DISTRIBUTION OF THE SPECIES *Zerynthia polyxena* (LEPIDOPTERA, PAPILIONIDAE), IN NATURAL AND ANTHROPIC HABITATS IN THE CARPATHIAN PIEDMONT BETWEEN THE RIVERS BUZĂU AND PRAHOVA (ROMANIA), IMPLICATIONS FOR ITS CONSERVATION

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Abstract. *Zerynthia polyxena* is a Palearctic species, spanning across Europe through Central Asia, in disjunct populations restricted to patchy habitats providing its food plants from the genus *Aristolochia* and suitable habitat. It is a beautiful flag-species for conservation programs and a remarkably interesting model-system for toxicologists studying resistance mechanisms against the genotoxic and malignant lethal effects of Aristolochic Acids, against which this species is immune. Native to most of Southeastern Europe (where it is declining by 6-30%), and extinct in Germany and Switzerland, it was relatively rare allover its vast European range, due to its narrow steno-monophagous diet and its relatively strict habitat requirements. In Romania, it is widely distributed in patchy, disjunct and vulnerable local populations in all provinces, feeding mainly on *Aristolochia clematitis*, and it is listed as endangered species in Romanian fauna declining >30%, and a Natura 2000 species protected by law. Therefore, knowing the actual population range, population sizes and trends in a given region is an objective of great importance to which our study is herein bringing a first contribution. We present herein more than 30 locations where we documented the occurrence, abundance and habitat data for this species in the Carpathian Piedmont between the rivers Prahova and during more than previous 10 years of fieldwork. Despite the apparently encouraging numbers, the populations are small and very vulnerable especially to indiscriminate use of chemical insecticides, often not only in the vineyards and crop-fields, but also on the fallow/ruderal land bordering the cultivated fields which both harbor the weed-like *A. clematitis* food-plants. The data we gathered indicate the occurrence of resident populations with fluctuating distribution and abundance between the sites, having the characteristics of a metapopulation, increasing its conservations hopes. This first batch of results prompted newer research aimed at validating the hypotheses we hereby formulated.

Keywords: *Zerynthia polyxena, Aristolochia clematitis*, chorology, conservation, metapopulation.

Rezumat. Distribuția speciei *Zerynthia polyxena* (Lepidoptera, Papilionidae), în habitate naturale și antropice în Subcarpații dintre râurile Buzău și Prahova (România), implicații pentru conservarea ei. *Zerynthia polyxena* este o specie Palaearctică, distribuită de-a latul Europei până în Asia Centrală, în populaţii disjuncte, restrânse la habitate care oferă planta gazdă din genul *Aristolochia* şi habitate adecvate. Este o superbă specie-fanion pentru programe de conservare şi un remarcabil sistem-model pentru toxicologii care studiază mecanismele de rezistenţă împotriva efectelor genotoxice şi maligne, mortale, ale Acizilor Aristolochici, împotriva cărora această specie este imună. Spontană în mai toată Europa de Sud - Est (unde specia este în declin cu 6-30%), a dispărut din Germania şi Elveţia şi este relativ rară în tot vastul ei areal European, datorită dietei steno-monofage şi cerinţelor de habitat relativ stricte. În România, este larg răspândită în populaţii locale disjuncte şi vunerabile în toate provinciile, hrănindu-se în special cu *Aristolochia clematitis*, şi este listată ca specie periclitată în fauna Românei, în declin >30%, şi specie Natura 2000 protejată de lege. Ca urmare, cunoaşterea distribuţiei actuale, a mărimii populaţiilor şi a tendinţelor dintr-o regiune, este un obiectiv de mare importanţă, la care studiul nostru aduce aici o primă contribuţie. Prezentăm aici peste 30 locaţii unde am documentat existenţa, abundenţa şi informaţii despre habitat pentru această specie în Subcarpaţii dintre rîurile Prahova şi Buzău în decursul a peste 10 ani de observaţii în teren. În ciuda aparent încurajatoare, populaţiile sunt mici şi foarte vulnerabile în special la folosirea fără discriminare a insecticidelor chimice, adesea nu doar în vii şi terenuri cultivate, dar şi pe terenuri virane-ruderale mărginind terenurile cultivate care ambele adăpostesc planta gazdă - buruiana *A. clematitis*. Datele culese de noi indică prezenţa unor populaţii rezidente cu distribuţii şi abundenţe fluctuante între locaţii, având caracteristicile unei metapopulaţii, ceea ce creşte speranţele de conservare. Această primă tranşă de rezultate a impulsionat noi cercetări destinate validării ipotezelor formulate în acest cadru.

Cuvinte cheie: *Zerynthia polyxena, Aristolochia clematitis*, corologie, conservare, metapopulaţie.

INTRODUCTION

Zerynthia polyxena (Denis & Schiffermüller, 1775), is a Palaearctic species, spanning across Europe and Western and Central Asia, in disjunct populations restricted to patchy habitats where it can find its specialized food plants from the genus *Aristolochia* and suitable habitat. It is native to the southeastern France, Italy (including Sicily) through most of Southeastern Europe (Albania, Austria, Greece, FYR Macedonia, Bosnia and Herzegovina, Montenegro, Bulgaria, Croatia, Serbia, Slovenia, Romania, Moldova) extending North-Eastwards through Hungary, Slovakia, Czech Republic, Belarus, Ukraine, Russian Federation, Turkey to Southern Urals and Northwest Kazakhstan where it occurs between 0-1700m, but usually at lower elevations than 900 m (VAN SWAAY et al., 2010). Formerly also native to Germany and Switzerland, more recent work do not mention the current occurrence in these countries (BERGMANN, 1952; TOLMAN & LEWINGTON, 1998; KUDRNA, 2002) and according to (VAN SWAAY et al., 2010) it has gone extinct in these countries.

From taxonomic point of view, *Zerynthia polyxena* (Dennis & Schiffermuller, 1775) is a complex species which reportedly has more than 31 subspecies (NARDELLI & HIRSCHFELD, 2002) distinguished by a complex of

morphological characters set forth by FORD (1944a, 1944b) and EISNER (1974) and which have an intricate intra- and inter-specific hybridization pattern investigated by DESCIMON & MICHEL (1989) and LUX (1990).

DINCĂ & VILA (2008) reported successful molecular DNA-based identification *Zerynthia polyxena* and distinction from *Z. cerisyi ferdinandi* based on larvae found feeding on *Aristolochia clematitis* in Canaraua Fetei natural reserve in Southern Romania, while DAPPORTO (2010) segregated *Zerynthia cassandra* (Geyer, 1828) from *Zerynthia polyxena* (Dennis & Schiffermuller, 1775) on morphological grounds via geometric morphometry.

Its sozological status is rather precarious, according to the IUCN evaluation from 2010 (VAN SWAAY et al., 2010), still valid at current moment, *Zerynthia polyxena* is reported extinct from Germany; Switzerland with a "strong decline in distribution or population size of more than 30% reported from Romania, while decline in distribution or population size of 6-30% has been reported from Albania, Austria, France, Serbia, Turkey (European part) and Ukraine.

While the species has a vast range in Europe, it was not very abundant all over its range, due to its narrow steno-monophagous diet and its relatively strict habitat requirements, which make the species use much less of the available food sources (DINCĂ et al, 2009; DAPPORTO, 2010).

Despite its decreasing current population trend the current threat status at European level is LC (Least Concern) but the species is listed on the Habitats Directive Annex 4 and Bern Convention Annex 2 (VAN SWAAY et al., 2010).

Due to their attractive habitus, *Z. polyxena* is very popular among lepidopterologists who studied their life history and ecology in considerable detail.

Depending on the availability at a certain location, its larvae feed on various *Aristolochia* species, such as *Aristolochia clematitis*, *A. rotunda*, *A. pallida* and *A. pistolochia*, all of which are very toxic. Like many other Papilionidae, the larvae of *Z. polyxena*are capable of sequestering phytotoxines from their food-plant, which render both the caterpilars, pupae and the adults toxic and unpalatable for predators.

Unlike the case of other lepidopteran food-plants which are less dangerous for humans, *Aristolochia* species are quite dangerous to humans, being incriminated as causal agents in lethal conditions involving the excretory system, as their main toxines, the Aristolochic Acids and their aristolactams are believed to cause both upper transitional epithelial cancers and kidney progressive fibrosis leading to terminal failure (known as Balkan Endemic Nephropathy).

In Romania, the main food-plant for *Z. polyxena* is *Aristolochia clematitis* and much less frequently other species of the genus, which are much rare and less abundant, like *A. rotunda / A. pallida* complex. *Aristolochia clematitis* with the vernacular names in Romanian "marul lupului", or "Oesterluzei" in German,

is (along with the other *Aristolochia* species) of paramount importance for the conservation of not only *Zerynthia polyxena* but also of another rare and important Papilionidae species from Romanian fauna , viz. *Z. (Allancastria) cerisyi ferdinandi* (Stichel, 1907), as they are the only known food-plants for these lepidopteran species.

Knowledge regarding the biology and sozology of *Z. polyxena* in Romania is relatively good, and it is considered endangered at a country level as declines of more than 30% have been reported, (VAN SWAAY et al., 2010), it is listed as an endangered species in the Romanian fauna (RÁKOSY, 2003) and a Natura 2000 species of conservative interest being in principle protected by law.

It is relatively widely distributed in Romania, but indisjunct patchy, local populations. in all provinces, being rediscovered in Southern Dobrogea, (DINCĂ & VILA, 2008; DINCA et al., 2009), 80 years from the last report (MANN, 1866).

Not many precise chorological data from Romania were available at the beginning of this study (but ,see NICULESCU, 1961; SZÉKELY, 1985) and the situation still has room for improvement, despite some new data from reports in recent years , SZÉKELY, 1996; RÁKOSY et al., 2003; DINCĂ et al., 2009)

Continuing our previous work on chorology and conservation of interesting plant or insect taxa (also see ARBUNE et al., 2009; BÂRCĂ & NICULAE, 2005, 2006, 2009, 2011; BÂRCĂ, 2016a, 2016b; NICULAE & BÂRCĂ, 2005, 2006; BÂRCĂ et al., 2011), we present herein the results of more than 15 years of field research in this region rather poorly explored until recently.

In addition to being a beautiful species with a great potential for serving environmentalists as a flag-species for conservation programs beyond its individual benefit, *Z. polyxena* is a remarkably interesting species as a model system for toxicologists trying to understand the mechanism used by it to escape the genotoxic and malignant lethal effect of the Aristolochic Acids, towards which this species is apparently immune. Therefore, knowing the actual population range, population sizes and trends in a given region is an objective of great importance to which our study is herein bringing a first contribution.

MATERIAL AND METHODS

The area involved in the present work is situated on the territory of two counties, Prahova and Buzău, in the Eastern-part of Romania, covering the hills of the Carpathian Piedmont spanning betweenthe river Prahova to the West and the river Buzău to the North and East, being limited to the south by a virtual arch passing through Ploiesti and cities and the villages Drăgănești de Prahova, Fulga, Lacu Sinaia, Amaru, Margineanu, Movila Banului, Costești, Pietrosu, Spătaru. The survey could not be performed with an exhaustive approach, being more focused on the areas where natural stands with populations of *Aristolochia* sp. were identified by us or had been previously reported. Thus,

some areas with known or presumed to have *Aristolochia* natural populations or a higher biodiversity were over-surveyed for several years while others were much less thoroughly surveyed. Therefore, a place not mentioned in the present work might very well harbor a viable population of *Z. polyxena*.

On the other hand, like previously reported for the *Aristolochia clematitis* in Southern Dobrogea (BÂRCĂ, 2018), some of the populations surveyed in several (even consecutive) years showed fluctuating sizes, some populations even disappearing altogether and reemerging in subsequent years. In some cases factors contributing to the fluctuating population sizes could be inferred as the local farmers heavily use insecticides for the agricultural management of vineyards and other crops, but in some other instances no factors could be detected, while entire, previously thriving stands of *Arostolochia* vanished without trace or apparent cause, just to reemerge years later without any logical explanation.

The sites were surveyed personally by the first author and positive occurrence was recorded only when either adult specimens (imagines) or larvae where personally seen. A few locations are mentioned after records from the scientific literature and are marked accordingly in the table, and one site is derived from a photographic record found over the internet and it is also marked accordingly. In all instances ,I avoided collecting butterfly specimens, identification being easy and straight forward for both adults and larvae (under the assumption that the other similar species *Z. (Allancastria) cerisyi ferdinandi* (Stichel, 1907) does not occur in the studied region).

The geographical coordinates are given in the WGS84 system, and were collected either on spot using a GPS device with a reported error of less than 5 m, or, for older sites, were inferred where possible from field notes using ACME Mapper 2.1 software.

When recording the food-plant locally available, in order to avoid confusions with related species (*A. rotunda / A. pallida*) I mention the diagnostic criteria used to positively assign the individual plants to *A. clematitis* species, criteria that were the same as in BÂRCĂ, 2018, as follows:

– **General habitus**: – tall plants, with whirling stems 1–1.5 m tall, growing in rather dense colonies.
– **Flower habitus**: – yellow, concolor (without dark spots or stripes), multiple, growing often several at each one node.
– **Leaf habitus**: – leaves are cordiform, with pointed apices, with well-defined and longer stalks.
– **Roots/underground stems habitus**: – the plants present elongated tuberiform rhizomes, not rounded, ovalar or spherical bulbiform.

The results are presented in tabular format in Table 1, together with some ecological characteristics of the sites of occurrence where available. We also present data regarding the abundance of the individuals recorded on site (population sizes) and about the life stages found at the time of survey at the site, i.e. larvae or adults, and the number of individuals seen each year (if here have been visits in multiple years).

RESULTS AND DISCUSSIONS

During the last 30 years, our fieldwork research in the Carpathian Piedmont region between the rivers Prahova and Buzău, resulted in a number of 3+ sites where I have positively identified either flying imagines or larvae of *Zerynthia polyxena* (Dennis & Schiffermuller, 1775) on *Aristolochia clematitis* oftentimes redundantly. These individuals belonged presumably to resident populations of *Zerynthia polyxena* despite living in mostly seminatural, more anthropic habitats.

The sites where I have found *Zerynthia polyxena* in the studied region studied are listed in tabular format below (Table 1), sorted in descending order by counties and by location geographical coordinates. For most of the sites I present some notes about the habitat and about the number of colonies and abundance of the host-plants *Aristolochia clematitis* and about the abundance of *Zerynthia polyxena* at the site at the moment of my visit.

Table 1. List of the sites with their geographical coordinates where we have positively identified the occurrence of *Zerynthia polyxena* or from which credible data are published.

No	County	Closest human settlement	Site code	Coordinates WGS84 system	Notes, Host/ Habitat	Data Source
1	PH	?unverified source Drăgăneşti	NA	N 44 49' 39" E 26 17' 15"	Photo Date Taken: May 1, 2014 Retrieved from https://yourshot.nationalgeographic.com/photos/7795648/	Photo on the WWW, See Notes in the previous cell at the left
2	PH	Fulga de sus	FU	N 44 53' 25" E 26 26' 35"	Adults on flight on pasture by the lake shore **SANTH**	BV14[2A]
3	PH	Gura Vadului	GVN	N 45 2' 8" E 26 25' 58"	by a flood-control ditch along the ditch and inside cultivated fields and/or vine-yards **SANTH**	BV2011-2017[#A, #L]
4	PH	Gura Vadului	GV2	N 45 2' 10" E 26 25' 52"	by ditch 2-3AC **SANTH**	BV2011-201[#A, #L]7
5	PH	Gura Vadului	GV3	45 2' 13" E 26 25' 36"	by ditch 1-3AC **SANTH**	BV2011-2017[#A, #L]
6	PH	Gura Vadului	GV4	45 2' 17" E 26 25' 20"	by ditch some adults perching on a large Rubus stand! 1-3AC **SANTH**	BV2011-2017[#A, #L]

7	PH	Gura Vadului	GV5	45 2' 19" E 26 25' 10"	uncult field by the road 2AC **SANTH**	BV2011-2017[#A, #L]
8	PH	Gura Vadului	GV6	45 1' 46" E 26 25' 31"	ditch 2 uncult 1AC **SANTH**	BV2011-2017[#A, #L]
9	PH	Gura Vadului	GV7	45 1' 42" E 26 25' 8"	ditch 2 crossing uncult 1AC **SANTH**	BV2011-2017[#A, #L]
10	PH	Gura Vadului	GV8	45 1' 27" E 26 24' 42"	seminatural field by natural ravine 2-4AC **SANTH**	BV2011-2017[#A, #L]
11	PH	Gura Vadului	GV9	45 1' 23" E 26 24' 48"	Natural ravine along a temporary creek 2-4AC	BV2011-2017[#A, #L]
12	PH	Vadu Sapat	VS	N 45 1' 14" E 26 24' 10"	Ravine by a natural creek between Vadu Sapat and "Bozieni" 1AC	BV2007[2A, #L]
13	PH	Călugăreni	CASW	N 45 4' 41" E 26 21' 48"	natural ravine by Călugăreni 1AC	BV2007[3A, #L]
14	PH	Călugăreni	CASE	N 45 5' 4" E 26 23' 1"	natural? ravine by Călugăreni 2AC	BV2007[3A, #L]
15	PH	Călugăreni	CASE	N 45 5' 8" E 26 23' 17"	natural ravine by Călugăreni 1AC	BV2007[1A, #L]
16	PH	Călugăreni	CASE	N 45 4' 49" E 26 24' 15"	natural ditch between Călugăreni (Valea Scheilor) and Boboci –Jugureni 1AC **SANTH**	BV2007 [1A,#L]
17	PH	Jugureni	JUNW	N 45 6' 0" E 26 25' 33"	natural ravine by the road towards "Marginea Padurii" village 2AC **SANTH**	BV2007[3A, #L]
18	PH	Jugureni	JUSE	N 45 5' 12" E 26 25' 20"	natural ravine in uncultivated field /pasture towards Tohani village 1-4AC, large stands	BV2005[1A]; B2007[2A, 5L]; BV2008[3A, #L]; BV2010[4A, #L]; BV2012[2A]; BV2013[2A, #L]; BV2014[6A, #L]; BV2017[1A]; BV2018[#L]
19	PH	Tohani	ToNW	N 45 4' 15" E 26 25' 39"	natural ravine in uncultivated field /pasture by a forest plantation between 2 limestone hills 1-4AC, small stands	BV2005[1A]; B2007[4A, #L]; BV2008[1A, #L]; BV2010[3A, #L]; BV2011[8L]; BV2012[1A]; BV2013[1A, #L]; BV2014[8A, #L]; BV2017[1A]; BV2018[#L]
20	PH	Tohani	TON	N 45 4' 20" E 26 26' 13"	Vast pasture with limestone and calcareous breccia, conglomerate outcrops N of limestone hills by Tohani village, multiple small AC. In 2018 remarkable abundance of AC	BV2005[2A]; B2007[5A, #L]; BV2008[1A, #L]; BV2010[2A, #L]; BV2011[4L]; BV2012[2A]; BV2013[2A, #L]; BV2014[3A, #L]; BV2017[2A]; BV2018[#L]
21	PH	Tohani	TON2	N 45 3' 57" E 26 26' 22"	natural ravine in uncultivated field /pasture by a forest plantation between 2 limestone hills 1-2AC **SANTH**	BV2008[2A, #L]; BV2010[3A, #L]; BV2011[5L]; BV2012[1A];
22	PH	Persunari	PENW	N 45 3' 31" E 26 26' 43"	natural ravine in uncultivated field /pasture with brushes **SANTH**	BV2005[1A];; BV2007[1A]; BV2008[#L];BV2010[#L]; BV2011[3L];
23	PH	Persunari	PENW2	N 45 3' 41" E 26 26' 42"	natural ravine in uncultivated field /pasture by a limestone hill multiple AC	BV2005[1A]; BV2007[1A]; BV2008[7L]; BV2010[#L]; BV2011[2L];
24	PH	Persunari	PENE	N 45 3' 39" E 26 27' 12"	natural ravine in uncultivated field /pasture by a limestone hill multiple AC	BV2005[1A]; BV2007[1A]; BV2008[5L]; BV2010[#L]; BV2011[2L];
25	PH	Persunari	PEE	N 45 3' 29" E 26 27' 8"	natural ravine by a meandered creek multiple AC	BV2005[1A]; BV2007[1A]; BV2008[6L]; BV2010[8L]; BV2011[3L];
26	PH	Muntele Roşu/cheia	MR1	NA	close to Izvorul Nicolaie Ioan" spring 4th instar Larvae 1AC	BV1976[?L];
27	PH	Muntele Roşu	MR2	NA	"valea Berii 4th instar Larvae 1AC	BV1976[?L];
28	BZ	Ratesti	RAN	N 45 18' 17" E 26 37' 52"	forest margins close to "Manastirea Ratesti" monastery multiple AC **SANTH**	BV2010[#L];
29	BZ	Nehoiu	NE	NA	Larvae on multiple AC ruderal by the railway station	BV2008[#L];
30	BZ	Siriu	SIN	N 45 31' 31" E 26 12' 13"	uncultivated slope towards the lake Siriu by a motel with thermal/mineral springs 3AC	BV2004[#L];
31	BZ	Siriu	SIN2	N 45 31' 45" E 26 12' 0"	pasture by the river/lake Siriu (at the uphill end of the lake Siriu) by a forestry hut ("canton forestier") multiple AC	BV2004[#L];
32	BZ	Mizil	Istriţa Hill IH	NA.	relatively frequent 1 West-Asiatic Mediterranean xerothermophilous Endangered	DINCA, 2006
33	BZ	Dănciuleşti	NA	NA	20.V.2007 (collected as last instar larva)	RVcoll.07-D396 DINCA et al., 2009

Legend: abbreviations used in the table: #AC=number of colonies of *A. clematitis*; AC= Number of colonies of *A. clematitis* observed at site; SANTH =semi-anthropic habitat. The number attached to the source (date0 depicts the abundance of *Zerynthia polyxena* at the site at that respective moment, eg BV 2008[3A] BV2008[4L] represents occurrence of 3 adult specimens or 4Larvae seen in 2008 by the author Bârcă Valentin. For other sources see references; [#A] or [#L] represents more than 9 specimens seen per visit on site.

The data gathered during over 15 years of fieldwork observations in just a rather small part of the Carpathian Piedmont region between the rivers Prahova and Buzău document more than 30 populations of with fluctuating sizes and abundance. The clustering exhibited by our data does not necessarily or adequately reflect the real, natural distribution of *Z. polyxena* in the region, due to an inherent biased pattern of visitation during our research, so the fact that no populations were mentioned from other locations does not guarantee the absence of the species in other locations.

The species is rare in the studied region and very vulnerable mainly to insecticide use and secondarily to habitat degradation and only in the last instance by host-plant destruction –as *Aristolochia clematitis* has all the characteristics of a weed which seems quite resistant to local efforts to eradicate it from the cultivated fields and vineyards (see Fig. 1 for the general habitus and morphological details of the host-plant growing in abundant patches in ruderal habitats).

Despite the fluctuating character of the populations, the data presented here document multiannual presence of the species in many of the sites, suggesting the case of resident populations and not of just vagrant individuals.

Even if that were the case for some sites, the fact that I found larval stages well represented in many sites over several years suggest that, despite fluctuations in size and even presence, we are dealing in effect with a metapopulation of *Z. polyxena sensu* HANSKI (1999), a fact which could increase the chances of survival of this species in the region.

The population sizes are small especially if we take into account the number of adults seen, despite the relatively higher abundance of individuals in larval stages and the fact this species is toxic enough to have many natural predators. A likely explanation for the fact that this species is so rare despite the abundance of its food-plant, as evidenced by our study, is the nefarious synchronization of larval stages with the (abundant, indiscriminate, useless and negligently) applications of insecticides on the ruderal lands and on the strips of land bordering the cultivated fields and vineyards encroaching the patches of otherwise perfectly adequate habitat, which could wipe out entire populations of thriving larvae before reaching pupal stage –during which the individuals could presumably be less sensitive.

The populations found occupy various habitats and such habitat diversity didn't allow observable retrospective evaluation of habitat quality for the populated patches (which alternated spatially and temporally with patches of seemingly identical habitat with apparently equal quality).

HANSKI's (1999) criteria for metapopulation, i.e. discrete local breeding populations of the species; all of which have a high risk of extinction (due to indiscriminate, large-scale use of insecticides); but between which recolonization seems possible (due to *Z. polyxena*'s behavior and it being a strong flyer with good inter-patch mobility) seem to be fulfilled in this case and such a supposition might be valid. The metapopulation supposition is further supported by the arguments of DAPPORTO (2010) who states that *Z. polyxena* maintains reproductively isolated populations because it is a *"sedentary butterfly showing a short-flight period, forming small and scattered populations linked to a single plant genus"*.

Albeit the data gathered in this study were not sufficient to allow validation of such a model, they prompted a new prospective research investigating the population trends and the impact on patch occupancy of both patch size and isolation as historically hypothesized by THOMAS et al., (1992) and HANSKI (1994) and that of habitat quality as demonstrated by later studies (DENNIS & EALES, 1997; THOMAS et al., 2001; WAHLBERG et al., 2002; KRAUSS et al., 2005), especially as *Z. polyxena* is virtually monophagous in the studied region.

CONCLUSIONS

The most important contribution of the present research is that it documents a relatively constant (albeit fluctuating in size) *presence* of *Zerynthia polyxena* in the region and that its occurrence is not an exception -as it was previously believed, but rather something quite normal.

The species is rare in the studied region and very vulnerable mainly to insecticide use and secondarily to habitat degradation and only in the last instance by host-plant *Aristolochia clematitis* destruction.

The main protective measure applicable for decreasing the threats for the local *Z. polyxena* populations is completely avoiding applications of insecticides on the ruderal lands and on the strips of land bordering the cultivated fields and vineyards or at least delaying the applications of insecticides until larvae reached the pupal stage –during which the individuals could presumably be less sensitive, as the nefarious synchronization of the applications of insecticides with larval stages uselessly kill them on patches of otherwise perfectly adequate habitat, destroying entire viable populations.

The study reported herein was not aimed at finding and predicting trends, and the weak quantitative data presented do not allow for such a retrospective approach, but it represented an encouraging start and also provided a basis for a newer prospective research started recently which should provide such insights, which we will use for adequate population management programs.

Based on our findings presented herein we hypothesized that some of the populations reported in this region are interlinked in one or more metapopulations, as we believe that they fulfill HANSKI's (1999) metapopulation criteria.

The data reported herein prompted a new prospective research investigating the population trends and the impact of patch size, patch isolation and of habitat quality on patch occupancy towards the validation of such a model.

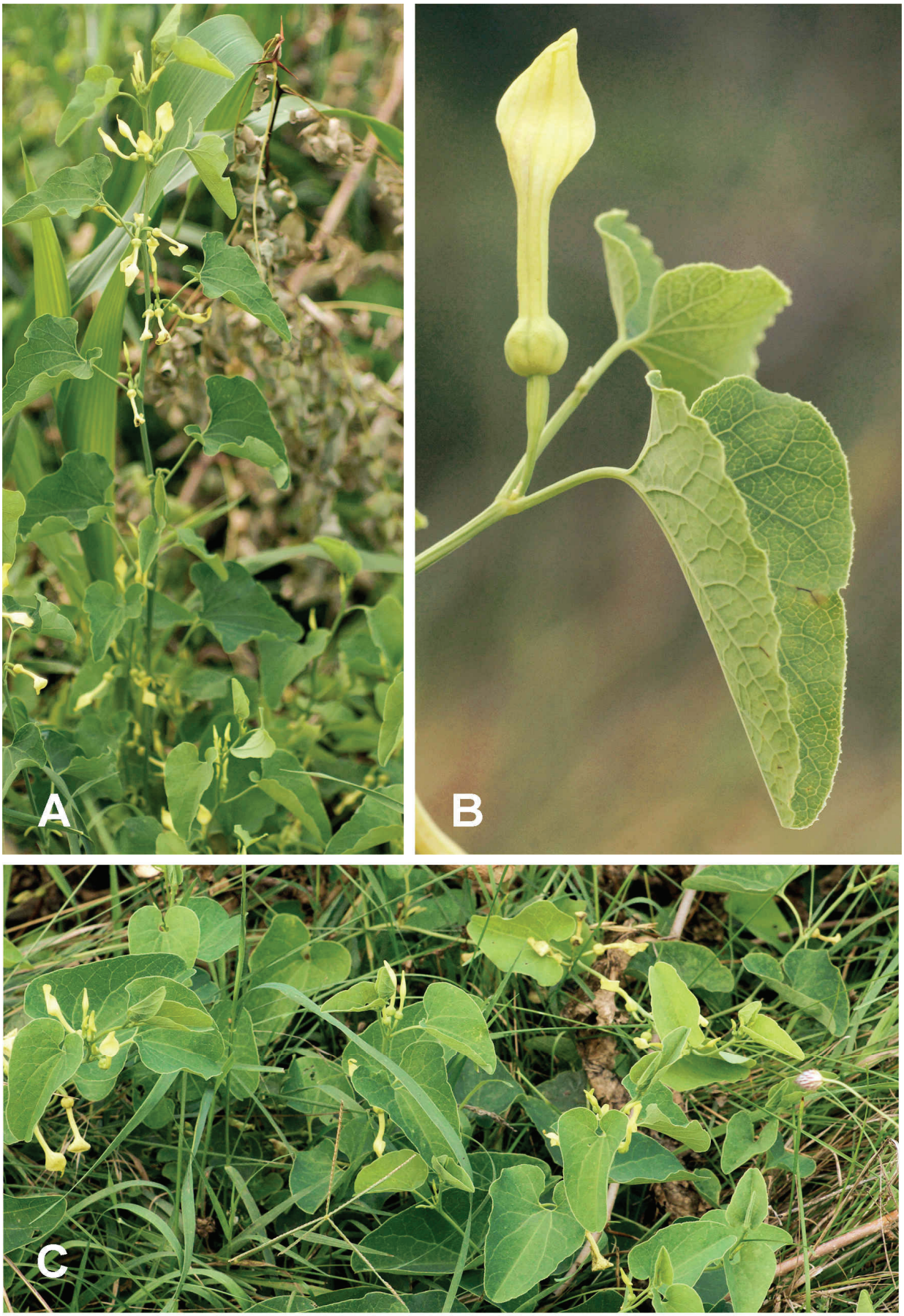

Figure 1. Typical aspect of *Aristolochia clematitis*, the host plant of *Z. polyxena*; A: Flowering hoot general habitus; B: Aspect of the flower and leaf; C: Clump of individuals by a ditch in Gura Vadului, PH, Photo Bârcă V., original.

REFERENCES

ARBUNE A., NICULAE M., STANCIU A., VARGA A., HOGEA C., PANAITESCU D., BÂRCĂ V. 2009. Conservation status, present threats and their causes, grieving the medicinal plant species of the genus Sempervivum in natural occurrence sites in the Romanian SE Carpatians. *Planta Medica*. **75**(09), PB38.

BÂRCĂ V. 2016a. Typification of the binomial Sedum boissierianum Haussknecht *(Crassulaceae)*. *Annals of Forest Research.* DOI: 10.15287/afr.2016.496. **59**(1): 165-171.

BÂRCĂ V. 2016b. The chorology of the species Sedum annuum (Crassulaceae) in the Romanian Eastern Carpathians. *Oltenia. Studii şi comunicări. Ştiinţele Naturii.* Muzeul Olteniei Craiova. **32**(2): 52-60.

BÂRCĂ V. 2018. Natural historic distribution of *Aristolochia clematitis* L in Romanian Southern Dobrogea, implications for conservation. *Proceedings of the Romanian Academy*, Series B, 2018, ***20(1)***, p. 13-22.

BÂRCĂ V. & NICULAE M. 2011. Infestation of the medicinal plant *Sedum telephium* L. (Crassulaceae) by the weevil *Aizobius sedi* Germ. (Apionidae, Curculionoidaea) in Oltenian carstic Piedmont (Southern Romania). *Oltenia. Studii şi comunicări. Ştiinţele Naturii.* Muzeul Olteniei Craiova. **27**(2): 73-79.

BÂRCĂ V. & NICULAE M. 2009. Morphometric data about seed coat ornamentation with taxonomic considerations in *Jovibarba heuffelii* (Crassulaceae) populations from Southern Carpathians. *Romanian Journal of Biology-Plant Biology,* Bucharest. Edit. Academiei. **53**(1): 17-22.

BÂRCĂ V. & NICULAE M. 2006. Preliminary data about the chorology of the species *Sempervivum marmoreum* Griseb. (Crassulaceae) in Southern Carpatian Mountains in Romania. *Contribuţii Botanice.* Universitatea Babeş Bolyai, Grădina Botanică (Cluj Napoca). **41**(2): 23-32.

BÂRCĂ V. & NICULAE M. 2005. Preliminary data about the chorology of the species *Jovibarba heuffelii* Schott A. Love D. Love Crassulaceae in Southern Carpatian Mountains in Romania. *Contribuţii Botanice.* Universitatea Babeş Bolyai. Grădina Botanică (Cluj Napoca). **40**(1): 25-33 2005.

BÂRCĂ V., NICULAE M., PANAITESCU D. 2011. Infestation of the medicinal/ornamental plant *Alcearosea* L. (Malvaceae) by the weevil *Rhopalapionlon girostre* Olivier, 1807 (Coleoptera: Curculionoidea: Apionidae) in Oltenia (Southern, Romania). *Oltenia. Studii şi comunicări. Ştiinţele Naturii.* Muzeul Olteniei Craiova. **27**(2): 80-84.

BERGMANN A. 1952. *Die Großschmetterlinge Mitteldeutschlands* 2. Urania, Jena. 495 pp.

DAPPORTO L. 2010. Speciation in Mediterranean refugia and post-glacial expansion of *Zerynthia polyxena* (Lepidoptera, Papilionidae). *Journal of Zoological Systematics and Evolutionary Research.* **48**: 229-237.

DENNIS R. L. H. & EALES H. T. 1997. Patch occupancy in *Coenonympha tullia* (Müller, 1764) (Lepidoptera: Satyrinae): habitat quality matters as much as patch size and isolation. *Journal Insect Conserationv.* **1**: 167-176.

DESCIMON H. & MICHEL F. 1989. Expériences d'hybridation intra- et interspécifiques dans le genre *Zerynthia* (Papilionidae). Relativité des critères mixiologiques de l'espèce. *Nota lepidopterologica.* **12**(1): 28-31.

DINCĂ V. 2006. The Macrolepidoptera (Insecta: Lepidoptera) from Istriţa Hill (Buzău County, Romania). *Entomologia Romanica*. **10**: 5-24.

DINCĂ V. & VILA R. 2008. Improving the knowledge on Romanian Rhopalocera, including the rediscovery of *Polyommatus amandus* (Schneider, 1792) (Lycaenidae) and an application of DNA-based identification. *Nota Lepidopterologica.* **31**(1): 3–23.

DINCĂ V., CUVELIER S., SZÉKELY L., VILA R. 2009. New data on the Rhopalocera (Lepidoptera) of Dobrogea (south-eastern Romania). *Phegea.* **37**(1): 1-21.

EISNER C. 1974. Parnassiana Nova XLIX. Die Arten und Unterarten der Baroniidae, Teinopalpidae und Parnassiidae (Ersterteil) (Lepidoptera). *Zoologische Verhandelingen Uitgegeven door het Rijksmuseum van Natuurlijke Historiete Leiden*. **135**: 1-96.

FORD E. B. 1944a. Studies on the chemistry of pigments in the Lepidoptera, with references to their bearing on systematics. 3. The red pigment of the Papilionidae. *The Proceedings of the Royal Entomological Society of London*. **19**: 92-106.

FORD E. B. 1944b. Studies on the chemistry of pigments in the Lepidoptera, with references to their bearing on systematics. 4. The classification of the Papilionidae. *The Transactions of the Royal Entomological Society of London*. **94**: 201-223.

HANSKI I. 1994. A practical model of metapopulation dynamics. *Journal of Animal Ecology.* **63**: 151-162.

HANSKI I. 1999. *Metapopulation Ecology*. Oxford University Press. 313 pp.

KRAUSS J., STEFFAN-DEWENTER I., MÜLLER C. B., TSCHARNTKE T. 2005. Relative importance of resource quantity, isolation and habitat quality for landscape distribution of a monophagous butterfly. *Ecography.* **28**: 465-474.

KUDRNA O. 2002. The distribution atlas of European butterflies. *Oedippus.* **20**: 1-343.

LUX C. 1990. Ethologie, systematique and ecologie de *Zerynthia polyxena creusa* Meigen dans les Alples-Maritimes (Fomes, variétés et aberrations du Papilionidae). *Bulletin de la Societe Sciences Natureles*. **66**: 9-17.

MANN J. 1866. Aufzählung der im Jahre 1865 in der Dobrudscha gesammelten Schmetterlinge. *Verhandlungen der k. k. zoologisch-botanischen Gesellschaft Wien.* **16**: 1-40.

NARDELLI U. & HIRSCHFELD G. 2002. Abberations, formes et sous-especes de *Zerynthia polyxena* Denis and Schiffermüller, 1775 (Lepidoptera: Papilionidae). *Lambillionea.* **102**: 223-240.

NICULAE M. & BÂRCĂ V. 2005. Preliminary data regarding the distribution of the species *Sedum hispanicum* L. (Crassulaceae) in Romanian southern Carpathians. *Contribuţii Botanice.* Universitatea Babeş Bolyai, Grădina Botanică. Cluj Napoca. **40**(1): 35-42.

NICULAE M. & BÂRCĂ V. 2006. Preliminary data regarding the distribution of the species *Sedum annuum* L (Crassulaceae) in Romanian Southern Carpathians. *Contribuţii Botanice.* Universitatea Babeş Bolyai Grădina Botanică. Cluj Napoca. **41**(2): 33-40.

NICULESCU E. V. 1961. *Fauna R. P. R.: Fam. Papilionidae (Lepidoptera).* Edit. Academiei R. P. R., Bucureşti. **11**(5): 120 pp.

RÁKOSY L. 2003. Lista roşie pentru fluturii diurni din România. *Buletin informativ.* Societatea lepidopterologică română. Cluj-Napoca. **13**: 1-4.

RAKOSY L., GOIA M., KOVACS Z. 2003. *Catalogul Lepidopterelor României / Verzeichnis der Schmetterlinge Rumäniens*. Societatea Lepidopterologică Română, Cluj-Napoca. 446 pp.

SZÉKELY L. 1985. Újabb adatok a nagylepkék elterjedéséhez Délkelet-Erdélyben. *Folia entomologica hungarica*. Budapest. **46**(2): 222-227.

SZÉKELY L. 1996. Lepidopterele *(Fluturii) din sud-estul Transilvaniei (România),* Disz-Tipo, Săcele. 78 pp.

THOMAS C. D., THOMAS J. A., WARREN M. S. 1992. Distributions of occupied and vacant butterfly habitats in fragmented landscapes. *Oecologia.* **92**: 563–567.

THOMAS J. A., BOURN N. A. D., CLARKE R. T., STEWART K. E., SIMCOX D. J., PEARMAN G. S., CURTIS R., GOODGER B. 2001. The quality and isolation of habitat patches both determine where butterflies persist in fragmented landscapes. *Proceedingd of the Royal Society London (B).* **268**: 1791-1796.

TOLMAN T. & LEWINGTON R. 1998. *Tagfalter Europas und Nordwestafrikas*. Franckh-Kosmos, Stuttgart. 319 pp., 104 pis.

VAN SWAAY C., WYNHOFF I., VEROVNIK R., WIEMERS M., LÓPEZ MUNGUIRA M., MAES D., SASIC M., VERSTRAEL, T., WARREN, M., SETTELE J. 2010. *Zerynthia polyxena* The IUCN Red List of Threatened Species 2010: e.T174224A7031650 (accessed March 08, 2018).

WAHLBERG N., KLEMETTI T., HANSKI I. 2002. Dynamic populations in a dynamic landscape: the metapopulation structure of the marsh fritillary butterfly. *Ecography*. **25**: 224-232.

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