proceedings

MDPI

Proceedings

Managing Protected Areas Benefits: New Findings of *Zeuneriana marmorata*, Endangered Species as Listed in IUCN Red List (Insecta: Orthoptera) †

Filippo Maria Buzzetti [1,*], Marco Bardiani [2] and Fausto Leandri [3]

[1] Fondazione Museo Civico di Rovereto, Borgo Santa Caterina, 41, 38068 Rovereto (TN), Italy; buzzettifilippo@fondazionemcr.it, ORCID https://orcid.org/0000-0003-4061-5192
[2] Centro Nazionale Carabinieri Biodiversità "Bosco Fontana", Strada Mantova 29, 46045 Marmirolo (MN), Italy; bardianimarco@gmail.com
[3] World Biodiversity Association onlus, c/o Museo Civico di Storia Naturale, Verona (VR), Italy; faustoleandri@hotmail.com
* Correspondence: buzzettifilippo@fondazionemcr.it
† Presented at the 1st International Electronic Conference on Entomology (IECE 2021), 1–15 July 2021; Available online: https://iece.sciforum.net/.

Abstract: Correct management of protected areas is one of the key factors in biodiversity conservation. Routine surveys in Mincio Natural Park resulted in the finding of a population of *Zeuneriana marmorata* (Fieber, 1853), listed as EN (Endangered) by IUCN in the Red List of European Orthoptera. Other known populations were known only for NE Adriatic coast in Italy and inland in Slovenia. We assume that the current presence of this species is what remains of a larger metapopulation living in the wet habitats of the plains around the North Adriatic Sea. Causes of range fragmentation are supposed, current threats outlined and possible conservation actions proposed.

Keywords: *Zeuneriana marmorata*; Orthoptera; threatened species; Molinia meadows; distribution; habitat protection; species conservation; biodiversity; bioacoustic

Citation: Buzzetti, F.M.; Bardiani, M.; Leandri, F. Managing Protected Areas Benefits: New Findings of *Zeuneriana marmorata*, Endangered Species as Listed in IUCN Red List (Insecta: Orthoptera), in Proceedings of the 1st International Electronic Conference on Entomology, 1–15 July 2021, MDPI: Basel, Switzerland, doi:10.3390/IECE-10519

Published: 1 July 2021

1. Introduction

The Adriatic Marbled Bush-Cricket, *Zeuneriana marmorata* (Fieber, 1853), is a medium sized bush-cricket that lives in a varied range of wet habitats of North East Italy and Slovenia.

Described sub *Platycleis* (Fieber, 1853) from "Illyrien", the Kingdom of Illyria being a crown land of the Austrian Empire from 1816 to 1849, without any further geographical details.

The nomenclature of the species has changed many times after the description, being mentioned sub *Chelidoptera* [1], sub *Metrioptera* [2], sub *Sphagniana* [3], then transferred to the new genus *Zeuneriana* [4].

The first accurate finding locality is Chioggia, mentioned by [5]. [6] mentions collections in Aquileia, while [7] cites "mouth of the River Adige" as collecting locality. Further localities and more extensive geographical information are listed in [8] and [9] from the collections of the Museo Civico di Storia Naturale di Venezia, Museo Civico di Storia Naturale di Trieste and La Greca Collection (presently at the Museo Civico di Storia Naturale di Milano). The last and most updated inventory of localities of the species is in [10]. *Zeuneriana marmorata* is listed as Endangered (EN) by IUCN [11], included in the European Red List of Grasshoppers, Crickets and Bush-crickets [12] and focus of two IUCN national action plans, one for Italy [13] and one for Slovenija [14].

Recent field research in the Regional Natural Park "Parco del Mincio" resulted in the discovery of several sub-populations of this species. New distributional data,

considerations on distribution and implications for species conservations are presented below.

2. Materials and Methods

The study was carried out at the Regional Reserve "Valli del Mincio" (1,082 ha; 45°10'N 010°42'E; Mantova province; Figure 1) managed by the Mincio Regional Park "Parco del Mincio". The Reserve has been designated as a Ramsar Sites (Wetlands of International Importance; Ramsar site no. 294. [https://www.ramsar.org/wetland/italy]) and is included within two NATURA 2000 sites: the Special Area of Conservation IT20B0017 "Ansa e Valli del Mincio" and the Special Protection Areas IT20B0009 "Valli del Mincio".

The study area has been chosen after that an occasionally observed Orthoptera was tentatively identified as *Zeuneriana* in early summer 2019 (04.VI). The following year, specific entomological surveys have been conducted by Fausto Leandri (FL), Marco Bardiani (MB), Filippo Maria Buzzetti (FMB) during the months of July, August and September (20.VII.2020, 28.VII.2020, 31.VII.2020, 17.VIII.2020, 26.VIII.2020, 07.IX.2020, 10.IX.2020), ensuring specimens to identify correctly and reliably. Specimens have been detected by hearing, entomological sweeping net, pictures and song recording (Tascam DR07X and ZOOM H1), then geolocated with a GPS Garmin Etrex 30.

Each observation has been related to the habitat on the basis of the map at 1:10.0000 "Tav.6 - Carta degli habitat" (www.parcodelmincio.it/pdf/Tavole/T6_vallidelmincio_habitat.pdf). The habitat codes follow the Habitat Directive and CORINE BIOTOPES coding.

We use here the terms subpopulation and metapopulation according the distinction proposed by IUCN and [15]:

Subpopulation: a population that is so isolated from others of the same species that it is considered extremely unlikely that there is any genetic interchange. In general, listings of subpopulations should be restricted to those that have been isolated for a long period of time;

Metapopulation: a population of subpopulations.

3. Results

3.1. Direct Observations

Overall 6 specimens of *Zeuneriana marmorata* were detected within the study area, as listed below:

Valli del Mincio: 4.VI.2019, FL, 1 immature male (Figure 2A); 20.VII.2020, MB & FL, 1 female (Figure 2B); 31.VII.2020, MB & FL, 1 male; 7.IX.2020, FMB & FL, 3 females (FMB collection).

3.2. Song Recording

Overall 19 audio-recordings of singing specimens were performed in the field in 18 different points of the study area . The first recording was obtained on 20 July 2020 and the last on 31/07/2020. Other singing specimens have bee heard in the same period, without recording. All acoustic detections and recordings were performed during daytime.

3.3. Habitat

Zeuneriana marmorata has been observed (direct or acoustic observation) in the following habitats: Selino-Molinietum caeruleae (Habitat Directive code: 6410) in 18 occasions; Caricetum elateae (Corine Biotopes code: 53.2151) or on *Carex* in riparian vegetation in 11 occasions; Lolietum multiflorae, (Habitat Directive code: 6510) in 11 occasions (mainly related to the edges, along riparian vegetation); flooded *Phragmites* bed (Corine Biotopes code: 53.111) in one single occasion.

3.4. Figures

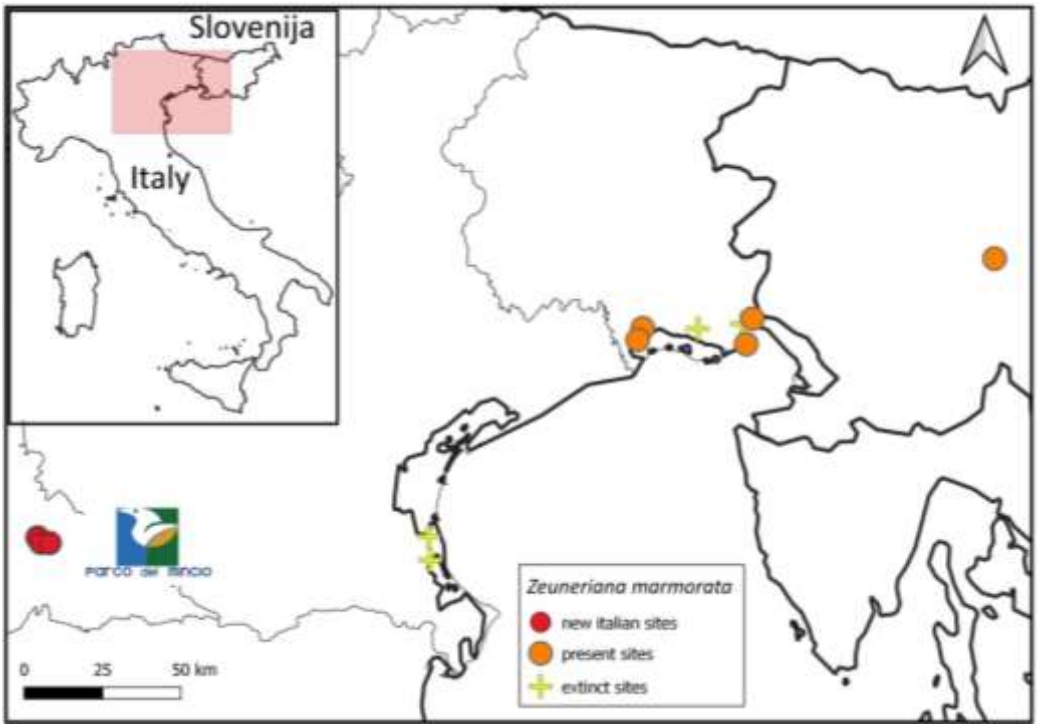

Figure 1. map with the known (existing and historical) populations of *Zeuneriana marmorata*.

(**a**) (**b**)

Figure 2. *Zeuneriana marmorata* from Mincio Park.: (**a**) male nymph; (**b**) adult female.

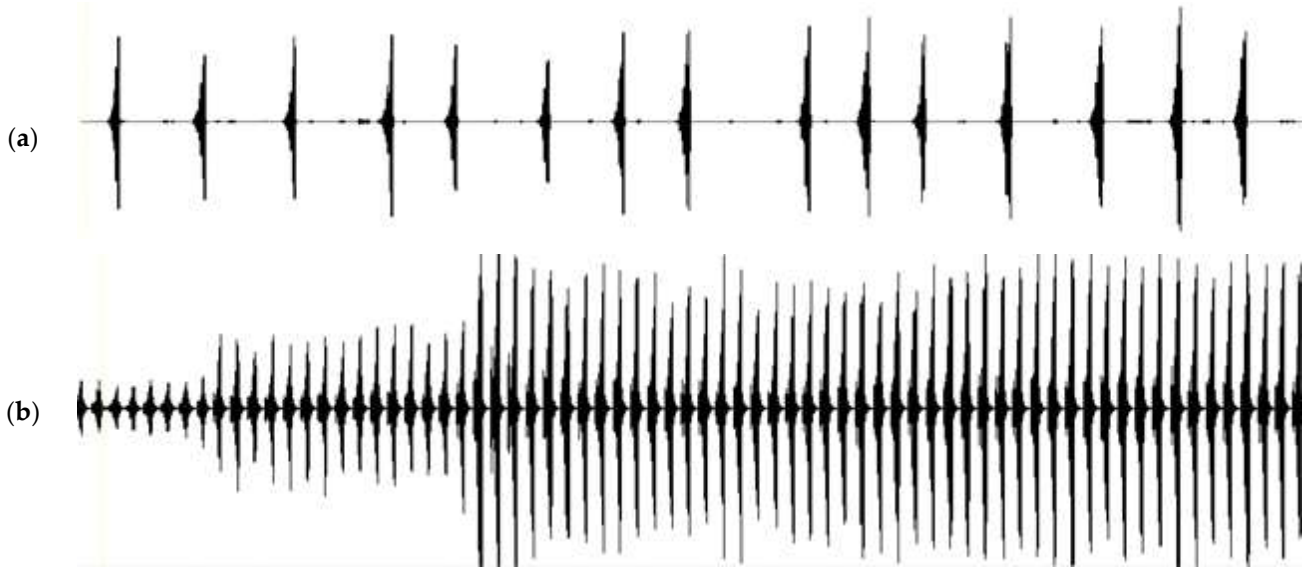

Figure 3. male calling song of *Zeuneriana marmorata* from two different subpopulations, length 10 sec.: (**a**) Mincio Park; (**b**) Marano lagoon.

4. Discussion

The discovery of a new subpopulation of *Zeuneriana marmorata* at Mincio Park, the first inland population, has a manifold meaning and suggests implications.

This finding extends the known distribution [16,17] to the inland of Padanian Plain.

The morphological comparison between the three females from Mincio (no males were collected to date) and females of other species of *Zeuneriana* from the collection of the Fondazione Museo Civico di Rovereto (Galvagni collection and Fontana collection) confirms the identification as *Z. marmorata*. However more specimens, also males, are needed for a more complete diagnosis, especially on male internal genitalia structure.

A preliminary sound analysis (Fig. 3A,B) has been carried out comparing the sounds field recorded from Mincio Park and a male calling song from another Italian subpopulation (Marano lagoon, NE Italy). Although the recordings were made with different equipment (sonic response from Mincio and ultrasonic response for Marano), the comparison allows some comments. The Mincio song is composed of less echemes with 1.6 echeme/sec. in the Mincio recording, 7 echeme/sec. in the Marano recording. The echeme structure is very similar but a deeper analysis is needed. The frequency analysis shows the peak around 12kHz in both recordings.

The first implication regards the distribution of the species. After confirming the identity of this population to *Z. marmorata* species, the present distribution of this taxon is larger than thought until date. In facts, all the previously known Italian subpopulations [14], live in coastal wet habitats while the only Slovenian subpopulation lives inland [13]: thus, the Mincio subpopulation is the first in Italian inland and it is about 100 km far from the nearest coastal subpopulation. This suggests that the historical range of the species could be much larger than now and not limited to coastal habitats, but hypothetically present in many wet habitats of Padanian Plain. What we observe today is most likely the relict of a more extensive geographic range of *Z. marmorata*, fragments of a past distribution, a metapopulation of geographically more or less disjunct subpopulations.

A second consideration, linked to the distribution pattern of the species, is about the subpopulation of *Z. marmorata* so far detected in Mincio Park. This subpopulation is composed of population patches that seem to be closely related to the presence of *Molinia* meadow, sedges and lowland hay meadows. The historical management of these habitats is based on a single annual mowing of the vegetation, during winter. In the past this management was leaded by local craftsmanship economy (e.g. processing of straw, sedge and

reed). For about the last 20 years, within the protected area, the management has been supported by European funding aimed at the conservation of these increasingly rarefied habitats. Molinia meadows (Habitat Directive code: 6410) are considered priority for habitats and species protection under Habitat Directive within Lombardy [18]. The conservative management of this habitat allowed the survival of relict populations of rare butterfly species in Po Plain, such as *Melitaea diamina* and *Maculinea alcon* [19]. Furthermore, within a *Molinia* meadow into the Mincio Park, a new site of a protected habitat has been detected: Natural dystrophic lakes and ponds (Habitat Directive code: 3160), previously considered "marginal" for Continental Region in Italy [20].

Further assumption is that protecting areas, and therefore habitats, positively affect the species dwelling on there. We believe that an "habitat approach" on red lists and protection, could be more effective in nature conservation than a "species approach": protecting a species doesn't always prevent its habitat from being exploited, damaged or even destroyed. This assumption is stronger when we have to consider elusive species such as *Z. marmorata*. Therefore it is necessary to act for the broadest possible vision in protection planning, focusing not only on the target species but also on its habitat. In addition, protecting habitats focusing on a species can also protect species that are not known to be present in that habitat, as the Mincio/*Zeuneriana* case demonstrates.

Given that the species is present locally also in restricted suitable habitat, we assume that presently the cause of disappearance and major threat is habitat loss.

5. Conclusions

The future step needed is understanding if *Z. marmorata* is present elsewhere and assessing the phenology and its actual distribution in the Mincio Park. Given the well delimited area of the Park, a possible instrument for species detection could be the bat-detector approach, that is demonstrated to be effective on Orthoptera species detection [21]. The Park is an interesting research area for students of birds and Chiroptera: they could be involved in sharing their recordings to orthopterologists that could identify the song of target species (i.e. *Z. marmorata*).

The recent Action Plan for Italy [14] and Slovenia [14] reported only four populations of *Z. marmorata* still exist (with an estimated total of 3,000-5,000 adult individuals per year) and an entire remaining habitat of this species about 0.57 km² (57 ha) with only ca. 16 ha being left in Italy. This new inland subpopulation potentially represents a huge extension of the habitat available for the species: in fact, if further surveys will confirm the presence of *Z. marmorata* on the whole Molinion habitat surface (ca. 100 ha) of the Park, the entire coverage will triplicate.

Zeuneriana marmorata has the potential to become a flagship of local animal conservation. Urgent coordinated action among institutions are needed and can be summarized in these first steps: seasonal monitoring of existing populations yearly and raising of public and institution awareness. The first topic involves quantifying the population size (number of individuals and areal distribution), detection of threats and conservation of the localities where the actual populations occur. This will also give information on ecology of the species (habitat preference, phenology and voltinism, feeding and mating behaviour, bioacoustic), morphology variability inside and among populations. Clear homogeneous and updated information on all existing populations are essential for comparison among populations and their assessment and conservation. The second topic regards the public that has to be informed about the existence of this natural treasure, and the institutions that have to be involved and cooperate for the conservation of the species. Awakening of public opinion can be made by means of informative material (a leaflet and a web page), plus media coverage of the subject. More technically, and concerning institution involvement and cooperation, is a conservation strategy plan that follows the approach of IUCN Species Survival Commission as successfully applied elsewhere in Europe and Worldwide. The first step could be a participatory informative

workshop about *Zeuneriana marmorata* and its situation, involving specialists, institutions, government agencies, protected areas managers and citizens. The way may be simpler than it looks but is strongly needed if we want to be successful in *Zeuneriana* conservation as a step in Nature conservation. After these first actions, further deployment can be expected in fundraising that could be more easy after entangling a clear figure of the present situation of *Z. marmorata* locally: subpopulation state, threats and actions of conservation needed.

Author Contributions: Conceptualization, F.M.B. and F.L.; investigation, M.B., F.L., and F.M.B.; writing—original draft preparation, F.M.B, M.B., and F.L. All authors have read and agreed to the published version of the manuscript.

Funding: The first sighting of a *Zeuneriana marmorata* specimen (2019) was carried out during field works as part of the LIFE14 IPE IT 018GESTIRE2020 project - Nature Integrated Management to 2020 - with the contribution of the LIFE + financial instrument of the European Commission and the Lombardy Region. The Mohamed bin Zayed Species Conservation Fund is financially supporting on the project "Preserving the last remaining populations of the Adriatic Marbled Bush-cricket" (project n. 192521710).

Informed Consent Statement: Not applicable.

Data Availability Statement: Please refer to suggested Data Availability Statements in section "MDPI Research Data Policies" at https://www.mdpi.com/ethics.

Acknowledgments: We thank The Mincio Regional Park for the permissions and support during the research. Paolo Fontana (Fondazione Edmund Mach) and Axel Hochkirch (University of Trier) for their instigation on study and conservation of *Zeuneriana marmorata* in Italy.

Conflicts of Interest: The authors declare no conflict of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, or in the decision to publish the results.

References

1. Kirby, W.F. A Synonymic Catalogue of Orthoptera (Orthoptera Saltatoria, Locustidae vel Acridiidae). British Museum of Natural History: London, UK, 1906.
2. Caudell, A.N. Orthoptera Fam. Locustidae Subfam. Decticinae. In: Wytsman, P., Genera Insectorum 72. V. Verteneuil & L. Desmet, Bruxelles, **1908**, 1–42.
3. Zeuner, F.E. The classification of the Decticinae included in Platycleis or Metrioptera. Trans. R. Entom. Soc. London **1941**, *91*, 1–50.
4. Ramme, W. Zur Systematik, Faunistik und Biologie der Orthopteren von Südost-Europa und Vorderasien. Mitt. Zool. Mus. Berlin **1951**, *27*, 1–431.
5. Brunner Von Wattenwyl, C. Prodromus der Europäischen Orthopteren; Verlag W. Engelmann, Leipzig, 1882, pp. 466.
6. Giordani Soika, A. Studi sulle olocenosi. II. Fattori ecologici e fattori geografici nella distribuzione degli Ortotteri nell'estuario veneto. Mem. Soc. entomol. it. **1949**, *28*, 61–72.
7. Marcuzzi, G.; Dalla Venezia, L.; Lorenzoni, A.M. Appunti ecologico-qualitativi sul popolamento animale di alcuni biotopi litorali dell'Alto Adriatico. Atti Ist. Ven. Sc. Lett. Arti, Cl. Sc. mat. nat. **1971**, *129*, 119–207.
8. Kleukers, R.; Fontana, P.; Ode, B. Zeuneriana marmorata (Fieber): an endemic bushcricket from the coast of the northern Adriatic sea. Atti Acc. Rov. Agiati, **1997**, 63–79.
9. Fontana, P.; La Greca, M.; Kleukers, R. Insecta Orthoptera. In: Checklist e distribuzione della fauna italiana. 10.000 specie terrestri e delle acque interne; Ruffo, S.; Stoch, F. Eds; Mem. Mus. civ. Stor. nat. Verona, 2. serie, Scienze della Vita **2005**, *16*, 137–139 + CD ROM.
10. Fanin, Y.; Tami, F.; Merluzzi, P.; Candotto, S.; Guzzon, C. Nuove località di Zeuneriana marmorata (Fieber, 1853) (Insecta Orthoptera) in Friuli Venezia Giulia (Italia Nord-Orientale). Gortania, **2015**, *37*, 35–41.
11. Adriatic Marbled Bush-cricket. Zeuneriana marmorata. The IUCN Red List of Threatened Species 2016: e.T44712377A101711740. Available online: https://www.iucnredlist.org/species/44712377/101711740 (accessed on 13 June 2021).
12. Hochkirch, A.; Nieto, A.; García Criado, M.; Cálix, M.; Braud, Y.; Buzzetti, F.M.; Chobanov, D.; Odé, B.; Presa Asensio, J.J.; Willemse, L.; Zuna-Kratky, T.; Barranco Vega, P.; Bushell, M.; Clemente, M.E.; Correas, J.R.; Dusoulier, F.; Ferreira, S.; Fontana, P.; García, M.D.; Heller, K-G.; Iorgu I.Ş.; Ivković, S.; Kati, V.; Kleukers, R.; Krištín, A.; Lemonnier-Darcemont, M.; Lemos, P.;

Massa, B.; Monnerat, C.; Papapavlou, K.P.; Prunier, F.; Pushkar, T.; Roesti, C.; Rutschmann, F.; Şirin, D.; Skejo, J.; Szövényi, G.; Tzirkalli, E.; Vedenina, V.; Barat Domenech, J.; Barros, F.; Cordero Tapia, P.J.; Defaut, B.; Fartmann, T.; Gomboc, S.; Gutiérrez-Rodríguez, J.; Holuša, J.; Illich, I.; Karjalainen, S.; Kočárek, P.; Korsunovskaya, O.; Liana, A.; López, H.; Morin, D.; Olmo-Vidal, J.M.; Puskás, G.; Savitsky, V.; Stalling, T.; Tumbrinck, J. European Red List of Grasshoppers, Crickets and Bush-crickets. Publications Office of the European Union: Luxembourg, Belgium, 2016.

13. Hochkirch, A.; Tami, F.; Fanin, Y.; Guzzon, C.; Merluzzi, P.; Tout, P. Adriatic Marbled Bush-cricket (Zeuneriana marmorata), A National Action Plan for Italy 2016–2022. IUCN-SSC & ASTORE FVG: Staranzano, Italy, 2017, pp. 38.
14. Hochkirch, A.; Gomboc, S.; Veenvliet, P.; Lipovšek, G. Adriatic Marbled Bush-cricket (Zeuneriana marmorata), A National Action Plan for Slovenia 2016-2022. IUCN-SSC & Javni zavod krajinski park Ljubljansko barje: Ljubljana, Slovenia, 2017, pp. 52.
15. Hambler, C. Conservation; Cambridge University Press: Cambridge, 2004, pp. 368.
16. Iorio, C.; Scherini, R.; Fontana, P.; Buzzetti, F.M.; Kleukers, R.; Odè B.; Massa B. Grasshoppers & Crickets of Italy. WBA Handbooks 10. WBA Project: Verona, Italy, 2019, pp. 579.
17. Massa, B.; Fontana, P.; Buzzetti, F.M.; Kleukers, R.; Odé, B. Fauna d'Italia, vol. XLVIII, Orthoptera. Calderini: Bologna, Italy, 2012; pp. 563+XXIV+DVD.
18. Brusa, G.; Dalle Fratte, M.; Armiraglio, S.; Ceriani, R.M.; Zanzottera, M.; Cerabolini, B.E.L. Flora e habitat di interesse comunitario (Direttiva 92/43/CEE) in Lombardia: sintesi della distribuzione e importanza della conservazione. Natura Bresciana **2019**, *42*, 91–102.
19. Corezzola, S.; Hardersen, S.; Maffezzoli, L.. Discovery of isolated populations of Phengaris alcon and of Melitaea diamina in the central Po Plain, Italy. *Boll. Soc. entomol. Ital.* **2012**, *144 (2)*, 71–78.
20. Gianguizzi, L.; Bagella, S.; Bazan, G.; Caria, M.C.; Cerabolini, B.E.L.; Dalla Vecchia, A.; Rivieccio, G.; Bolpagni, R. New national and regional Annex I Habitat records: from #13 toi #15. Plant Sociol. **2020**, *57(1)*, 65–74.
21. Newson S.E.; Bas Y.; Murray A.; Gillings S. Potential for coupling the monitoring of bush-crickets with established large-scale acoustic monitoring of bats. Methods in Ecology and Evolution **2017**, *8*, 1051–1062. doi: 10.1111/2041-210X.12720