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HORVATH'S ROCK LIZARD *IBEROLACERTA HORVATHI* IN ITALY: SUMMARY OF ITS DISTRIBUTION, FIRST QUANTITATIVE DATA AND NOTES ON CONSERVATION

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Riassunto – La Lucertola di Horvath *Iberolacerta horvathi* in Italia: sintesi distributiva, primi dati quantitativi e note sulla conservazione
Nell'ultima ventina di anni la Lucertola di Horvath *Iberolacerta horvathi* è stata rinvenuta in oltre 40 nuovi siti che hanno permesso di delineare un nuovo quadro distributivo e di fornire elementi di novità per la sua comprensione. In Italia la specie è diffusa solo nell'estremità nord-orientale in 37 celle UTM. Sono aumentate di molto le segnalazioni sulle Prealpi Carniche ed in Veneto. I primi dati quantitativi sulla specie in Italia provenienti da due aree (una posta sulle Alpi Carniche, l'altra sulle Alpi Giulie) hanno evidenziato un'alta variabilità fra i mesi in cui è stata censita. A discapito del fatto che generalmente sia ritenuto che impatti e minacce siano scarsamente influenti, sono riportati fattori che possono incidere (in alcuni casi lo hanno già fatto) anche su popolazioni che vivono in siti apparentemente sicuri come interventi in ambienti derivanti dall'attività antropica, realizzazione di opere, eventi meteorologici causati dal cambiamento climatico.

Parole chiave: Lucertola di Horvath, *Iberolacerta horvathi*, Distribuzione, Abbondanza, Habitat, Sintopia, Sinantropia, Minaccia, Conservazione, Alpi Orientali, Friuli, Veneto, Italia.

Abstract – In the last 20 years or so, Horvath's Rock Lizard *Iberolacerta horvathi* has been found at over 40 new sites, allowing us to describe a more realistic distribution pattern of the species and to provide novel elements for its understanding. In Italy, the species is distributed only in the north-eastern extremity in 37 UTM squares. Records in the Carnic Prealps and in Veneto have greatly increased. The first quantitative data on the species in Italy, coming from two areas (one in the Carnic Alps, the other in the Julian Alps), show high variability among the months in which it was censused. Although impacts and threats are generally considered to be not very serious, there are factors that can affect (in some cases having done so already) even populations living in apparently safe sites, e.g. interventions in environments deriving from human activity, construction works and meteorological events caused by climate change.

Key words: Horvath's rock lizard, *Iberolacerta horvathi*, Distribution, Abundance, Habitat, Syntopy, Synanthropy, Threat, Conservation, Eastern Alps, Friuli, Veneto, Italia.

1. – Introduction

Horvath's rock lizard *Iberolacerta horvathi* (MÉHELŸ, 1904) has an Alpine-Dinaric distribution (SILLERO *et al.*, 2014); it is found in the Bavarian Alps on both the German and Austrian sides (CAPULA & LUISELLI, 1991; CABELA *et al.*, 2004), southern Austria (GRILLITSCH & TIEDEMANN, 1986; TIEDEMANN, 1992; CABELA *et al.*, 2002), north-eastern Italy (LAPINI *et al.*, 2004; RASSATI, 2010), Slovenia and Croatia (BISCHOFF 1984; DE LUCA, 1989; KROFEL *et al.*, 2009; ŽAGAR *et al.*, 2014).

Until the early years of this century, the known presence of the lacertid in Italy was limited to about 50 localities in the eastern Alps (SINDACO *et al.*, 2006). Targeted studies have made it possible to find *Iberolacerta horvathi* in more than 30 localities (RASSATI, 2010, 2012) and more recent discoveries (RASSATI, 2017, 2018) have indicated a much different scenario than the one described in the past. Therefore, it was decided to provide an updated distribution of the species and novel elements for its understanding. The first quantitative data for the species in Italy are also reported.

Finally, although it is generally believed that there are no particular threat factors, continuous surveys have indicated otherwise. Therefore, some remarks on conservation are provided.

2. – Study Areas and Methods

For the distribution, only data published by 31-12-2018 in the scientific literature were considered; those deriving from papers which, although published in specialist journals, objectively lacked peer review (essential for filtering and validation) were ignored. For completeness of information, unpublished data of the present author have also been used. The cartographic synthesis was carried out using the UTM system with a 10x10 km grid (Fig. 1).

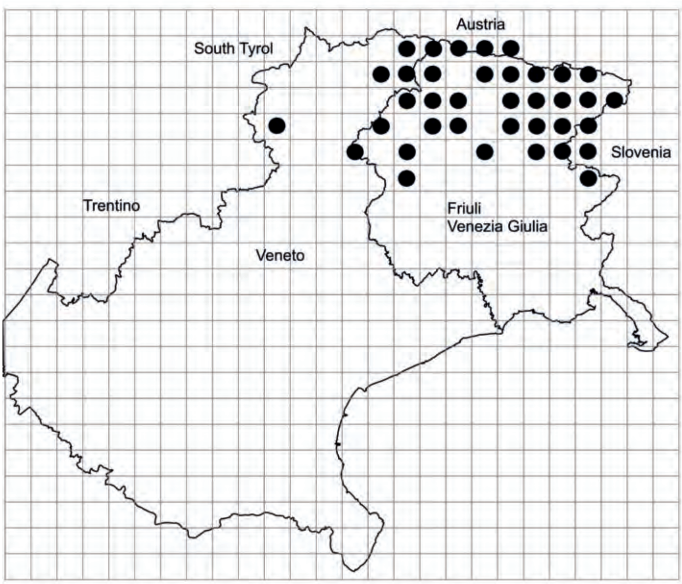

Figure 1 - Distribution of *Iberolacerta horvathi* in Italy arranged according to the UTM cartographic system with a 10x10 km grid / Distribuzione di *Iberolacerta horvathi* in Italia disposta secondo il sistema cartografico UTM con griglia 10x10 km

For the quantitative data, two populations were censused in two suitable areas within the range of the species (RASSATI, 2010): one in the Lumiei Valley (Carnic Alps), the other in the Raccolana Valley (Julian Alps).

The first (Zahre area; Municipalities of Vigo di Cadore and Sauris; UM 14-UM 24; 1500-1510 m a.s.l.; Fig. 2), on the medium slope (with prevalent S to SE exposure) of Mounts Pezzocucco, Palone and Oberkovel, is made up of rocks and screes and is crossed by some streams. The gradient is generally high and even exceeds 100%. The area is crossed by a paved road along which the vegetation cover is zero

Figure 2 - Sector of the Zahre area / Settore dell’area Zahre (Photo G. Rassati)

or slight, with a wood of Norway spruce *Picea abies*, European larch *Larix decidua* and European beech *Fagus sylvatica* only in short stretches.

The second (Sclûse area; Municipality of Chiusaforte; UM 83; 990-1090 m a.s.l.; Fig. 3), on the lower slope (with prevalent SE exposure) of the Jôf di Montasio group,

Figure 3 - Sector of the Sclûse area / Settore dell’area Sclûse (Photo G. Rassati)

consists of rocks and, to a small extent, screes and is bordered in small part by a watercourse. The gradient is generally high and exceeds 100% for large tracts. The area is crossed by a paved road along which the vegetation cover is zero or slight, with a wood of European beech and Norway spruce only in small portions.

In both cases, there are concrete and stone retaining walls along the road; in the first area there are road protection works (e.g. gabions and barriers with wooden beams and metal uprights) above some walls, while the second area has some tunnels and stretches of concrete slope faces.

The mean annual temperatures are 5-6°C in the Zahre area and 8-9°C in the Sclûse area, while annual precipitation is 1400-1600 mm in the former and 2200-2400 mm in the latter (POLLI, 1971).

The first area covers territories belonging to both Friuli Venezia Giulia and Veneto, while the second is wholly within Friuli Venezia Giulia.

The two areas were chosen as they are easily identifiable and walkable. Hence, they are suitable for standardization of surveys so as to be repeatable also by other investigators over time. Moreover, the areas are representative since they belong to two different Alpine sections and involve both regions where *Iberolacerta horvathi* has thus far been found.

Individuals were counted along pre-established 1 km-long transect lines (BUCKLAND *et al.*, 2004); in the first area the path was continuous, while in the second some stretches were interrupted by tunnels. Three censuses were conducted per area, in May, July and September 2018, on days with no precipitation. There were no problems with species determination in the Zahre area since the Common wall lizard *Podarcis muralis* was never found in those sites (RASSATI, 2010). Examination of the individuals was performed at a very close distance and by means of photographs.

The kilometric abundance index (KAI; No. ind./km) was obtained both per single census and per the total of the censuses (Tab. 1). The distance between closest individuals was measured: when it was within 15 metres, they were considered grouped (based on the home range size as derived from *in situ* observations and the consequent ease of interactions), otherwise they were considered isolated. Finally, the mean distance between the grouped individuals was calculated.

3. – Results

Investigations in the last 20 years or so have made it possible to record *Iberolacerta horvathi* (Fig. 4) in over 40 new sites. Active individuals were observed from late February to early November.

In Italy the species is reported from 250 m a.s.l. (LAPINI *et al.*, 2004) to 2000 m a.s.l. (DARSA, 1972), exclusively in the north-eastern extremity in 37 UTM squares (Fig. 1). It seems more widespread (albeit with varying intensity) along the Carnic Alps, Julian Alps and northern sector of the Julian Prealps, while it appears to be rarer in the other sectors of the Julian Prealps, in the Carnic Prealps and generally in western Friuli and the Venetian Alps.

Figure 4a - *Iberolacerta horvathi.* Neonate (Mount Brizzia, Pontebba, Carnic Alps) / Neonato (Monte Brizzia, Pontebba, Alpi Carniche) (Photo G. Rassati)

Figure 4b - *Iberolacerta horvathi.* Juvenile of about 10 months (Mount Palone, Vigo di Cadore, Carnic Alps) / Giovane di circa 10 mesi (Monte Palone, Vigo di Cadore, Alpi Carniche) (Photo G. Rassati)

Figure 4c - *Iberolacerta horvathi*. Adult (Mount Pighera, Taibón Agordino, Dolomites) / Adulto (Monte Pighera, Taibón Agordino, Dolomiti) (Photo G. Rassati)

Figure 4d - *Iberolacerta horvathi.* Adult (Selve, Chiusaforte, Julian Alps) / Adulto (Selve, Chiusaforte, Alpi Giulie) (Photo G. Rassati)

	May	July	September	Total	Mean	SD
Zahre	3	16	9	28	9.33	6.51
Sclûse	2	9	6	17	5.67	3.51

Table 1 - Kilometric abundance index (KAI; No. ind./km) in the two areas where the censuses were conducted / Indice chilometrico di abbondanza (IKA; N° ind./Km) nelle due aree in cui sono stati effettuati i censimenti

The KAI ranged from 3 to 16 in the Lumiei Valley (mean 9.33 ± 6.51 SD) while in the Raccolana Valley it varied from 2 to 9 (mean 5.67 ± 3.51 SD) (Tab. 1). In both areas, the KAI was highest in July and lowest in May.

Considering all the censuses, in the Zahre area 53.6% of the individuals were grouped into 4 groups, while in the Sclûse area 41.2% were in 3 groups. The mean number of grouped individuals was 3.75 ± 1.26 SD in the Lumiei Valley and 2.33 ± 0.58 SD in the Raccolana Valley, while both the maximum number (Zahre area n=5; Sclûse area n=3) and the maximum percentage value of grouped individuals were recorded in July in both areas.

The mean distance between grouped individuals was 8.12 m ± 4.87 SD in the Lumiei Valley (Fig. 5) and 4.97 m ± 3.25 SD in the Raccolana Valley.

Figure 5 - *Iberolacerta horvathi*. Grouped individuals (Zahre area) / Individui raggruppati (Area Zahre) (Photo G. Rassati)

4. – Discussion

Distribution

Iberolacerta horvathi has been found in almost all the main valleys, from the Piave Valley in the west to the Natisone Valley in the east. However, the distribution is not homogeneous, as already indicated, and not merely for biogeographical reasons: although it can certainly be assumed that this is due to a lack of investigations, in some zones of the Carnic Alps and in part of the Carnic Prealps and Julian Prealps the morphology and the lower presence of suitable habitat certainly contribute.

Records in the western sector of the range have greatly increased, e.g. in the Carnic Prealps and in Veneto where the species appeared strongly localized (SINDACO *et al.*, 2006) and where the southernmost population in Italy was found (gorge of the Cellina-Alba-Molassa Rivers, Carnic Prealps; RASSATI, 2010) near the mouth of the valley in the Friuli plain. In Veneto, at the beginning of the century, the taxon was known only in two localities and in two UTM squares (BONATO *et al.*, 2007); at present, it is known in about 10 localities and 7 squares (Fig. 1), and these numbers are destined to increase since it has been found in other still to be reported sites in the Province of Belluno (DE MARCHI G., *in litteris*).

Regarding the distribution limits, to the north and west of the Piave River (Veneto), only six sites with the species are currently known: from northeast to southwest, Mount Ferro and Acquatona Ravine and surroundings (RASSATI, 2018), Mount Carro (RASSATI, unpub. data), Diebba Valley (RASSATI, 2010), Cordevole River gorge (LAPINI & DAL FARRA, 1994), Mount Pighera (RASSATI, unpub. data). The last site, where the species cohabits with *Podarcis muralis*, is located along mountain slopes at a higher altitude (730-750 m a.s.l.) than that reported in the gorge environment in the same municipality (Taibón Agordino) (LAPINI & DAL FARRA, 1994). It is believed that, also in this case, further research will reveal other populations. Given the proximity to some of the known localities, it is also possible that the range of the species extends into Trentino and South Tyrol.

The intensification and perseverance of the investigations have allowed us to establish, through the numerous and varied data collected, that the presumed presence in only a few tens of localities is due merely to a lack of research and to assume that the species is widespread on most of the mountain massifs from the central-northern sector of the Julian Prealps and Carnic Prealps to the Alpine zone. Moreover, the isolation of some populations, inferred on the basis of few (sometimes single) data is, only presumed; in fact, on many occasions the sites where the species was found probably supported metapopulations in contact through suitable habitats, also artificially created ones such as roads (RASSATI, 2018). A further indication of populations more widely distributed than previously thought or, more likely, of metapopulations is the finding of individuals at several altitudes within the same valley (e.g. Raccolana Valley, Julian Alps; Fig. 6).

Figure 6 - *Iberolacerta horvathi*. Individual with bifid tail (Raccolana Valley, Julian Alps) / Individuo con coda bifida (Val Raccolana, Alpi Giulie) (Photo G. Rassati)

Monitoring of a rupicolous species that strongly resembles another (in various cases syntopic) species such as *Podarcis muralis* cannot be conducted by making single visits and, in the case of a find, limiting oneself to reporting it (moreover providing geographical coordinates referable to a "punctiform" site) without further investigations, as this would lead to poor understanding of the situation and the dissemination of scenarios far from reality. The real situation started to become clear with studies in the first decade of this century that revealed a broad distribution of the species in some valleys (e.g. Lumiei Valley, Incarojo Valley; Carnic Alps) and on some mountain massifs (e.g. Mount Zermula, Mounts Pezzocucco-Palone-Oberkovel-Festons, Carnic Alps) (RASSATI, 2010). With data collected later, it was ascertained that on the main Carnic chain, from the massifs of Rinaldo and Peralba-Chiadenis-Avanza to the mountains of Malborghetto and Ugovizza, there is a succession of populations that are only partially and apparently isolated. The various finds also in Veneto to the south and east of the Piave River suggest a similar situation, although probably with larger gaps. In some valleys, *Iberolacerta horvathi* has been found in a wide altitudinal range that even reaches 1000 m (Lumiei Valley) and that in the case of the Incarojo Valley extends from the valley floor to the mountain ridges for about 900 m. The need for thorough investigations to achieve a minimum level of knowledge in order to understand the spatial and altitudinal distribution modalities is also increased by the fact that some individuals present characters used for the specific determination that are typical of the other species, e.g. caudal rings of subequal thickness in *Iberolacerta horvathi* and, vice versa, caudal rings of regularly alternating thickness in *Podarcis muralis*.

Particular, also in relation to the cohabitation with *Podarcis muralis*, is the spatial-altitudinal distribution in the Lumiei Valley (Carnic Alps) described by RASSATI (2010): in the lower, more "open" and warmer part of the valley, *Podarcis muralis* was found up to an altitude of ca. 750 m; *Iberolacerta horvathi* lives further upstream where the valley becomes narrower and much more gorge-like (Bûs di Sauris); the valley then "opens" again and *Podarcis muralis* is found both in the Lake Sauris zone and in the villages, in an altitudinal range approximately between 1000 and 1400 m a.s.l.; further up the valley, the environment and the climatic conditions favour the presence of *Iberolacerta horvathi*, found up to 1800 m a.s.l. and occupying the mountain slopes of the valley head. In this case, syntopy occurs only at the edge of the gorge where the variations of conditions and intensity of ecological factors result in a coexistence of environments more favourable to one or the other species. In most of the other cases, syntopy occurs more or less "diffusely" also in low-altitude gorge habitats (e.g. gorge of the Cellina-Alba-Molassa Rivers, 350-400 m a.s.l.) where *Iberolacerta horvathi* is less favoured than in similar situations at higher altitudes and in more internal sectors of the Alpine arch. The presumed existence of mixed (*horvathi* - *muralis*) populations only at "medium" altitudes was also due to a dearth of investigations: syntopy was verified from 350 m a.s.l. (last site mentioned) to 1800 m a.s.l. (Mount Dimon, Carnic Alps; RASSATI, 2010).

Given the broad altitudinal range in which the species lives, the used habitats are found in various positions, from the valley floor through the gorges and mountain slopes to the highest zones, and they are situated at the edges of different environmental types which, in the case of vegetation, vary from stands of thermophile broad-leaved trees and meadows to shrub thickets and alpine pastures. Relatively frequent is the use of various types of habitats by the same population, especially when it is numerous and in the presence of roads. The parameters of the sites used by a population also vary widely: for example, it has been observed that, even in the presence of optimal habitat, part of the population uses sectors shaded by arboreal and/or shrub vegetation even at high altitudes.

Abundance

The censuses revealed high variability among the months, with a peak in July (Tab. 1).

There were more individuals and a much higher mean KAI in the Zahre area than in the Sclûse area where the counts indicated less variability, albeit with a wide range (Tab. 1). This result is difficult to interpret because of the small number of years (only one) in which these data were collected and the lack of previous data. Factors that could have had an influence are the higher gradient and larger number of vehicles in the second area, which can sometimes make observation more difficult.

The results show that, even in the presence of a widespread population in a large tract, contact may not be immediate, especially in the spring months. This confirms that investigations on *Iberolacerta horvathi* must be thorough and protracted in time.

The mean abundance values are higher than almost all those found in Slovenia (ŽAGAR, 2016), which however were recorded in lower altitudinal bands than those of the sites investigated in this study. The only altitudinal band that includes one of the two areas where the censuses were carried out in Italy (Sclûse) is that of 900-1099 m a.s.l., where the value in Slovenia (12.71 ind./km) is much higher than that found in Italy (5.67 ind./km).

Conservation

The position of the sites inhabited by the species and the type of habitat used have led, in various cases, to the belief that impacts and threats are not very serious. Although correct for some sites, this is not valid for all of them. In fact, the taxon lives both in natural habitats, such as rock faces, screes, beds and banks of watercourses, pastures with rocks, and in environments deriving from human intervention, such as road scarps, walls, bridges, weirs, embankments and other structures (RASSATI, 2010). The populations that live in the latter environments may be affected by maintenance, modification, reconstruction or demolition works (Fig. 7), which can have a strong impact. This factor has greater weight for *Podarcis muralis*, for which substantial impacts have already been reported (cf. e.g. RASSATI, 2010), due to both the greater frequency of the species and the extent of the range but also the fact that it is present in urbanized areas and in abundance on buildings and other structures. In the case of *Iberolacerta horvathi*, only one locality where it lives in conditions of synanthropy is known in the Carnic Alps (Mount Croce Carnico Pass, 1360 m a.s.l., RASSATI, 2018).

Threats to populations living in areas with scarce anthropization have become increasingly substantial over time due to infrastructure and consequently settlement expansion, favoured by works that also have strong effects on the natural habitats (cf. RASSATI, 2018). Over time, this factor could increase the impact on populations which in the past were not thought to be affected, due to greater availability of high-capacity mechanization and insensitivity to environmental problems (*sensu lato*), as ascertained by the author on several occasions.

Another factor that could have strong repercussions should be added to those reported above: investigations in recent years failed to reveal *Iberolacerta horvathi* in localities where in the past it was the only species or was syntopic with *Podarcis muralis*, which instead was found. Although in some sites numerous surveys were necessary to find *Iberolacerta horvathi* and the sites in question could be marginal, the concomitance of the "disappearance" of this species and the "appearance" of *Podarcis muralis* is symptomatic of a transformation that can be attributed to climate change. If the marginality of the sites were to be considered, this hypothesis would have even more value, since in a source-sink dynamic the source could no longer have the same strength and/or the sites in question could be less suitable for *Iberolacerta horvathi* and more favourable to the generalist *Podarcis muralis*. It would be interesting to verify this phenomenon in the entire range.

Climate change acts directly also through modification and destruction of habitats and this has more of an impact in the case of buildings and other structures: the artificially produced habitat has lower resilience since it cannot be spontaneously reformed, as verified on several occasions and also in the Zahre area. Moreover, climate change has indirect effects. The meteorological events it causes result in landslides, subsidences, destruction of works, etc., which lead to the types of interventions described above (Fig. 7) and with greater frequency than that recorded in the past.

To provide greater possibilities of survival for sensitive species and in particular stenoecious ones such as *Iberolacerta horvathi*, it is necessary to ensure that there is awareness by the greatest number of people that such species exist and require conservation. This must be done through practical conservation actions conducted by experts with multidisciplinary skills. Such actions should encompass the largest number of species and directly affect works carried out, often in a compulsive and disorganized manner, also in areas of high naturalness.

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Figure 7a - Renovation works of a bridge (Lumiei Valley) / Lavori di ristrutturazione di un ponte (Val Lumiei) (Photo G. Rassati)

Figure 7b - Two individuals of *Iberolacerta horvathi* in the zone being renovated / Due individui di *Iberolacerta horvathi* nella zona in ristrutturazione (Photo G. Rassati)

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