoonotic risk in subterranean ecosystems.

**Keywords:** cave ecology, carnivores, non-volant mammals, shrews, recent fauna, rodents, subterranean habitats

## Introduction

Caves are widely recognised as key habitats for bats, providing essential conditions for roosting, hibernation, breeding, and seasonal movements (Kunz, 1982). In contrast, the use of subterranean environments by non-volant mammals has received far less attention, despite increasing evidence that a wide range of terrestrial species regularly exploit caves on a temporary or seasonal basis (Roper, 2010; Culver & Pipan, 2019; Vernes & Davos, 2022; Deleva et al., 2023). Forming a distinctive ecotone between epigeal and hypogeal environments, caves are characterised by a relatively stable thermal regime, high humidity, and protection from climatic extremes, creating favourable microclimatic conditions that can be exploited for resting, denning, overwintering, and occasional foraging (Prous et al., 2004; Moseley, 2009). Numerous studies have shown that small mammals and carnivores occur most frequently in entrance and twilight zones, where surface and subterranean environments overlap (Romero, 2009; Prous et al., 2015; Marchewka & Postawa, 2023). In such settings, some species may also prey opportunistically on bats at roosts or during emergence (Twente, 1955; Labadie et al., 2025; Rauch et al., 2025). Fossil data further demonstrate that the association between terrestrial mammals and caves dates back at least to the Pleistocene, indicating that the ecological use of subterranean shelters by non-flying mammals is both widespread and long-standing (Beron, 2006; Dudin et al., 2011; Churcher, 2020; Boev et al., 2024). Nevertheless, the functional importance of caves for these taxa remains insufficiently understood.

Across south-eastern Europe, biospeleological research has traditionally focused almost exclusively on Chiroptera. As a result, even basic information on the diversity and occurrence of other mammals in caves is fragmented. Bulgaria exemplifies this imbalance. To date, 26 species of cave-dwelling bats have been reported from the country (Beron, 2015), reflecting decades of targeted research and monitoring. By comparison, published data on other mammals using caves are sparse and largely incidental. Available records indicate the presence of only a limited number of non-chiropteran species. Among Carnivora, the wildcat *Felis silvestris* (Schreber, 1777) has been reported from Suhi Pech Cave. The red fox *Vulpes vulpes* (Linnaeus, 1758) has been documented from a small cave near Beledie Han and from Starshelitsa Cave (Gueorguiev & Bekchiev, 2009), with addi-

tional evidence from Spropadnaloto Cave based on scats (Beron, 2015). The Eurasian badger *Meles meles* (Linnaeus, 1758) has been observed deep within Futyovskata Cave, approximately 500 m from the entrance (Beron, 2015). Rodents are similarly poorly represented in the literature, with the edible dormouse *Glis glis* (Linnaeus, 1766) reported from Malkata Yama Cave and the wood mouse *Apodemus sylvaticus* (Linnaeus, 1758) from Razhishka Cave and Golyamata Vrazha Dupka. These isolated observations clearly indicate that caves in Bulgaria are utilised by a broader spectrum of mammals than is commonly recognised, yet their overall diversity and ecological roles remain inadequately characterised.

Importantly, much of the currently available information derives indirectly from long-term monitoring programmes focused on caves of national and international importance for bat conservation. During these surveys, non-chiropteran mammals have often been recorded opportunistically, particularly in winter, when bats are in torpor, and caves may represent predictable and energetically favourable environments for other mammals, including potential predators. Although individually scattered, these records collectively form a substantial body of evidence that has not previously been synthesised. The present study seeks to address this gap by compiling and critically analysing available records of non-volant mammals from Bulgarian caves. By providing the first integrated overview of their diversity, spatial distribution, and patterns of cave use, the study aims to draw attention to the broader mammalian component of subterranean ecosystems in Bulgaria and to underline its potential relevance for bat conservation and cave ecosystem functioning.

## Material and methods

### Study scope and field methods

Records of non-volant mammals from Bulgarian caves were compiled for the period 1993–2026. In total, 29 caves distributed across the country were included in the analysis. The dataset integrates both systematic sampling and opportunistic observations accumulated during speleological and faunistic surveys. Since no unified methodology for recording mammal presence in caves was applied during the entire study period, the collected data originate from different sources and sur-

vey approaches, and partly reflect incidental findings accumulated over time. Mammal presence within caves was recorded during separate studies conducted during the aforementioned period: (i) direct visual observations during cave visits, (ii) identification of tracks and other field signs, (iii) small mammal bycatch in invertebrate-targeted pitfall trapping, primarily in entrance zones and accessible passages (2022), (iv) camera trapping at selected sites (2022–2025), and (v) identification of scats and other remains (2021–2026). Therefore, the dataset should be interpreted primarily as records of mammal occurrences rather than standardised estimates of individual abundance, except for the incidental pitfall-trap bycatch, where individual specimens were recorded.

Pitfall traps (originally intended for invertebrate sampling) were deployed year-round in three large caves supporting substantial bat colonies – Devetashkata Cave (N 43.2, E 24.8), Parnitsite (N43.2, E 24.4) and Orlova Chuka (N 43.5, E 25.9). In each cave, two transects of five pitfall traps were installed (ten traps per cave). Traps within each transect were spaced at 5 m intervals. The first transect was positioned near the cave entrance but within the dark zone, while the second transect was placed in the main gallery in proximity to the bat colony. In Devetashkata Cave, both transects were located close to the bat colonies, with the second transect additionally situated near the cave river within the main gallery. In Parnitsite Cave, both transects were positioned near the cave river. Small mammals were recorded only as incidental bycatch in these invertebrate-targeted traps, and no species of conservation concern were involved. The specimens were subsequently integrated into the scientific collections of the National Museum of Natural History, Sofia (NMNHS-BAS).

Two camera traps were deployed in caves. The first cave is located in a predominantly coniferous forest near Gyuvren Village (N41.6, E24.4). It has a wide entrance (~3 m high, 5 m wide) and a depth of approximately 14 m. A single camera trap was mounted on a vertical wall 2 m from the entrance and oriented towards it. The camera operated from September 2022 until November 2022. The second cave is situated on a ridge in predominantly beech-dominated broadleaf forest in the Central Balkan Range (N42.7, E25.1). It is a through-cave with two narrow entrances on opposite sides of the ridge, approximately 27 m apart. The interior forms a passage high enough for a person to walk upright. Two camera traps were

installed near the midpoint of the cave, each facing one of the entrances, and operated almost continuously from 28 September 2023 to May 2025.

#### Data treatment and analysis

The curated analytical dataset is available as [Supplementary material 01](#) . Each independent observation event was treated as a single record. Standard faunistic practices typically relied on the total number of independent observations to determine range. However, in our case, since continuous monitoring (e.g., with camera traps) exponentially increases the number of records compared to discrete bycatch sampling (e.g., pitfall traps), using raw observation counts biases dominance metrics toward heavily monitored sites. Consequently, we assessed the faunal structure primarily using naïve occupancy (Soto-Werschitz et al., 2023), in our case, different cave sites where a given species was found for 29 sites surveyed. Excluding direct observations, our sampling methods (pitfalls, camera traps, tracks and scats) were concentrated at 9 of the 29 sites, resulting in an observed sample coverage of 31%. Considering this, the estimated sample coverage was established at 26–38% (Brose et al., 2003). The species richness of the cave was defined as the number of different mammal taxa recorded at that site. Based on site occurrence, species were classified into modified frequency categories: widespread (occurrence in  $\geq 11$  sites (more than 38%), common (occurrence in 7–11 sites), rare (occurrence in 4–6 sites), and occasional (occurrence in  $< 3$ ). Each species record was treated as a single occurrence, except for pitfall trap data, where individual counts were used because specimens could be reliably distinguished.

Temporal patterns were evaluated using annual totals of records. Seasonal analyses were based exclusively on observations for which the season could be determined. Records were assigned to four seasons (spring, summer, autumn and winter) based on the recorded date. Seasonal summaries were produced both as overall totals and as species-level heatmaps to visualise intra-annual patterns of cave use. Cave-level patterns of mammal diversity were explored using the distribution of species richness across sites. Distances from cave entrances were analysed to quantify species-specific penetration into cave systems. Records lacking distance measurements were ex-

Table 1. Occurrence of non-volant mammals across surveyed caves in Bulgaria. For each taxon, we report the number of cave sites where it was detected (Sites) and independent detection events (Occurrences). Records include camera-trap events, bycatch pitfall trapping, direct observations, and tracks.

| Order        | Family     | Species                              | Sites (n) | Independent detection events (Occurrences) (n) |
|--------------|------------|--------------------------------------|-----------|------------------------------------------------|
| Rodentia     | Echimyidae | <i>Myocastor coypus</i>              | 1         | 2                                              |
|              | Gliridae   | <i>Dryomys nitedula</i>              | 1         | 1                                              |
|              |            | <i>Glis glis</i>                     | 7         | 107                                            |
|              | Cricetidae | <i>Microtus subterraneus</i>         | 1         | 1                                              |
|              | Muridae    | <i>Apodemus cf. sylvaticus</i>       | 1         | 1                                              |
| Eulipotyphla | Soricidae  | <i>Crocidura suaveolens</i>          | 2         | 2                                              |
|              |            | <i>Neomys milleri</i>                | 3         | 11                                             |
| Carnivora    | Mustelidae | <i>Martes foina</i>                  | 9         | 32                                             |
|              |            | <i>Meles meles</i>                   | 4         | 5                                              |
|              |            | <i>Mustela putorius</i>              | 1         | 1                                              |
|              | Ursidae    | <i>Ursus arctos</i>                  | 2         | 10                                             |
|              | Canidae    | <i>Vulpes vulpes</i>                 | 4         | 7                                              |
|              | Felidae    | <i>Felis silvestris</i>              | 3         | 4                                              |
| Artiodactyla | Bovidae    | <i>Rupicapra rupicapra balcanica</i> | 1         | 31                                             |

cluded. Because depth distributions were strongly right-skewed, differences among species were tested using the Kruskal-Wallis rank-sum test. Pairwise contrasts were assessed using Dunn tests with Benjamini-Hochberg adjustment. Median and maximum penetration distances were calculated to distinguish typical from extreme cave use. The relationship between cave altitude and species richness was evaluated using ordinary least squares linear regression. Because richness data may deviate from parametric assumptions, the analysis was complemented with a non-parametric Spearman rank correlation. All statistical analyses and visualisations were conducted in R (R Core Team, version 4.1.1). Figures were produced using ggplot2 and patchwork (Wickham, 2016; Pedersen, 2025).

## Results

The analysed data comprises 214 occurrences of non-volant mammals from 29 caves distributed across Bulgaria (Fig. 1). In total, 14 mammal taxa were documented (Table 1), representing Eulipotyphla

(Soricidae – 2 species), Rodentia (Muridae – 1 species, Cricetidae – 1 species, Echimyidae – 1 species, Gliridae – 2 species), Carnivora (Mustelidae – 3 species, Canidae – 1 species, Felidae – 1 species, Ursidae – 1 species) and Artiodactyla (Bovidae – 1 species). Records were unevenly distributed among caves and years, reflecting a combination of structured sampling and opportunistic observations.

The assemblage was dominated by a small number of taxa (Fig. 2A). No species had a wide distribution across all sampling sites. *Glis glis* accounted for the largest share of occurrences ( $n = 107$ ), followed by *Martes foina* ( $n = 32$ ) and *Rupicapra rupicapra balcanica* ( $n = 31$ ; Table 1). However, relative record frequency did not correspond closely to spatial distribution (Fig. 2B). Although *R. r. balcanica* was frequently recorded, it was detected in only one cave regularly used by the species; its high number of records therefore reflects repeated detections at a small number of sites rather than a broad distribution across the cave system. In contrast, *M. foina* (31.03% of caves – 9 sites) and *G. glis* (24.13% – 7 sites) combined relatively high record frequencies with broader distribution across the surveyed cave system (cate-



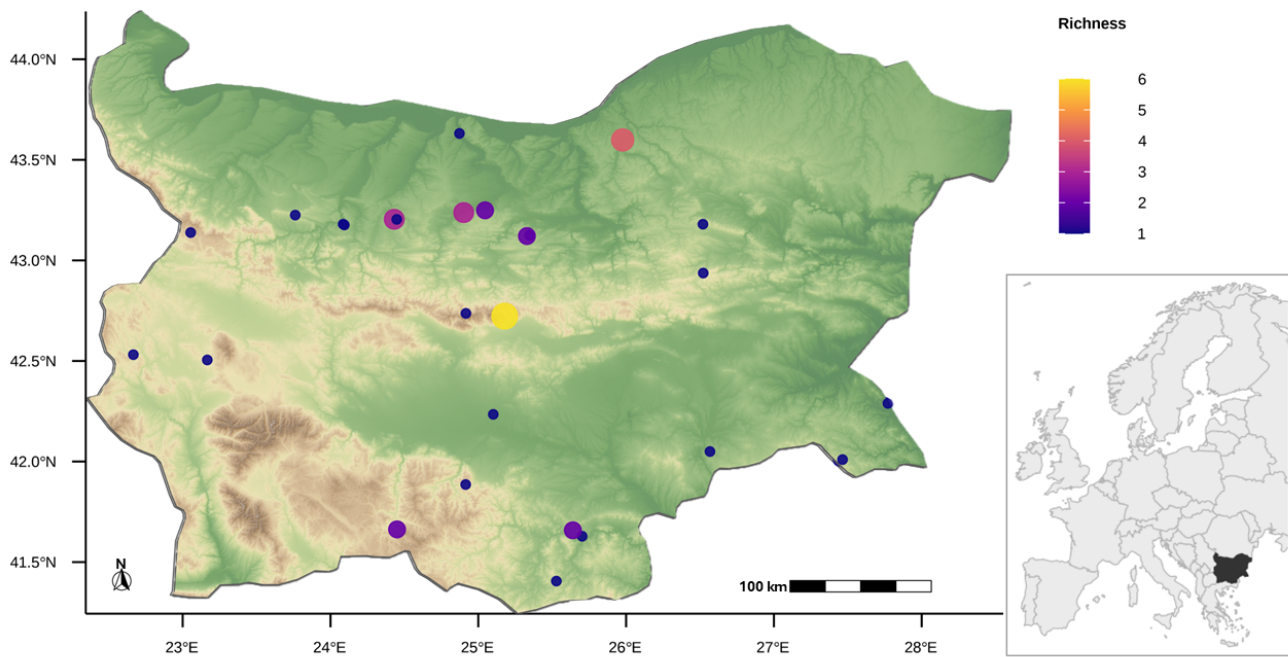


Fig. 1. Surveyed caves in Bulgaria. Circles indicate cave localities; size and colour correspond to mammal species richness recorded at each site.

gory common, 7–11 sites). On the other hand, *Meles meles* and *Vulpes vulpes* were recorded at only four sites (category rare). Most species showed low occupancy (category occasional, <3), typically occurring in fewer than 11% of caves, and many were recorded at a single site only (Fig. 2C). Small insectivores and rodents were detected predominantly by pitfall trapping, whereas medium- and large-sized mammals were recorded mainly through direct observations, camera trapping and indirect evidence such as scats. As records represent observation events rather than unique individuals, repeated detections of the same animals across sampling occasions cannot be excluded. The faunistic structure based on record frequency was strongly uneven (Fig. 2C). In contrast, the occupancy-based classification emphasised the restricted distribution of most species (Fig. 2C), with only a small number occurring across a larger proportion of caves.

Species richness per cave was generally low (Fig. 3A). Most caves harboured one or two taxa, and only a few sites supported richer assemblages. Mammal records were strongly concentrated near cave entrances (Fig. 3B), with only occasional deep penetrations. Depth differed significantly among

species (Kruskal-Wallis:  $\chi^2 = 28.30$ ,  $d.f. = 6$ ,  $p = 8.24 \times 10^{-5}$ ). Although the deepest single record was obtained for *Martes foina* (600 m), *Neomys milleri* showed the greatest typical penetration (median 175 m), whereas most taxa remained concentrated near cave entrances. No significant relationship was detected between cave altitude and mammal species richness (Fig. 3C; linear model:  $R^2 = 0.011$ ,  $p = 0.603$ ; Spearman  $\rho = -0.06$ ,  $p = 0.765$ ;  $n = 27$ ).

The temporal distribution of records shows a pronounced increase after 2020 (Fig. 4A), with earlier years characterised by sporadic observations, whereas more recent data reflect intensified survey effort. Seasonal patterns were also uneven: records with known seasons were concentrated in summer and autumn, whereas winter detections were scarce (Fig. 4B). The species-level heatmap highlights that this seasonal signal was driven largely by *Glis glis* and *Martes foina*, with most taxa recorded infrequently across seasons (Fig. 4C). Pitfall data indicate that small mammals were recorded mainly during the warmer part of the year; the taxa most frequently detected by pitfalls were *Neomys milleri*, *Crocidura suaveolens*, *Apodemus* cf. *sylvaticus* and *Microtus subterraneus*.

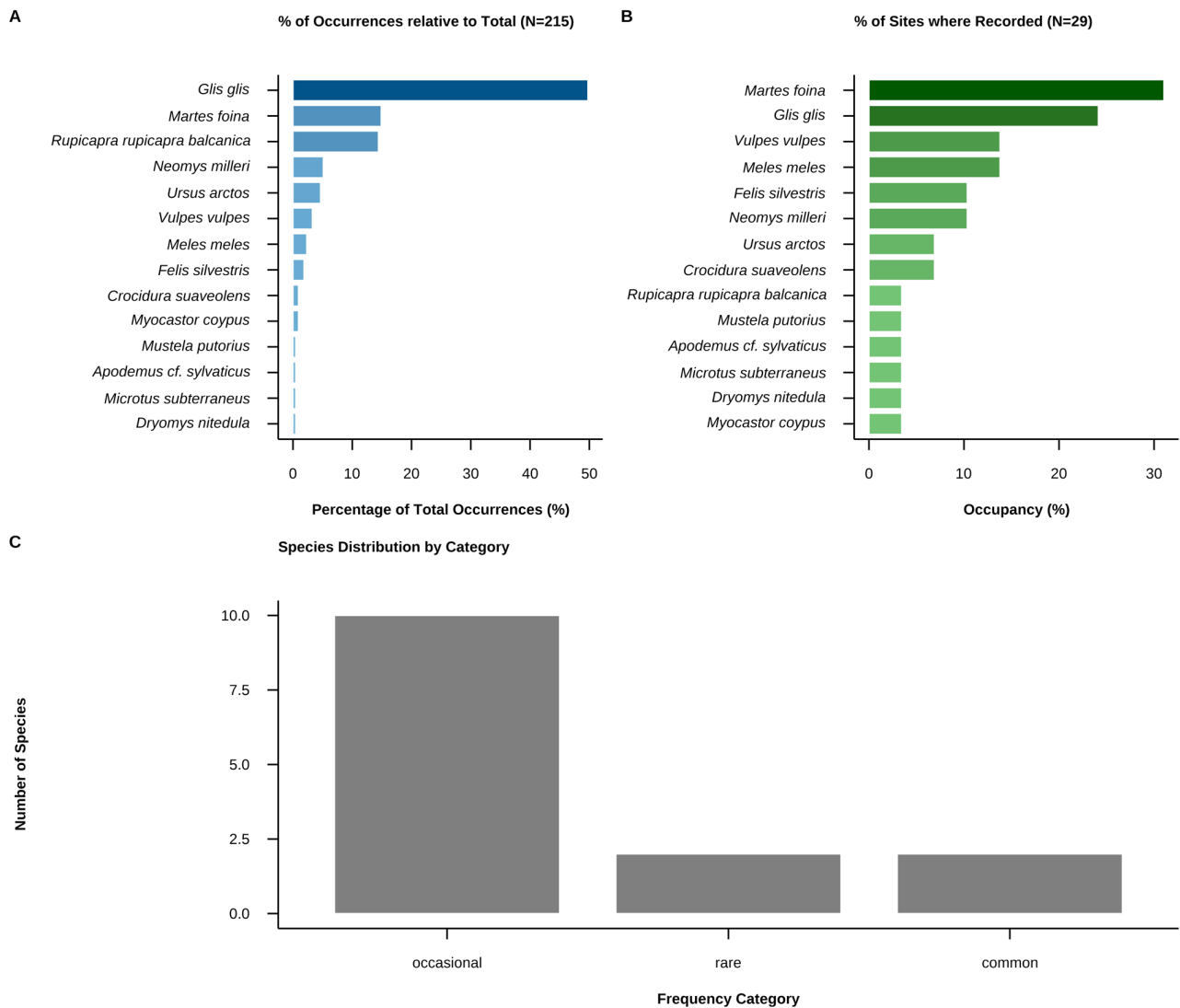


Fig. 2. Species contributions, occupancy and frequency structure. (A) Relative contribution of each species to the total number of independent occurrences (%). (B) Species occupancy expressed as the percentage of surveyed caves in which each species was detected (Occupancy %). (C) Occupancy-based frequency structure, showing the number of species assigned to categories reflecting spatial distribution (widespread, common, rare and occasional).

Discussion

The data assembled in this study demonstrate that caves in Bulgaria are used by a broader range of non-volant mammals than previously recognised (Beron, 2015), although the pattern of occurrence clearly indicates facultative rather than obligate subterranean use. Across the 29 investigated caves, records were obtained for 14 taxa representing orders Eulipotyphla, Rodentia, Carnivora and Artiodactyla. The highly uneven faunistic structure, with only a few frequently recorded species and many isolated observations, is

consistent with patterns observed in regional studies, where a small number of common mammals dominate cave use while most species occur sporadically, reflecting opportunistic rather than obligate subterranean use (Montalvo et al., 2017).

The assemblage is composed mainly of ecological generalists. Small insectivores, particularly *Neomys milleri* and *Crocidura suaveolens*, were recorded chiefly along subterranean watercourses and in dark entrance zones. Water shrews were detected up to ~400 m from cave entrances, usually following underground streams, indicating active exploitation

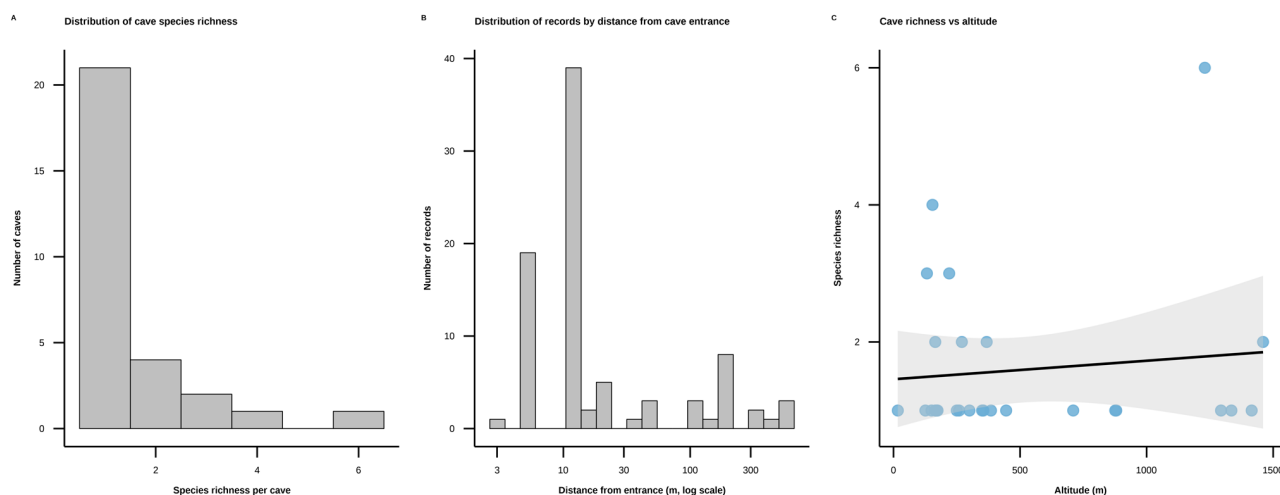


Fig. 3. Cave-level richness patterns. (A) Distribution of mammal species richness per cave. (B) Distribution of records by distance from cave entrance (log scale). (C) Relationship between cave altitude and mammal species richness (solid line, linear regression; shaded area, 95% confidence interval).

of aquatic corridors rather than accidental penetration. Medium-sized carnivores, especially *Martes foina*, appear to use caves primarily as temporary shelters, and several instances of bat predation were also documented during the survey. The stone marten predation on bats has been documented in previous studies (Nováková & Vohralík, 2017), however, our observations indicate repeated predation events within some important bat hibernacula, suggesting a consistent use of these sites as foraging grounds. In our study, the edible dormouse (*Glis glis*) was also recorded in caves (Fig. 5B), supporting previous findings that this species uses underground sites not only for hibernation but also as regular shelters during the active season (Marchewka & Postawa, 2022). In Italy, *Glis glis* was recorded breeding in caves, usually near the entrance, approximately 20–30 m (Scavelli & Bassi, 1995). In our dataset, seasonal patterns were strongly biased towards the warmer part of the year. This likely reflects both biological activity and sampling effects, as pitfall efficiency and small-mammal activity decline markedly in winter. The cave assemblage largely mirrors the surrounding terrestrial fauna, reinforcing the interpretation that caves are used opportunistically rather than supporting a distinct mammal community.

Large mammals such as *Ursus arctos* were recorded only sporadically in the surveyed caves, suggesting that these sites are used primarily as an

occasional refuge, rather than regular denning habitats. Published sources indicate that brown bears in Bulgaria may establish maternity dens in shallow caves in remote high-elevation forest and subalpine zones (typically above 1000–1800 m a.s.l., usually small (c. 2–3 m deep) and lined with plant material (Popov et al., 2007). The apparent scarcity of cave records should, however, be interpreted with caution. Precise locations of bear dens are commonly withheld in the literature for conservation reasons, and the present study follows the same approach. Consequently, the low number of documented occurrences likely reflects reporting constraints rather than genuinely rare cave use by *U. arctos* in the country. Furthermore, in one case, a camera trap was initially deployed to monitor potential hibernation activity of *Ursus arctos*. However, it was removed after chamois (*Rupicapra rupicapra*) were recorded using the cave, as field observations suggest that bears do not hibernate in caves regularly used by chamois (unpublished data).

The occurrence of mammals in caves reflects both incidental incursions and the repeated use of suitable subterranean habitats. The present results indicate that trophic resources are a key determinant of these patterns. Subterranean streams sustain aquatic invertebrates, whereas bat colonies provide concentrated inputs of organic matter, such as guano and carcasses, creating resource-rich patches within otherwise nutrient-limited systems. Observations from several caves

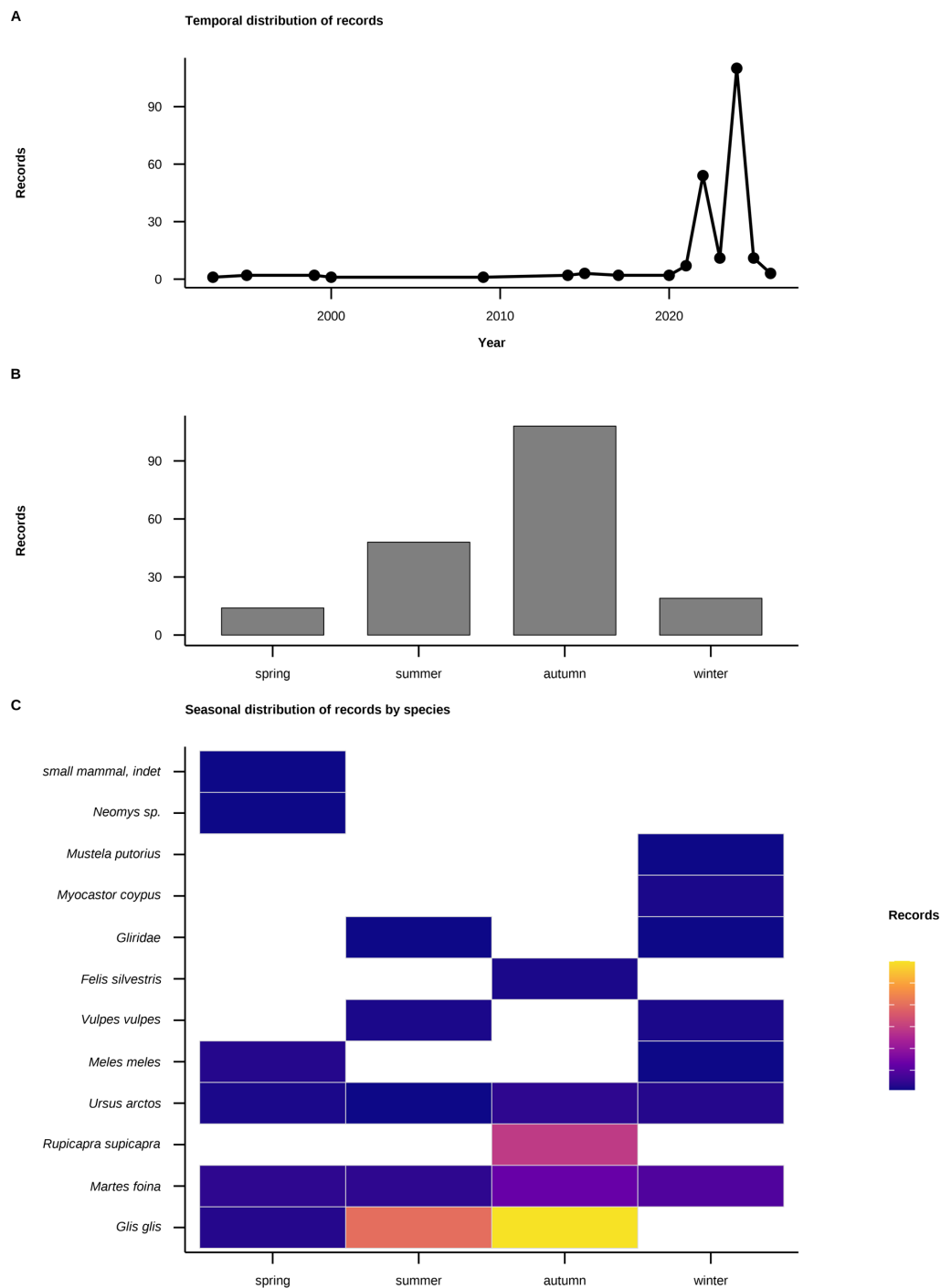


Fig. 4. Temporal and seasonal distribution of records. (A) Records per year (1993–2026), illustrating the increase in survey effort over time. (B) Seasonal totals for records with known seasons. (C) Seasonal distribution of records by species (heatmap), based on observations with known seasons.

show that bat remains beneath hibernating colonies are rapidly removed, most plausibly by carnivores such as martens (Fig. 5A), polecats and wild cats. Mammalian predation on bats has been documented

previously for a range of taxa, including *Martes foina*, *Vulpes vulpes* and *Apodemus sylvaticus* (Bekker, 1989; Romanowski & Lesiński, 1991; Kokurewicz, 2004; Haarsma & Kaal, 2016). In particular, detailed



monitoring of Dutch hibernacula has shown that predation by wood mice may be systematic and can influence local bat populations (Haarsma & Kaal, 2016). Given that Bulgaria supports some of the largest bat aggregations in Europe (Toshkova & Simov, 2025), comparable predator–prey interactions are likely, although they remain poorly documented. Direct observations are scarce; however, occasional records suggest that predation events may be locally intense. A notable example is the mass predation of bats by a domestic or feral cat in a tourist part of the Orlova Chuka Cave in 1996 (Fig. 5C), indicating that episodic events can result in substantial mortality within hibernating colonies. There is currently no evidence for rat predation on bats in Bulgarian caves, despite recent reports from urban hibernacula elsewhere in Europe (Gloza-Rausch et al., 2025). This absence may reflect limited observation rather than true absence. The systematic documentation of such interactions is increasingly important. Predator–prey contacts involving bats may create opportunities for cross-species pathogen transmission, particularly where carcasses accumulate or are handled by multiple scavengers. Bats are recognised reservoirs for a range of zoonotic agents (Calisher et al., 2006; Brook & Dobson, 2015), and increased contact between bats and other mammals and humans may elevate transmission risk (Salinas-Ramos et al., 2021; Gloza-Rausch et al., 2025). Improved documentation of predation events, carcass persistence and scavenger assemblages is therefore essential for understanding both ecological dynamics and potential public health implications.

Furthermore, although mammalian use of caves is often sporadic, its ecological effects may be disproportionate. Large mammals can introduce substantial allochthonous organic matter, while predators and scavengers redistribute biomass through carcass removal. Such processes are likely to influence nutrient availability and microhabitat conditions at fine spatial scales, with potential consequences for the cave ecosystem functioning. In this context, particular attention should be given to the documented use of caves in Bulgaria by invasive alien mammals such as the nutria (Fig. 5D), whose rapid range expansion and population growth in recently invaded regions may pose an additional threat to subterranean habitats.

Whether any non-volant mammal can complete its entire life cycle within a cave environment remains

uncertain. However, the repeated occurrence of water shrews deep within cave systems suggests the possibility of prolonged subterranean activity associated with underground streams and food resources. Soil traps placed in cave passages, particularly beneath or near bat colonies, contained large numbers of invertebrates, including moths and flies, including their larvae, as well as beetles such as Tenebrionidae and predatory Staphylinidae and Carabidae. Rove beetles (Staphylinidae) were particularly numerous in some caves, such as Parnitsite and Devetashka. The abundance of these potential prey items suggests that cave environments may provide substantial food resources, and water shrews may enter subterranean habitats in response to concentrations of invertebrates. Diet studies show that although water shrews are semi-aquatic, they consume predominantly terrestrial prey, with aquatic organisms forming a smaller proportion of the diet, indicating considerable flexibility in prey use (Churchfield & Rychlik, 2006).

Furthermore, although data on the home range of *Neomys milleri* are lacking, radio-tracking studies of the larger and closely related species *Neomys fodiens* indicate relatively small home ranges, averaging about 207 m<sup>2</sup> in spring–summer and around 106 m<sup>2</sup> in autumn–winter, with activity largely confined to stream habitats (Lardet, 1988). Such spatially restricted ranges suggest that short sections of subterranean watercourses could potentially sustain individuals for extended periods if suitable prey is available. Although this does not demonstrate a fully subterranean life cycle, it raises the possibility that water shrews may spend substantial portions of their lives within cave-stream environments, particularly where invertebrate prey is abundant. Evaluating this hypothesis will require targeted long-term studies and more detailed investigation of aquatic cave habitats using specialised survey methods, as these species remain difficult to observe and are consequently poorly documented in subterranean ecosystems.

The findings also have practical implications. Bulgaria hosts more than 100 caves and mines recognised as important underground bat roosts of national or international significance (Ivanova, 2005; Deleva et al., 2023). Such sites represent predictable concentrations of resources that may attract a range of terrestrial mammals. However, cave monitoring in Bulgaria has traditionally focused on bats, yet the present results show that a broader spectrum of vertebrates regularly uses these habitats. Incorporating non-volant





Fig. 5. Different mammals in the caves: A – Stone marten in the Urushka Maara Cave; B – Edible dormouse in the Popov Izvor Cave; C – Mass predation on bats in the tourist cave Orlova Chuka in 1996. Numerous bat carcasses and detached wings on the cave floor following repeated predation by a domestic or feral cat. This observation illustrates the potential for localised, high-intensity predation events within hibernating colonies; D – Nutria entering one of the entrances of the Chirpan Bunar Cave.

mammals into monitoring protocols could improve the ecological interpretation of bat mortality by providing insight into predator–scavenger interactions. An integrated monitoring approach would also help address persistent knowledge gaps regarding the role of non-volant mammals in cave ecosystems and their interactions with bat colonies in Bulgaria (Toshkova & Simov, 2026).

The close correspondence between the modern cave-visiting fauna documented here and the vertebrate assemblages reported from Bulgarian cave deposits (Beron, 2006) suggests that part of the fossil record may reflect the direct use of caves by surface-dwelling species. Cave assemblages are commonly interpreted as the result of multiple taphonomic processes, with predator activity, particularly owl-

mediated accumulation at cave entrances often considered dominant. However, the present observations show that a range of small-bodied taxa (e.g. *Glis glis*, *Crocidura suaveolens*, *Neomys* spp., *Apodemus* cf. *sylvaticus*, *Microtus subterraneus*) actively enter and utilise caves. Remains of *Rupicapra rupicapra*, frequently reported from Quaternary cave deposits across Europe (Fosse et al., 2020), may similarly reflect natural use of karstic cavities, as indicated by repeated records of *R. r. balcanica* in the studied sites. Taken together, this shows that modern ecological data provide a robust framework for interpreting fossil cave assemblages. Considering direct cave use alongside predator-mediated accumulation allows a more accurate reconstruction of the processes responsible for vertebrate deposition in karst environments.

## Acknowledgments

We are grateful to Stoyan Yordanov and Angel Ivanov for their data contributions. This study was supported by the Bulgarian National Science Fund, project KP-06-N51/9 “Caves as a reservoir for novel and reoccurring zoonoses – ecological monitoring and metagenomic analysis in real-time.” The work of SD was supported by the Bulgarian Ministry of Education and Science under the National Research Programme “Young scientists and postdoctoral fellows 2” approved by DCM 206/07.04.2022.

## Conflicts of interest

No potential conflict of interest has been reported by the authors, reviewers, or subject editor. As members of the editorial board, Mario Langourov, Ilya Acosta-Pankov and Nikolay Simov withdrew from discussions and decisions on the manuscript.

## Author’ contributions

(using [CrediT](#) )

Nia Toshkova: conceptualisation, data curation, formal analysis, investigation, methodology, software, visualisation, writing—original draft, writing—review and editing; Vladimir Todorov: data curation, formal analysis, investigation, methodology, software,

visualisation, writing—original draft, writing—review and editing; Stanimira Deleva: data curation, formal analysis, investigation, methodology, software, visualisation, writing—original draft, writing—review and editing; Ilya Acosta: data curation, formal analysis, investigation, methodology, validation, writing—original draft, writing—review and editing; Rostislav Bekchiev: investigation, methodology, writing—review and editing; Mario Langourov: investigation, methodology, visualisation, writing—review and editing; Nikolay Simov: conceptualisation, data curation, funding acquisition, investigation, methodology, project administration, resources, supervision, validation, visualisation; Venislava Spasova: funding acquisition, project administration, writing—review and editing; Nedko Nedyalkov: data curation, investigation, methodology, supervision, validation, writing—review and editing.

## References

- Bekker J.P. 1989 Pine marten, bats and underground limestone mines. *SOK Med* 13: 33–43.
- Bekker J.P., Mostert K. 1991 Predation on bats in The Netherlands: facts and assumptions. *Myotis* 29: 91–96.
- Beron P. 2015 Cave fauna of Bulgaria. East-West Publishing, Sofia, 434 pp.
- Beron P., Daaliev T., Jalov A. 2006 Caves and speleology in Bulgaria. Pensoft Publishers, Bulgarian Federation of Speleology, National Museum of Natural History, Sofia, 507 pp.
- Brook C., Dobson A. 2015 Bats as ‘special’ reservoirs for emerging zoonotic pathogens. *Trends in Microbiology* 23 (3): 172–180.  
<https://doi.org/10.1016/j.tim.2014.12.004> 
- Boev Z., Nedyalkov N., Georgiev D., Spassov N. 2024 Late Pleistocene birds and mammals from the Kiliite Cave (central Stara Planina Mts-central North Bulgaria). *Geologica Balcanica* 53 (1).
- Brose U., Martinez N.D., Williams R.J. 2003 Estimating species richness: sensitivity to sample coverage and insensitivity to spatial patterns. *Ecology* 84 (9): 2364–2377.
- Calisher C.H., Childs J.E., Field H., Holmes K.V., Schountz T. 2006 Bats: Important Reservoir Hosts of Emerging Viruses. *Clinical Microbiology Reviews* 19 (3): 531–545.  
<https://doi.org/10.1128/cmr.00017-06> 



- Churcher C.S. 2020 Pleistocene mammals from Extinction Cave, Belize. *Canadian Journal of Earth Sciences* 57 (3): 366–376.  
<https://doi.org/10.1139/cjes-2018-0178>
- Culver D.C., Pipan T. 2019 The biology of caves and other subterranean habitats. Oxford University Press, Oxford, 301 pp.  
<https://doi.org/10.1093/oso/9780198820765.001.0001>
- Deleva S., Toshkova N., Kolev M., Tanalgo K.C. 2023 Important underground roosts for bats in Bulgaria: current state and priorities for conservation. *Biodiversity Data Journal* 11: e98734.  
<https://doi.org/10.3897/BDJ.11.e98734>
- Deleva S., Ulloa A., Oliveira H.F.M., Simov N., Didonna F., Chaverri G. 2023 Cave-dwelling fauna of Costa Rica: current state of knowledge and future research perspectives. *Subterranean Biology* 47: 29–62.  
<https://doi.org/10.3897/subtbiol.47.113219>
- Dudin G., Georgiev D., Stoycheva S. 2011 Recent Vertebrate Animal Bones (Animalia: Vertebrata) from Yubileyna Cave (Rhodopes Mountain, South Bulgaria). *Ecologia Balkanica* 3 (1): 107–109.
- Fosse P., Fourvel J.B., Madeleine S. 2020 Quaternary cliff-dwelling bovids (*Capra*, *Rubicapra*, *Hemitragus*, *Ovis*): site's typology and taphonomic remarks. *SAGVNTVM Extra* 21: 137–163.  
<https://turia.uv.es/index.php/saguntumextra/article/view/19160>
- Gloza-Rausch F., Bergmann A., Knörnschild M. 2025 Active predation by brown rats (*Rattus norvegicus*) on bats at urban mass hibernacula in Northern Germany: conservation and one health implications. *Global Ecology and Conservation* 63: e03894.  
<https://doi.org/10.1016/j.gecco.2025.e03894>
- Haarsma A., Kaal R. 2016 Predation of wood mice (*Apodemus sylvaticus*) on hibernating bats. *Population Ecology* 58 (4): 567–576.  
<https://doi.org/10.1007/s10144-016-0557-y>
- Ivanova T. 2005 Important bat underground habitats (IBUH) in Bulgaria. *Acta Zoologica Bulgarica* 57 (2): 197–206.
- Kokurewicz T. 2004 Sex and age related habitat selection and mass dynamics of Daubenton's bats *Myotis daubentonii* (Kuhl 1817) hibernating in natural conditions. *Acta Chiropterologica* 6: 121–144.
- Kunz T.H. 1982 Roosting ecology of bats. In: Kunz T.H. (ed.) *Ecology of bats*. Springer, Boston, 55 pp.
- Labadie M., Morand S., Bourgarel M., Roch Niamsa F., Ngulili G.F., Tobi N., Caron A., De Nys H. 2025 Habitat sharing and interspecies interactions in caves used by bats in the Republic of Congo. *PeerJ* 13: e18145.  
<https://doi.org/10.7717/peerj.18145>
- Lardet J.P. 1988 Spatial behaviour and activity patterns of the water shrew, *Neomys fodiens*, in the field. *Acta Theriologica* 33 (21): 293–303.
- Marchewka A., Postawa T. 2023 Spying in the dark: camera traps as a monitoring method to detect small mammals in underground environments. *Cave and Karst Science* 50 (1): 23–30.
- Marchewka A., Postawa T. 2022 Living underground: edible dormouse (*Glis glis*) activity in the underground shelters during the active period. *ARPHA Conference Abstracts*.
- Moseley M. 2009 Are all caves ecotones. *Cave and Karst Science* 36 (2): 53–58.
- Montalvo A.E., Lopez R.R., Parker I.D., Silvy N.J., Cooper S.M., Feagin R.A. 2017 Quantifying meso-mammal cave use in central Texas. *Wildlife Biology* 2017 (1): 1–7.  
<https://doi.org/10.2981/wlb.00320>
- Nováková L., Vohralík V. 2017 Diet of *Martes foina* in Bohemia, Czech Republic (Carnivora: Mustelidae). *Lynx, New Series* 48: 155–164.
- Pedersen T. 2025 patchwork: The composer of plots. R package version 1.3.2.9000.
- Popov V., Spasov N., Ivanova T., Mihova B., Georgiev K. 2008 Mammals, important for conservation in Bulgaria. *Dutch Mammal Society VZZ, Arnhem*, 328 pp.
- Prous X., Ferreira R.L., Martins R.P. 2004 Ecotone delimitation: epigeal–hypogean transition in cave ecosystems. *Austral Ecology* 29 (4): 374–382.  
<https://doi.org/10.1111/j.1442-9993.2004.01366.x>
- Prous X., Ferreira R.L., Jacobi C.M. 2015 The entrance as a complex ecotone in a Neotropical cave. *International Journal of Speleology* 44 (2): 177–189.  
<https://doi.org/10.5038/1827-806X.44.2.7>
- Romanowski J., Lesiński G. 1991 A note on the diet of stone marten in southeastern Romania. *Acta Theriologica* 36: 201–204.
- Romero A. 2009 *Cave biology: life in darkness*. Cambridge University Press, Cambridge, 291 pp.

- Roper T.J. 2010 Badger. HarperCollins, London, 386 pp.
- Salinas-Ramos V.B., Mori E., Bosso L., Ancillotto L., Russo D. 2021 Zoonotic Risk: One More Good Reason Why Cats Should Be Kept Away from Bats. *Pathogens* 10 (3).  
<https://doi.org/10.3390/pathogens10030304>
- Scavelli D., Bassi S. 1995 *Myoxus glis* as a cave dwelling animal. *Hystrix (the Italian Journal of Mammalogy)* 6 (1–2): 283–285.
- Soto-Werschitz A., Mandujano S., Passamani M. 2023 Influence of forest type on the diversity, abundance, and naïve occupancy of the mammal assemblage in the southeastern Brazilian Atlantic Forest. *Therya* 14 (3): 329–341.
- Toshkova N., Simov N. 2026 Notes on winter bat mortality, hibernation preferences, and the demographic structure of deceased individuals from one of Europe's largest bat colonies. *Conservation* 6 (1): 3.  
<https://doi.org/10.3390/conservation6010003>
- Twente J.W. Jr. 1955 Aspects of a population study of cavern-dwelling bats. *Journal of Mammalogy* 36 (3): 379–390.  
<https://doi.org/10.2307/1375680>
- Vernes K., Devos F. 2022 Use of cenotes and the cave environment by mammals on the Yucatán Peninsula, Mexico. *Biotropica* 54: 881–892.  
<https://doi.org/10.1111/btp.13111>
- Wickham H. 2016 ggplot2: elegant graphics for data analysis. Springer-Verlag, New York.

## Supplementary materials

01

Document title: An Excel dataset compiling all recorded occurrences of non-volant mammals included in this study, encompassing 214 records of 17 taxa from 29 caves in Bulgaria (1993–2026), with associated metadata on locality, detection method, and cave zone.

Kind of document: Microsoft Excel (OpenXML)

MIME type: application/vnd.openxmlformats-officedocument.spreadsheetml.sheet

Document name: 000626000482026-01.xlsx

<https://doi.org/10.48027/hnb.48.071/01>

---



Research article

# On the abundance of *Triturus ivanbureschi* Arntzen & Wielstra, 2013 (Amphibia: Salamandridae): a case study in three Natura 2000 sites in Bulgaria

Borislav Naumov<sup>1</sup>, Simeon Lukanov<sup>2</sup>, Emiliya Vacheva<sup>3</sup>, Maria Naumova<sup>4</sup>,  
Deyan Duhlov<sup>5</sup>, Andrey Kolev<sup>6</sup>

- (1) [Corresponding author] Institute of Biodiversity and Ecosystem Research, Bulgarian Academy of Sciences, 2 Yurii Gagarin Street, 1113 Sofia, Bulgaria, [herpetologybg@gmail.com](mailto:herpetologybg@gmail.com) ✉; <https://orcid.org/0000-0003-2146-208X> 
- (2) Institute of Biodiversity and Ecosystem Research, Bulgarian Academy of Sciences, 1 Tsar Osvoboditel Blvd, 1000 Sofia, Bulgaria, [simeon\\_lukanov@abv.bg](mailto:simeon_lukanov@abv.bg) ✉; <https://orcid.org/0000-0002-2546-6590> 
- (3) Institute of Biodiversity and Ecosystem Research, Bulgarian Academy of Sciences, 1 Tsar Osvoboditel Blvd, 1000 Sofia, Bulgaria, [emilia.vacheva@gmail.com](mailto:emilia.vacheva@gmail.com) ✉; <https://orcid.org/0000-0002-3008-6648> 
- (4) Institute of Biodiversity and Ecosystem Research, Bulgarian Academy of Sciences, 1 Tsar Osvoboditel Blvd, 1000 Sofia, Bulgaria, [munny@abv.bg](mailto:munny@abv.bg) ✉; <https://orcid.org/0000-0003-0060-048X> 
- (5) Independent researcher, Vrabnitsa 1, Block 538, 1229 Sofia, Bulgaria, [deyan\\_duchalov@abv.bg](mailto:deyan_duchalov@abv.bg) ✉; <https://orcid.org/0009-0002-9805-7015> 
- (6) Faculty of Biology, Sofia University “St. Kliment Ohridski”, 8 Dragan Tzankov Blvd, Sofia 1164, Bulgaria, [andikolev@gmail.com](mailto:andikolev@gmail.com) ✉

**Abstract:** In Bulgaria, data on the abundance of newt populations are extremely scarce, which greatly complicates their conservation. For most sites of the Natura 2000 network, such data are completely lacking. This paper presents data on the relative abundance of Buresch’s crested newt (*Triturus ivanbureschi*) in three Natura 2000 sites. The data were collected by sampling newts with funnel traps in April and May for two years (2022–2023). The results showed significant variation in newt abundance between ponds and among individual trapping sessions in the same ponds (recorded values ranged between 0.004 and 0.409 adult newts per trapping hour). The representativeness of the collected data, as well as the advantages and disadvantages of the methods used are discussed.

**Keywords:** Balkan Peninsula, conservation, newt, population estimate

## Introduction

Protected areas from the Natura 2000 network play a significant role in the conservation of plant and animal species within the European Union (EEA, 2023). Although nature reserves, national parks and other protected areas have stricter regimes and provide stronger protection for species and habitats, they are relatively small in area. For example in Bulgaria, they cover only 5.27% of the country’s territory, while the Natura 2000 network covers 34.9% (according to official data from the

Environment executive agency and Ministry of environment and water of Bulgaria).

Amphibians are considered the most threatened group of vertebrates globally (Luedtke et al., 2023), which determines the need to implement measures for their conservation. There are 95 amphibian species in Europe (Speybroeck et al., 2020), of which 29 (including all species of newts of the genus *Triturus* Rafinesque, 1815) are listed under Annex II of the Habitats Directive (Council Directive 92/43/EEC), i.e. they are among the target species in the Natura 2000 network. Species conservation in Natura 2000

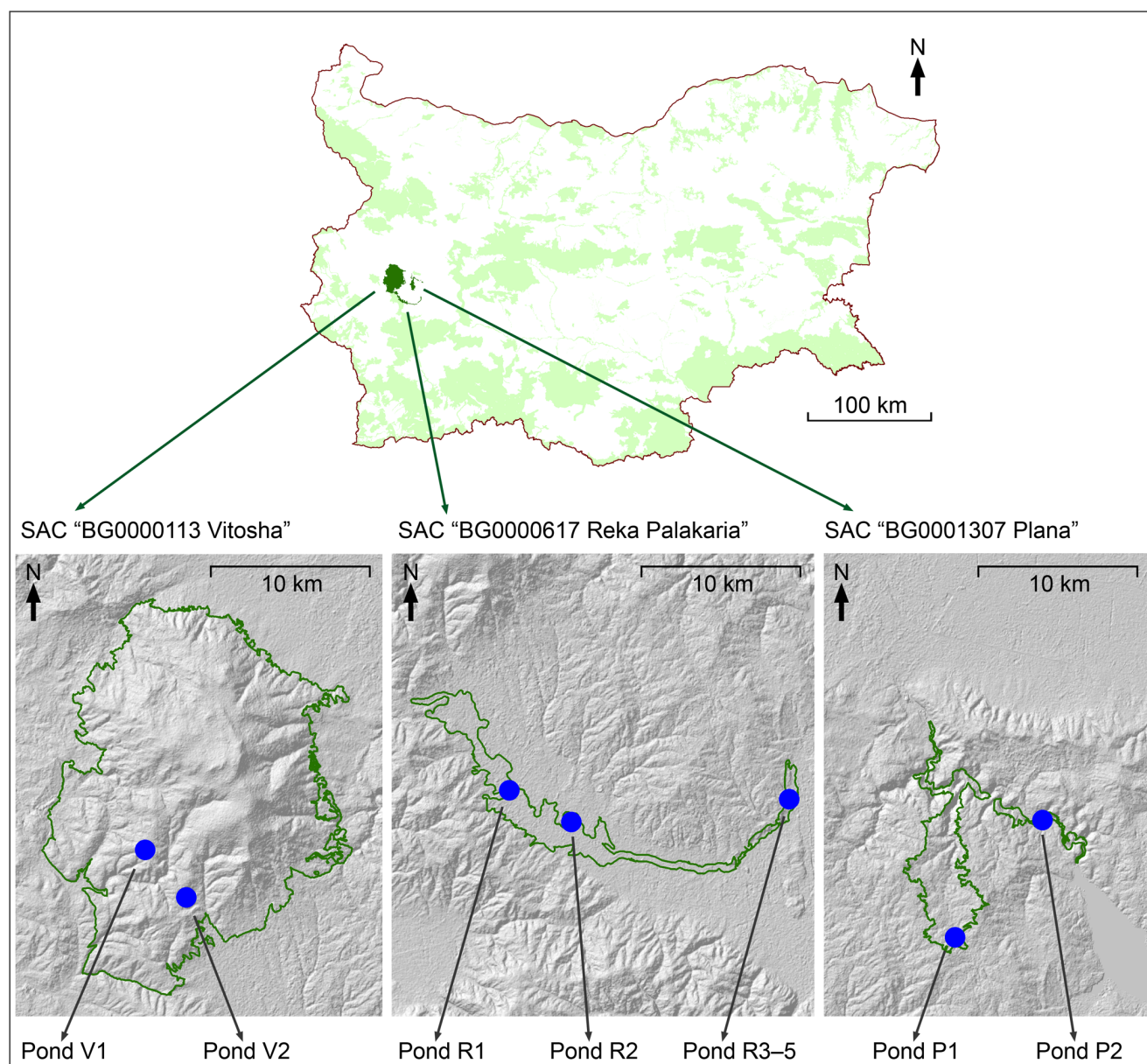


Fig. 1. Above: Natura 2000 network in Bulgaria with an indication (dark green) of the study sites; below: location of the ponds studied on a relief map with outlines of the corresponding Natura 2000 sites.

sites is normally based on data from scientific research and/or monitoring, but in many cases, there is a complete lack of data regarding population size for many amphibian species. This is especially true for newts, and Buresch's crested newt (*Triturus ivanbureschi*) in particular – although the species is a conservation target in 156 Natura 2000 sites in Bulgaria, data on relative population numbers are available for only 22 of them (see the Information system for protected areas from the ecological network Natura 2000 <https://natura2000.egov.bg/>

[EsriBg.Natura.Public.Web.App](https://natura2000.egov.bg/)). On the other hand, documenting population trends in amphibians is crucial to assessing species status (Crnobrnja-Isailović et al., 2025). In view of this, any scientific data on population size/structure would be of key importance for species conservation at both local and national levels.

The Buresch's crested newt is found in the eastern Balkan Peninsula and northwestern Asia Minor, with the main part of its range falling within Bulgaria (Wielstra et al., 2014). It inhabits a variety of standing

Table 1. Characteristics of the ponds studied: N, E = latitude and longitude in decimal degrees (Datum WGS 1984); Alt. = altitude in metres a.s.l.; Area = water surface area in m<sup>2</sup> (measured on the national orthophoto 2022 using the corresponding interactive tool: <https://kais.cadastre.bg/bg/Map>), Dep. = approximate maximum depth of the water body in meters (authors' estimation); Origin = origin of the water body (authors' estimation); Water reg. = water regime i.e. the duration of the presence of water in the pond (permanent – the pond does not dry up; temporary – the pond dries up most summers/autumns); Fish = presence/absence of fish (authors' observations 2022–2023).

| Pond ID | N       | E       | Alt. | Area     | Depth   | Origin       | Water reg. | Fish |
|---------|---------|---------|------|----------|---------|--------------|------------|------|
| V1      | 42.5141 | 23.2284 | 1401 | ca. 200  | ca. 0.5 | Natural      | Temporary  | no   |
| V2      | 42.4894 | 23.2538 | 1324 | ca. 800  | ca. 1   | Semi-natural | Temporary  | no   |
| R1      | 42.4032 | 23.3256 | 921  | > 10000* | ca. 0.5 | Natural      | Temporary  | yes  |
| R2      | 42.3884 | 23.3653 | 915  | ca. 1450 | ca. 1.5 | Artificial   | Permanent  | no   |
| R3      | 42.4023 | 23.5248 | 865  | ca. 3100 | ca. 1.5 | Artificial   | Permanent  | yes  |
| R4      | 42.4009 | 23.5250 | 864  | ca. 50   | ca. 1.5 | Artificial   | Permanent  | no   |
| R5      | 42.4005 | 23.5259 | 859  | ca. 100  | ca. 1.5 | Artificial   | Permanent  | no   |
| P1      | 42.4687 | 23.4562 | 1116 | ca. 800  | ca. 1   | Semi-natural | Temporary  | no   |
| P2      | 42.5357 | 23.5100 | 716  | ca. 1200 | ca. 1   | Natural      | Permanent  | no   |

\* This water body is a seasonal river flood, not visible on orthophoto 2022 (<https://kais.cadastre.bg/bg/Map>).

water bodies and their surroundings from sea level to about 1350 m a.s.l., and in places even higher (Stojanov et al., 2011). While the distribution of *T. ivanbureschi* is relatively well-studied (Wielstra et al., 2013a, b, 2014), little is known about the population ecology of this species in general. The only scientific studies on this subject concern a single population, located near Sofia, Bulgaria, but outside the Natura 2000 network (see Lukanov & Atanasova, 2025 and references therein).

Here we present data on the relative abundance of *Triturus ivanbureschi* populations in three Natura 2000 sites, obtained by simple methods of capture and individual identification. In the context of amphibian conservation, this paper aims to provide specific examples of newt monitoring, which could be useful in planning conservation activities.

## Material and methods

### Study area and sampling

The research was conducted in nine ponds (Fig. 1) distributed in three Special Areas of Conservation

(SAC) of the Natura 2000 network in Bulgaria as follows: SAC “BG0000113 Vitosha” – Pond V1 (near Chuypetlovo Village) and Pond V2 (near Yarlovo Village); SAC “BG0000617 Reka Palakaria” – Pond R1 (near Popovyane Village), Pond R2 (near Alino Village), and Ponds R3–R5 (a group of three water bodies near Shiroki Dol Village); SAC “BG0001307 Plana” – Pond P1 (near Plana Village) and Pond P2 (near Dolni Pasarel Village). A detailed description of the ponds studied is given in Table 1 and photos – in Figure 2.

In each pond, newts were sampled four times during the breeding season (April–May in 2022 and 2023) using live traps. We employed rectangular funnel traps (L = 70 cm, H = 25 cm, W = 25 cm; 0.5 cm mesh size; 7 cm funnel opening diameter) with an average exposure time of 17 hours, roughly from sunset to sunrise (for more details on this method see Bock et al., 2009). All captured adult newts were counted, sexed and their ventral side was photographed with a digital camera (for subsequent individual identification), after which they were released into the same pond. Handling of the newts was carried out in accordance with the Bulgarian Ministry of Environment and Water (permit No. 361/13.01.2021).



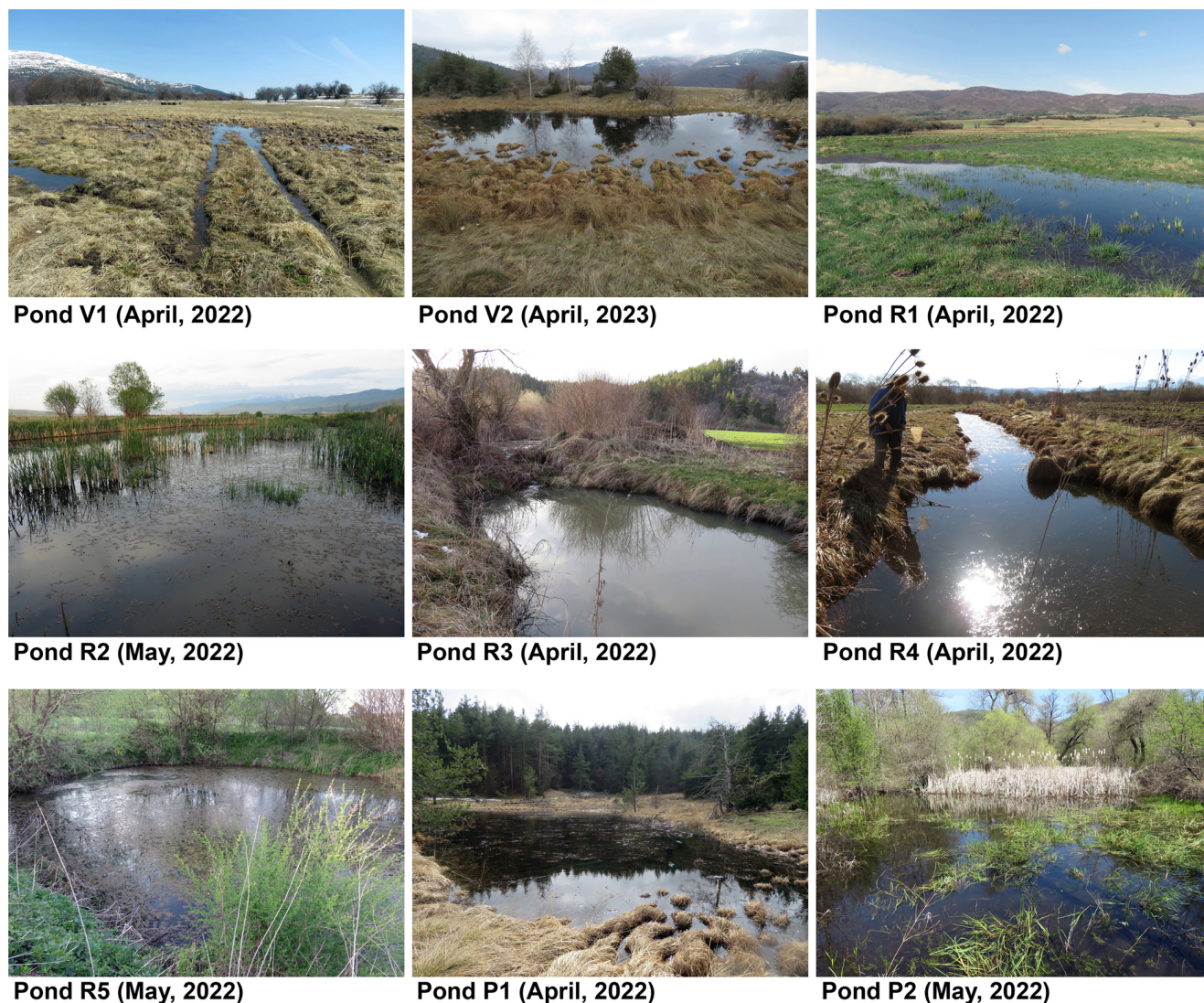


Fig. 2. The ponds studied (photos were taken by the authors during the fieldwork).

## Data processing and analysis

Relative abundance (Ab) was used as an indicator of the abundance of adult newts in the study ponds, calculated by the formula:  $Ab = N/(T \cdot H)$ , where N is the number of individuals captured, T is the number of traps, and H is the trap exposure time (Tzankov et al., 2014; Naumov et al., 2025).

Individual identification was performed by software-assisted comparison of the ventral patterns of all captured newts from the respective pond. We used the Hotspotter v. 1.0 software (Crall et al., 2013), which has been demonstrated to work well for crested newts and *T. ivanbureschi* in particular (Lukanov & Atanasova, 2025 and references therein). If newt recapture rate was sufficient (i.e., at least 10–20%, see

Kaschube et al., 2022), we used the Jolly–Seber model for open population in order to calculate population size (adults of both sexes in the pond). The model fit was determined by the lowest value for the Akaike’s Information Criterion (AIC) and the model notations were survival rate ( $\Phi$ ), capture probability ( $p$ ), probability of entrance ( $b$ ) and population size ( $N$ ). Population estimates were calculated using the RMark and dplyr libraries in R v. 4.2.1 (R Core Team, 2024).

## Results

During the 36 trap sessions, a total of 546 adult individuals of *Triturus ivanbureschi* were caught (396

Table 2. Data for individual trapping sessions per Natura 2000 sites (SAC ID) and ponds (Pond ID): T = number of traps; H = duration of trap exposure (accuracy ½ hour); N = number of (adult) individuals caught; M = number of males caught; F = number of females caught; M(rc) = number of males caught in previous sessions; F(rc) = number of females caught in previous sessions; Ab = relative abundance (calculated as  $N/(T \cdot H)$ ).

| SAC ID                   | Pond ID | Date              | T  | H    | N  | M  | F  | M(rc) | F(rc) | Ab     |
|--------------------------|---------|-------------------|----|------|----|----|----|-------|-------|--------|
| BG0000113 Vitosha        | V1      | April 14–15, 2022 | 10 | 18   | 10 | 5  | 5  | n/a   | n/a   | 0.0556 |
|                          |         | May 16–17, 2022   | 8  | 18.5 | 6  | 3  | 3  | 3     | 2     | 0.0405 |
|                          |         | April 7–8, 2023   | 10 | 24.5 | 4  | 1  | 3  | —     | 3     | 0.0163 |
|                          |         | May 10–11, 2023   | 10 | 24   | 5  | 3  | 2  | 2     | 1     | 0.0208 |
|                          | V2      | April 6–7, 2022   | 20 | 23   | 84 | 65 | 19 | n/a   | n/a   | 0.1826 |
|                          |         | May 13–14, 2022   | 17 | 18   | 42 | 27 | 15 | 12    | —     | 0.1373 |
|                          |         | April 5–6, 2023   | 20 | 23.5 | 86 | 56 | 30 | 8     | 4     | 0.1830 |
|                          |         | May 3–4, 2023     | 20 | 23   | 77 | 54 | 23 | 19    | 5     | 0.1674 |
| BG0000617 Reka Palakaria | R1      | April 22–23, 2022 | 15 | 15.5 | 1  | 1  | —  | n/a   | n/a   | 0.0043 |
|                          |         | May 14–15, 2022   | 15 | 15.5 | 4  | 2  | 2  | —     | n/a   | 0.0172 |
|                          |         | April 11–12, 2023 | 15 | 15.5 | —  | —  | —  | n/a   | n/a   | n/a    |
|                          |         | May 16–17, 2023   | 10 | 14   | 1  | 1  | —  | —     | n/a   | 0.0071 |
|                          | R2      | April 22–23, 2022 | 15 | 15   | 92 | 76 | 16 | n/a   | n/a   | 0.4089 |
|                          |         | May 14–15, 2022   | 15 | 14   | 62 | 44 | 18 | 1     | —     | 0.2952 |
|                          |         | April 11–12, 2023 | 15 | 15.5 | 26 | 20 | 6  | 4     | —     | 0.1118 |
|                          |         | May 16–17, 2023   | 10 | 14   | 8  | 7  | 1  | —     | 1     | 0.0571 |
|                          | R3      | April 11–12, 2022 | 10 | 14.5 | —  | —  | —  | n/a   | n/a   | n/a    |
|                          |         | May 11–12, 2022   | 10 | 13.5 | 4  | 1  | 3  | n/a   | n/a   | 0.0296 |
|                          |         | April 7–8, 2023   | 10 | 17.5 | 2  | 2  | —  | —     | n/a   | 0.0114 |
|                          |         | May 13–14, 2023   | 10 | 16   | 4  | 4  | —  | —     | n/a   | 0.0250 |
|                          | R4      | April 11–12, 2022 | 10 | 14.5 | —  | —  | —  | n/a   | n/a   | n/a    |
|                          |         | May 11–12, 2022   | 10 | 14.5 | 8  | 6  | 2  | n/a   | n/a   | 0.0552 |
|                          |         | April 7–8, 2023   | 10 | 15   | 5  | 4  | 1  | 2*    | —     | 0.0333 |
|                          |         | May 13–14, 2023   | 10 | 15   | 5  | 5  | —  | 3     | n/a   | 0.0333 |
|                          | R5      | April 11–12, 2022 | 8  | 14.5 | —  | —  | —  | n/a   | n/a   | n/a    |
|                          |         | May 11–12, 2022   | 10 | 13.5 | 17 | 16 | 1  | n/a   | n/a   | 0.1259 |
|                          |         | April 7–8, 2023   | 10 | 15.5 | 17 | 17 | —  | 7**   | n/a   | 0.1097 |
|                          |         | May 13–14, 2023   | 10 | 14   | 6  | 6  | —  | 4     | n/a   | 0.0429 |
| BG0001307 Plana          | P1      | April 6–7, 2022   | 18 | 24   | 11 | 8  | 3  | n/a   | n/a   | 0.0255 |
|                          |         | May 13–14, 2022   | 13 | 18.5 | 2  | 1  | 1  | 1     | 1     | 0.0083 |
|                          |         | April 3–4, 2023   | 10 | 17   | 1  | 1  | —  | —     | n/a   | 0.0059 |
|                          |         | May 1–2, 2022     | 10 | 21.5 | —  | —  | —  | n/a   | n/a   | n/a    |
|                          | P2      | April 19–20, 2022 | 9  | 19   | 25 | 13 | 12 | n/a   | n/a   | 0.1462 |
|                          |         | May 27–28, 2022   | 10 | 18   | —  | —  | —  | —     | —     | n/a    |
|                          |         | April 3–4, 2023   | 10 | 17.5 | 5  | 4  | 1  | —     | —     | 0.0286 |
|                          |         | May 1–2, 2022     | 10 | 21.5 | 7  | 7  | —  | —     | —     | 0.0326 |

\* Incl. one individual initially caught in May 2022 in Pond R5.

\*\* Incl. one individual initially caught in May 2022 in Pond R4.



Table 3. Relative abundance of *Triturus ivanbureschi* in the study ponds (N = number of trap sessions with positive results; Ab = relative abundance calculated).

| SAC ID                   | Pond ID | N | Ab (mean (min–max)) |
|--------------------------|---------|---|---------------------|
| BG0000113 Vitosha        | V1      | 4 | 0.033 (0.016–0.056) |
|                          | V2      | 4 | 0.168 (0.137–0.183) |
| BG0000617 Reka Palakaria | R1      | 3 | 0.010 (0.004–0.017) |
|                          | R2      | 4 | 0.218 (0.057–0.409) |
|                          | R3      | 3 | 0.022 (0.011–0.030) |
|                          | R4      | 3 | 0.041 (0.033–0.055) |
|                          | R5      | 3 | 0.093 (0.043–0.126) |
| BG0001307 Plana          | P1      | 3 | 0.013 (0.006–0.026) |
|                          | P2      | 3 | 0.069 (0.029–0.146) |

Table 4. Population estimates for Pond V2 (SAC “BG0000113 Vitosha”), based on CMR data (Phi = survival rate; p = capture probability; b = probability of entrance; N = population size).

| Sex     | Parameter | Estimate | Standard error | 95% confidence interval |       |
|---------|-----------|----------|----------------|-------------------------|-------|
|         |           |          |                | Lower                   | Upper |
| Females | Phi       | 0.951    | 0.389          | $1.37 \times 10^{-6}$   | 1.000 |
|         | p         | 0.088    | 0.064          | 0.019                   | 0.317 |
|         | b         | 0.119    | 0.191          | 0.004                   | 0.829 |
|         | N         | 322      | 111            | 183                     | 647   |
| Males   | Phi       | 0.797    | 0.130          | 0.449                   | 0.950 |
|         | p         | 0.214    | 0.063          | 0.115                   | 0.363 |
|         | b         | 0.123    | 0.049          | 0.054                   | 0.254 |
|         | N         | 381      | 50             | 303                     | 502   |

males and 150 females). The raw data for the individual trap sessions are given in Table 2. The results are described below, separately for each of the three Natura 2000 sites.

In SAC “BG0000113 Vitosha”, the mean relative abundance of newts was 0.100 (0.033 for Pond V1 and 0.168 for Pond V2 respectively; Table 3). In Pond V1, a total of 14 individuals (7 males and 7 females) were captured, with 9 of them recaptured (5 males and 4 females), and in Pond V2, a total of 241 individuals (163 males and 78 females) were captured, with 48 of them recaptured (39 males and 9 females). Sample size and the overall recapture rate of 16.61% allowed for population estimates for Pond V2, and the lowest AIC value (375) was for the model with sex-dependent population parameters (Table 4).

In SAC “BG0000617 Reka Palakaria”, the mean relative abundance of newts was 0.064 (with a variation between 0.010 for Pond R1 and 0.218 for Pond R2; Table 3). In Pond R1, 4 males and 2 females were captured (none of which were recaptured), and in Pond R2, a total of 188 individuals (147 males and 41 females) were captured, but only 6 of them recaptured (5 males and 1 female, i.e. the recapture rate was insufficient for reliable estimates of population parameters). In Pond R3, 7 males and 3 females were captured, but none of which were recaptured. In Pond R4, a total of 14 individuals (11 males and 3 females) were captured, with 4 of them recaptured (only males, including one individual originally recorded in Pond R5), and in Pond R5, a total of 30 individuals (29 males and 1 female) were captured, 11 of which were

recaptured (only males, including one individual originally recorded in Pond R4). The recorded cases of migration were as follows: one of the 6 males captured in 2022 in Pond R4 was captured in 2023 in Pond R5; one of the 16 males captured in 2022 in Pond R5 was captured in 2023 in Pond R4 (the distance between the two ponds is about 80 m).

In SAC “BG0001307 Plana” the mean relative abundance of newts was 0.041 (0.013 for Pond P1 and 0.069 for Pond P2 respectively; Table 3). In Pond P1, a total of 12 individuals (9 males and 3 females) were captured, with 2 of them recaptured (1 male and 1 female), and in Pond P2, a total of 37 individuals (24 males and 13 females) were captured with none of them were recaptured.

## Discussion

Our results contribute to knowledge regarding the distribution of *Triturus ivanbureschi* in Bulgaria by establishing new localities within each of the three studied Natura 2000 sites. Regarding the relative abundance of the local populations, our data provide the first such assessment for two of the sites and complement existing data for the third.

### SAC “BG0000113 Vitosha”

The presence of *Triturus ivanbureschi* in this SAC is known from literature data, but from other ponds (Buresch & Zonkow, 1941; Stoyneva & Michev, 2007; Tzankov & Stoyanov, 2008; Tzankov et al., 2014). The relative abundance (Ab) from three of these ponds, collected using funnel traps, was estimated as follows: “Dendrariuma: the lower pond” (1190 m a.s.l.) – 0.018, 0.018 and 0.087 (3 trapping sessions); “Dendrariuma: the upper pond” (1200 m a.s.l.) – 0.010 (one trapping session); “Boyana Lake” (1050 m a.s.l.) – 0.005 and 0.010 (2 trapping sessions) (Tzankov et al., 2014). Therefore, on average for these three ponds, we obtain  $Ab = 0.025$ . On the other hand, the average value for the relative abundance of the species in the ponds from this study is much higher ( $Ab = 0.100$ ). Likely, this difference is due to the ecological characteristics of the ponds, i.e. the water bodies we studied are natural, periodically drying up and do not contain fish, while the water bodies studied by Tzankov et al. were artificial, permanent, and

contained fish. If we derive a general average value (based on the cited results plus the data from this study), we obtain  $Ab = 0.063$ , which is based on 14 trapping sessions in five ponds located in the northern and southern parts of the SAC. This could be the reference value for the relative abundance of the species in the SAC, because it is based on the same methodology, covers sampling in different parts of the SAC and in different types of water bodies.

There are other ponds in the SAC [visible on satellite images (Google Earth Pro) and/or national orthophoto (<https://kais.cadastre.bg/bg/Map>)] in which trapping has not been carried out, but were visited by us at least twice in 2010–2024. Two of these are permanent fish ponds (coordinates: N42.4867° E23.2242°, N42.4859° E23.2243°), and another four are decorative ponds that have not been supplied with water for many years (N42.6363° E23.2251°, N42.6435° E23.2587°, N42.6189° E23.2826°, and N42.6207° E23.3040°). The group of eight small water bodies in the central part of the SAC are located at 1930 m a.s.l. (N42.5860° E23.2680°), i.e. above the known vertical distribution limit of *T. ivanbureschi* (up to ca. 1700 m a.s.l. according to Stojanov et al., 2011). Another known pond (at Aleko hut: N42.5736° E 23.3081°, 1720 m a.s.l.), has been visited repeatedly in attempts to catch newts using traps, but in all cases only *Mesotriton alpestris* (Laurenti, 1768) was caught (Tzankov et al., 2014; unpubl. data of the authors from 2015 and 2023–2025). In view of this, it can be assumed that the listed water bodies are not important for the reproduction of *T. ivanbureschi* in the SAC.

Recapture rate was sufficient for estimates of population parameters only in Pond V2, located near the upper limit of the species distribution at 1360 m a.s.l. The only other place with available population data for the species in Bulgaria is also in Vitosha Mts (outside the SAC boundaries), but at an altitude of 800 m a.s.l., near the village of Bistritsa. In a multi-year study, Lukanov & Atanasova (2025) report yearly survivability, probability of capture and population size, which are very similar to the values of the present model for Pond V2 (i.e., for females and males, respectively:  $\Phi = 0.831\text{--}0.911$  and  $0.910\text{--}0.941$ ,  $p = 0.061\text{--}0.111$  and  $0.092\text{--}0.311$ ,  $N = 195\text{--}259$  and  $254\text{--}379$ ). The values for probability of entrance are, however, rather different, as their reported estimates are  $b = 0.038\text{--}0.051$  and  $0.040\text{--}0.043$  for females and males, respectively (i.e., the values in this study are

more than double what has been previously reported for both sexes of the species in a pond of similar size). Rather than reflecting a deeper ecological difference between these two ponds, the differences in estimated values for this parameter is more likely due to the limited number of sampling sessions in the present study. We conducted four monthly sessions (April and May in two consecutive years), while for the same years, the Bistritsa site has been sampled weekly for a total of 50 sessions (Lukanov & Atanasova, 2025). Females were less likely to be recaptured than males, which Lukanov & Atanasova (2025) attribute to males having greater vagility and spending more time in the water. The low number of sampling sessions is the likely cause for the large standard errors and the wide confidence intervals for all reported estimates in this study (i.e., the population size interval for females ranges from nearly half to more than double the estimate value, and the standard error is 1/3<sup>rd</sup> of the estimate). Preliminary exploration of more complex models resulted in unstable estimates and very large uncertainty intervals due to the few sampling sessions and relatively low recapture rates; in addition, *Triturus ivanbureschi* individuals (especially males) may enter or leave breeding ponds during the aquatic season. For these reasons, we retained the simpler POPAN model as an exploratory approach better suited to the structure and limitations of the available data. Our results for this pond strongly indicate a stable population with good male to female ratio, although actual numbers could be lower than the estimates, especially for females.

#### SAC “BG0000617 Reka Palakaria”

There are no published data on the presence of *Triturus ivanbureschi* in this SAC, but we have detected the species in five water bodies. Other ponds in the SAC, visible on satellite/orthophoto images were not surveyed: the fish farm basins, south of the village of Yarlovo (N42.4502° E23.2816°), the small dams, south of the village of Alino (N42.3796° E23.3867°), etc. Likely, *T. ivanbureschi* occurs in some of these water bodies, but additional research is needed to clarify that. However, the average value derived here ( $Ab = 0.064$ ) could be considered as a reference for the SAC, since it is based on data from five ponds, located in different parts of the SAC, i.e. it probably covers a large part of the variation. Pond R2

had the highest number of captured newts for this SAC (188 individuals), but the recapture rate was still too low for reliable estimates (3.19%). The main reason for this is the large discrepancy in the number of captured newts between the years: 154 in 2022 vs. 34 in 2023. It remains unclear what this difference is due to, as no significant differences were noted between the two years during the fieldwork, either in terms of habitat or weather conditions.

Of special interest are the two cases of male migration in this SAC (see Results), although the distance between Pond R4 and Pond R5 is small (ca. 80 m). A similar phenomenon in *T. ivanbureschi* was recorded by Lukanov (2022) for a larger distance between ponds (ca. 200 m), but also only for males. It is possible that such movements between neighbouring ponds are common in this species, but further studies based on the capture-mark-recapture (CMR) method are needed to clarify this issue.

#### SAC “BG0001307 Plana”

*Triturus ivanbureschi* has been reported for one pond – “Bent Dolni Pasarel 1” (Stoyneva & Michev, 2007), and we detected it in two others. It is important to note that the cited locality is a barrage on the Iskar River, hosting various fish species, including predatory ones (see Petkova et al., 2019). Within the SAC there are four more such barrages on the Iskar River (in-between the Iskar Reservoir and Dolni Pasarel Village), in which, we set funnel traps, but detected no newts (authors’ unpublished data from 2011–2012). Therefore, we assume that newt occurrence there may be only sporadic, i.e., these barrages do not play a significant role in the reproduction of newt populations. The only other water bodies visible on satellite/orthophoto images are the two mentioned in this work, which are free of fish. Thus, the  $Ab = 0.041$  derived by us could be considered as a reference for the SAC.

#### Conclusion

The relative abundance of adult *Triturus ivanbureschi* between individual water bodies within Natura 2000 sites varies greatly. Therefore, estimating the  $Ab$  for a single pond is not sufficient to derive a reference value for the entire SAC, and further research is needed.

The application of the CMR method undoubtedly gives a much clearer idea of the size of newt populations, but it requires much more effort (more repetitions in the same sites, more manipulations with the newts themselves and subsequent work with specific software), as well as a large number of recaptures, which is far from always possible. In view of this, it is clear that the application of this method even within just one Natura 2000 site would be difficult, and at a regional level – practically impossible. On the other hand, according to the current requirements for periodic reporting under Article 17 of the Habitats Directive, the size of newt populations at the biogeographical region level should be estimated only in the form of the number of individuals (see [https://cdr.eionet.europa.eu/help/habitats\\_art17](https://cdr.eionet.europa.eu/help/habitats_art17)). As a consequence, there are only two options: to report the population size as unknown (which is exactly the case from a scientific point of view) or – as an intermediate (min-max) number of individuals, which in turn can only be subjective (i.e., a formal estimate without scientific justification). This leads to the following paradox: in both scenarios (unknown or formal number of individuals), population size assessments cannot be used to track any trend, while their purpose is precisely to do so.

In view of the presented results, we recommend that the size of newt populations in Natura 2000 sites (including at the biogeographical level) be estimated on the basis of relative abundance, as an average value from at least four trapping sessions per site, carried out during the breeding season. Although it does not provide information on the absolute abundance of the populations, this method is sufficiently reliable for assessing long-term trends, as long as it is applied regularly and uniformly.

## Acknowledgments

We thank Georgi Krastev and Miroslav Slavchev for the field work assistance, as well as the two anonymous reviewers for comments that improved the manuscript.

## Conflicts of interest

No potential conflict of interest has been reported by the authors, reviewers, or subject editor.

## Author contributions

(using [CrediT](#))

Borislav Naumov: conceptualisation, data curation, formal analysis, investigation, methodology, supervision, validation, visualisation, writing—original draft, writing—review and editing; Simeon Lukanov: data curation, formal analysis, investigation, validation, writing—original draft, writing—review and editing; Emiliya Vacheva: data curation, investigation, validation, writing—original draft, writing—review and editing; Maria Naumova: data curation, investigation, writing—review and editing; Deyan Duhlov: data curation, investigation, writing—review and editing; Andrey Kolev: formal analysis, investigation.

## References

- Bock D., Henning V., Steinfartz S. 2009 The use of fish funnel traps for monitoring crested newts (*Triturus cristatus*) according to the Habitats Directive. *Zeitschrift für Feldherpetologie*, Supplement 15: 317–326.
- Buresch I., Zonkow J. 1941 Untersuchungen über die Verbreitung der Reptilien und Amphibien in Bulgarien und auf der Balkanhalbinsel. III. Teil: Schwanzlurche (Amphibia, Caudata). *Mitteilungen aus den Königlichen Naturwissenschaftlichen Instituten in Sofia* 14: 171–273. (In Bulgarian)
- Crall J., Stewart C., Berger-Wolf T., Rubenstein D., Sundaresa S. 2013 Hotspotter – patterned species instance recognition. In: *Proceedings of the 2013 IEEE Workshop on Applications of Computer Vision (WACV 2013)*. Washington, DC: IEEE Computer Society, pp. 230–237. Software available at <http://cs.rpi.edu/hotspotter>.
- Crnobrnja-Isailović J., Schmidt B.R., Denoël M., Ficetola G.F., Cogălniceanu D., Martínez-Solano I., Corti C., Crochet P.-A., Ferri V., Halpern B., Jablonski D., Krása A., Litvinchuk S., Maletzky A., Manenti R., Poboljšaj K., Schulte U., Sotiropoulos K., Speybroeck J., Strachinis I., Romano A., Üzümlü N., Wilkinson J., Hobin L., Bellotto V., Clay J., Allen D.J., Trottet A. 2025 Measuring the pulse of European biodiversity. *European Red List of Amphibians*. European Commission, Brussels, 56 pp. <https://doi.org/10.2779/035237>



- EEA 2023 European Environment Agency: Natura 2000 network's contribution to good status. <https://www.eea.europa.eu/en/topics/at-a-glance/nature/state-of-nature-in-europe-a-health-check/natura-2000-networks-contribution-to-good-status> .
- Kaschube D.R., Saracco J.F., Ray C., Godwin C.M., Foster K.R., Pyle P. 2022 Minimum capture-recapture rates and years of banding station operations to obtain reliable adult annual survival estimates. *Journal of Field Ornithology* 93 (1): 7. <https://doi.org/10.5751/JFO-00071-930107> .
- Luedtke J.A., Chanson J., Neam K., et al. 2023 Ongoing declines for the world's amphibians in the face of emerging threats. *Nature* 622: 308–314. <https://doi.org/10.1038/s41586-023-06578-4> .
- Lukanov S. 2022 Inter-pond migration during the aquatic phase by male *Triturus ivanbureschi*. *Russian Journal of Herpetology* 29 (6): 373–376. <https://doi.org/10.30906/1026-2296-2022-29-6-373-376> .
- Lukanov S., Atanasova I. 2025 Correlation Between Individual Body Condition and Seasonal Activity in Buresch's Crested Newt, *Triturus ivanbureschi*. *Diversity* 17 (5): 350. <https://doi.org/10.3390/d17050350> .
- Naumov B., Lukanov S., Vacheva E., Lazarkevich I., Slavchev M. 2025 Phenology and Sex Ratio of *Triturus cristatus* (Laurenti, 1768) (Amphibia: Salamandridae) at its Southern Range Limit. *Acta Zoologica Bulgarica* 77 (1): 71–84. <https://doi.org/10.71424/azb77.1.002822> .
- Petkova S., Kanev E., Dimitrova I., Kisliakov D., Uzunova E. 2019 Fish Pass Functionality in Relation to the Dynamics of Hydrological Conditions in the Upper Course of the River Iskar (Case Study). *Journal of Ecological Engineering* 20 (6): 66–72. <https://doi.org/10.12911/22998993/108918> .
- R Core Team 2024 R: A Language and Environment for Statistical Computing. R Foundation for Statistical Computing: Vienna, Austria, 2024. <https://www.R-project.org/>  (accessed 20 December 2025).
- Speybroeck J., Beukema W., Dufresnes C., Fritz U., Jablonski D., Lymberakis P., Martínez-Solano I., Razzetti E., Vamberger M., Vences M., Vörös J., Crochet P.-A. 2020 Species list of the European herpetofauna – 2020 update by the Taxonomic Committee of the Societas Europaea Herpetologica. *Amphibia-Reptilia* 41: 139–189. <https://doi.org/10.1163/15685381-bja10010> .
- Stojanov A., Tzankov N., Naumov B. 2011 Die Amphibien und Reptilien Bulgariens. Chimaira, Frankfurt am Main, 588 pp.
- Stoyneva M., Michev T. 2007 Database of Bulgarian non-lotic wetlands and their biodiversity. In: Michev T.M., Stoyneva M.P. (eds) Inventory of Bulgarian Wetlands and their Biodiversity. Part 1: Non-Lotic Wetlands, Publ., House Svetlostrouy, Sofia, 364 pp. + CD supplement.
- Tzankov N., Popgeorgiev G., Naumov B., Stoyanov A., Kornilev Y., Petrov B., A. Dyugmedzhiev, Vergilov V., Draganova R., Lukanov S., Westerström A. 2014 Identification guide of the amphibians and reptiles in Vitosha Nature Park. Directorate of Vitosha Nature Park, Sofia, 248 pp. (In Bulgarian)
- Tzankov N., Stoyanov A. 2008 *Triturus cristatus* (Laurenti, 1768): a new species for Bulgaria from its southernmost known localities. *Salamandra* 44 (3): 153–162.
- Wielstra B., Crnobrnja-Isailovic J., Litvinchuk S., Reijnen B., Skidmore A., Sotiropoulos K., Toxopeus A., Tzankov N., Vukov T., Arntzen J. 2013a Tracing glacial refugia of *Triturus* newts based on mitochondrial DNA phylogeography and species distribution modeling. *Frontiers in Zoology* 10: 13.
- Wielstra B., Litvinchuk S., Naumov B., Tzankov N., Arntzen J. 2013b A revised taxonomy of crested newts in the *Triturus karelinii* group (Amphibia: Caudata: Salamandridae), with the description of a new species. *Zootaxa* 3682 (3): 441–453. <https://doi.org/10.11646/zootaxa.3682.3.5> .
- Wielstra B., Sillero N., Vörös J., Arntzen J. 2014 The distribution of the crested and marbled newt species (Amphibia: Salamandridae: *Triturus*) – an addition to the New Atlas of Amphibians and Reptiles of Europe. *Amphibia-Reptilia* 35: 376–381. <https://doi.org/10.1163/15685381-00002960> .

Research article

# Two autumn collecting expeditions highlight the under-researched Lepidoptera fauna of Albania: new records and notes on related literature with additions to the fauna of the country (Lepidoptera: Macroheterocera)

Botond Balogh<sup>1,2,3</sup>, Balázs Tóth<sup>4</sup>, Áron Horváth<sup>5</sup>, Stoyan Beshkov<sup>6</sup>, Nimród Varga<sup>7,8</sup>

(1) [Corresponding author] Hungarian National Museum Public Collections Centre – Hungarian Natural History Museum, Department of Zoology, Lepidoptera Collection, H-1088, Budapest, Baross utca 13, Hungary

(2) Eötvös Loránd University, Faculty of Science, H-111, Budapest, Pázmány Péter sétány 1, Hungary

(3) ArtEnto Foundation & Hungarian Entomological Society – Young Entomologists' Club, H-1088, Budapest, Bródy S. utca 32. 1/19, Hungary, [balogh.botond@nhmus.hu](mailto:balogh.botond@nhmus.hu) ; <https://orcid.org/0009-0002-9852-4218> 

(4) Hungarian National Museum Public Collections Centre – Hungarian Natural History Museum, Department of Zoology, Lepidoptera Collection, H-1088, Budapest, Baross utca 13, Hungary, [toth.balazs@nhmus.hu](mailto:toth.balazs@nhmus.hu) ; <https://orcid.org/0000-0002-6089-1218> 

(5) ArtEnto Foundation & Hungarian Entomological Society – Young Entomologists' Club, H-1088, Budapest, Bródy S. utca 32. 1/19, Hungary, [horvath2006aron@gmail.com](mailto:horvath2006aron@gmail.com) ; <https://orcid.org/0009-0001-6939-8294> 

(6) National Museum of Natural History, Bulgarian Academy of Sciences, 1 Tsar Osvoboditel Blvd, 1000 Sofia, Bulgaria, [stoyan.beshkov@gmail.com](mailto:stoyan.beshkov@gmail.com) ; <https://orcid.org/0000-0002-5459-0101> 

(7) University of Veterinary Medicine Budapest, H-1078, Budapest, István utca 2, Hungary

(8) ArtEnto Foundation & Hungarian Entomological Society – Young Entomologists' Club, H-1088, Budapest, Bródy S. utca 32. 1/19, Hungary, [kaanpz@student.univet.hu](mailto:kaanpz@student.univet.hu) ; <https://orcid.org/0009-0002-2054-4008> 

**Abstract:** The results of two entomological expeditions conducted in September–October 2025 near Mali me Gropa (Central Albania) concerning Macroheterocera are presented. One genus and three species are new for Albania, nine species are reported for the second time from the country. Among the new species, *Gortyna borelii lunata* (Freyer, 1838) is from Appendices II and IV of the EEC 92/43 Habitats Directive, while *Nothocasis rosariae* Scalercio, Infusino & Hausmann, 2016 is recorded for the second time from the Balkan Peninsula. The highest altitudes and the southernmost observation of *Gortyna borelii lunata* are also presented. For thirty other species, third and fourth reports for Albania are announced. Comprehensive literature sources are gathered to all 122 reported species.

**Keywords:** Albania, faunistics, Geometridae, Lepidoptera, Noctuidae, protected species

## Introduction

Albania, situated on the southwest part of the Balkan Peninsula, is a country with exquisite and well-preserved natural habitats. Given these conditions, it also has a large and diverse Lepidoptera fauna. One of the first insights into this diversity was given by Rebel (1913), who published the results of several different collecting trips in the country. The first checklist, or even a catalogue, dealing exclusively with the Lepidoptera of Albania was the work of Rebel & Zerny (1931). Literature from the following years is scarce.

The expedition of 1961 by the German Entomological Institute ignited the renewal of scientific research on the Lepidoptera fauna of the country, providing considerable increase in the number of species known from the region (Fries, 1967). Professor Kastriot Misja (1933–2022) was a key person in Albanian entomology. Vast majority of his works circled around Lepidoptera giving a stable base to recent understanding of the butterfly and moth fauna of the country (Misja, 1976, 1978, 1980). In recent years, an increasing number of studies have been published on the Lepidoptera of Albania. Butterflies (Papilionoidea), being the most thoroughly



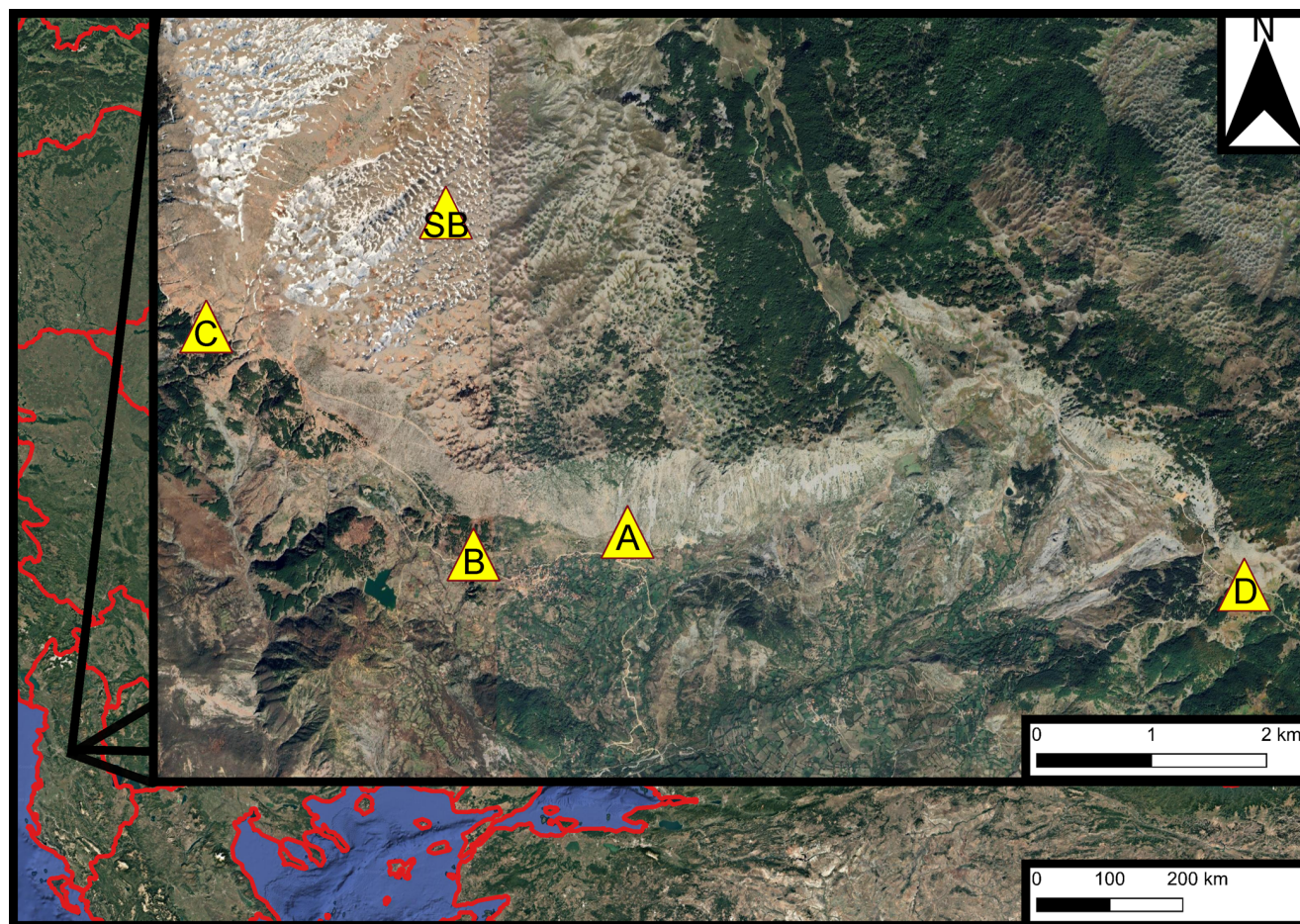


Fig. 1. The distribution map of nighttime collecting localities.

studied among them, are covered in several checklists such as the works of Verovnik & Popović (2013) and Cuvelier et al. (2018), with the most recent compilation by Bjerregård et al. (2023). In terms of nocturnal species, Stoyan Beshkov is responsible for the exceptional increase in research from Albania in recent times (Beshkov, 1994, 1995, 1996, 2018; Beshkov & Nahirić, 2018a; 2019a; Beshkov et al., 2020a, 2024; Beshkov & Nahirić-Beshkova, 2021, 2025). His work contributed to the discovery of several species new to the fauna of the country, forming the base of a future checklist regarding the Lepidoptera of Albania. While his articles primarily revolve around Macroheterocera, a work on the informal group “Microlepidoptera” is already in progress (Plant, 2023). It is expected to be the first comprehensive list of Albania’s micromoths.

In the autumn of 2025, an expedition was conducted by the authors Nimród Varga, Áron Horváth and Botond Balogh between 9<sup>th</sup> and 13<sup>th</sup> October in the vicinity of Mali me Gropa, a limestone massif situated

in Tiranë County, central Albania. A few weeks prior, on 22<sup>nd</sup> September, Stoyan Beshkov spent a night collecting in the central part of the massif. The aim of that visit was to search for *Antitype suda schimae* Schawerda, 1911, a species he found in a similar-looking locality in Bosnia and Herzegovina at the beginning of September in the same year, but has not been recorded from Albania at that time. The aim of this article is to present the results of the two trips concerning Macroheterocera, with a particular focus on nocturnal species, providing further insight into Albania’s Lepidoptera fauna.

### Material and methods

Hungarian team: Daytime search was carried out between two lakes, Liqeni i Shkallës and Liqeni i Bizës with samples collected around the nearby roads. Unlike the explorations during the day, nighttime





Fig. 2. The sight of the main sheet in operation on location B.

surveys were restricted to a limited area each night (Fig. 1).

Several devices focused on the attraction of nighttime flying moths. Each day two white sheets were illuminated with UV lights. The main sheet was illuminated by a few metres of 5 and 12V, 395 and 365nm UV LED strips, a 20W UV-A 368nm Sylvania bulb and 9 and 12V 365nm compact lights (Fig. 2). A second, simpler sheet was used for the purpose of greater area coverage. Illuminated by two 365nm UV flashlights, this sheet was put on branches or rock walls not far from the main light source. The only exception was on the third day when a third small sheet was also put up beside the road SH54 on a rock wall illuminated by UV flashlights and one rolled up UV LED strip. This sheet attracted the highest number of moths that day until it was stolen by the passenger of the only car using the road during the nighttime collecting. Alongside the light sources, ten

sugar ropes were deployed on branches at locations B and D. The use of these ropes, rinsed in mashed fruits and sugar, pinpointed the presence of certain species that are not responsive to light, thereby expanding the species list. Nighttime search was also performed with headlamps nearby the light sources, but outside their illuminated areas. Each location differed in their environmental setting.

Site A (elevation: 933 metres, exact location: 41°20'35.9"N 20°04'18.2"E) was located on the steep southern edge of Mali me Gropa on an isolated spot of vegetation surrounded by limestone walls and scree (Fig. 3A). The main sheet was put up on the grass, while the second sheet was placed on the limestone wall facing south. The sheets were operated from 09.10.2025 dusk to 10.10.2025 00:15.

Site B (elevation: 957 metres, exact location: 41°20'29.6"N 20°03'19.3"E) was located on an open shrubland with scattered pine trees (*Pinus* spp.) (Fig.



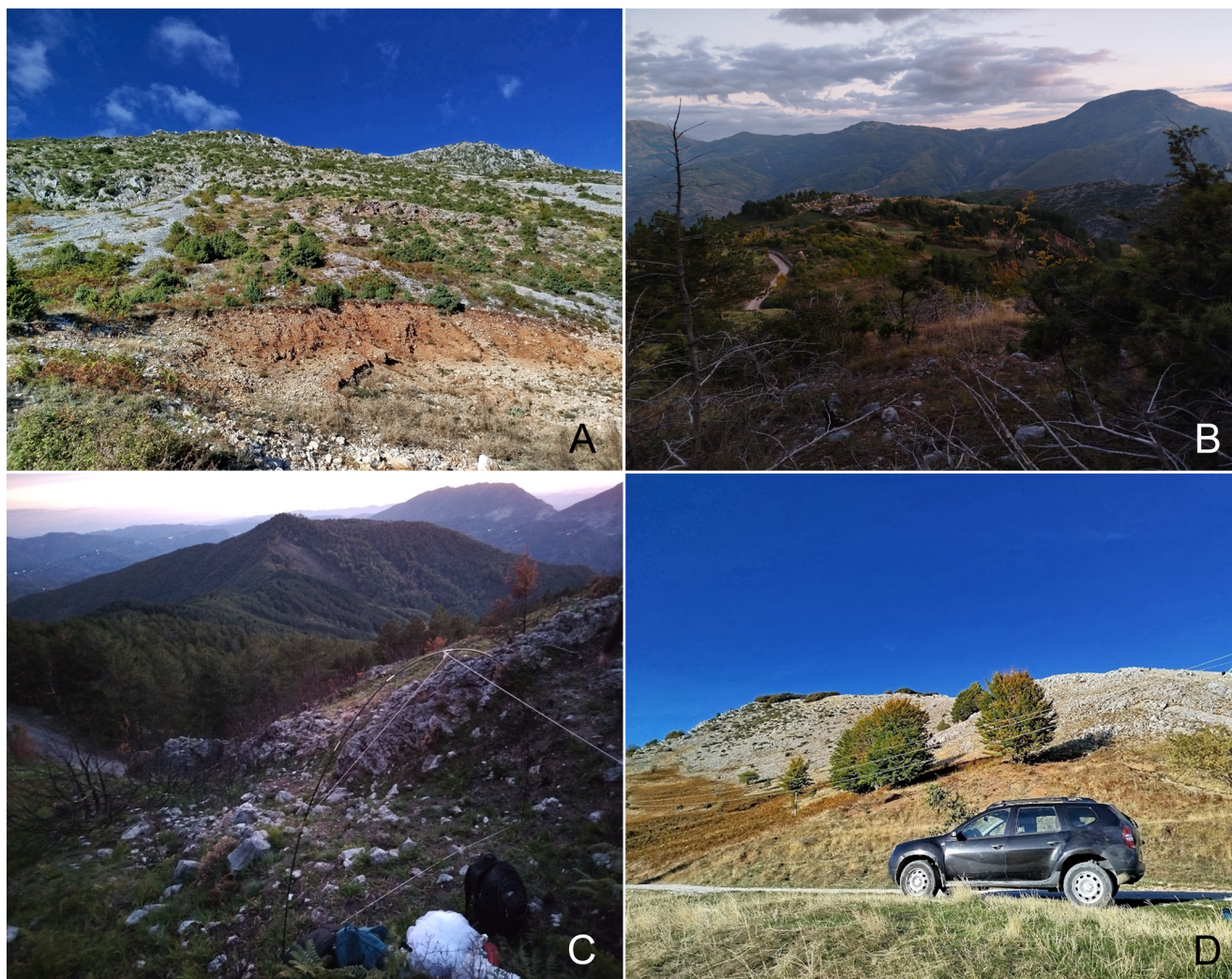


Fig. 3. The view of the collecting sites. A, location A; B, location B; C, location C; D, location D.

3B). The main sheet was put up in a more open area of the location, while the supplementary sheet was placed approximately 40 metres away on a dead branch in a more enclosed space surrounded by pine trees, causing the almost complete absence of any other plants. Baits were placed nearby on branches of trees and shrubs. The collecting period was on 10.10.2025 from dusk to 23:30.

Site C (elevation: 1380 metres, exact location:  $41^{\circ}21'34.1''\text{N}$   $20^{\circ}01'39.5''\text{E}$ ) was a rocky grassland higher than the previous two localities, with fresh herbaceous vegetation and a complete lack of live bushes and trees above the road SH54 (Fig. 3C). This phenomenon was not only the effect of the altitude, grazing or a lack of nutrition in the soil, but it was mainly caused by a recent fire that was indicated by the dead and burnt remains of bushes and trees and a

distinct layer of ash on the surface of the ground. The sheets used that day were placed in a 40-metre radius from each other above the road, on 11.10.2025 from dusk to 21:20.

Site D (elevation: 1395 metres, exact location:  $41^{\circ}20'21.1''\text{N}$   $20^{\circ}08'07.8''\text{E}$ ) was also located on a higher altitude rocky grassland, but there were no signs of fire (Fig. 3D). The main sheet was put up above a hornbeam tree (*Carpinus betulus* L.). The supplementary sheet was placed on a branch approximately 300 metres eastward in the first continuous forest above the road. Baits were also used that day 40 metres below the main sheet. The collecting period lasted from 18:40 to 23:00 on 12.10.2025.

The species were photographed, and their abundance was noted in the field. Adults of particular faunistic importance or not identifiable in field were



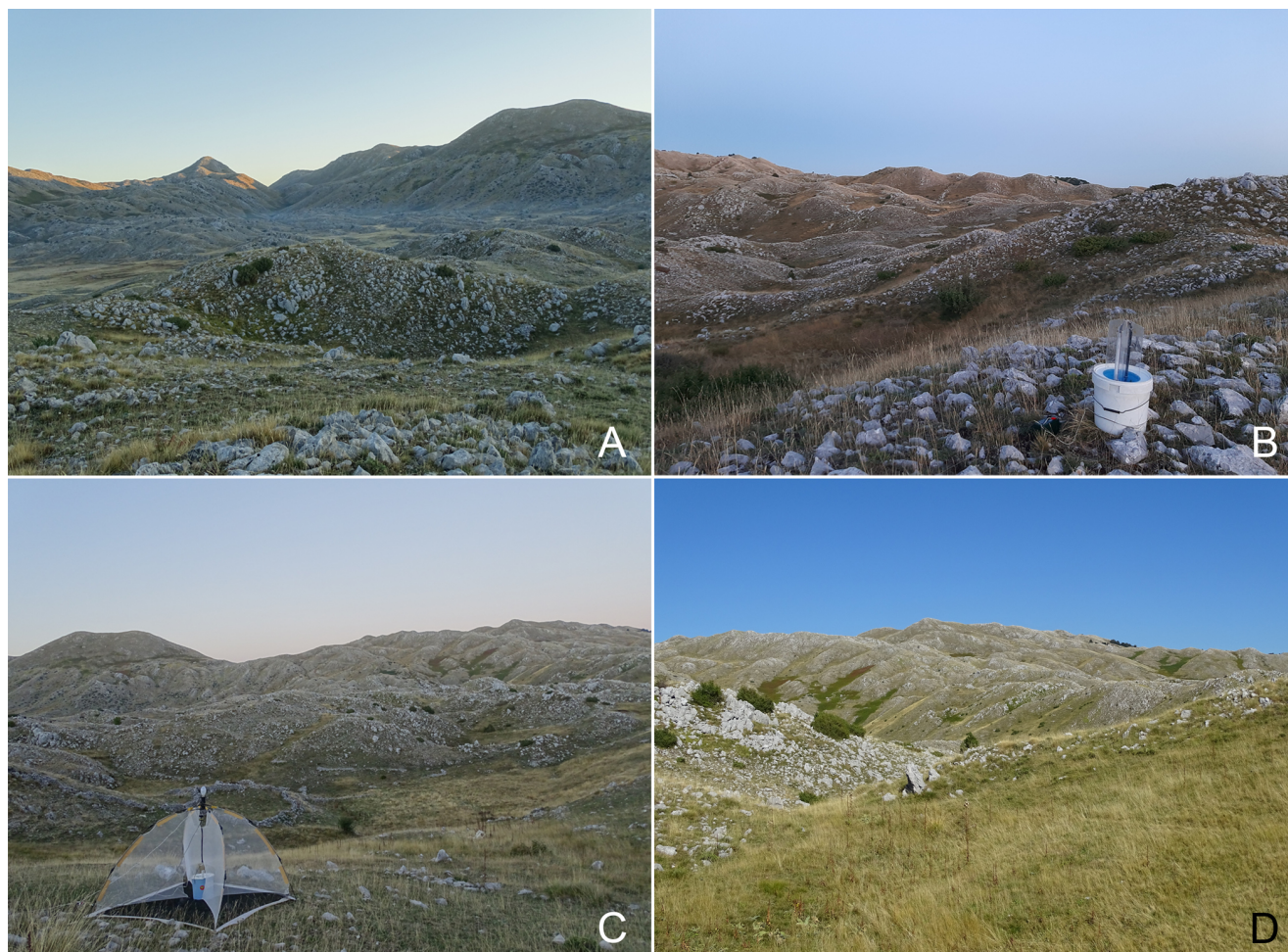


Fig. 4. The view of the collecting sites and devices. A, locality of Stoyan Beshkov, Mali me Gropa, near Nomad, 22.09.2025; B, portable light trap; C, Finnish tent-like trap; D, the view of location SB during the day.

collected and deposited in the Lepidoptera Collection of the Hungarian National Museum Public Collections Centre – Hungarian Natural History Museum, Budapest and in the private collection of Áron Horváth. Genitalia slides were prepared via the standard method, stained with eosine and mounted in Euparal. The slides were photographed with an Olympus SZX12 photographic microscope.

**Stoyan Beshkov:** Conducted a nighttime survey on 22.09.2025. The collecting methods have involved two portable light traps with an 8W “Blacklight” white tube (368 nm), powered by 12V 9Ah batteries as well as a Finnish “tent trap” with a 160W MV bulb at the top of the pole and a 20W (368 nm) black light lamp over the catching pot below, onwards the Finnish “tent trap” was furnished with LepiLED, a 1.5 maxi model UV LED lamp with adapter and transformer 220 – 12V, powered by a generator. An

additional EntoLight UV LED E27-300mm 8W 365–375nm and 395–405nm, 12W with transformer lamp was also positioned about 70–90 m from the tent trap. The maximum distance between the light traps was ca. 400 metres, as they were deployed with different outlooks wherever possible. All traps ran throughout the night, on 22.09.2025 from dusk to the dawn of 23.09.2025.

**Site SB** (elevation: 1491 metres, exact location: 41°22'05.9"N 20°03'09.0"E) was located south of the plateau near the Nomad Lake. This locality was a limestone area with dolines and mountain steppe with *Thalictrum*, *Verbascum*, and other, low growing vegetation. Part of the area located south-southeast of the road leading into the doline zone was burned in the summer of the same year. The location was situated between those of the Hungarian team, but norther (Fig. 4A–D).

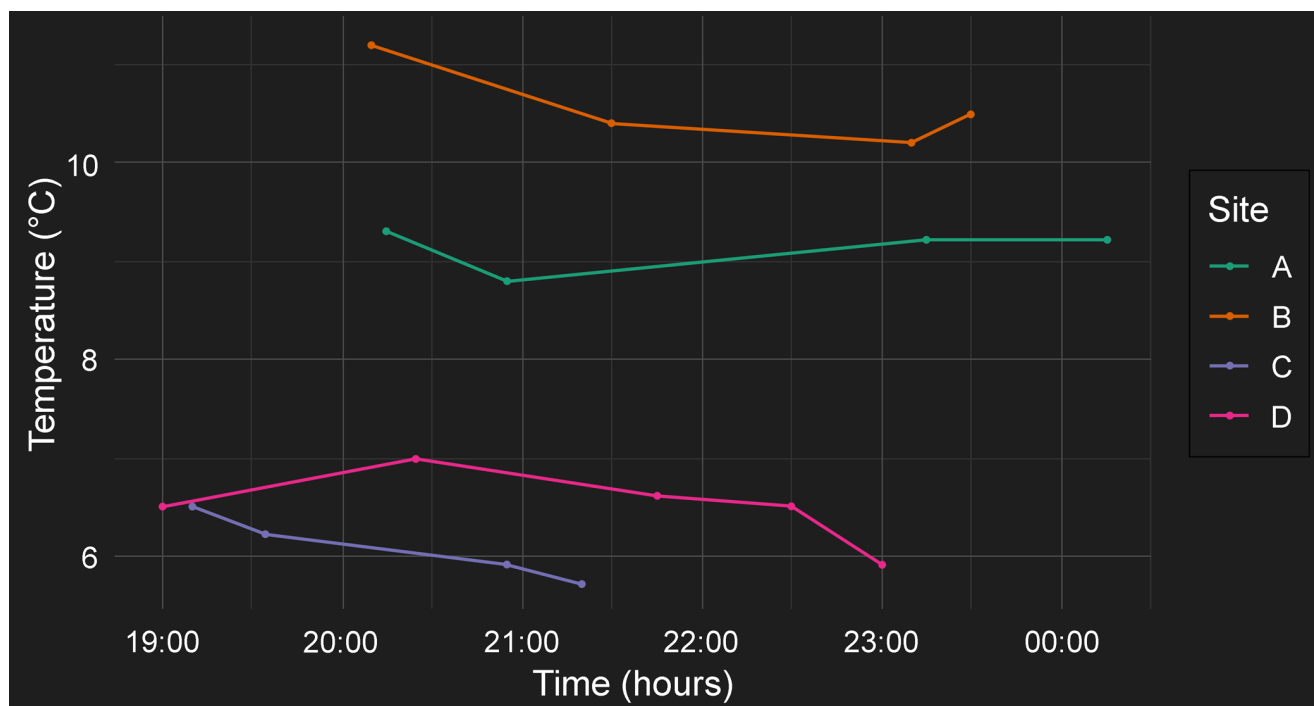


Fig. 5. The temperature shifts on different locations visited by the Hungarian team during the nights.

Specimens and collecting localities were photographed with a Sony DSChX400v digital camera, the portable light trap was captured with a Samsung A30 S Android mobile phone. Genitalia were extracted and mounted on glass slides in Euparal after staining with a 2% Merbromin solution. All genitalia slides were photographed with a Zeiss stereo microscope Stemi 2000-C with Canon 2000 digital camera. The illustrated everted vesicae, and in some cases the female genitalia were photographed in alcohol before mounting on glass in Euparal. The genitalia slides and collected specimens are part of the collection of S. Beshkov in the NMNHS (National Museum of Natural History, Sofia). The number of specimens from locality SB indicates the material in the collection of Stoyan Beshkov in NMNHS. Otherwise, field observations are reported. The trip was self-financed and undertaken in holiday time.

## Results

During the four days of the expedition conducted in October several locations were visited near Mali me Gropa and their Lepidoptera fauna was in the centre of attention. The daytime observations accumulated to a smaller fraction of the total number of species

found during the given timeframe. Varying environmental conditions contributed to the various results observed on the collecting sites. These differences are primarily driven by temperature contrasts associated with elevation and vegetation density, while wind also having notable influence (McGeachie, 1989) (Fig. 5).

Lepidoptera families and the order of the Sphingidae and the Lasiocampidae list are arranged according to Ronkay et al. (2024). The sequence and nomenclature of families Erebidae and Noctuidae follow Fibiger et al. (2011), with changes incorporated from subsequent taxonomic revisions and the recently published books of Top-Jensen et al. (2023) and Ronkay et al. (2024). The Geometridae are arranged according to Müller et al. (2019). The days of occurrence for species on or near given sites addressed by capital letters are the same as the operation dates stated in the material and methods, unless stated otherwise.

Order Lepidoptera Linnaeus, 1758  
Family Lasiocampidae Harris, 1841  
Subfamily Lasiocampinae Harris, 1841

*Lasiocampa trifolii* (Denis & Schiffermüller, 1775).  
Material: Field observation on location SB. Remarks.

The species can be found in the work of Rebel & Zerny (1931) and generally considered common across Albania (Misja, 1978; Beshkov, 1995; Beshkov et al., 2020a).

*Macrothylacia rubi* (Linnaeus, 1758). Material: Approximately 20 larvae near location C. Found feeding beside the road SH54 during the night. Remarks. Rebel & Zerny (1931) already mention the species from Albania. Additional data were later provided regarding the distribution of the species in the country (Misja, 1978; Beshkov & Misja, 1995; Beshkov et al., 2020b).

Family Brahmaeidae Swinhoe, 1892  
Subfamily Lemoniinae Hampson, 1918

*Lemonia strigata* Antoshin & Zolotuhin, 2011. Material: Approximately 9 adults on location B, 6 on location C and 5 on location D. Arrived to the main sheet on sites B and D and to all the sheets on location C. Remarks. According to Prozorov et al. (2022), in Albania only *Lemonia strigata* is present from the taxa closely related to *Lemonia taraxaci* (Denis & Schiffermüller, 1775). Rebel & Zerny (1931) and Misja (1978) mention *L. taraxaci* from the country, but these are likely *Lemonia strigata* observations. Beshkov (1995) refers to the species as “*Lemonia taraxaci strigata* Rebel, 1910”. Later reports only mention *L. strigata* and question the credibility of previous *L. taraxaci* observations from the country (Nahirnić & Beshkov, 2017; Beshkov & Nahirnić, 2019a; Beshkov & Nahirnić-Beshkova, 2021, 2025).

Family Sphingidae Latreille, 1802  
Subfamily Macroglossinae Harris, 1839

*Macroglossum stellatarum* (Linnaeus, 1758). Material: 3 adults near Liqeni i Shkallës (41°19'41.3"N 19°57'47.2"E) on 09.10.2025, 3 near Shëngjin (41°19'03.1"N 20°04'08.5"E) on 10.10.2025 and also 3 near location C. Observed in flight during the day. Remarks. The species appears in the checklist by Rebel & Zerny (1931). Eichler & Friese (1965), Misja (1978), Beshkov (1994) and Bond (2023) also mention the species with additional records across Albania. The reason behind the lack of recent data might be caused by the focus towards Papilionoidea in publications on daytime-flying

Lepidoptera and lack of scientific interest in the country towards economically insignificant abundant species.

*Hyles euphorbiae* (Linnaeus, 1758). Material: 1 larva near Liqeni i Shkallës (41°19'41.3"N 19°57'47.2"E) on 09.10.2025. Found feeding on Euphorbia sp. during the day. Remarks. Appears in the publication by Rebel & Zerny (1931). Several publications provided additional information regarding the species in the country (Eichler & Friese, 1965; Misja, 1978; Beshkov, 1996; Beshkov & Abadjiev, 1996; Plóciennik et al., 2009; Beshkov et al., 2020b).

Family Geometridae Leach, 1815  
Subfamily Ennominae Duponchel, 1845

*Dicrognophos sartata* (Treitschke, 1827). Material: Approximately 5 adults on location A and 4 on location B. Arrived to both the main and supplementary sheets. Remarks. The species appears in the work of Rebel (1913), Rebel & Zerny (1931) and numerous other articles from the country indicating its well-established presence in Albania (Moucha, 1963b; Urbahn, 1966; Misja, 1990; Beshkov, 1995; Beshkov & Misja, 1995; Nahirnić & Beshkov, 2017; Beshkov & Nahirnić, 2019a; Beshkov et al., 2020b; Beshkov & Nahirnić-Beshkova, 2021, 2025).

*Ennomos quercaria* (Hübner, 1813) (Fig. 6F). Material: 1 female on location B. Arrived to the main sheet. Remarks. Even though Rebel & Zerny (1931) mention the species from “Albania”, the location “Jezero Kar bei Vunsaj”, referring to a lake near the village Vusanje is located in current day Montenegro. Therefore, its first published observation from Albania is linked to the work of Urbahn (1966). No other reported occurrence is known from the country. Second report for Albania. Distribution. Western Palearctic. Found mainly in the Mediterranean region, but the species bears data from non-Mediterranean parts of Central and Eastern Europe (Müller et al., 2019).

*Campaea margaritaria* (Linnaeus, 1761). Material: 3 adults on location A and 1 on location B. Arrived to both the main and supplementary sheets on the first mentioned location and to the main sheet on location B. Remarks. Rebel & Zerny (1931) already mentioned the species from Albania. Later reports



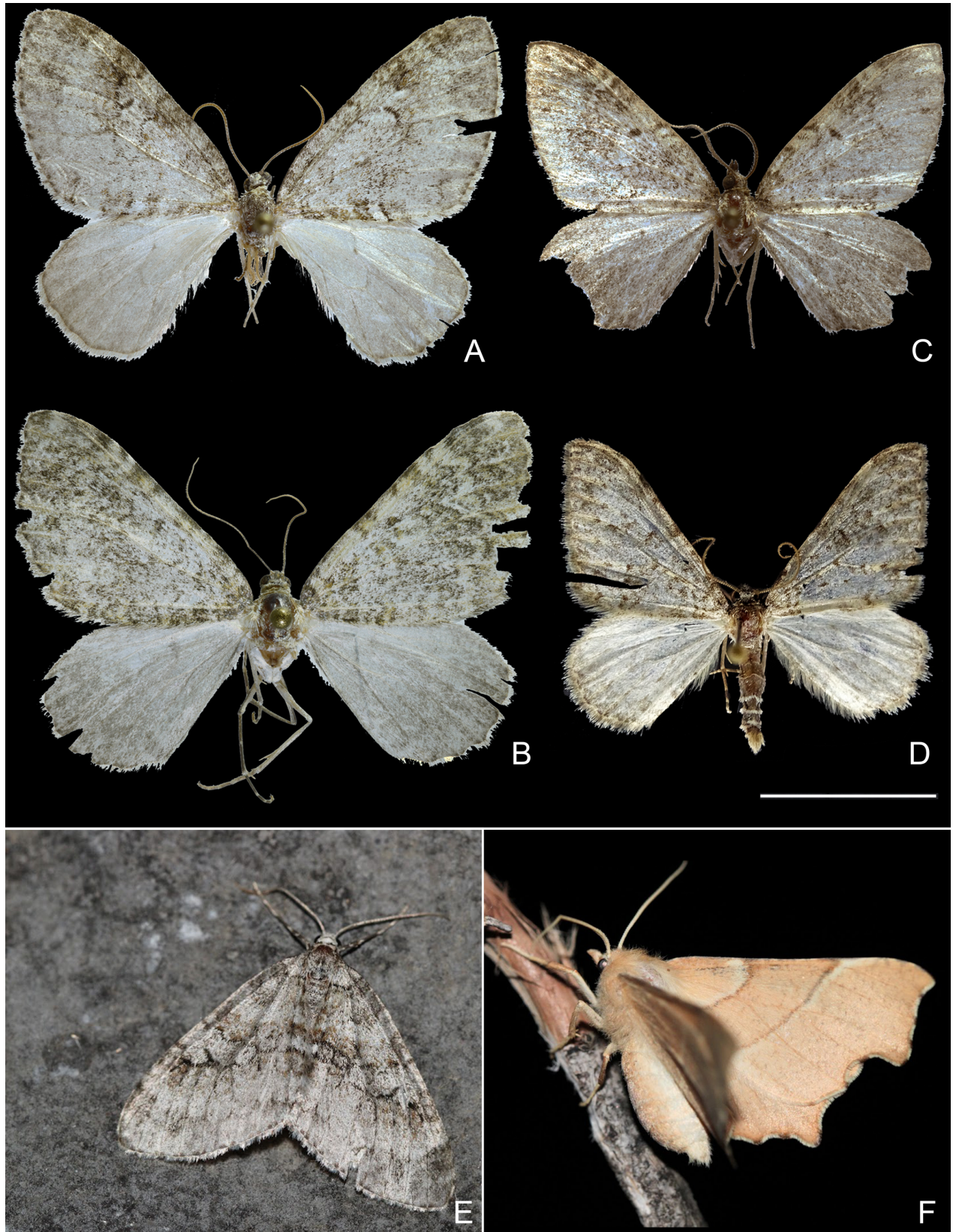


Fig. 6. Geometridae from Albania. A, *Nothocasis rosariae*; B, *Euphyia frustata*; C, *Colostygia wolfschlaegerae*; D, *Nebula senectaria*; E, *Nothocasis rosariae*, live specimen; F, *Ennomos quercaria*, live specimen. Scale bar to Figs A–D: 10 mm. Photos by Balázs Tóth (A–C), Stoyan Beshkov (D) and Áron Horváth (E, F).

reveal additional data on the species from the country (Urbahn, 1966; Misja, 1977; Beshkov & Nahirnić, 2019a; Beshkov et al., 2020b).

*Charissa obscurata* (Denis & Schiffermüller, 1775). Material: 1 male on location A. Arrived to the main sheet. Genitalia examined (Gen. prep. TB2453). Remarks. The species can be found in the checklist by Rebel & Zerny (1931). The following decades bear no published observation of *C. obscurata*. The second report only dates to 2019 when the species appeared in the work of Beshkov & Nahirnić (2019a). Other reports are published by Beshkov et al. (2020a) and Beshkov & Nahirnić-Beshkova (2021). The finding is stated as second report in the latter work. Even though the records are older than those in the previous two articles, due to the publication year being 2021 it cannot be considered as such.

*Charissa variegata* (Duponchel, 1830). Material: 4 adults on location A and 3 near location B. Arrived to both the main and supplementary sheets on location A and to the supplementary sheet on location B. Genitalia of two males were examined (Gen. preps TB2469, TB2475). Remarks. The species can be found in the publication by Rebel & Zerny (1931). After decades without published sighting from Albania, the species reappeared in the work of Beshkov & Nahirnić (2019a). Additional reports provide valuable information regarding the distribution of the species in the country (Beshkov et al., 2020b; Beshkov & Nahirnić-Beshkova, 2021).

*Charissa supinaria* (Mann, 1854). Material: 2 adults on location A. Arrived to the main sheet. Genitalia of one female was examined (Gen. prep. TB2470). Remarks. The species appears in the checklist by Rebel & Zerny (1931) and was also found by the German Entomological Institute (Urbahn, 1966). It appears to be widespread in Albania (Beshkov & Nahirnić, 2019a; Beshkov & Nahirnić-Beshkova, 2021, 2025; Beshkov et al., 2024). The possibility of previous misidentification of the species in articles from the country as *Charissa glaucinaria* (Hübner, 1799) is well detailed by Beshkov & Nahirnić-Beshkova (2021).

*Peribatodes rhomboidaria* (Denis & Schiffermüller, 1775). Material: Approximately 5 adults on locations A and B. Arrived to both the main and supplementary sheets on each mentioned location. Remarks. First appearing in the work of Rebel & Zerny (1931), the species is generally considered as common in Albania (Moucha, 1963b;

Urbahn, 1966; Misja, 1977; Beshkov, 1995; Beshkov et al., 1996, 2020b; Beshkov & Nahirnić, 2019a).

*Peribatodes umbraria* (Hübner, 1809). Material: 1 adult on location A. Arrived to the main sheet. Remarks. Rebel & Zerny (1931) mention the species in their checklist from the country. Many additional reports are linked to *P. umbraria* from Albania (Misja, 1977; Beshkov, 1995; Beshkov & Nahirnić, 2019a; Beshkov et al., 2020a, 2020b).

*Peribatodes correptaria* (Zeller, 1847). Material: Approximately 10 adults on location A and 1 on location B. Arrived to both the main and supplementary sheets on location A and to the main sheet on location B. Remarks. Even though numerous specimens were found during the trip, the reported observations regarding the species are scarce. It was first reported from the country by Beshkov et al. (1996) and the sole other publication mentioning its occurrence was published by Beshkov & Nahirnić (2019a). Third report for Albania. Distribution. Western Palearctic. From Italy throughout the Balkans, Ukraine, Turkey, Lebanon and Jordan to Israel (Müller et al., 2019).

*Opisthograptis luteolata* (Linnaeus, 1758). Material: 5 adults on location A and 4 on location B. Arrived to both the main and supplementary sheets on each mentioned location. Was also found on location SB. Remarks. Rebel & Zerny (1931) already refer to the species from Albania. Currently it is known from several locations across the country (Urbahn, 1966; Misja, 1977; Beshkov & Nahirnić, 2019a; Beshkov et al., 2020b).

#### Subfamily Sterrhinae Meyrick, 1892

*Idaea seriata* (Schrank, 1802). Material: 1 adult in Shëngjin (41°19'21.5"N 20°04'18.1"E) on 11.10.2025. Found resting during the day. Remarks. The species already appears in the checklist by Rebel & Zerny (1931). Even though Urbahn (1966) and Misja (1977) mention *I. seriata* from several locations, the species has no recent data published. Fourth report for Albania.

*Idaea camparia sodaliaria* (Herrich-Schäffer, 1852). Material: 6 adults on location A and 1 on location B. Arrived to both the main and supplementary sheets on location A and to the main sheet on location B. Genitalia of one male was examined (Gen. prep. TB2460). Remarks. Rebel & Zerny (1931) already mention the species from



Albania. Urbahn (1966) added two new localities to the distribution of *I. camparia*. The latest report by Beshkov & Nahirnić (2019a) provided two more observations with additional localities from the country. Fourth report for Albania.

*Idaea degeneraria* (Hübner, 1799). Material: 1 adult near location A. Arrived to the supplementary sheet. Was also found on location SB. Remarks. The species can be found in the work of Rebel & Zerny (1931) and in numerous other articles (Urbahn, 1966; Misja, 1977; Beshkov et al., 1996, 2020b; Beshkov & Nahirnić, 2019a).

*Scopula ornata* (Scopoli, 1763). Material: 1 adult on location B. Arrived to the main sheet. Was also found on location SB. Remarks. Rebel & Zerny (1931) already mention this species from several locations. Additional records accumulated to the better understanding of the distribution of *S. ornata* in the country (Urbahn, 1966; Misja, 1977; Beshkov & Nahirnić, 2019a; Beshkov et al., 2020b; Bond, 2023).

*Scopula incanata* (Linnaeus, 1758). Material: Field observation on location SB. Remarks. The oldest report for Albania is that of Rebel (1913). Several records followed proving the constant presence of the species in the country (Rebel & Zerny, 1931; Urbahn, 1966; Misja, 1977; Beshkov et al., 2020a, 2020b).

*Scopula submutata* (Treitschke, 1828). Material: Approximately 3 adults on location A and 2 on location B. Arrived to both the main and supplementary sheets on each mentioned location. Genitalia of one male was examined (Gen. prep. TB2468). Remarks. This species is also found in the work of Rebel & Zerny (1931). Further data about the species from Albania can be found in the article of Urbahn (1966), Beshkov & Misja (1995), Beshkov & Nahirnić (2019a) and Beshkov et al. (2020b).

*Scopula imitaria* (Hübner, 1799). Material: 1 adult on location A. Arrived to the main sheet. Remarks. The species is present in the work of Rebel & Zerny (1931). The number of additional reports and recorded specimens suggest that it is widely distributed and common in the country (Urbahn, 1966; Misja, 1977; Beshkov & Misja, 1995; Beshkov et al., 1996, 2020b; Beshkov & Nahirnić, 2019a).

*Scopula marginepunctata* (Goeze, 1781). Material: Approximately 10 adults on location A, 5 on location B and 1 on location D. Arrived to both the main and supplementary sheets on location A and B and to the main sheet on location D. Remarks. The species is

mentioned in the checklist by Rebel & Zerny (1931). Beshkov & Nahirnić (2019a) consider the species as common in Albania. The number of other records supports this statement (Moucha, 1963b; Urbahn, 1966; Misja, 1977; Beshkov et al., 2020b).

#### Subfamily Larentiinae Duponchel, 1845

*Aplocera plagiata* (Linnaeus, 1758). Material: 2 adults on locations A and D. Arrived to both the main and supplementary sheets on location A and to the main sheet on location D. Remarks. Rebel & Zerny (1931) already mention the species as part of the Albanian fauna backed by several records. Its occurrence in the country is further documented by additional publications (Urbahn, 1966; Misja, 1977; Beshkov & Nahirnić, 2019a; Beshkov et al., 2020b).

*Nothocasis rosariae* Scalercio, Infusino & Hausmann, 2016 (Figs 6A, E, 7A). Material: 1 male near location B. Arrived to the supplementary sheet. Genitalia examined (Gen. prep. TB2452). Remarks. In the original description by Scalercio et al. (2016) *Fagus sylvatica* (L.) was hypothesised as potential hostplant. This theory was later disproved by Greco et al. (2019) recognising *Acer* spp. as hostplant similarly to its sister species *Nothocasis sertata* (Hübner, 1817). While additional data from southern Italy where the type locality is located kept appearing soon after the description of *N. rosariae*, the single male specimen from Greece mentioned by Scalercio et al. (2016) remained the only known representative of its species from the Balkan Peninsula (Infusino et al., 2017; Scalercio & Greco, 2018). This data scarcity might be caused by lack of research conducted in the mountainous forests of the southern regions with high number of *Acer* spp. during the autumnal period. New genus and species for Albania, second report for the Balkan Peninsula and northernmost observation of *N. rosariae*. Distribution. Previously known only from Italy and Greece (Scalercio et al., 2016).

*Scotopteryx bipunctaria* (Denis & Schiffermüller, 1775) (Fig. 7G). Material: 1 female on location A. Arrived to the main sheet. Genitalia examined (Gen. prep. TB2471). Remarks. Rebel & Zerny (1931), Urbahn (1966) and Misja (1977) all mention the species from several locations, but it ceased to appear in the following publications. The only recent report from Albania by Beshkov & Nahirnić-Beshkova (2021) mentions only one specimen.



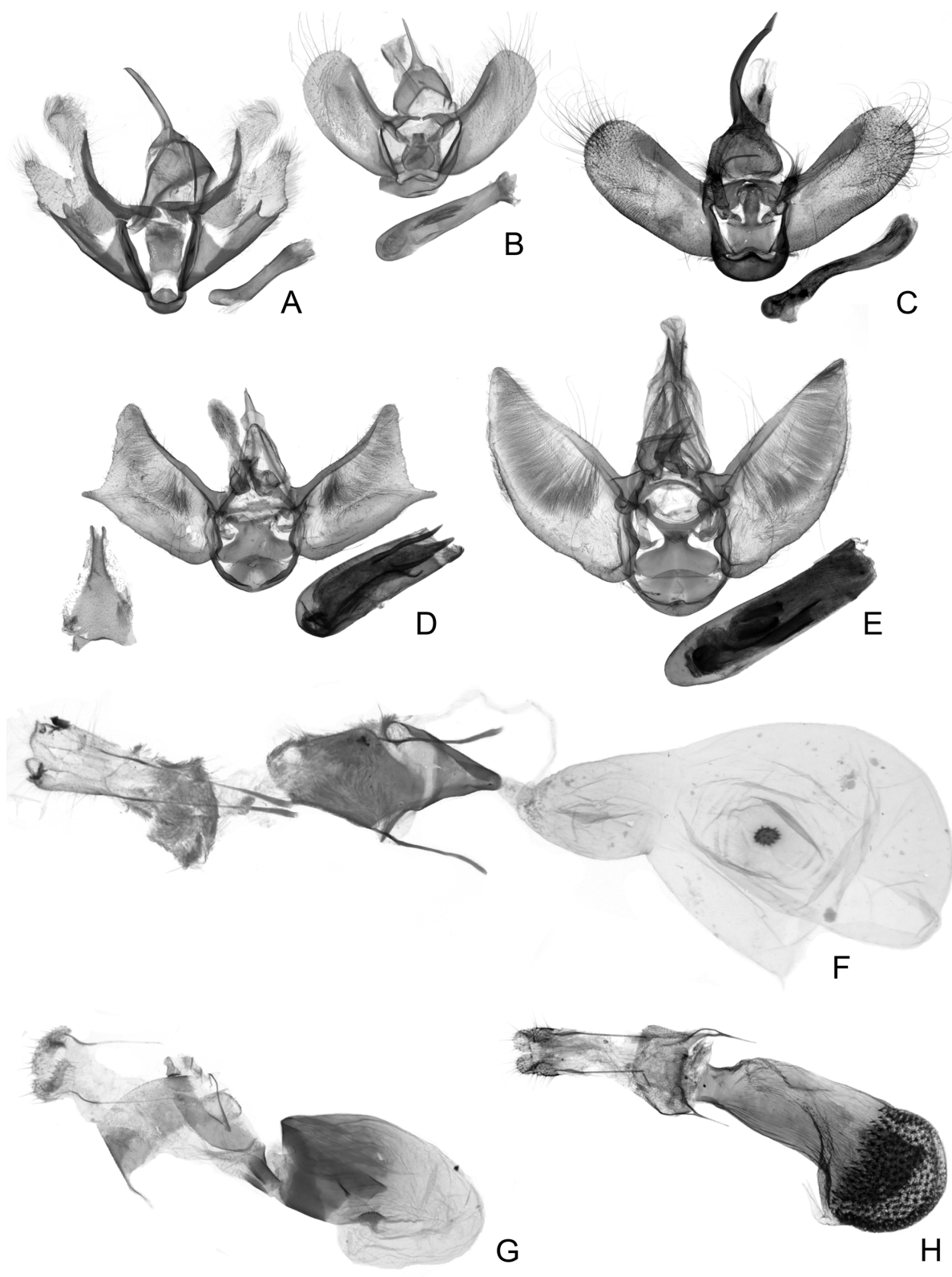


Fig. 7. Genitalia of Geometridae from Albania. A, *Nothocasis rosariae*, slide No. TB2452m; B, *Colostygia wolfschlaegerae*, slide No. TB2465m; C, *Nebula senectaria*, slide No. GP1.04.III.2026; D, *Eupithecia ericeata*, slide No. GP3.04.III.2026; E, *Eupithecia semigraphata*, slide No. GP2.04.III.2026; F, *Euphyia frustata*, slide No. TB2451f; G, *Scotopteryx bipunctaria*, slide No. TB2471f; H, *Eupithecia ericeata*, slide No. GP1.05.III.2026. Scale bar: 1 mm. Photos by Botond Balogh (A, B, F, G) and Stoyan Beshkov (C–E, H).

*Camptogramma bilineata* (Linnaeus, 1758). Material: 3 adults on locations A and B. Arrived to both the main and supplementary sheets on each mentioned location. Remarks. The species can be found in the checklist compiled by Rebel & Zerny (1931). *Camptogramma bilineata* is currently known from many different locations across Albania (Urbahn, 1966; Misja, 1977; Beshkov & Nahirnić, 2019a; Beshkov et al., 2020b).

*Epirrhoe galiata* (Denis & Schiffermüller, 1775). Material: Field observation on location SB. Remarks. The oldest report for Albania is that of Rebel & Zerny (1931). Additional reports from the country subsequently followed (Urbahn, 1966; Misja, 1977; Beshkov et al., 2020b).

*Euphyia frustata* (Treitschke, 1828) (Figs 6B, 7F). Material: 1 female on location A. Arrived to the main sheet. Genitalia examined (Gen. prep. TB2451). Remarks. Rebel & Zerny (1931) mentioned the species from the country. Additional reports followed, some noting unusual colouration, from which the specimen of the present study is no exception (Urbahn, 1966; Beshkov et al., 2020b, 2024; Beshkov & Nahirnić-Beshkova, 2021).

*Pennithera firmata* (Hübner, 1822). Material: 2 adults on location B. Arrived to both the main and supplementary sheets. Remarks. First reported from Albania by Misja (1990). The sole other article mentioning the species from the country was published by Beshkov & Nahirnić (2019a). Third report for Albania. Distribution. Western Palearctic. Found across Europe from Portugal to western parts of European Russia. The species is also present in northern Türkiye and in the Caucasus (Hausmann & Viidalepp, 2012).

*Dysstroma truncata* (Hufnagel, 1767). Material: 1 adult on location B and 1 near Liqeni i Bizës (41°19'43.0"N 20°10'07.5"E) on 12.10.2025. Arrived to the main sheet on location B and caught in flight during the day on the other location. Remarks. Similarly to *P. firmata*, this species was also published first for the country by Misja (1990). Beshkov & Nahirnić-Beshkova (2021) contributed with the second report. Third report for Albania. Distribution. Holarctic. In Europe, the species is found from the British Isles to the Ural Mountains. It lives at higher altitudes in the south. Outside Europe, the species is known from the Caucasus region, Turkey, Russia, China and Japan. A subspecies, *Dysstroma truncata traversata* (Kellcott, 1886) is found in North America as well (Hausmann & Viidalepp, 2012).

*Colostygia wolfschlaegerae* (Pinker, 1953) (Figs 6C, 7B). Material: 1 male on location A. Arrived to the main sheet. Genitalia examined (Gen. prep. TB2465). Remarks. The species was reported as new for the Albanian Lepidoptera fauna recently by Beshkov & Nahirnić-Beshkova (2025). No further publication mentions its occurrence in the country. Second report for Albania. Distribution. The species is found in the southern Balkans and north-eastern Turkey (Hausmann & Viidalepp, 2012).

*Coenotephria ablutaria probaria* (Herrich-Schäffer, 1852). Material: Approximately 20 adults on location A and 10 on location B. Arrived to both the main and supplementary sheets. Genitalia of one male was examined (Gen. prep. TB2467). 3 males were also found on location SB. Remarks. In Albania, according to Hausmann (2011) and Müller et al. (2019), this subspecies can be found. Beshkov & Nahirnić (2019a) reported the species as new to Albania and Beshkov et al. (2020b) even contribute with a “second report”. Previous articles mention “*Coenotephria salicata* (Denis & Schiffermüller, 1775)” from the country, however *C. ablutaria* was its synonym for a long period. For example, Rebel & Zerny (1931) added the phrase “Form *ablutaria*” to their “*C. salicata*” observations and Urbahn (1966) stated that “Form *ablutaria*” is not always clearly defined. The locality Borsh, mentioned by Urbahn (1966), is a seashore village, with habitats more suitable for *C. ablutaria* than the other species. In conclusion, all mention of *Coenotephria salicata* from the country presumably refer to *Coenotephria ablutaria*.

*Nebula senectaria* (Herrich-Schäffer, 1852) (Figs 6D, 7C). Material: 1 male on location SB (Gen. prep. 1./04.III.2026, S. Beshkov). Remarks. The differences between *Nebula senectaria*, *Nebula nebulata* (Treitschke, 1828), *Nebula pirinica* (Reisser, 1936) and *Nebula achromaria* (la Harpe, 1853) are very moderate both in external appearance and in genitalia (males). In Albania *Nebula senectaria* is known only from Plani i Bardhë (Beshkov & Nahirnić, 2019a). Second report for Albania. Distribution. In Europe the species can be found in Italy and the Balkan Peninsula, but its eastern distribution stretches as far as the Caucasus and Israel (Hausmann & Viidalepp, 2012).

*Horisme vitalbata* (Denis & Schiffermüller, 1775). Material: 1 adult near location A. Arrived to the supplementary sheet. Remarks. Mentioned in the checklist by Rebel & Zerny (1931). Additional data suggest the constant presence of this species in

Albania (Urbahn, 1966; Misja, 1977; Beshkov & Nahirnić, 2019a; Beshkov et al., 2020a, 2020b).

*Eupithecia ericeata* (Rambur, 1833) (Figs 7D, 7H). Material: 1 female on location A. Arrived to the main sheet. Genitalia examined (Gen. prep. TB2458). 3 males and 5 females were also found on location SB and their genitalia were also examined (Gen. prep. 3./04.III.2026, S. Beshkov; Gen. prep. 1./05.III.2026, S. Beshkov). Remarks. Even though Beshkov & Nahirnić (2019a) reported the species from several locations across Albania with numerous specimens, their finding remained the only reported encounter of the species from the country until now. Second report for Albania. Distribution. The species is found from Spain to southern Russia in Europe, mainly in the Mediterranean region, but reaching up to the Czech Republic. Outside Europe, the species is found in Asian parts of Turkey (Mironov, 2003).

*Eupithecia semigraphata* Bruand, 1847 (Fig. 7E). Material: Approximately 40 specimens on location A and 5 on location B. Arrived to both the main and supplementary sheets. Genitalia of two females were examined (Gen. preps TB2459, TB2466). 1 male was also found on location SB. Genitalia examined (Gen. prep. 2./04.III.2026, S. Beshkov). Remarks. The species can be found in the checklist by Rebel & Zerny (1931). Misja (1990) also mentions *E. semigraphata* from the country. The latest encounter is published by Beshkov & Nahirnić (2019a). Fourth report for Albania.

#### Family Erebidae Leach, 1815

##### Subfamily Hypeninae Herrich-Schäffer, 1851

*Hypena lividalis* (Hübner, 1796). Material: 1 adult on location A. Arrived to the main sheet. Remarks. The species is in the checklist compiled by Rebel & Zerny (1931). Heinicke (1965) referred to the previously published data without newly recorded specimen. Additional reports reveal several new locations for this species in the country (Beshkov, 1995; Beshkov & Nahirnić, 2019a; Beshkov & Nahirnić-Beshkova, 2025).

##### Subfamily Boletobiinae Guenée, 1858

*Eublemma ostrina* (Hübner, 1808). Material: 1 adult on location A. Arrived to the main sheet. Remarks. Similarly to the previous species, *E. ostrina* is found

in the checklist by Rebel & Zerny (1931) and also mentioned in the work of Heinicke (1965) without new data. Multiple reports were published since regarding *E. ostrina* (Misja, 1980; Beshkov, 1995; Beshkov et al., 1996, 2020b; Beshkov & Nahirnić, 2019a; Beshkov & Nahirnić-Beshkova, 2025).

*Eublemma purpurina* (Denis & Schiffermüller, 1775). Material: 1 adult near Liqeni i Shkallës (41°19'41.3"N 19°57'47.2"E) on 09.10.2025. Found resting in the vegetation during the day. Remarks. Rebel & Zerny (1931) mention the species from Albania. *E. purpurina* is known from several locations across the country (Heinicke, 1965; Misja, 1976; Beshkov & Misja, 1995; Beshkov & Nahirnić, 2019a; Beshkov et al., 2020b).

##### Subfamily Arctiinae Leach, 1815

*Setina irrorella* (Linnaeus, 1758). Material: Field observation on location SB. Remarks. In the country, the species is known from Tomor (Rebel & Zerny, 1931) and Vermosh (Misja, 1978). Third report for Albania. Distribution. *S. irrorella* is a widespread species with Palearctic distribution. Found from Spain to the southern parts of Russia (Macià et al., 2025).

*Dysauxes famula* (Freyer, 1836). Material: 2 adults on location B. Arrived to both the main and supplementary sheets. Remarks. Since this species was a synonym for *Dysauxes punctata* (Fabricius, 1781) for a protracted period, identification of the species in older literature is difficult. Rebel & Zerny (1931) mention "*Dysauxes hyalina* ab. *famula* Frr." which almost certainly refers to *D. famula*. Misja (1990) only mentions *D. punctata*, but from several locations and no further mention of this species occurs in literature from Albania. The determination of whether any of the data provided could be record for *D. famula* is impossible without the examination of specimens, as both species might be present in the country according to Ignatyev & Zolotuhin (2006). The only recent data regarding *D. famula* from Albania is provided by Beshkov et al. (2020a).

##### Subfamily Toxocampinae Guenée, 1852

*Lygephila cracca* (Denis & Schiffermüller, 1775). Material: 5 adults on location A and 4 on location B. Ar-



rived to both the main and supplementary sheets on each location and also to bait on location B. Remarks. Plóciennik et al. (2009) reported the species as new to the fauna of Albania, even though it was previously mentioned by Rebel & Zerny (1931), Heinicke (1965) and Misja (1980). Recent records are provided by Beshkov & Nahirnić (2019a) and Beshkov et al. (2020b).

*Lygephila procax* (Hübner, 1813). Material: 1 adult on location A and 6 on location B. Arrived to the main sheet on location A and to both the main and supplementary sheets and bait on location B. Remarks. Beshkov & Nahirnić (2018b) reported the species first from Albania. Later found in several locations across the country (Beshkov & Nahirnić, 2019a; Beshkov et al., 2020a, 2020b, 2024).

*Apopestes spectrum* (Esper, 1787). Material: 2 adults near location B, 1 in Shëngjin inside a private apartment (41°19'22.1"N 20°04'18.7"E) on 11.10.2025 and 3 in Burimas inside a small cave (41°20'29.7"N 20°03'54.8"E) on 12.10.2025. Arrived to bait on location B and found resting during the day on the other locations. Remarks. This species is already mentioned in the checklist by Rebel & Zerny (1931). Heinicke (1965) mentions the species from Albania but only refers to the data published previously. Further records of the species can only be found in two articles from the country, presumably due to its rare appearance on light sources and not because its rarity (Misja, 1976; Beshkov & Nahirnić, 2019a).

#### Subfamily Erebiinae Leach, 1815

*Catocala elocata* (Esper, 1787). Material: 2 adults on location A and 1 on location B. Arrived to the main sheet. Also found on location SB. Remarks. Rebel & Zerny (1931) already report the species from Albania. Further mention by Heinicke (1965) provided no additional data. Misja (1976) however contributed with several new records from different localities. The latest report from the country is linked to Beshkov & Nahirnić (2019a) mentioning the species as a common member of the Albanian fauna.

#### Family Noctuidae Latreille, 1809

##### Subfamily Plusiinae Boisduval, 1829

*Chrysodeixis chalcites* (Esper, 1789). Material: 1 adult on location B. Arrived to the main sheet. Remarks. The

species appears to be abundant in Albania as it can be found in several publications from the country (Rebel & Zerny, 1931; Heinicke, 1965; Misja, 1976; Beshkov, 1994; Kullaj et al., 2005; Beshkov & Nahirnić, 2019a; Beshkov et al., 2020b; Bond, 2023).

*Autographa gamma* (Linnaeus, 1758). Material: 1 adult on location B. Arrived to the main sheet. Was also found on location SB. Remarks. This migratory species appears to be widespread in the country as it was mentioned in the checklist by Rebel & Zerny (1931) and many other works (Moucha, 1963b; Heinicke, 1965; Misja, 1976; Beshkov, 1994, 1996; Beshkov & Abadjiev, 1996; Kullaj et al., 2005; Plóciennik et al., 2009; Beshkov & Nahirnić, 2019a; Beshkov et al., 2020b; Bond, 2023).

#### Subfamily Acontiinae Guenée, 1841

*Anophia leucomelas* (Linnaeus, 1758). Material: Field observation on location SB. Remarks. The oldest report for Albania is that of Rebel & Zerny (1931) for Tirana and Miloti. The species was later reportedly observed in several other locations (Heinicke, 1965; Beshkov, 1995; Nahirnić & Beshkov, 2017; Beshkov & Nahirnić, 2019a; Beshkov et al., 2020a).

#### Subfamily Acronictinae Harris, 1841

*Acronicta euphorbiae* (Denis & Schiffermüller, 1775). Material: 1 larva near location D. Found feeding on *Euphorbia* sp. around sunset. Remarks. The species was first reported from Albania by Misja (1980). Rebel & Zerny (1931) also mention *A. euphorbiae* as part of the “Albanian” fauna, but the locations given are not part of the country as explained by Beshkov (1995). Reliable additional data surfaced recently (Beshkov et al., 2020a, 2020b; Beshkov & Nahirnić-Beshkova, 2021).

#### Subfamily Cuculliinae Herrich-Schäffer, 1850

*Cucullia formosa* Rogenhofer, 1860 (Figs 12A–B). Material: Approximately 20 larvae near location A and another 12 near location C below the road where the fire did not affect the vegetation. The specimens near site C were observed on two days: 10–11.10.2025 feeding on *Artemisia* sp. both during the

night and the day. Remarks. The species was first reported from the country by Beshkov & Nahirnić (2018a) from Shkallë and for the second time by Beshkov et al. (2020a) from Mali me Gropa between locations A and C and from Plani i Bardhë near Bulqizë Town. Its presence was deemed unexpected in the initial publication from the country, but the species appears to have stable populations in the vicinity of Mali me Gropa. Third report for Albania. Distribution. The species has a sporadic distribution across Europe. It is known from France, Italy, Hungary, Slovenia, Serbia, Bulgaria, Albania, Greece and North Macedonia (Beshkov & Nahirnić, 2018a). Kranjčev (1999) mentions the species from Croatia as well. Outside Europe, according to Ronkay & Ronkay (1994), this species can also be found in the Asian steppe region, although sporadically.

*Cucullia tanaceti* (Denis & Schiffermüller, 1775). Material: 1 larva near location C on 10.10.2025. Found feeding on *Artemisia* sp. during the day. Remarks. First reported from the country by Misja (1980). The only other known Albanian record of the species is provided by Beshkov et al. (2024). Third report for Albania. Distribution. The species is widely distributed in Europe and can be found in dry steppe and mountainous regions except the British Isles, the north-western Atlantic coast and northern Scandinavia. Outside Europe the species can be found in the North African coast and western Asia (Ronkay & Ronkay, 1994).

#### Subfamily Oncocnemidinae Forbes & Franclemont, 1954

*Praestilbia armeniaca* Staudinger, 1892. Material: Around 10 adults on location A and 2 on location B. Arrived to both the main and supplementary sheets on each location. Remarks. It was first reported from Albania by Beshkov & Misja (1995). The occurrence of the species has been documented in several locations since, but not in Mali me Gropa (Beshkov, 1995; Beshkov & Nahirnić, 2019a; Beshkov & Nahirnić-Beshkova, 2025).

#### Subfamily Amphipyrinae Guenée, 1838

*Amphipyra effusa* (Boisduval, 1828). Material: 1 adult near location A. Caught in flight not far from the

main sheet but it flew not towards the light sources. Remarks. The species appears in the checklist compiled by Rebel & Zerny (1931). It has been reported from several locations so far from Albania (Misja, 1980; Beshkov et al., 1996, 2024; Beshkov & Nahirnić, 2019a; Beshkov et al., 2020b; Naumova, 2020; Beshkov & Nahirnić-Beshkova, 2025).

*Amphipyra tragopoginis* (Clerck, 1759). Material: Field observation on location SB. Remarks. The oldest report for Albania is that of Rebel & Zerny (1931) from Beshtriku. Other reported occurrences followed significantly later (Beshkov & Nahirnić, 2018b, 2019a; Beshkov et al., 2020b).

*Amphipyra pyramidea* (Linnaeus, 1758). Material: 1 adult on location A and 1 near location B. Arrived to the main sheet on site A and to bait on site B. Remarks. Rebel (1913) already mentions the species as part of the Albanian fauna. It appears in several works from the country (Rebel & Zerny, 1931; Heinicke, 1965; Misja, 1976; Beshkov & Nahirnić, 2019a).

#### Subfamily Psaphidinae Grote, 1896

*Meganephria bimaculosa* (Linnaeus, 1767). Material: 2 adults on location B. Arrived to the main sheet. Remarks. The species was first reported from the country by Misja (1980). Additional observations were published by Beshkov & Nahirnić (2018b, 2019a). Fourth report for Albania.

*Allophyas oxyacanthae* (Linnaeus, 1758). Material: 2 adults near location D. Arrived to the supplementary sheet and to bait. Remarks. The species is in the checklist compiled by Rebel & Zerny (1931). It appears three more times in literature from the country (Heinicke, 1965; Misja, 1976; Beshkov & Nahirnić, 2019a).

#### Subfamily Heliothinae Boisduval, 1829

*Helicoverpa armigera* (Hübner, 1808). Material: 1 adult near location A. Arrived to the supplementary sheet. Was also found on location SB. Remarks. Rebel & Zerny (1931) already mention the species from Albania. Its constant presence in the country is backed by numerous articles (Heinicke, 1965; Misja, 1976; Beshkov, 1994; Plóciennik et al., 2009; Beshkov & Nahirnić, 2019a; Beshkov et al., 2020b).

Subfamily Eriopinae Herrich-Schäffer, 1851

*Calloplistria latreillei* (Duponchel, 1828). Material: 5 adults on location A and 1 on location B. Arrived to both the main and supplementary sheets on site A. The specimen on site B was found on the main sheet. Remarks. Mentioned in the checklist by Rebel & Zerny (1931). The species is known from numerous locations across Albania (Heinicke, 1965; Misja, 1980; Beshkov, 1995; Beshkov & Misja, 1995; Beshkov & Nahirnić, 2019a; Beshkov et al., 2020b).

Subfamily Xyleninae Guenée, 1852

*Spodoptera exigua* (Hübner, 1808). Material: 1 adult on location B. Arrived to the main sheet. Remarks. This migratory species appears in literature from Albania in many instances (Rebel & Zerny, 1931; Heinicke, 1965; Misja, 1980; Beshkov, 1994, 1996; Beshkov & Abadjiev, 1996; Kullaj et al., 2005; Plóciennik et al., 2009; Beshkov & Nahirnić, 2019a; Beshkov et al., 2020b).

*Spodoptera littoralis* (Boisduval, 1833). Material: 1 adult on location A. Arrived to the main sheet. Remarks. The species was first reported from the country by Beshkov (1995). Recent research gives more data on the occurrence of this moth in Albania (Beshkov & Nahirnić, 2018b, 2019a; Beshkov & Nahirnić-Beshkova, 2025).

*Paradrina flavirena* Guenée, 1852. Material: 1 female on location A. Arrived to the main sheet. Genitalia examined (Gen. prep. TB2474). Remarks. The species was reported as new to the Albanian fauna by Beshkov et al. (1996). Later reports mention the species from several locations across the country (Beshkov & Nahirnić, 2018b, 2019a; Beshkov et al., 2020b).

*Paradrina clavipalpis* (Scopoli, 1763). Material: 1 male on location A. Arrived to the main sheet. Genitalia examined (Gen. prep. TB2472). Remarks. The species is found in the checklist by Rebel & Zerny (1931). It appears to be widely distributed and common across Albania (Moucha, 1963b; Heinicke, 1965; Beshkov, 1994, 1996; Beshkov & Nahirnić, 2019a). Misja (1980) only mentions *Paradrina selini* (Boisduval, 1840) from the country. Due to individual variations, some forms of these and other closely related species can be inseparable from each other without the examination of the genitalia, therefore

arising uncertainty for previous reports without genitalia examination.

*Hoplodrina ambigua* (Denis & Schiffermüller, 1775). Material: 3 adults on location A and 5 on location B. Arrived to the main and supplementary sheets on both locations. Was also found on location SB. Remarks. The species appears in the checklist by Rebel & Zerny (1931). It is known from several locations across Albania (Heinicke, 1965; Misja, 1980; Beshkov & Misja, 1995; Beshkov & Nahirnić, 2019a; Beshkov et al., 2020b).

*Thalpophila matura* (Hufnagel, 1766). Material: 1 adult on location A. Arrived to the main sheet. Remarks. Rebel & Zerny (1931) already mention the species from Albania. Its occurrence in the country is further documented by several publications (Heinicke, 1965; Misja, 1976; Beshkov et al., 2020a). Beshkov & Nahirnić (2019a) also mention a species “*Thaupophila*” *matura* (Hufnagel, 1766) which certainly refers to *Thalpophila matura* and is a misspelling.

*Phlogophora meticulosa* (Linnaeus, 1758). Material: 1 adult near location C. Arrived to the supplementary sheet on the dead branch. Was also found on location SB. Remarks. Appears in the publication by Rebel & Zerny (1931). The observations of this migratory species in the country are published in numerous articles (Heinicke, 1965; Misja, 1976; Beshkov, 1994, 1996; Beshkov & Abadjiev, 1996; Beshkov & Nahirnić, 2019a).

*Gortyna flavago* (Denis & Schiffermüller, 1775) (Fig. 8A). Material: 1 adult on location A. Arrived to the main sheet. Remarks. Beshkov & Nahirnić (2020) reported the species and the genus as new for the country. No observation was published since. Second report for Albania. Distribution. The species has a wide distribution across western Eurasia, stretching from Portugal to western Siberia (Zilli et al., 2005).

*Gortyna borelii lunata* (Freyer, 1838) (Figs 8B–C, 12D). Material: 1 male on location D. Arrived to the main sheet. 1 female was also collected by Stoyan Beshkov near location SB on 22.09.2025. Remarks. The subspecies *lunata* is currently the only known subspecies from the Balkan Peninsula (Baranyi et al., 2006). The species does not have any previous data from the country. The habitat where the specimens of the present work were found most resembles the habitats of the Domogled, Romania (Rákossy et al., 2024). The reports from Bulgaria were also from similar habitats, but they were proven incorrect due to mislabelled specimens (Beshkov, 2013a, 2013b) from





Fig. 8. Noctuidae from Albania. A, *Gortyna flavago*; B, *Gortyna borelii lunata*, male; C, *Gortyna borelii lunata*, female; D, *Episema tersa*; E, *Dryobotodes eremita*; F, *Anchoscelis litura*; G, *Xylena lunifera*. Scale bar: 10 mm. Photos by Botond Balogh (A, B, F, G) and Stoyan Beshkov (C–E).

the collection of Al. Slivov in the Institute of Zoology, at present the Institute of Biodiversity and Ecosystem Research, Bulgarian Academy of Sciences. The present findings mark the highest altitudes (1395–1491 metres) and southernmost observations of this species, which is strictly protected in the EU (Habitats Directive 92/43/EEC, Appendices II and IV) (Gyulai, 1987; Ringwood et al., 2002; Rákossy et al., 2024). These findings suggest the possible occurrence of

*Gortyna borelii lunata* in similar habitats in Bosnia and Herzegovina and Montenegro. New species for the fauna of Albania. Distribution. The species has large but localised distribution across Europe (Ringwood et al., 2004). This pattern suggests a previously continuous area where the species could have been found, but due to fragmentation of suitable habitats, the populations became isolated from each other (Zilli et al., 2005).

*Mesapamea secalis* (Linnaeus, 1758). Material: 3 males on location SB. Genitalia examined. Remarks. In Albania, this species is known from Beshtriku, Rogozhina (Rebel & Zerny, 1931, Heinicke, 1965), Tirana (Misja, 1976), Ionian Sea Coast, Dhermi Village (Beshkov, 1995), Tomori (Beshkov et al., 2020a) and Shkallë (Beshkov et al., 2020b). It may have been confused in the past with *Mesapamea secalella* Remm, 1983, a species also present in Albania.

*Episema tersa* (Denis & Schiffermüller, 1775) (Fig. 8D). Material: 1 male below location A (41°20'30.6"N 20°04'14.4"E) on the day of nighttime collecting. Caught in flight by hand, after all equipment were packed away for the night. Genitalia examined (Gen. prep. TB2473). 2 males were also found on location SB. Remarks. Beshkov & Nahirnić (2018b) reported the species as new to the Albanian fauna. Further data are provided by the same authors (Beshkov & Nahirnić, 2019a; Beshkov & Nahirnić-Beshkova, 2021, 2025).

*Cirroedia centrigo* (Haworth, 1809). Material: 1 adult on location A. Arrived to the main sheet. Remarks. Its first observation in the country was published by Misja (1976). Additional data was provided by Beshkov & Nahirnić-Beshkova (2021). Third report for Albania. Distribution. Throughout Europe from Portugal to Russia represented by the nominate subspecies. In Asia reaching as far as the western chains of Himalayas in the East, where several different subspecies can be found (Ronkay et al., 1990).

*Tiliacea citrigo* (Linnaeus, 1758). Material: 1 adult on location B. Arrived to the main sheet. Remarks. Beshkov & Nahirnić (2019a) reported its sole occurrence in Albania, and no further data is available about this species from the country. Second report for Albania. Distribution. A quite widespread European species, which can be found from the Pyrenees to the Urals, Caucasus and western Turkey (Ronkay et al., 1990).

*Tiliacea aurago* (Denis & Schiffermüller, 1775). Material: 2 adults on location A, 1 specimen on location B and 3 specimens on location D. Arrived to the main sheet on each location. Was also found on location SB. Remarks. The species was first mentioned in Albanian literature regarding Lepidoptera by Misja (1976). Beshkov & Nahirnić (2019a) reported the species the second time from the country. Third report for Albania. Distribution. Very

similar to *T. citrigo* but this species extends further north (Ronkay et al., 1990).

*Tiliacea cypreago christiani* (Fibiger, 1992). Material: 3 adults on location A and another 3 on location B. Arrived to both the main and supplementary sheets on each mentioned location. Remarks. Its initial finding in the country was reported by Beshkov & Nahirnić (2019a). Additional data were provided by Beshkov & Nahirnić-Beshkova (2021, 2025). Fourth report for Albania.

*Lithophane ornitopus* (Hufnagel, 1766). Material: 1 adult on location D. Arrived to the main sheet. Remarks. First reported by Beshkov & Nahirnić (2018b) from Albania. Beshkov & Nahirnić (2019a) provided further data with the second report of this species from the country. Third report for Albania. Distribution. Euro-Siberian. Found from Portugal to western Siberia (Ronkay et al., 1990; Pino Pérez et al., 2019).

*Xylena lunifera* (Warren, 1910) (Figs 8G, 12D). Material: 2 adults near location B. Arrived to bait. Remarks. Its first observation in the country was published by Beshkov & Nahirnić (2018a). Additional data was provided by Beshkov & Nahirnić (2019a). Third report for Albania. Distribution. The species is found from the southern edge of the Carpathians across the Balkans and Turkey to the South Caucasus (Ronkay et al., 1990).

*Conistra vaccinii* (Linnaeus, 1761). Material: 3 adults near location D. Arrived to bait. Remarks. First reported from Albania by Beshkov & Nahirnić (2018b). Additional data was later provided by the same authors constituting the second record of this species in the country (Beshkov & Nahirnić, 2019a). Third report for Albania. Distribution. The most widespread among all *Conistra* species. Found across Europe, North Africa along the shore of the Mediterranean Sea, Asia Minor, in the Near East, reaching the end of its eastern distribution in China and central Siberia on the steppes (Ronkay et al., 1990).

*Conistra rubiginea* (Denis & Schiffermüller, 1775). Material: 1 adult near location A, 1 on location B, 2 on location C and 1 near location D. Arrived to the main sheet on locations B and C, to the supplementary sheet on location A and to bait on location D. Was also found on location SB. Remarks. Even though this species appeared on all locations during the nights, its appearance in Albanian literature is scarce. Beshkov & Nahirnić (2018b, 2019a) were the only reporters of this species from the country. Third report for Albania. Distribution.



Widespread species. Found from Portugal across Europe to western Siberia (Ronkay et al., 1990).

*Anchoscelis litura* (Linnaeus, 1761) (Figs 8F, 10C). Material: 1 male on location B. Arrived to the main sheet. Genitalia examined (Gen. prep. TB2463). Remarks. The species was first reported from the country by Beshkov & Nahirnić (2018c). Beshkov & Nahirnić-Beshkova (2021) contributed with the second published observation. Third report for Albania. Distribution. Found across Europe reaching its northern limit in Central Sweden and Finland. The eastern border of its distribution is hard to determine as the separation is difficult from its sister species *Anchoscelis luteogrisea* (Warren, 1911), which reaches the western limit of its distribution in the Balkans (Ronkay et al., 1990).

*Leptologia macilenta* (Hübner, 1809). Material: 1 adult on location B and 10 on location D. Arrived to the main sheet on location B and to both the main and supplementary sheet on location D. Was also found on location SB. Remarks. As most of the species belonging to the autumn fauna, this one was also reported recently from Albania the first time (Beshkov & Nahirnić, 2018a). The species has two additional appearances in the literature from the country (Beshkov & Nahirnić, 2019a; Beshkov & Nahirnić-Beshkova, 2025). Fourth report for Albania.

*Sunira circellaris* (Hufnagel, 1766). Material: 5 adults on location D. Arrived to the main sheet. The species was also found on location SB. Remarks. Beshkov & Nahirnić (2018b) reported the species as new to Albania. The species' sole other report from the country was published by the same authors (Beshkov & Nahirnić, 2019a). Third report for Albania. Distribution. The species can be found from Portugal across Europe to western Siberia, even reaching Iceland in the North (Ronkay et al., 1990).

*Dryobotodes eremita* (Fabricius, 1775) (Figs 8E, 10A). Material: 2 adults on location B. Arrived to the main sheet. Genitalia of one male was examined (Gen. prep. TB2464). 1 female was also found on location SB. Genitalia examined (Gen. prep. 2./18. XII.2025). Remarks. Even though Beshkov & Nahirnić (2018b) reported the species as new to the Albanian fauna, another article of them (Beshkov & Nahirnić, 2018a) stating "second report" for this species has been published 1 month before, therefore involuntarily claiming the right for first report. Beshkov & Nahirnić (2019a) also mention the species from the country. Fourth report for Albania.

*Antitype chi* (Linnaeus, 1758) (Fig. 9A). Material: 1 adult on location B. Arrived to the main sheet. Remarks. Beshkov & Nahirnić (2019a) reported the species as new to the Albanian fauna. Second report is that of Beshkov et al. (2020a). No further mention has surfaced since from the country. Third report for Albania. Distribution. The species has the widest distribution among the species in its genus, reaching from Portugal and the British Isles to Asia Minor and the Russian Far East (Ronkay et al., 1990).

*Antitype suda schimae* Schawerda, 1911 (Figs 9B–F, 10B, 10E–H, 12E). Material: 1 male on location A. Arrived to one of the two sheets. Genitalia examined (Gen. prep. TB2461). 52 males and 3 females were found on location SB. Genitalia of both sexes examined (Gen. preps S. Beshkov 1./07. XI.2025; 1./08. XII.2025; 2./08. XII.2025). Remarks. *Antitype suda schimae* is very variable, confusion with *Antitype jonis* (Lederer, 1865) is possible even after examination of the male genitalia. Examination of the everted vesica is recommended. The female genitalia are more diagnostic. The finding was expected, because on 01<sup>st</sup> September in a very similar looking locality in Bosnia and Herzegovina on a lower altitude, Stoyan Beshkov and Ana Nahirnić-Beshkova found several specimens of *Antitype suda schimae* at light. This suggested the possible occurrence of the species in Albania, Mali me Gropa, near the location SB. *Antitype jonis* can be found in the checklist compiled by Rebel & Zerny (1931). Heinicke (1965) reported that species from the same locality where the previously reported specimens were found. New localities were published recently (Beshkov & Nahirnić, 2019a; Beshkov & Nahirnić-Beshkova, 2021). Due to the finding of *A. suda schimae* in the country, these reports are considered doubtful, although the examination of the male genitalia of the reported specimens is possible after brushing. Ongoing revision might reveal additional subspecies or even species from this group. New species for Albania. Distribution. The species has a scattered distribution with a different subspecies on each fragment. Two are found in the Alps, one in the Apennines and the present subspecies is endemic to the Balkans (Ronkay et al., 1990; Mrnjavčić Vojvoda et al., 2014).

*Ammoconia caecimacula* (Denis & Schiffermüller, 1775). Material: 2 adults on location A, 3 on location B, 2 near location C and 3 on location D. Arrived to both the main and supplementary sheets



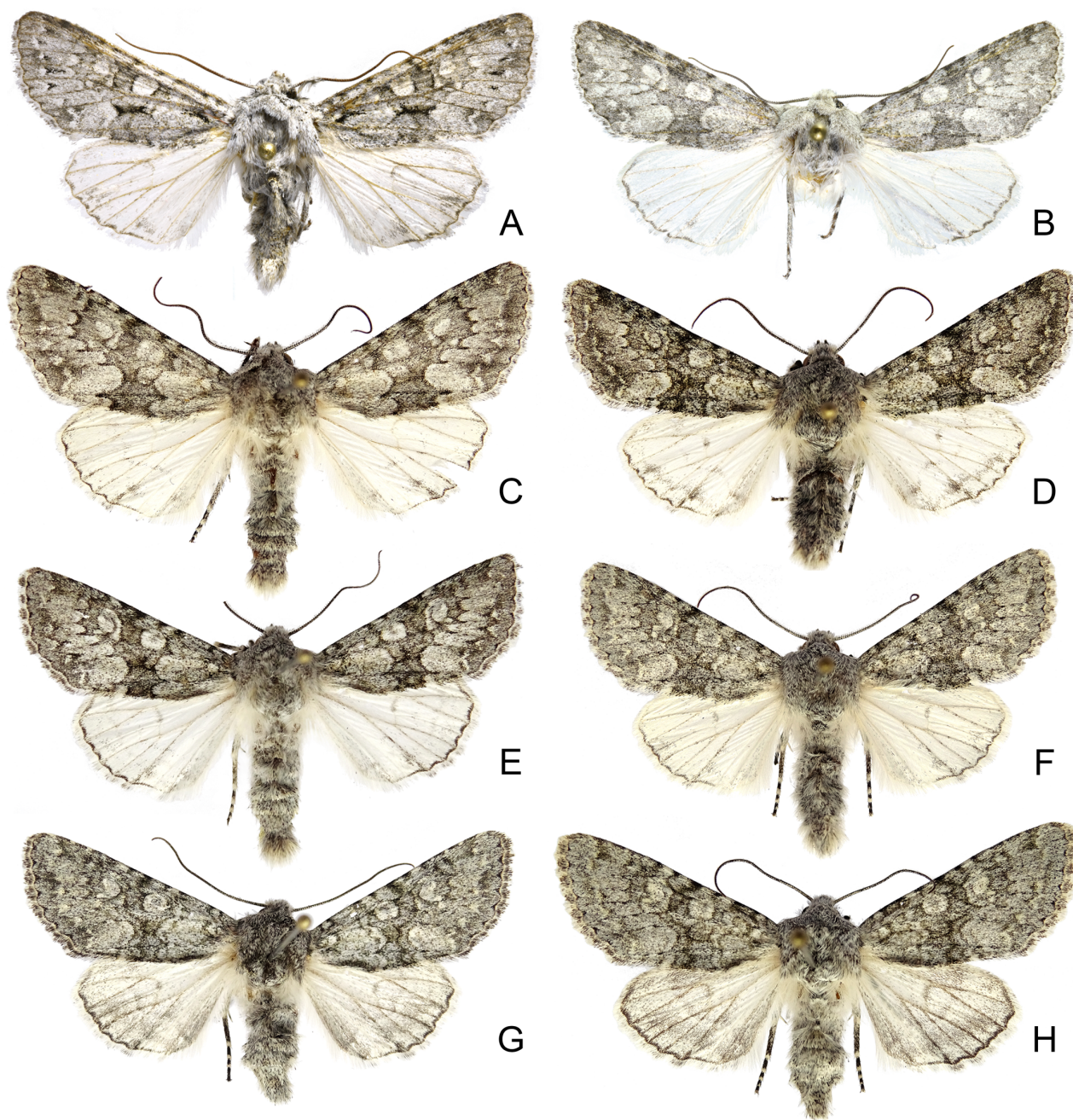


Fig. 9. *Antitype* spp. from Albania. A, *Antitype chi*; B–F, *Antitype suda schimae*, males; G–H, *Antitype suda schimae*, females. Scale bar: 10 mm. Photos by Balázs Tóth (A, B) and Stoyan Beshkov (C–H).

on locations A and B, to both supplementary sheets on location C and to the main sheet on location D. Was also found on location SB. Remarks. First reported from the country by Misja (1980). Additional information was provided by Beshkov & Nahirnić (2018a, 2019a). Fourth report for Albania.

*Ammoconia senex* (Geyer, 1828). Material: 2 adults on location A, 6 on location C and 8 on location

D. Arrived to both the main and supplementary sheets on each given location. Remarks. Beshkov & Misja (1995) reported the species as new to Albania. Later mentioned in several articles (Beshkov & Nahirnić, 2018a, 2019a; Beshkov & Nahirnić-Beshkova, 2021).

*Trigonophora flammea* (Esper, 1785). Material: 1 adult near location A and 2 on location B. Arrived to the supplementary sheet of location A, to the main

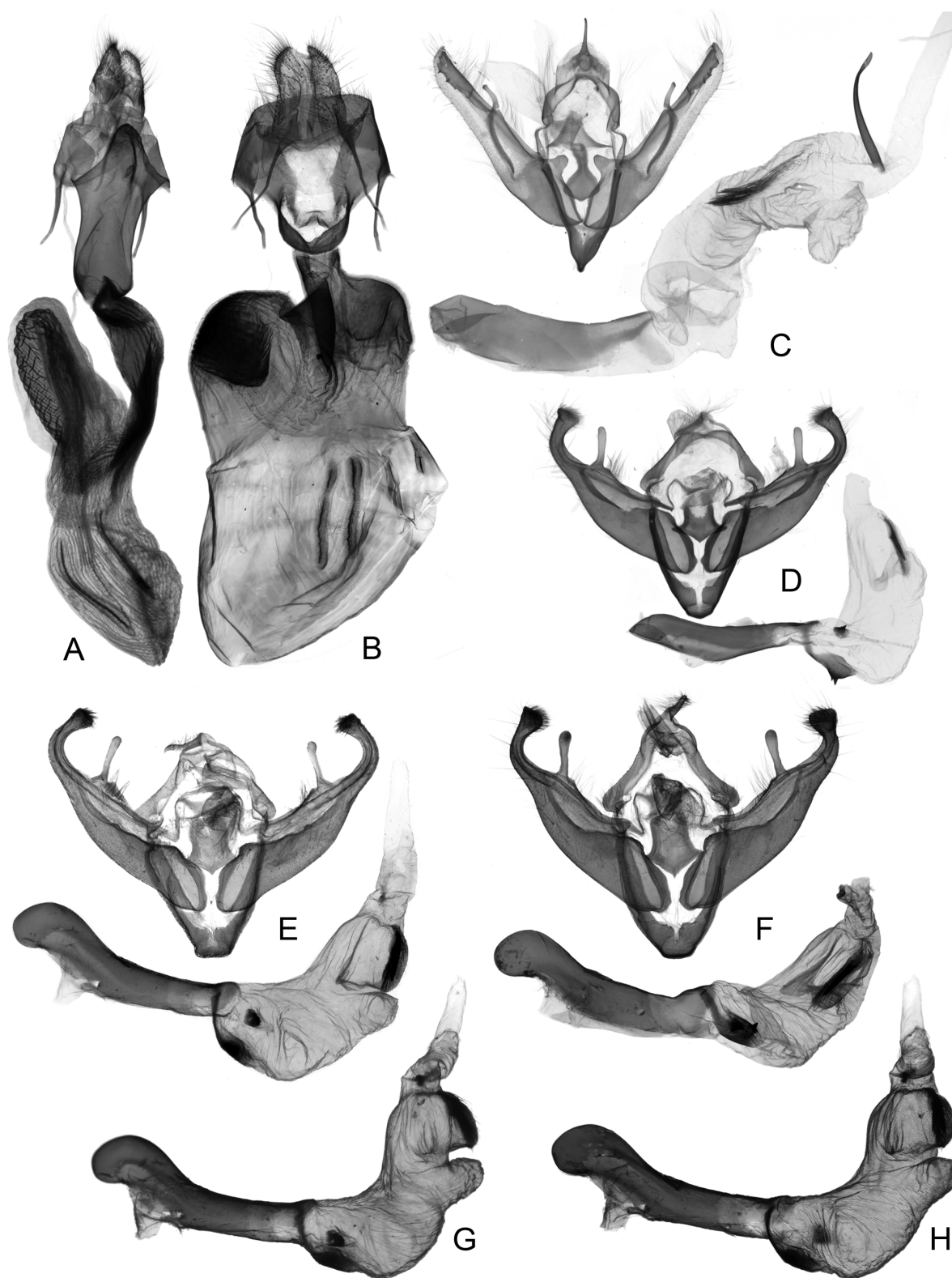


Fig. 10. Genitalia of Noctuidae from Albania. A, *Dryobotodes eremita*, slide No. GP2.18.XII.25; B, *Antitype suda schimae*, slide No. GP1.08.12.2025; C, *Anchoscelis litura*, slide No. TB2463m; D, *Antitype suda schimae*, slide No. TB2461m; E, *Antitype suda schimae*, slide No. GP1.7.11.2025; F, *Antitype suda schimae*, slide No. GP2.08.12.2025; G, *Antitype suda schimae*, everted vesica, slide No. GP1.7.11.2025; H, *Antitype suda schimae*, everted vesica, slide No. GP1.7.11.2025. Scale bar: 1 mm. Photos by Stoyan Beshkov (A, B, E–H) and Botond Balogh (C, D).



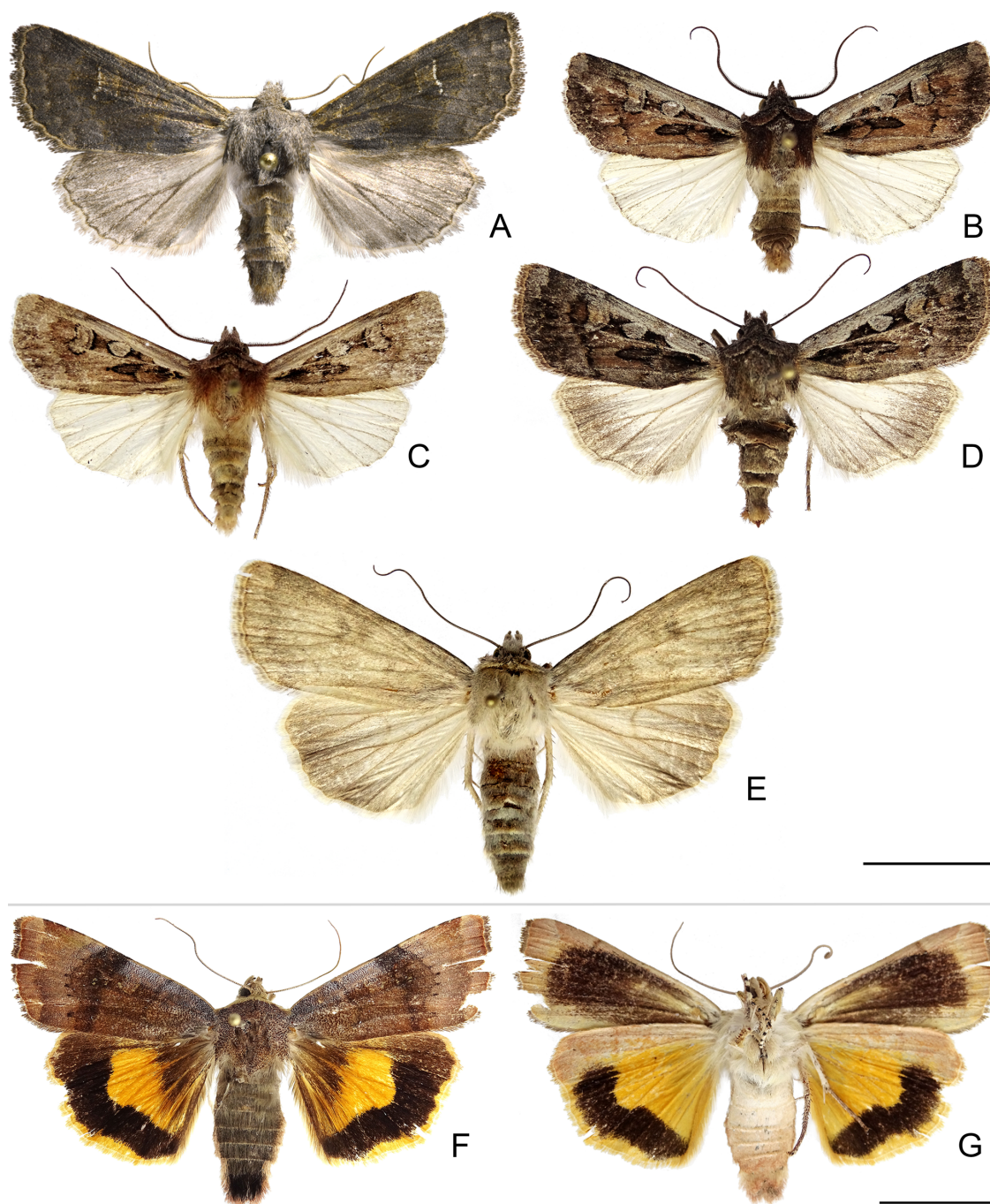


Fig. 11. Noctuidae from Albania. A, *Aporophyla lutulenta*; B–C, *Euxoa vitta herzegovinensis*, males; D, *Euxoa vitta herzegovinensis*, female; E, *Standfussiana lucerneae*; F, *Noctua tertia*, upperside; G, ditto, underside. Scale bars: 10 mm. Photos by Balázs Tóth (A) and Stoyan Beshkov (B–G).

sheet and bait on location B. Remarks. The initial finding of the species in the country was reported by Misja (1980). Further data on its distribution in Albania are provided in recent research articles (Nahirić & Beshkov, 2017; Beshkov & Nahirić, 2019a; Beshkov & Nahirić-Beshkova, 2025).

*Aporophyla lutulenta* (Denis & Schiffermüller, 1775) (Fig. 11A). Material: 1 adult on location D. Arrived to the main sheet. Remarks. The species only appears once in literature from the country in the work of Beshkov & Nahirić (2019a). Second report for Albania. Distribution. The species can be found





Fig. 12. Live individuals of Noctuidae from Albania. A, *Cucullia formosa*, larva, dorsal view; B *Cucullia formosa*, larva, lateral view; C, *Gortyna borelii lunata*, male adult; D, *Xylena lunifera*, adult; E, *Antitype suda schimae*, male adult; F, *Standfussiana lucerneae illyrica*, female adult. Photos by Áron Horváth (A–D, F) and Stoyan Beshkov (E).

from Italy across the southern regions of Central and Eastern Europe reaching the Caucasus and Asia Minor (Ronkay et al., 1990; Nowacki et al., 2023).

*Aporophyla canescens* (Duponchel, 1827).  
Material: 8 adults on location A and 10 on location B.

Arrived to both the main and supplementary sheets on each mentioned location. Genitalia of one male was examined (Gen. prep. TB2462). Remarks. This species already appears in the checklist compiled by Rebel & Zerny (1931). Numerous additional records

back the constant occurrence of the species in Albania (Heinicke, 1965; Beshkov, 1995; Beshkov & Nahirnić, 2019a; Beshkov & Nahirnić-Beshkova, 2021).

*Dasypolia templi vecchiontium* Ronkay & Varga, 1985. Material: 1 adult near location A and 1 on location D. Arrived to the supplementary sheet on location A and to the main sheet on location D. Remarks. Beshkov & Nahirnić (2018b) reported the species from Albania for the first time. Further data are provided by Beshkov & Nahirnić-Beshkova (2021, 2025). Fourth report for Albania.

*Polymixis serpentina* (Treitschke, 1825). Material: 5 adults on location A and 7 on location B. Arrived to both the main and supplementary sheets on each mentioned location and even to bait near site B. Remarks. Misja (1976) mentions the species for the first time from Albania. Several sightings were reported since (Beshkov, 1995; Nahirnić & Beshkov, 2017; Beshkov & Nahirnić, 2019a; Beshkov & Nahirnić-Beshkova, 2025).

*Polymixis rufocincta* (Geyer, 1828). Material: 1 adult on location C and 8 on location D. Arrived to the main sheet on each location. Remarks. Rebel & Zerny (1931) already mention this species from Albania. Additional data is also available regarding *P. rufocincta* from the country (Heinicke, 1965; Beshkov & Nahirnić, 2018b, 2019a).

*Mesogona acetosellae* (Denis & Schiffermüller, 1775). Material: 1 adult on location B. Arrived to the main sheet. Remarks. This species is mentioned in Albanian literature two times by Beshkov & Nahirnić (2018b, 2019a). Third report for Albania. Distribution. The range of distribution for the present species spans across Europe from Portugal to the Caucasus and Asia Minor (Fibiger & Hacker, 2007).

#### Subfamily Hadeninae Guenée, 1837

*Mythimna vitellina* (Hübner, 1808). Material: Field observation on location SB. Remarks. Found in the work of Rebel & Zerny (1931). This species is widespread and common in Albania (Moucha, 1963b; Heinicke, 1965; Misja, 1976; Beshkov, 1994, 1996; Beshkov & Abadjiev, 1996; Beshkov & Nahirnić, 2019a; Beshkov et al., 2020b).

*Mythimna unipuncta* (Haworth, 1809). Material: 1 adult on location D. Arrived to the main sheet. Was also found on location SB. Remarks. This migratory

species was reported new for Albania in the work of Heinicke (1965). Several sightings and mention in literature followed (Misja, 1976; Beshkov, 1994, 1996; Beshkov & Abadjiev, 1996; Beshkov & Nahirnić, 2019a; Beshkov et al., 2020b; Bond, 2023).

*Mythimna sicula* (Treitschke, 1835). Material: 2 adults on location A. Arrived to the main and supplementary sheet. Remarks. Initial finding of the species in Albania was reported by Heinicke (1965). Further data on this species are provided by Stoyan Beshkov and his co-authors (Beshkov, 1995; Beshkov & Misja, 1995; Beshkov et al., 1996, 2020a, 2020b; Beshkov & Nahirnić, 2019a).

*Mythimna albipuncta* (Denis & Schiffermüller, 1775). Material: Field observation on location SB. Remarks. Appears in the checklist by Rebel & Zerny (1931). A common species with well-established populations in Albania (Heinicke, 1965; Misja, 1976; Beshkov, 1996; Beshkov & Abadjiev, 1996; Beshkov & Nahirnić, 2019a; Beshkov et al., 2020b).

*Mythimna ferrago* (Fabricius, 1787). Material: 1 adult on location B. Arrived to the main sheet. Remarks. This species appears in the checklist compiled by Rebel & Zerny (1931) but without proper location data. Heinicke (1965) also mentions the species but refers only to the previously reported specimen. Misja (1980) provided more reliable data regarding *Mythimna ferrago* from Albania with numerous observations. The species has not been reported since from the country, although it was found in numerous localities by S. Beshkov. Third report for Albania. Distribution. Widespread species, with its native range spanning across Europe, through the Near East and Asia Minor ending in Central Asia and in the western Himalayas (Hacker et al., 2002).

*Mythimna l-album* (Linnaeus, 1767). Material: 2 adults on location A and 1 on location B. Arrived to the main sheet. Was also found on location SB. Remarks. Rebel & Zerny (1931) already mention the species from the country. Its appearance in several following works with high abundance indicates that this species can be frequently found in Albania (Heinicke, 1965; Misja, 1976; Beshkov, 1994, 1996; Beshkov & Abadjiev, 1996; Beshkov & Nahirnić, 2019a; Beshkov et al., 2020b).

*Anapoma riparia* (Rambur, 1829). Material: 1 adult on location D. Arrived to the main sheet. Remarks. Beshkov (1995) reported this species as new to the Albanian fauna. Beshkov & Nahirnić (2018b) published supplementary data. The last



mention from the country is tied to Beshkov & Nahirnić-Beshkova (2025). Fourth report for Albania.

*Tholera cespitis* (Denis & Schiffermüller, 1775). Material: Field observation on location SB. Remarks. In Albania reported from Pogradec, between Dardhas and Guri i Kamjes; Prespa e vogel near Tren (Beshkov & Nahirnić-Beshkova, 2025). The only previous report by Rebel & Zerny (1931) for Plav concerns Montenegro and not Albania (Heinicke, 1965). Second report for Albania. Distribution. The species can be found across Europe, from Spain reaching the Middle East, western Siberia and even China (Hacker et al., 2002).

*Tholera decimalis* (Poda, 1761). Material: 2 adults on location B. Arrived to the main sheet. Was also found on location SB. Remarks. The first report of this species from Albania is in the work of Misja (1976). Misja (1980) also mentions the species but only refers to the previously published data. Additional reports of the species from the country can be found in the work of Plóciennik et al. (2009) and Beshkov & Nahirnić (2019a). Fourth report for Albania.

#### Subfamily Noctuidae Latreille, 1809

*Peridroma saucia* (Hübner, 1808). Material: Field observation on location SB. Remarks. The oldest report for Albania is that of Rebel (1913). Several later reports confirm the presence of this species in Albania (Moucha, 1963a; Misja, 1976; Beshkov, 1994, 1996; Beshkov & Abadjiev, 1996; Beshkov & Nahirnić, 2019a; Beshkov et al., 2020b).

*Euxoa temera* (Hübner, 1808). Material: 1 adult on location A. Arrived to the main sheet. 1 male and 1 female were also found on location SB. Remarks. The first report of this species from Albania is linked to Beshkov (1995). Beshkov & Nahirnić (2018b) provided additional data regarding *Euxoa temera* from the country, but no observation was published since. Third report for Albania. Distribution. The species is widespread in the southern part of Europe. It can be found from Portugal to Central Asia and the Near East (Fibiger, 1990).

*Euxoa vitta hercegovinensis* Schawerda, 1938 (Figs 11B–D). Material: 9 males and 2 females on location SB. Remarks. In Albania, this species is only known from Mali i Thatë (= Galičica Mts), above Korita (Bregas) Village (Beshkov & Nahirnić, 2018a). Second report for Albania. Distribution. While the

species has a wide-ranging distribution across Europe reaching into Asia, ssp. *hercegovinensis* is restricted to the Balkans (Fibiger, 1990).

*Agrotis segetum* (Denis & Schiffermüller, 1775). Material: 1 adult on location B. Arrived to the main sheet. Was also found on location SB. Remarks. The species is already mentioned in the checklist by Rebel & Zerny (1931). Given its pest status, *Agrotis segetum* appears in several works from Albania (Moucha, 1963a; Heinicke, 1965; Misja, 1976; Beshkov, 1994, 1996; Beshkov & Abadjiev, 1996; Kullaj et al., 2005; Beshkov & Nahirnić, 2019a; Beshkov et al., 2020b).

*Agrotis trux* (Hübner, 1824). Material: 2 adults on location A. Arrived to both the main and supplementary sheets. Remarks. Misja (1980) published the finding of the first known specimen from Albania. The species now appears in a few more works regarding the country (Beshkov, 1995; Beshkov & Nahirnić, 2019a; Beshkov & Nahirnić-Beshkova, 2021).

*Agrotis ipsilon* (Hufnagel, 1766). Material: 1 adult near location A, 1 on location B and 2 on location D. Arrived to the supplementary sheet on location A and to the main sheet on locations B and D. Was also found on location SB. Remarks. The species appears in the work of Rebel & Zerny (1931). Similarly to *Agrotis segetum*, this species also has many reported occurrences from Albania (Heinicke, 1965; Misja, 1976; Beshkov, 1994, 1996; Beshkov & Abadjiev, 1996; Kullaj et al., 2005; Plóciennik et al., 2009; Beshkov & Nahirnić, 2019a; Beshkov et al., 2020b).

*Chersotis margaritacea* (de Villers, 1789). Material: 10 adults on location A and 11 on location B. Arrived to both the main and supplementary sheets on each mentioned location. Was also found on location SB. Remarks. The first findings of the species in Albania are reported by Beshkov & Nahirnić (2018b). Additional data was made public soon after by the same authors (Beshkov & Nahirnić, 2019a). The most recent observations of this species from the country are published by Beshkov et al. (2020a). Fourth report for Albania.

*Standfussiana lucerneae illyrica* (Rebel & Zerny, 1932) (Figs 11E, 12F). Material: 1 female near location D. Found in the vegetation not far from the main sheet. 1 female was also found on location SB. Remarks. This subspecies was described from Albania by Rebel & Zerny (1931) in their checklist and was cited by Heinicke (1965). Additional reports



reveal its need for high altitude as all known well detailed occurrence in the country was above 1000 metres (Beshkov & Nahirnić, 2019b; Beshkov et al., 2020b; Beshkov & Nahirnić-Beshkova, 2025).

*Noctua pronuba* (Linnaeus, 1758). Material: Approximately 20 adults on location A, 20 on location B, 5 on location C and 10 on location D. Arrived to both the main and supplementary sheets on location A and B, to the supplementary sheets on location C and to the main sheet on location D. Was also found on location SB. Remarks. Appears in the checklist by Rebel & Zerny (1931). This species has a wide distribution and is very common in Albania. Known from many surveyed locations (Heinicke, 1965; Misja, 1976; Beshkov, 1994, 1996; Beshkov & Abadjiev, 1996; Plóciennik et al., 2009; Beshkov & Nahirnić, 2019a; Beshkov et al., 2020b).

*Noctua fimbriata* (Schreber, 1759). Material: Observed on location SB. Genitalia examined. Remarks. First reported from the country by Beshkov (1994). Very common species in Albania, but difficult separation from its sister species *Noctua tirrenica* Biebing, Speidel & Hanigk, 1983 makes it hard to identify (Beshkov, 1996; Beshkov & Nahirnić, 2019a; Beshkov et al., 2020b).

*Noctua tirrenica* Biebing, Speidel & Hanigk, 1983. Material: Observed on location SB. Genitalia examined. Remarks. The oldest report for Albania is from Korabi, Pshtriik and Jablanica (Hacker, 1989), but the specimen reported as “*Agrotis (Triphaena) fimbria* L.” by Rebel & Zerny (1931) has turned out to be *N. tirrenica* as well, as explained by Beshkov (1995). Many other localities are known in Albania from the sea level up to more than 2000 metres (Beshkov & Misja, 1995; Plóciennik et al., 2009; Nahirnić & Beshkov, 2017; Beshkov & Nahirnić, 2019a; Beshkov et al., 2020a, 2020b).

*Noctua orbona* (Hufnagel, 1766). Material: 1 adult on location A and 1 on location B. Arrived to the main sheet. Remarks. The initial report of this species from Albania by Misja (1976) mentions *Noctua comes* Hübner, 1813 as a synonym for *N. orbona*. Therefore, the likelihood of misidentification is high as previously stated in the articles from Albania, where the authors gave more reliable data for this species (Beshkov & Nahirnić, 2019a; Beshkov et al., 2020a, 2024; Beshkov & Nahirnić-Beshkova, 2025).

*Noctua comes* Hübner, 1813. Material: Approximately 5 adults on location A, 10 on location B and 5 on location D. Arrived to both the main and

supplementary sheets on location A and B and to the main sheet on location D. Was also found on location SB. Remarks. Rebel & Zerny (1931) already mention this species from several locations. Appears in many articles later on, indicating its stable presence in the country (Heinicke, 1965; Misja, 1976; Beshkov, 1995; Beshkov & Nahirnić, 2019a; Beshkov et al., 2020b).

*Noctua interjecta* Hübner, 1803. Material: Field observation on location SB. Remarks. Reported as a new species for the Albanian fauna from the Adriatic Sea Coast: Velipoja Beach near Shkodra and Curila near Durres by Beshkov (1995). Many other reported localities followed (Beshkov & Nahirnić, 2018b; Beshkov et al., 2020b, 2024).

*Noctua janthe* (Borkhausen, 1792). Material: 2 adults on location A, 1 on location B and 1 on location D. Arrived to the main sheet. Remarks. Beshkov & Misja (1995) reported the species as new to the fauna of Albania. As stated in the article, the specimen Misja (1976) reported as *Noctua janthina* (Denis & Schiffermüller, 1775) turned out to be *N. janthe* after the examination of the genitalia. In contrast to older articles where the reports about *Noctua janthe* in the Balkan Peninsula are scarce, recent works show that this species appears more often than previously thought, conceivably its absence in previous reports was perhaps due to its difficult separation from *Noctua janthina* and *Noctua tertia* von Mentzer, Moberg & Fibiger, 1991 (Plóciennik et al., 2009; Beshkov et al., 2020a, 2024; Beshkov & Nahirnić-Beshkova, 2025).

*Noctua tertia* von Mentzer, Moberg & Fibiger, 1991 (Figs 11F–G). Material: 1 female on location SB. Remarks. The oldest report from Albania regarding the species is from Shkodra Lake: Zogaj Village (Beshkov, 1995). Not a rare species in the country, known from more localities in North and South Albania (Beshkov & Nahirnić, 2018b, 2019a; Beshkov et al., 2020a).

*Xestia castanea michaeli* Ronkay, Ronkay & Varga, 2024. Material: 1 adult near location A and 15 on location B. Arrived to the supplementary sheet on location A, to both the main and supplementary sheet and to bait on location B. 1 female was also found on location SB. Remarks. Even though this subspecies was described recently, the species appears in the literature from Albania several times (Rebel & Zerny, 1931; Heinicke, 1965; Plóciennik et al., 2009; Beshkov & Nahirnić, 2019a; Beshkov & Nahirnić-Beshkova, 2021, 2025).

*Xestia xanthographa* (Denis & Schiffermüller, 1775). Material: 3 adults on location A and 6 on location B. Arrived to both the main and supplementary sheets on each mentioned location and was also attracted to bait on location B. Remarks. Already mentioned in the checklist by Rebel & Zerny (1931). This species has many reports from Albania (Misja, 1976; Beshkov, 1995; Beshkov & Misja, 1995; Beshkov & Nahirnić, 2019a).

*Xestia cohaesa* (Herrich-Schäffer, 1849). Material: 3 adults on location B. Arrived to the main sheet. 1 female was also found on location SB. Remarks. The species was first reported from Albania by Beshkov et al. (1996). Nahirnić & Beshkov (2017) reported the second occurrence. Additional reports reveal several new locations for this species in the country (Beshkov & Nahirnić, 2019a; Beshkov & Nahirnić-Beshkova, 2021).

## Discussion

The total number of species observed during the collecting trips and reported above was 122, with three species and a genus new to the fauna of Albania. Nine species are reported for the second, eighteen species for the third and twelve species for the fourth time from the country. The localities of the Hungarian team with most species were locations A and B, most likely due to higher temperatures associated with elevation. The Lepidoptera observed on those localities were, on average, species with earlier flight periods than those found on higher altitudes with colder microclimate, resulting in the observation of species whose flight periods differ significantly in such a short timeframe. These results are further backed up by the observed species on location SB where the related expedition was conducted earlier resulting in the discovery of species that were found later on much lower altitudes by the Hungarian team. Among the observed species, most were found on habitats suitable for the development of their larvae, with few exemptions (e.g.: *Nothocasis rosariae*). The present results show that, although significantly improved, the level of research in Albania on nocturnal Macroheterocera still fall short of most countries in Europe. The authors advocate for further studies on this, and other insect groups in the country, because as exemplified by *Gortyna borelii lunata*, species with high conservation value might still be present in Albania without notice.

These species, usually with very local distributions require protection in order for their population to remain intact and contribute to the richness of the fauna. Mali me Gropa has proven to have a wide variety of Lepidoptera in the autumn period. The diversity at this and other aspects of the year should also be subject to future research to increase the number of known species from the area of the massif and the country itself, but also to collect comparative material.

## Acknowledgements

The authors would like to express their gratitude to László Ronkay for his comments on this manuscript and to Boglárka Korosecz who took tasks upon herself unrelated to the article, creating the opportunity for the main author to focus more on writing.

## Conflicts of interest

No potential conflict of interest has been reported by the authors, reviewers, or subject editor.

## Author's contributions

(using [CrediT](#) )

Botond Balogh: conceptualisation, data curation, formal analysis, investigation, project administration, resources, supervision, visualisation, writing—original draft; Balázs Tóth: data curation, investigation, resources, visualisation, writing—review and editing; Áron Horváth: investigation, resources, visualisation; Stoyan Beshkov: data curation, investigation, resources, visualisation, writing—review and editing; Nimród Varga: conceptualisation, data curation, investigation, resources, writing—review and editing.

## References

- Baranyi T., Korompai T., Józsa Á.Cs., Kozma P. 2006 *Gortyna borelii lunata* (Freyer, 1838). In: Varga Z. (ed.) Natura 2000 species studies. Dél-Nyírség-Bihari Tájvédelmi és Kulturális Értéktörző Egyesület, Debrecen, 1: 3–69.

- Beshkov S. 1994 Migrant Lepidoptera species in Macedonia and Albania, 1993 (Lepidoptera). *Atalanta* 25 (3/4): 461–468.
- Beshkov S. 1995 A Contribution to the knowledge of the Lepidoptera fauna of Albania 2. Some findings of a collecting trip in September 1993 (Lepidoptera, Macrolepidoptera). *Atalanta* 26 (1/2): 365–399.
- Beshkov S. 1996 Migrant Lepidoptera species in Albania and Macedonia in 1995 (Insecta, Lepidoptera). *Atalanta* 27 (3/4): 535–543.
- Beshkov S. 2013a An Annotated Systematic and Synonymic Check List of the Noctuidae of Bulgaria – 13 years later. XVIII European Congress of Lepidopterology, 29 July – 4 August 2013, Blagoevgrad, Bulgaria, Programme and Abstracts: 25–26.
- Beshkov S. 2013b Distributional maps of the NATURA 2000 butterfly and moth species in Bulgaria. XVIII European Congress of Lepidopterology, 29 July – 4 August 2013, Blagoevgrad, Bulgaria, Programme and Abstracts: 24.
- Beshkov S. 2018 A Contribution to knowledge of the Balkan Lepidoptera: New and rare Erebidae and Noctuidae for Albania, collected in 2016. *The Entomologist's Record and Journal of Variation* 130 (3): 155–172.
- Beshkov S., Abadjiev S. 1996 Migrant species in Macedonia and Albania, 1994 (Insecta, Lepidoptera). *Atalanta* 27 (1/2): 157–164.
- Beshkov S., Misja K. 1995 A Contribution to the knowledge of the Lepidoptera fauna of Albania. 1. Some materials from the collection of K. Misja in the Natural History Museum Tirana and some results of the collecting trip of Beshkov during 1992 (Lepidoptera, Macrolepidoptera). *Atalanta* 26 (1/2): 345–363.
- Beshkov S., Misja K., Abadjiev S. 1996 A Contribution to the knowledge of the Lepidoptera fauna of Albania. 3. Some results of the collecting in April 1994 and some materials from the collection of the Natural History Museum of Tirana (Lepidoptera, Macrolepidoptera, Heterocera). *Atalanta* 27 (3/4): 623–648.
- Beshkov S., Nahirnić A. 2018a A contribution to knowledge of the Balkan Lepidoptera: New and rare moths for Albania, collected in 2017. *The Entomologist's Record and Journal of Variation* 130: 215–232.
- Beshkov S., Nahirnić A. 2018b New and rare Noctuoidea species for Albania (Lepidoptera: Nolidae, Erebidae and Noctuidae). *Atalanta* 49 (1–4): 159–170.
- Beshkov S., Nahirnić A. 2018c Three new *Anchoscelis* Guenée, 1839 species for Albania and two for the Republic of Macedonia (Lepidoptera, Noctuidae). *Atalanta* 49 (1–4): 171–176.
- Beshkov S., Nahirnić A. 2019a A contribution to knowledge of the Balkan Lepidoptera: Species collected in the autumn of 2018 in Albania (Macrolepidoptera with some Crambidae). *The Entomologist's Record and Journal of Variation* 131: 66–102.
- Beshkov S., Nahirnić A. 2019b A contribution to knowledge of Balkan Lepidoptera: Some new and rare species for Albania and North Macedonia (Macrolepidoptera). *The Entomologist's Record and Journal of Variation* 131: 242–260.
- Beshkov S., Nahirnić A. 2020 Contribution to knowledge of the Balkan Lepidoptera (Lepidoptera: Macrolepidoptera). *Ecologica Montenegrina* 30: 1–27.  
<https://doi.org/10.37828/em.2020.30.1>
- Beshkov S., Nahirnić-Beshkova A. 2021 Contribution to knowledge of the Balkan Lepidoptera II (Lepidoptera: Macrolepidoptera). *Ecologica Montenegrina* 42: 1–44.  
<https://doi.org/10.37828/em.2021.42.1>
- Beshkov S., Nahirnić-Beshkova A. 2025 Studies on the Balkan Lepidoptera I. *Historia naturalis bulgarica* 47 (8): 169–285.  
<https://doi.org/10.48027/hnb.47.081>
- Beshkov S., Nahirnić-Beshkova A., Jakšić P. 2024 Contribution to knowledge of the Balkan Lepidoptera III. *Ecologica Montenegrina* 73: 226–287.  
<https://doi.org/10.37828/em.2024.73.21>
- Beshkov S., Plant C., Nahirnić A. 2020a A Contribution to Knowledge of the Balkan Lepidoptera: Some species collected in Albania in August 2018. *The Entomologist's Record and Journal of Variation* 132: 129–152.
- Beshkov S., Plant C., Nahirnić A., King A., Jakšić P. 2020b A contribution to knowledge of Balkan Lepidoptera: Moths collected in May-June 2018 in Austria, Slovenia, Serbia, North Macedonia and Albania. *The Entomologist's Record and Journal of Variation* 132: 24–45.



- Bjerregård E.B., Bjerg M., Clausen A.B., Dahl K., Glintborg S.P., Videnkjær C. 2023 Butterflies of Albania: new surveys, four new records and a new checklist (Lepidoptera: Papilionoidea). *Phegea* 51 (2): 65–76.
- Bond K. 2023 Lepidoptera recorded in Albania during two visits, 2009 and 2014. *The Entomologist's Record and Journal of Variation* 135: 129–136.
- Cuvelier S., Parmentier L., Paparisto A., Couckuyt J. 2018 Butterflies of Albania–Fluturat e Shqipërisë. New surveys, new species and a new checklist (Lepidoptera: Papilionoidea). *Phegea* 46 (2): 48–69.
- Eichler F., Friese G. 1965 Ergebnisse der Albanien-Expedition 1961 des Deutschen Entomologischen Institutes. 32. Beitrag. Lepidoptera: Sphingidae. *Beiträge zur Entomologie* 15 (5–6): 633–640. <https://doi.org/10.21248/contrib.entomol.15.5-6.633-640> 
- Fibiger M. 1990 Noctuinae I. Noctuidae Europaeae. Volume 1. Entomological Press, Sorø, 208 pp.
- Fibiger M., Yela J.L., Zilli A., Varga Z., Ronkay G., Ronkay L. 2011 Checklist of the quadrifid Noctuoidea of Europe. In: Witt T.J., Ronkay L. (eds) Noctuidae Europaeae, Volume 13: Lymantriinae and Arctiinae. Entomological Press, Sorø, 11–32.
- Fibiger M., Hacker H. 2007 Amphipyryinae – Xyleninae. Noctuidae Europaeae, Volume 9. Entomological Press, Sorø, 410 pp.
- Friese G. 1967 Ergebnisse der Albanien-Expedition 1961 des Deutschen Entomologischen Institutes. 60. Beitrag. Übersicht der ersten Auswertungssperiode 1961 bis 1965. *Beiträge zur Entomologie* 17 (3–4): 389–404. <https://doi.org/10.21248/contrib.entomol.17.3-4.389-404> 
- Greco S., Ienco A., Scalercio S. 2019 Abundance and diversity of macro-moths in an acer-dominated forest of the Pollino National Park, Southern Italy (Lepidoptera Macroheterocera). *Redia* 102: 73–79. <https://doi.org/10.19263/REDIA-102.19.11> 
- Gyulai P. 1987 Notes on the distribution of *Gortyna borelii lunata* Freyer in the Carpathian Basin. *Nota Lepidopterologica* 10 (1): 54–60.
- Hacker H. 1989 Die Noctuidae Griechendlands. Mit einer Übersicht über die Fauna des Balkanraumes (Lepidoptera, Noctuidae). *Herbipoliana* 2. Eitschberger, Marktleuthen, 589 + XII pp.
- Hacker H., Ronkay L., Hreblay M. 2002 Hadeninae I. – Noctuidae Europaeae, volume 4. Entomological Press, Sorø, 419 pp.
- Hausmann A. 2011 An integrative taxonomic approach to resolving some difficult questions in the Larentiinae of the Mediterranean region (Lepidoptera, Geometridae). *Mitteilungen der Münchner Entomologischen Gesellschaft* 101: 73–97.
- Hausmann, A., Viidalepp J. 2012 Larentiinae I. In: A. Hausmann (ed.) *The Geometrid Moths of Europe* 3. Apollo Books, Stenstrup, 743 pp.
- Heinicke W. 1965 Ergebnisse der Albanien-Expedition 1961 des Deutschen Entomologischen Institutes. 31. Beitrag. Lepidoptera: Noctuidae. *Beiträge zur Entomologie* 15 (5–6): 503–632. <https://doi.org/10.21248/contrib.entomol.15.5-6.503-632> 
- Ignatyev N.N., Zolotuhin V.V. 2006 A review of syntomids (Lepidoptera: Syntomidae) of Russia and adjacent territories. Part 2. Genus *Dysauxes* Hübner, 1826. *Eversmannia* 6: 27–49. (In Russian)
- Infusino M., Luzzi G., Scalercio S. 2017 I macrolepidotteri notturni dell'Arboreto Sbanditi, Area MAB-UNESCO, Parco Nazionale della Sila (Calabria, Italia). *Memorie della Società Entomologica Italiana* 94 (1–2): 137–153. <https://doi.org/10.4081/MemorieSEI.2017.137> 
- Kranjčev R. 1999 23 neue Arten von Nachtfaltern (Noctuidae, Lepidoptera) im Gebiet von Podravina in der Entomofauna der Republik Kroatien. *Podravski zbornik* 25: 261–266.
- Kullaj E., Çakalli A., Shahini S., Varaku S. 2005 Entomofaunistic study on alfalfa, a precondition to the biological control of its pests. In Conference: 1<sup>st</sup> Congress of Plant Protection “Environmental Concern and Food Safety” and XXX<sup>th</sup> Meeting for Plant Protection in the Republic of Macedonia. Skopje: Plant Protection Society of the Republic of Macedonia.
- Macià R., Ylla J., Masó G., Bau J. 2025 On *Setina irrorella pseudoirrorella* Freina and Witt, 1985, and *Setina cantabrica* Freina and Witt, 1985, in Spain and Portugal: taxonomic status, distribution, habitat, and molecular genetics (Lepidoptera: Erebidae: Arctiinae: Lithosiini). *Taxonomy* 2025 5 (2): 1–23. <https://doi.org/10.3390/taxonomy5020023> 
- McGeachie W.J. 1989 The effects of moonlight illuminance temperature and wind speed on light-

- trap catches of moths. Bulletin of Entomological Research 79: 185–192.
- Mironov V. 2003 Larentiinae II (Perizomini and Eupitheciini). In: Hausmann A. (ed.) The Geometrid Moths of Europe 4. Brill, Leiden, 463 pp.  
[https://doi.org/10.1163/9789004691612\\_001](https://doi.org/10.1163/9789004691612_001)
- Misja K. 1976 Données préliminaires sur les noctuelles de la Famille des Noctuidées. Buletini i Shkencave të Natyrës 30 (3): 79–95.
- Misja K. 1977 Données préliminaires sur l'étude des papillons nocturnes de la Famille des Geometridae. Buletini i Shkencave të Natyrës 31 (2): 81–91.
- Misja K. 1978 Données sur l'étude des papillons du groupe Heteroneura de Albanie. Buletini i Shkencave të Natyrës 32 (3): 65–73.
- Misja K. 1980 Quelques nouvelles données sur les papillons nocturnes de la famille Noctuidae d'Albanie. Buletini i Shkencave të Natyrës 35 (1): 73–81.
- Misja K. 1990 Further data on the group of Macrolepidoptera of our country. Buletini I Shkencave të Natyrës 45 (2): 43–50.
- Moucha J. 1963a Eine Lepidopterenausbeute aus Albanien. Entomologisches Nachrichtenblatt Wien 10 (1): 5–7.
- Moucha J. 1963b Eine Lepidopterenausbeute aus Albanien (Schluss). Entomologisches Nachrichtenblatt Wien 10 (2): 12–16.
- Mrnjavčić Vojvoda A., Mihoci I., Vajdić M., Kučinić M. 2014 *Antitype suda* (Geyer, 1832) (Lepidoptera: Noctuidae), new species of noctuid fauna of Croatia, found in the Biokovo Nature Park. Natura Croatica 23 (2): 379–388.
- Müller B., Erlacher S., Hausmann A., Rajaei H., Sihvonen P., Skou P. 2019 Ennominae II. In: Hausmann A., Sihvonen P., Rajaei H., Skou P. (eds) The Geometrid Moths of Europe 6. Brill, Leiden, 906 pp.  
[https://doi.org/10.1163/9789004387485\\_001](https://doi.org/10.1163/9789004387485_001)
- Nahirnić A., Beshkov S. 2017 *Penestoglossa dardoinella* (Millière, 1863) (Lepidoptera: Psychidae) recorded for the first time in Albania. ZooNotes 101: 1–3.
- Naumova M. 2020 Biospeleological notes on fauna in an artificial cave in Përmet (Albania). Importance of former military installations for Biodiversity. Zoology and Ecology 30 (1): 57–62.  
<https://doi.org/10.35513/21658005.2020.1.8>
- Nowacki J., Mahecha O., Wąsala R., Zubek A. 2023 The taxonomic separateness of the species *Aporophyla lueneburgensis* (Freyer, 1848) and *Aporophyla lutulenta* ([Denis & Schiffermüller], 1775) occurring in Poland (Lepidoptera: Noctuidae). SHILAP Revista de lepidopterología 51 (201): 37–50.  
<https://doi.org/10.57065/shilap.433>
- Pino Pérez J.J., Camaño Portela J.L., Pino Pérez R. 2019 *Lithophane* (*Lithophane*) *ornitopus* (Hufnagel, 1766) (Lepidoptera, Noctuidae, Hadeninae) en Orense (Galicia, NO España). Burbug 48: 1–9.
- Plant C.W. 2023 Micromoths of Albania. Entomologist's Record & Journal of Variation 135 (2): 100.
- Plóciennik M., Pawlikiewicz P., Pabis K. 2009 *Palpita vitrealis* (Rossi, 1794) and *Lygephila cracca* ([Denis & Schiffermüller], 1775)-Lepidoptera new for the fauna of Albania. Journal of the Entomological Research Society 11 (2): 39–41.
- Prozorov A.M., Prozorova T.A., Volkova J.S., Yakovlev R.V., Nedoshivina S.V., Pinzari M., Pinzari M., Scalercio S., Bianco G., Saldaitis A., Hausmann A., Revay E.E., Müller G.C. 2022 Revision of the *Lemonia taraxaci* complex, with a description of a new species from Italy and clarification of the status of *Lemonia strigata* (Lepidoptera: Brahmaeidae: Lemoniinae). Zootaxa 5195 (4): 337–360.  
<https://doi.org/10.11646/zootaxa.5195.4.2>
- Rákossy L., Martin M.A., Sitar G.M., Crişan A., Sitar C. 2024 Exploring Morphological Population Variability: Host Plant and Habitat Dependency in the Protected Moth *Gortyna borelii* (Lepidoptera, Noctuidae). Diversity 16 (4): 227.  
<https://doi.org/10.3390/d16040227>
- Rebel H. 1913 Studien über die Lepidopterenfauna der Balkanländer. III. Teil. Sammelergebnisse aus Montenegro, Albanien, Mazedonien und Thrazien. Annalen des naturhistorischen Museums in Wien 27: 281–334.
- Rebel H., Zerny H. 1931 Die Lepidopterenfauna Albaniens. Denkschriften der Kaiserlichen Akademie der Wissenschaften / Mathematisch-Naturwissenschaftliche Classe 103: 37–163.
- Ringwood Z., Gardiner T., Steiner A., Hill J. 2002 Comparison of factors influencing the habitat characteristics of *Gortyna borelii* (Noctuidae) and

- its larval foodplant *Peucedanum officinale* in the United Kingdom and Germany. *Nota lepidopterologica* 25 (1): 23–38.
- Ringwood Z., Hill J., Gibson C. 2004 Conservation management of *Gortyna borelii lunata* (Lepidoptera: Noctuidae) in the United Kingdom. *Journal of Insect Conservation* 8: 173–183.  
<https://doi.org/10.1023/B:JICO.0000045815.23727.58>
- Ronkay G., Ronkay L. 1994 Cucullinae I. – Noctuidae Europaeae, Volume 6: Entomological Press, Sorø, 282 pp.
- Ronkay G., Ronkay L., Varga Z. 2024 Fibigeriana Supplement. Magyarország nagylepkéi, Harmadik, átdolgozott kiadás. Volume 4. Heterocera Press, Budapest, 318 pp.
- Ronkay L., Yela J.L., Hreblay M. 1990 Hadeninae II. – Noctuidae Europaeae, Volume 5. Entomological Press, Sorø, 452 pp.
- Scalercio S., Greco S. 2018 Heterocera fauna of the Calabrian black pine forest, Sila Massif (Italy) (Insecta: Lepidoptera). *SHILAP Revista de lepidopterología* 46 (183): 455–472.  
<https://doi.org/10.57065/shilap.804>
- Scalercio S., Infusino M., Hausmann A. 2016 *Nothocasis rosariae* sp. n., a new sylvicolous, montane species from southern Europe (Lepidoptera: Geometridae, Larentiinae). *Zootaxa* 4161 (2): 177–192.  
<https://doi.org/10.11646/zootaxa.4161.2.2>
- Top-Jensen M., Fritsch D., Kononenko V. 2023 Noctuidae Europaeae Essential. Oestermarie, Bornholm, 837 pp.
- Urbahn E. 1966 Ergebnisse der Albanien-Expedition 1961 des Deutschen Entomologischen Institutes. 51. Beitrag. Lepidoptera: Geometridae. Beiträge zur Entomologie 16 (3–4): 407–446.  
<https://doi.org/10.21248/contrib.entomol.16.3-4.407-446>
- Verovnik R., Popović M. 2013 Annotated checklist of Albanian butterflies (Lepidoptera, Papilionoidea and Hesperioidea). *ZooKeys* 323: 75–89.  
<https://doi.org/10.3897/zookeys.323.5684>
- Zilli A., Ronkay L., Fibiger M. 2005 Apameini. Noctuidae Europaeae, volume 8. Entomological Press, Sorø, 323 pp.



---