

THE REDISCOVERY OF *Lycaena helle* (Lepidoptera: Lycaenidae) IN DORNA DEPRESSION (ROMANIA), 125 YEARS AFTER ITS FIRST MENTION

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Abstract

At present, the known populations of *Lycaena helle* from Romania are found at a lower altitude than those from Western and Central Europe. Besides land-use changes, climate warming severely threatens this specie that prefer humid and cool habitats. Withdrawal to higher altitudes is also restricted by the species' low dispersal ability. Therefore, the future of the Romanian population is uncertain. While implementing a peatlands restoration project in the northeastern part of the country, we investigated the local invertebrate fauna around a bog woodland from Dornel Depression (Suceava County). Here we found a mosaic of wet habitats sheltering a violet copper population. This population was mentioned long ago, representing the first recorded instance of this species in present-day Romania. The violet copper butterfly has not been spotted in the area since the initial record was published in 1897, and current literature only refers to it as historical data from the Dorna Depression. We describe the habitat occupied by this population, bring up to date the specie's distribution, and prompt for the designation of a special area of conservation for this European protected species.

Key words: *Bistorta officinalis*, *Lycaena helle*, protected species, Romania.

INTRODUCTION

Lycaena helle (Denis & Schiffermüller, 1775) is one of the smallest endangered coppers with a wing span smaller than 27 mm. Males have a distinctive, broadly distributed, purplish-blue iridescence on the upper side of the wings; this iridescence is more restricted to the marginal area of the wings in females. The males of the second generation are less violet-iridescent, and therefore they seem to be darker. The orange colour on the females' dorsal side of the wings varies within each generation (Lafranchis, 2004; Tshikolovets, 2011; Craioveanu et al., 2014; Settele et al., 2015; Leraut, 2016, Gergely et al., 2017). Due to the populations' isolation, many other subspecies were described in Europe, and their validity needed to be genetically confirmed (Rakosy, 2013).

The butterfly is bivoltine in Eastern Europe and has a lifespan of 7.6 days for the first generation

and 3.3 days for the second generation (Craioveanu et al., 2014). The larvae are feeding on the lower side of the leaves of *Bistorta officinalis*, causing characteristic feeding scars, and the adults use the same plant species as primary nectar sources (Székely, 2008). This butterfly inhabits wetlands, sometimes (like in Romania) loosely wooded, with patches of shrubs, trees, and host plants (Székely, 2008; Rákosy, 2013).

At a European scale, following the Red Data Book of European Butterflies, this species is endangered (EN) and it is protected by the Council Directive 92/43/EEC of 21 May, 1992, (Annexes 2 and 4) on the conservation of natural habitats and of wild fauna and flora (Van Swaay & Warren, 1999; Van Swaay et al., 2000). In Romania, this species is critically endangered (CR)/endangered (EN), being protected through the Emergency Ordinance no. 57/2007 regarding the regime of natural protected areas,

conservation of natural habitats, flora and fauna (Annexes 3 and 4 A) (Rákosy, 2021; Rákosy et al., 2021).

Due to climate warming and land-use changes, including improper forest management and abandonment of grassland, the populations all over Europe are threatened with extinction (Rákosy L., 2013; Craioveanu et al., 2014; Modin & Öckinger, 2020) and a loss of connection within a metapopulation is often considered when favorable habitats are still available (Mutanen & Välimäki, 2014).

In Romania, the populations of this butterfly are still present in three Sites of Community Importance (SCI) within the Continental region: ROSCI0205 Poienile cu narcise de la Dumbrava Vadului, ROSCI0214 Râul Tur and ROSCI0421 Pădurea celor Două Veverițe, but there are no recent data on the existence of viable population in Alpine region (Craioveanu et al., 2014).

Our primary goal was to conduct an invertebrate inventory in the areas where peatland restoration activities are being implemented. In the context of the rediscovery of this population of rare butterfly species, we present here a literature analysis regarding this species in Romania, clarify the taxonomic identification of some specimens, and discuss the importance of setting protection measures for this population of *Lycaena helle*, and its mosaic habitats that support this species.

MATERIALS AND METHODS

The Institute of Biology Bucharest implements two projects, aiming to restore 19 peatlands covering 802 ha in Suceava, Maramureș, Brașov, and Sibiu counties, Romania. The wetland where *Lycaena helle* was found is near Coșna village, Suceava County, in the Teșna river basin. Teșna left tributaries Tocila, and Bancu brooks define the studied area. After the junction with Bancu, Teșna flows into the Dorna River. Morphologically, the whole area belongs to the intramontane depression of Dorna.

In May 2022, we conducted an initial invertebrate fauna survey through direct visual observation with no capture, aiming for several invertebrate groups. On-site, observed butterfly species were noted and photographed, and the GPS coordinates of each observation point were recorded. Adult butterfly individuals were

identified to species level using identification keys (Lafranchis, 2004; Tshikolovets, 2011; Settele et al., 2015; Leraut, 2016, Gergely et al., 2017).

In a follow-up visit to the site in June 2022, we used a DJI Mini 2 drone to evaluate the specific habitat distribution and the extent of the host plant distribution. The aerial imagery was integrated with a botanical survey conducted on the ground to delineate the critical area for the survival of the *Lycaena helle*. Plant nomenclature used for the listed taxa is the one agreed by Flora Europaea through Euro+Med PlantBase, with up-to-date information on the taxa present in the European and Mediterranean region (<https://europlusmed.org/>). The phytosociological nomenclature follows the synthesis works on the vegetation of Romania (Coldea et al., 1997; Sanda et al., 2008; Doniță et al., 2009).

To update the distribution of the species in Romania, we reviewed the literature to clarify older records, especially indirect citations. Specimens from Oltenia Museum - Department of Natural Sciences, Craiova (catalogue numbers 33534, 33535, 33536, 33537) were revised by one of the authors. The updated distribution map of the violet copper in Romania, based on the map from The Red Book of Romanian Invertebrates (Rákosy, 2021), was generated in RoBioAtlas WebApp. The habitat map for *Lycaena helle* population in Coșna was produced using the collected data in ArcGIS 10.7.1.

RESULTS AND DISCUSSIONS

Field data

At least 30 specimens of *Lycaena helle*, both males and females, were observed and photographed within a half an hour at a single observation point in an area covered with *Bistorta officinalis*, close to the border of the forest situated N-V of Coșna primary school, on 17 May 2022. After examining photographs taken in the field, we also identified several specimens in the area right behind the school, 250 m from the first point. The temperature was 19°C, the sky was clear, and the wind speed was five kph. Fresh adults were on wing, feeding on species of *Viola sp.*, *Cardamine pratensis*, *Ranunculus acris*, and *Ranunculus repens*,

basking on *Bistorta officinalis* (not yet in with flowers), or even mating (Figure 1). On 12 June 2022, at the second visit, the temperature was 22°C, the sky was partially cloudy, and the wind was 20-30 kph. While the flowers of *Bistorta officinalis* were now open (Figure 2), the butterflies were not active, hiding in the lower part of the vegetation, mainly because of the unfavorable weather.

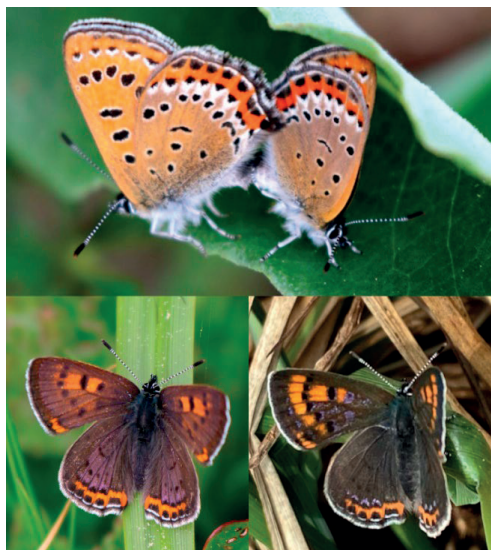


Figure 1. *Lycaena helle* specimens from Coșna, Romania

The area covered by the favorable habitat for *Lycaena helle*, delimited based on the vegetation study and aerial images, was no more than 22.2 ha (Figures 3 and 4) and in close proximity to human settlements.

We found a complex landscape within the area characterized by patches of wet meadows with eutrophic ecology and under different land uses that alternate with the bog woodland. These meadows, developed on a 1.2-4 m thick peaty soil (Pop, 1960), originate from the denaturation of some parts of the bog by draining and cutting trees and shrubs. They grow on flat or slightly sloping land with a high humidity regime,

ensuring the soil has excess water throughout the year.

Three types of meadows were identified, creating a mosaic beneficial for butterfly species in general and for *Lycaena helle* in particular.

Fenced and ungrazed wet meadows groups, a series of hygrophilous phytocenoses that belong to *Scheuchzerio - Caricetea fuscae* R. Tx. 1937 and *Molinio - Arrhenatheretea* R. Tx. 1937 (Figure 2). With a coverage between 80-90%, the herbaceous layer has a very special compact physiognomy, especially during the flowering period of *Bistorta officinalis*, the dominant species. In the floristic composition, *Rumex acetosa*, *Cirsium rivulare*, *Ranunculus repens*, *R. acris*, *Succisa pratensis* can be found, and isolated bushes of *Salix repens subsp. rosmarinifolia* and *S. caprea* were also reported.

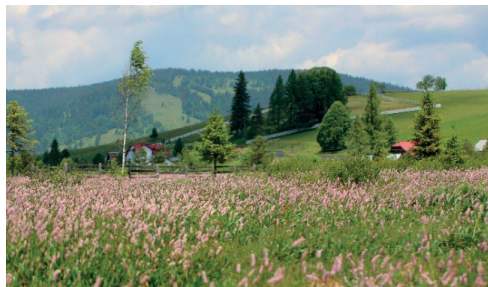


Figure 2. Fenced and ungrazed wet meadows with *Bistorta officinalis*



Figure 3. Aerial photo of the mosaic of habitats inhabited by *Lycaena helle*, Coșna, Suceava, 12 June, 2022



Figure 4. Boundaries of the critical habitats for the survival of the *Lycaena helle* population from Coșna area, Romania

Interleaved with the previous, low-intensity grazed meadows with poor floristic composition characterizes the *Agrostio stoloniferae* - *Deschampsietum caespitosae* Ujvarosi 1947 and *Juncetum tenuis* (Diemont, Siss. et Westhoff 1940) Schwik. 1944 phytocenoses; among the dominant species: *Deschampsia caespitosa*, *Agrostis capillaris*, *A. canina*, *Ranunculus repens*, *Trifolium repens*, *T. pratense*, *Caltha palustris* s.a. (Figure 5).

The marshy land behind the Coșna elementary school is an open habitat with scattered trees species of *Picea abies*, *Betula pendula*, *Frangula alnus*, *Salix capraea*, next to numerous *Betula humilis* and *Salix repens* subsp *rosmarinifolia* shrubs. In the upper herbaceous layer we recognised *Filipendula ulmaria*, *Succisa pratensis*, *Comarum palustre*, *Cirsium rivulare*, *Dryopteris cristata*, *Epilobium palustre*, *Valeriana officinalis*, *Equisetum*

palustre, *Crepis paludosa*, *Lysimachia vulgaris*, *Rumex acetosa*; among other small species that make up the lower herbaceous layer: *Galium aparine*, *Galium palustre*, *Galium uliginosum*, *Caltha palustris*, *Plantago lanceolata*, *Potentilla erecta*, *Viola declinata*, *Galeopsis speciosa*, *Cardamine pratensis*, *Agrostis canina*, *Campanula abietina*, *Carex diandra*, *Vaccinium oxycoccos* (Figure 6).



Figure 5. Low-intensity grazed meadows

A series of drainage channels cross these meadows, hosting hygrophilous species such as *Typha angustifolia*, *Carex rostrata*, *Carex nigra*, *Mentha aquatica*, *Menyanthes trifoliata*, *Potamogeton natans* and *Callitriche palustris* where the water is more than 40-50 cm deep.

The violet copper specimens were spotted near the edge of the bog woodland in a wet meadow with large stands of *Filipendula ulmaria* along with *Thelypteris palustris*, *Ligularia sibirica*, *Parnassia palustris*, *Potentilla anserina*, on *Sphagnum* substrate (Figure 7). Here, the host plant *Bistorta officinalis* is distributed in uneven size patches and ensures variable coverage that can go up to 80%.



Figure 6. Marshy land with *Betula humilis*

The bog woodland vegetation is assigned to *Vaccinio-Pinetum sylvestris* Kleist 1929 em. Matuszk. 1962.



Figure 7. Wet meadow at the bog woodland edge

The floristic composition of the bog is relatively poor due to the restrictive conditions offered by the oligotrophic swamp. In the structure of the plant community, four layers can be defined, respectively: the arborescent layer, which has as its dominant species *Pinus sylvestris* with rare individuals of *Betula pendula*, *Sorbus aucuparia* and *Rhamnus frangula*, and together achieve a coverage of 50-70%; the shrub layer includes the juveniles of *Pinus sylvestris* with *Betula pendula* and isolated bushes of *Betula humilis*; the layer of grasses and small shrubs is dominated by *Vaccinium vitis-idaea*, alongside with *Vaccinium myrtillus*, *V. oxycoccos* and *Eriophorum vaginatum* and achieve large coverages, up to 70-80%, where the tree layer is less developed. The moss layer is well-developed and dominated by *Sphagnum* species (Figure 8).



Figure 8. The bog woodland

Literature and museum data

Older papers on *L. helle* in Romania have almost exclusively faunistic data, but recently semi-

quantitative data on population size and structure, along with the dispersal capacity of individuals, were published based on studies of existing populations in Maramures county (Craioveanu et al., 2014). Based on the literature published, we compiled a timeline of data regarding *L. helle* presence and extinctions in Romania (Figure 9).

Most of the older discovered populations are considered extinct: Sighișoara (Czekelius, 1899; Rákósy & Weber, 1986), Chitila near Bucharest (Salay, 1910; Szabó, 1982), Valea Cernei at Crucea Ghizelei (Rebel, 1911, Craioveanu et al., 2014), Vlădeni Brașov (Ciocchia & Barbu, 1980) Livada 1 Satu-Mare (Bálint & Szabó, 1981; Craioveanu et al., 2014).

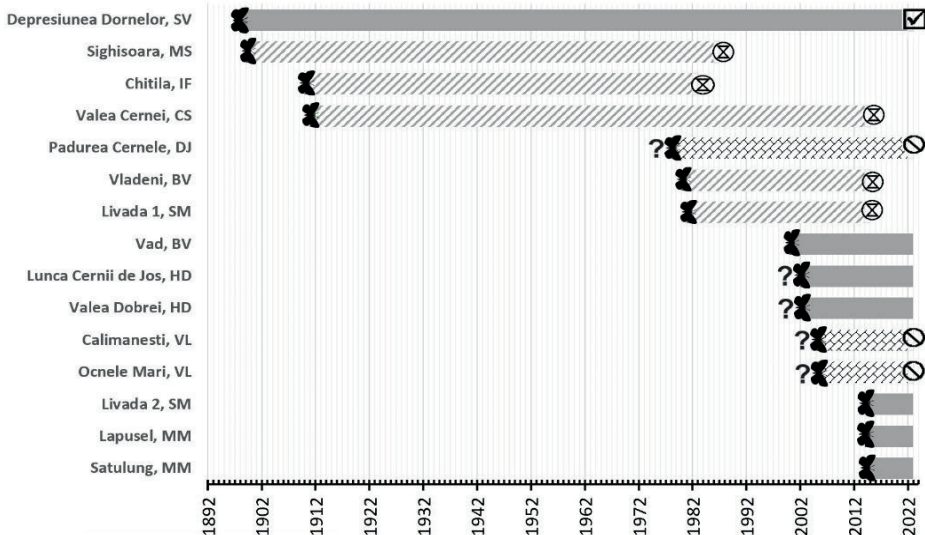


Figure 9. Timeline of literature data regarding *Lycaena helle* presence in Romania

(The butterfly symbol indicates the year of the first mention in the area. A question mark beside the first mention indicates a doubtful record. The grey horizontal bar marks the populations still viable or unproven to be extinct. Diagonally hatched bars symbolize the populations declared extinct, and the hourglass symbol points to the year of the published extinction. Brick-hatched bars mark the populations proven here to be wrong species identification. Checkmark symbol points to the year of confirmation in the field of the population in Dornelor Depression)

The revision of the specimens on which the doubtful report from Cernele Forest, Dolj county (Stănoiu et al., 1978), Călimănești and Ocele Mari, Vâlcea county (Chimișliu & Goga, 2005) were based, proved that in fact, these were misidentified specimens of the congeneric large copper - *Lycaena dispar rutila* (Werneburg, 1864) (Figures 10, 11).

The exact location of several other populations, e.g. those from Hunedoara county, Lunca Cernii de Jos, and Bătrâna-Bunila (Dobrei valley) (Burnaz, 2002), is unknown. These locations have never been checked out or evaluated following the publication of these records. Hence, up to now, the only known viable populations that still survive are those from Vad (Brașov) (Székely et al., 2000), Livada 2 (Satu-Mare) (Craioveanu et al., 2014), Lăpușel and Satulung (Maramureș) (Craioveanu et al., 2014)

all within the Continental region and situated at low altitudes, up to 500 m.



Figure 10. *Lycaena dispar rutila*, specimen no. 33.535 from Oltenia Museum, Craiova



Figure 11. *Lycaena dispar rutila*, specimen no. 33.537 from Oltenia Museum, Craiova

Hormuzaki's initial report (1897) is the first one for *Lycaena helle* on the present day territory of Romania. In the years to come, this record has been repeated, without being supported by new data, by several authors (e.g., Fleck, 1900; Pax, 1906). Following some misinterpretations, several recent authors (Dincă & Goia, 2005) have erroneously attributed to Pax (1906) a record of the violet copper from Rodnei Mountains. However, in the text, the author only mentions other nearby areas with Alpine elements and mentions the Dorna region with a list of butterfly species quoting Hormuzaki (1897). In his paper on the butterfly fauna of Bucovina, Hormuzaki (1897) listed *L. helle* under the name *Polyommatus amphidamas*: "in our country only in the higher mountains; on the peat bogs in the upper Dorna valley at the end of May 1894 we captured a large, vivid violet iridescent specimen". Hence the population we found near Coșna, between tributaries of Dorna river, might be a part of, or a remnant of, the long-ago reported population found by Hormuzaki, more than 125 years ago.

Found in an area at about 959 m altitude, the population from Coșna it is also the highest reported altitude for a purple copper population in Romania and the only one found at an altitude comparable to that at which similar populations are found in the Pyrenees or in Central Europe, thus distinguishing itself from the other three viable populations of this butterfly from Transylvania. It is also the only population of

this butterfly found on the territory of Romania within the Alpine bioregion.

In the updated distribution map, superimposed with the bioregion map of Romania, the rediscovered population is marked with a red triangle (Figure 12). Old records with blue dots, and viable present-day populations with red dots. Light green represents the Continental region, while the Alpine region is in a darker green shade.

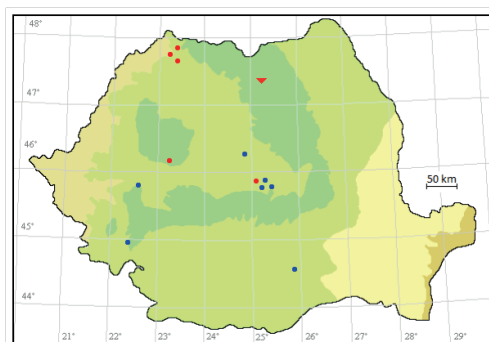


Figure 12. Distribution map of *Lycaena helle* in Romania

Future studies on this population will have to focus on a better estimation of the population size and the threats that confront it since the cover in *Bistorta officinalis* is considerable, and the opened, mixed habitat needed to support a large population of violet copper is found over a relatively large area (Székely, 2008; Rákossy, 2013; Craioveanu et al., 2013). Also, as the species is known to form metapopulation (Modin & Öckinger, 2020), and there are several peatland and wetlands areas around, we will further look for the host plant and individuals of this species while implementing the reconstruction projects.

Another aspect to consider is whether the population here is uni or bivoltine due to the high altitude and lower temperatures. While in mid-September 2022, there were still some flowers of *Bistorta officinalis*, it was too late in the year, even in a bivoltine situation as is the case of the other populations in Romania (Székely, 2008; Craioveanu et al., 2014).

The two points where the violet copper was spotted at Coșna, are within the average flight distance measured for the population in Maramureș county (Craioveanu et al., 2014). This small distance can ensure an exchange of

individuals necessary for the population's survival. However, the terrain at the back of the school was considered for urban development by the local administration.

The main threats of *L. helle* are climate warming, land-use changes (drainage, peat extraction, afforestation, forest grazing, transformations into arable land, urbanization), burning, and chemical treatment (Mutanen & Välimäki, 2014). Lack of appropriate forest management (clear cuts of the whole forest body or large area cuts at the edge of the forest body) and the abandonment of grassland are the leading causes of the species decline (Rákossy, 2013; Craioveanu et al., 2013).

Being situated in the Alpine area, unlike the other viable populations in Romania, the population from Coșna could remain the only refuge of the species in Romania, in case of climate warming. This aspect emphasizes the importance of our discovery, the need for further research, and immediate measures to protect the area, at least within the boundaries delimited in Figure 4. It is important to note that rare and protected plant species exist in the area. The terrain at the back of the school hosts numerous plants of *Betula humilis* an important glacial relict included in the red plant list of Romania (Oltean et al., 1994) and considered critically endangered (CR) at the national level (Dihoru & Negrean, 2009). Close to the forest edge, we also found *Ligularia sibirica*. This plant is also a rare glacial relict plant of great conservative value, protected at the European level (Annex 2 and 4 Habitat Directive) and threatened by the drainage of marshlands (Mânzu & Cișlariu, 2019)

CONCLUSIONS

Careful examination of old literature, now easier to access through digitalized libraries, can reveal important information on rare species distribution.

When designed with care for flora and fauna, habitat restoration projects can enhance knowledge and help species protection.

Protection and careful management measures must be implemented to protect this rare butterfly population, rediscovered after 125 years of its first mention, and the other rare plant species found in the area.

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