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DISTRIBUTION AND ECOLOGY OF *LACERTA HORVATHI* MÉHELY, 1904 (REPTILIA, LACERTIDAE) IN NORTH-EASTERN ITALY

DISTRIBUZIONE ED ECOLOGIA DI LACERTA HORVATHI *MÉHELY, 1904 (REPTILIA, LACERTIDAE) IN ITALIA NORD-ORIENTALE*

Abstract - The Authors present a synthesis of the distribution of *Lacerta horvathi* in north-eastern Italy and the first results of a research on its ecology in the same area.
Key words: *Lacerta horvathi*, Distribution, Ecology, NE Italy.

Riassunto breve - *Gli Autori presentano una sintesi cartografica della distribuzione di* Lacerta horvathi *nel Nord Est italiano redatta secondo il sistema cartografico UTM con un reticolo di 10 chilometri di lato. Essi inoltre riferiscono i primi risultati di alcune ricerche sull'ecologia della specie condotte nella stessa zona.*
Parole chiave: Lacerta horvathi, *Distribuzione, Ecologia, Italia nord-orientale.*

1. Introduction

Lacerta horvathi MÉHELY, 1904 (hereinafter *L.h.*) is an East Alpine - North Dinaric species (sensu La Greca, 1963) dwelling in rocky mountain biotopes of Germany (Capula & Luiselli, 1991), Austria (Grillitsch & Tiedemann, 1986; Cabela et al., 1992; Tiedemann, 1992), Italy (Lapini, 1983; Lapini & Dolce, 1983), Slovenia and Croatia (De Luca, 1989). Up to now its relict range (Lapini & Dolce, 1983) seems to have at least three disjunctions, but this may perhaps be due to a scarcity of research (De Luca, 1989). In spite of its peculiar distribution there are no significant differences in morphology (De Luca, 1989) and karyology (De Luca & Dulic, 1988; Capula et al., 1989) among Italian, Slovenian and Croatian populations, and the species is considered monotypic[1].

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[1] The discovery of *L.h.* in Germany has recently been questioned by Schmidtler and his colleagues. They published an amazing mocking article, under "pseudonyms" (Faberl F. & Faberl H., 1991 - Zwischenbericht zur Ausbreitung des Archaeolacerta - horvathi - Komplexes in Bayern und seinen Nachbarländern. *Die Eidechse*, 4: 9 - 12), describing a new subspecies on the basis of ludicrous characters. See Capula & Luiselli, 1993 for further comments.

From the distributional point of view we made a synthesis of both bibliographical and original available data on Austrian, Italian and Slovenian localities inhabited by *L.h.*, while the theatre of our ecological research was the Uccea Valley (Resia, Udine, north-eastern Italy), where the greatest Italian population of *L.h.* has been recently discovered (LAPINI, 1988).

The population studied by an ecological point of view dwells on the southern slopes of the M.ts Stregone and Chila (Uccea Valley, 700 - 800 m a.s.l.), in a deep valley with dinaric orientation and a very high raininess (IACUZZI & VAIA, 1980).

These environments are mainly covered by *Fagus sylvatica* woods conspicuously modified by human activity (copse, mown meadows) and characterized by the instability of vast rocky surfaces partly colonized by scattered grass and shrubs (MAINARDIS & SIMONETTI, 1991).

L.h. is syntopic in this locality with *Podarcis muralis* (LAPINI, 1988), *Lacerta (Z.) vivipara*, *L. viridis*, *Anguis fragilis*, *Coronella austriaca* and *Vipera berus,* but only the local ratio between Horvath's Rock lizard and Wall lizard is high enough (4:1) to represent a true case of cohabitaton.

We have recently studied the trophic niche overlap existing in these environments between syntopic *L.h.* and *Podarcis muralis* (RICHARD & LAPINI, 1993).

The aim of this paper is to increase the knowledge on distribution and ecology of the poorly known Horvath's Rock lizard (for a synthesis see BISCHOFF, 1984 and DE LUCA, 1992) also through the comparison with some ecological parameters of a syntopic population of *Podarcis muralis* (hereinafter *P.m.*).

These data may explain some ecological mechanisms which make possible a true syntopy between these lizards in the Julian Prealps.

2. Methods

a - Distribution

The synthesis of the distributional records of *L.h.* in Austria, Italy and Slovenia has been realized using the UTM 10x10 km international grid system. A complete data bank is also given. A detailed analysis of the altitudinal and environmental preferences of *L.h.* is made too. These are compared in the text with those of *P.m.* in the same area.

b - Reproductive biology

A small number of pregnant lizards (23 *L.h.* and 6 *P.m.*) was radiographed to determine the clutch size. This method, previously used on *Testudinidae* and *Iguanidae* (GIBBONS

& GREENE, 1979; DUNHAM et al., 1988), permits a low impact on the populations since the pregnant lizards may be released in good conditions after their exposure to X - rays. However, considering the very poor calcification of the eggs of these lizards, we have positively verified this study method by dissecting 5 pregnant females previously X - rayed.

The information on breeding and oviposition periods was obtained in three years of field observations, while that about sex ratio is due to the individual marking of 394 *L.h.* and 199 *P.m.* specimens. The toe - clipping identification code is that of PILORGE (1981), but for this work it was modified in order to reduce the number of clipped toes in each paw.

c - Growth, moult, hibernation

PILORGE's (1981) individual marking technique was also employed to obtain data on the growth (snout/vent length) of these lizards particularly up to the first oviposition (females' sexual maturity). Three years of field observations were necessary to determine the moulting periods of the lizards and the duration of their hibernation.

d - Micro - habitat selection

The micro - habitat selection operated by *L.h.* and *P.m.* was studied using the "Vegetation cover index" of tab. I (micro - habitats of tab. I were equally represented in the study area). The results were then tested using a G test performed with William's correction (SOKAL & ROHLF, 1981); besides, these values were compared to the numerical results of a X^2 test with the same degrees of freedom (FISHER & YATES, 1974).

e - Vagility

A capture - marking - recapture method, performed by using the toe clipping code quoted in paragraphs 2.b and 2.c, was used to evaluate the vagility of *L.h.* and *P.m.* in the same environment.

The subsequent annual (seasonal) recaptures of 120 specimens of *L.h.* and 80 of *P.m.* in three years of research permitted to gather some data about the general mobility of these lizards which were then tested by means of a G test performed as shown in paragraph 2.d.

Unfortunately, these data cannot be correctly used to obtain information on the annual Home Range of the lizards because their habitat is not homogeneous enough to utilize the medium recapture radii method (TINKLE & WOODARD, 1967). In fact, considering the characteristics of the studied environment, the lizards' Home Ranges cannot be circular, thus their extension might have been easily overestimated (ROSE, 1982).

The convex polygon method couldn't be used because our recapture spots were surely too much aligned (cfr. ROSE, 1982).

However, the medium recapture radii method was equally applied to our data; the "Ideal Home Ranges" obtained are in fact very useful to point out the differences in general mobility of *L.h.* and *P.m.* in the studied habitats.

3. Results and discussion

a - Distribution

A UTM 10x10 international grid system synthesis is given (fig.1), and the relative data bank can be summarized as follows (MFSN Z/E=Herpetological Collection of the Museo Friulano di Storia Naturale di Udine) :

Carnic Alps - UM26, Pierabech dint., m 1100 (Forni Avoltri, Udine), LAPINI & DOLCE, 1983; UM36, Stretta Fleons, m 1200 (Forni Avoltri, Udine), original; UM36, Hubertuskapelle, m 1140 (Wolayertal, Austria), GRILLITSCH & TIEDEMANN, 1986; UM55, Casera Pizzul dint., m 1500 (Paularo, Udine), LAPINI & DOLCE, 1983; UM65, Cason di Lanza dint., m 1552 (Paularo, Udine), original, ingesta (MFSN Z/E 973) in *Vipera berus* ♀ (MFSN Z/E 250); UM65, Torrente Pontebbana, m 650 (Studena Bassa, Pontebba, Udine), original; UM65, rocce lungo il Rio Pricotic, m 750 (Pontebba, Udine), original; UM65, Casera di Rio Secco dint., m 1200 (Moggio Udinese, Udine), original; UM65, rocce lungo la strada sotto la loc. Casarotta, m 1370 (Moggio Udinese, Udine), original; UM75, Val Rio Bianco, m 700 (Malborghetto-Valbruna, Udine), original; UM75, Vallone di Malborghetto, rocce lungo la strada, m 750 (Malborghetto-Valbruna, Udine), original; UM85, Vallone di Malborghetto, m 750-1200 (Malborghetto-Valbruna, Udine), original.

Julian Alps and pre-Alps - UM84-94, Raibl, m ? (Tarvisio, Udine), SOCHUREK, 1955; UM84-94, Raibl, m 900-1000 (Tarvisio, Udine), BRUNO, 1986; UM94 (Not UM84: DE LUCA, 1989), Passo di Predil, m ? (Tarvisio, Udine), DE LUCA, 1989; UM94, M.te Mangart, m 1800-1900 (Tarvisio, Udine), DARSA, 1972; UM94, Mangrt (Strmec), m 1094-1160 (Bovec, Slovenia), DE LUCA, 1989; UM94, M.te Ponza, m 1650-2000 (Tarvisio, Udine), DARSA, 1972; UM74 (Not UM64: DE LUCA, 1989), Pian dei Spadovai, m 1080 (Dogna, Udine), LAPINI & DOLCE, 1983; UM74, M.te La Veneziana, m 1000 (Pontebba, Udine), LAPINI & DOLCE, 1983, STERGULC, 1987; UM64, Pietratagliata dint., m 600 (Pontebba, Udine); UM83, Kanin, m 1100 (Bovec, Slovenia), BRELIH, 1962; UM83, Kanin, m 650-1050 (Bovec, Slovenia), DE LUCA, 1989; UM83, Svinjak, m 1200 (Bovec, Slovenia), BRELIH, 1962; UM93, Bala Pod Morezom, m ? (Bavsica, Slovenia), BRELIH, 1962; VM03, Planina Pod Skalo, m 1050 (Trenta, Slovenia), BRELIH, 1962; VM03, Crno Jezero-Dolina Triglavskih jezera, m 1340 (Triglav, Slovenia), BRELIH, 1954, 1962; VM02, Komarca, m 650 (Bohinj, Slovenia), BRELIH, 1962; VM23, Mrzli Studenec, m ? (Pokljuka, Slovenia), DE LUCA, 1989; VM04, Vrsic, m 1200 (Kranjska Gora, Slovenia), DE LUCA, 1989; UM63, Fontanon Barman dint., m 780 (Resia, Udine), original; UM93, Forte delle Chiuse di Plezzo, m ? (Bovec, Slovenia), LAPINI & DOLCE, 1983, LAPINI, 1984; UM72, Strada sotto i M.ti Polose e Nischiuarc, m 730-750 (Resia, Udine), LAPINI, 1988, CAPULA et al., 1989; UM72, Zanavarhlera, m 812 (Lusevera, Udine), LAPINI, 1988; UM73, Versante Sud Est del M.te Chila, m 750-800 (Resia, Udine), LAPINI, 1988; UM73, Uccea dint., m 700 (Resia, Udine), LAPINI, 1988; UM82, Krasji Vrh, m 1200-1600 (Slovenia), BRUNO, 1986; UM92, Ursic, m 1400-1500 (Kobarid, Slovenia), BRUNO, 1986; UM92, Tra M.te Vrata e M.te Nero, m 1400-1700 (Kobarid, Slovenia), BRUNO, 1986; UM83, Sella Nevea dint., m 1000 (Chiusaforte, Udine), original; UM53, Val Lavaruzza, m 1100 (Venzone, Udine), original; UM81, Bocche di Pradolino,

m 480 (Pulfero, Udine), original; VL19, Trnovski Gozd (Predmeja, Goljaki), m 1200-1500 (Ajdovscina, Slovenia), DE LUCA, 1989; VL44, Sneznik, Sviscaki, m 100-1050 (Ilirska Bistrica, Slovenia), DE LUCA, 1989; VL55, Sneznik, Sviscaki, m 1240 (Leskova dolina, Slovenia), DE LUCA, 1989.

These data do not include some localities of the Austrian Carnic Alps and Caravanche (EGGENBERGER in LAPINI, 1988: 210; CABELA et al., 1992; TIEDEMANN, 1992), as requested by the Austrian Authors, and a wrong quotation (Val Rosandra, Trieste: CORBETT, 1989).

An analysis of the altitudinal preferences of *L.h.* (fig. 2) clearly shows that it particularly prefers rocky environments between 800 and 1200 m a.s.l., while its altitudinal range is now extended from 480 to 2000 m a.s.l.
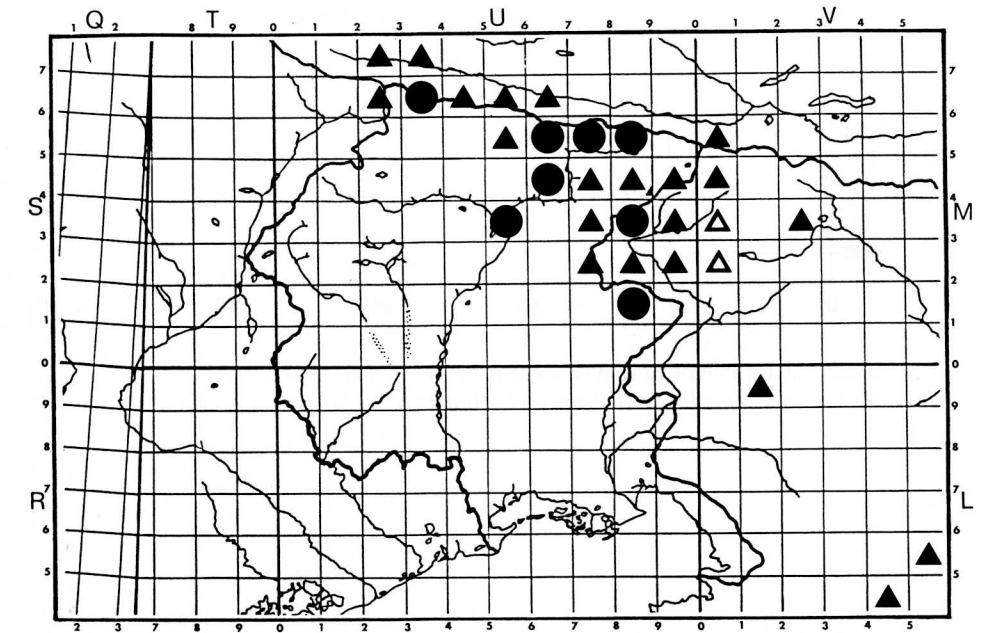

Fig. 1 - Distribution of *Lacerta horvathi* in Italy, Austria and Slovenia.
Δ :bibliographic records before 1970
○:original records before 1970
▲:bibliographic data after 1970
●:original records after 1970
- *Distribuzione di* Lacerta horvathi *in Italia, Austria e Slovenia.*
Δ *:dati bibliografici anteriori al 1970*
○*:dati originali anteriori al 1970*
▲*:dati bibliografici posteriori al 1970*
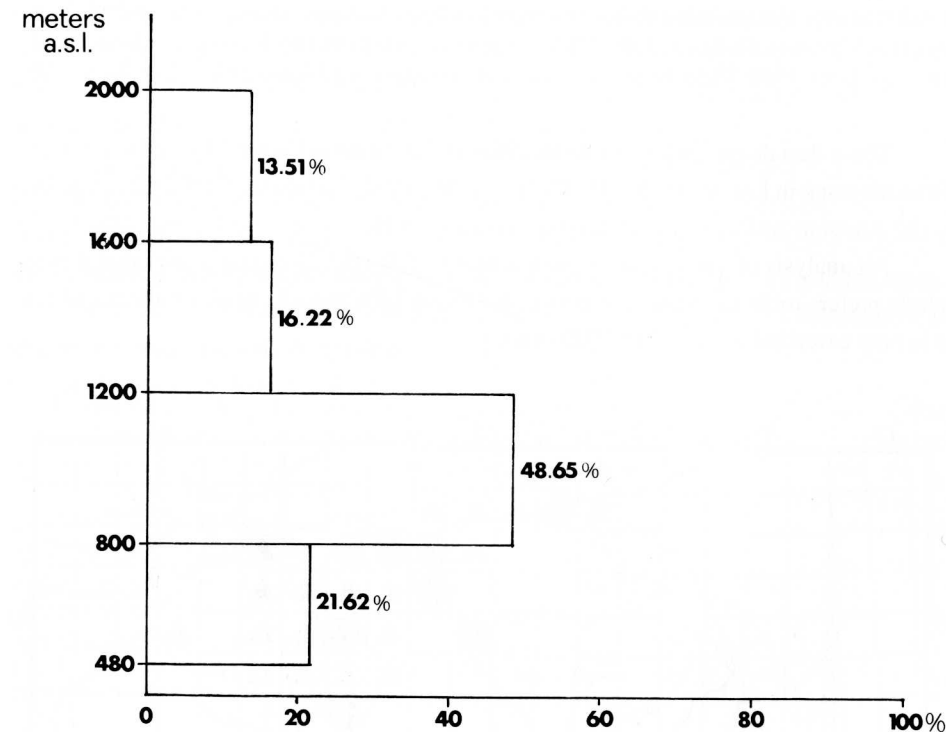●*:dati originali posteriori al 1970*

This last consideration supports the hypothesis that the present distribution of Horvath's Rock lizard might be potentially continuous, with no real disjunctions. Even DE LUCA (1989), which reported on some new localities (of the Mount Sneznik) in the "Slovenian - Croatian classic disjunction" (cfr. LAPINI & DOLCE, 1983), hypothesized that no real disjunction existed in that zone.

78% of the localities inhabited by *L.h.* is covered by *Fagus sylvatica*, *Abies alba*, *Picea abies*, *Pinus nigra* or *Larix decidua* woods, while various cold types of *Carpino - Fraxinetum*, *Aceri - Tilietum* or *Orno - Ostrietum* usually cover the lower habitats of this rock lizard.

Usually, the species selects rocky mountain environments, but the lower populations of the Julian Prealps (e.g. UM81, Bocche di Pradolino, m 480) sometimes live in deep wooded canyons with termic inversion, screes and boulders.

Fig. 2 - Altitudinal distribution of some records in the study area (n=37).
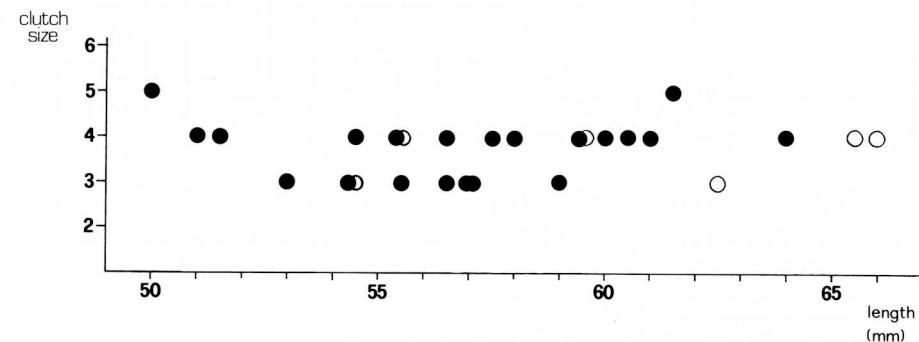- *Distribuzione altitudinale di alcuni dati nell'area di studio (n=37).*

Fig. 3 - Clutch size of *Lacerta horvathi* (●) and syntopic *Podarcis muralis* (○) in relation to snout -vent length.
- *Portata gravida complessiva di* Lacerta horvathi *(●) e* Podarcis muralis *(○) in condizioni di sintopia in relazione alle dimensioni (apice muso - rima cloacale).*
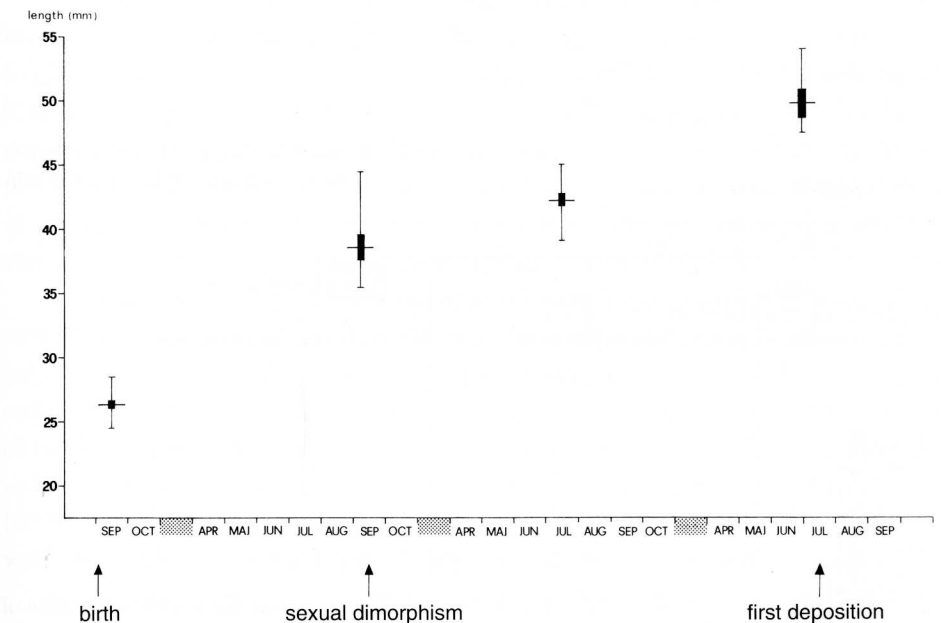

Fig. 4 - Growth of *Lacerta horvathi* (snout - vent length in mm) up to the first oviposition.
     Vertical lines=dimensional ranges
     Thin horizontal segments=medium values
     Thick vertical segments=standard errors
- *Accrescimento di* Lacerta horvathi *(apice muso - rima cloacale in mm) fino alla prima deposizione.*
     Linee verticali=intervalli di variazione dimensionale
     Segmenti orizzontali sottili=valori medi
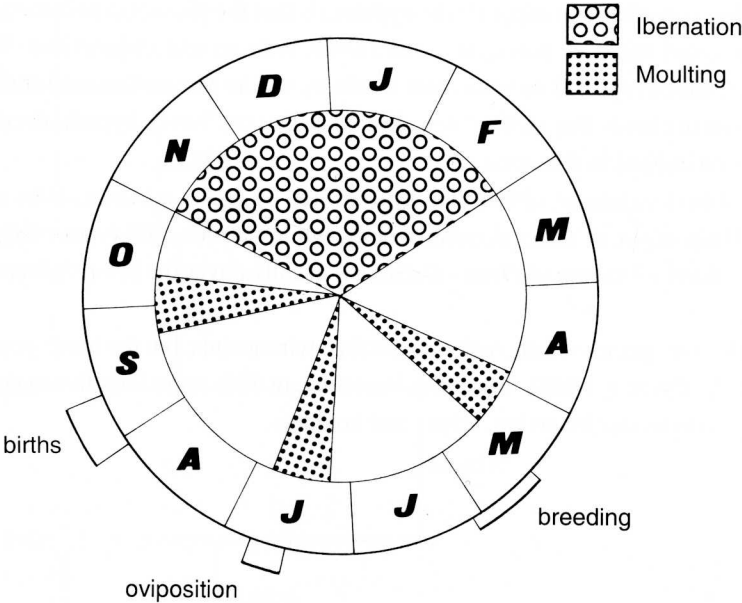   *Segmenti verticali spessi=errori standard*

Fig. 5 - Annual phenology of *Lacerta horvathi*.
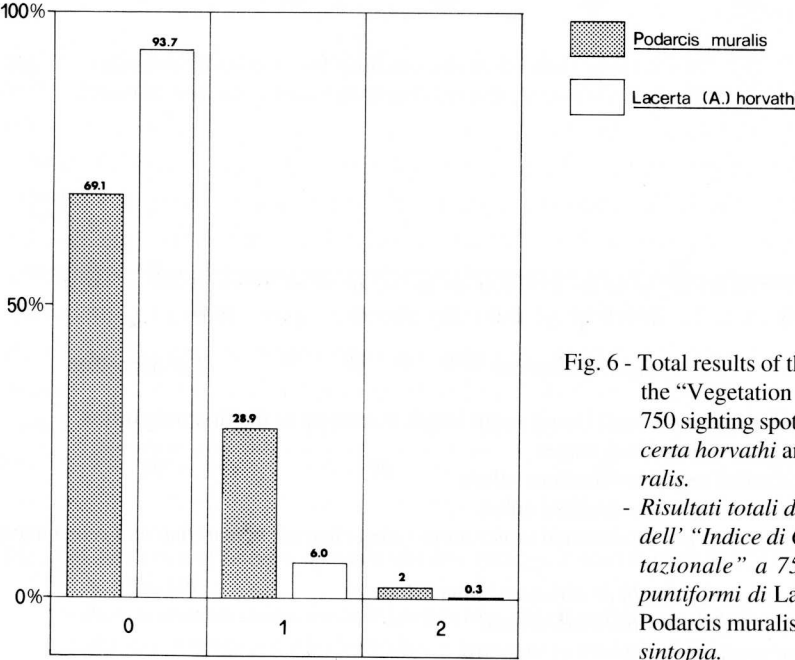- *Fenologia annuale di* Lacerta horvathi.

Fig. 6 - Total results of the application of the "Vegetation Cover Index" to 750 sighting spots of syntopic *Lacerta horvathi* and *Podarcis muralis*.
- *Risultati totali dell'applicazione dell' "Indice di Copertura Vegetazionale" a 750 avvistamenti puntiformi di* Lacerta horvathi *e* Podarcis muralis *in condizioni di sintopia.*

In the localities studied, the Horvath's Rock Lizard is often sympatric with various reptiles (*P.m.*, *Lacerta (Z.) vivipara*, *Lacerta viridis*, *Anguis fragilis*, *Coronella austriaca*, *Natrix natrix*, *Vipera berus* and *Vipera ammodytes*), but only the Green Lizard, the Smooth snake, the Nose Horned Viper and the Adder (one documented case: UM 65, Cason di Lanza, m 1552 - Pontebba, Udine - VII.1969) can prey on it.

A true cohabitation with *P.m.* in the same biotope has been observed in at least four cases. On the other hand, it must be noted that the Wall Lizard, in the extreme north - east of Italy, can usually be found up to 800-900 m a.s.l., rarely reaching higher quotes (the maximum limit in the Friuli - Venezia Giulia region is 1640 m a.s.l.: DARSA, 1972). Therefore the possibilities of cohabitation with *L.h.* are not so common.

b - Reproductive biology

In the study area *L.h.* breeds in the second half of May, and the oviposition occurs in the second half of July, lasting one week (fig. 5).The clutch size varies between 3 and 5 eggs ($\bar{x}$= 3,7; SE= 0,13; n=23) (fig. 3), and births occur from the end of August to the first decade of September. Observing fig. 3 a situation of invariant clutch size could be hypothesized. This would contrast with the data of DE LUCA (1992) and perhaps may be due to the low altitude where the studied population lives. Anyway, because of the little size of the sample, we think that both trying statistic interpretations and drawing definitive conclusions could be hazardous. Sex ratio of adults: ♂♂ 1,01 / ♀♀ 1.

The interpretation of the same observations made on a syntopic population of *P.m.* seems to be quite contradictory. Breedings were observed in May and an oviposition in mid July, but X - rays revealed the presence of mature eggs also in two females caught at the end of May. Thus the presence of a first period of sexual activity in the second half of March must be hypothesized. The determination of the clutch size was also very difficult, due to the small number of pregnant *P.m.*. Anyway it varied between 3 and 4 eggs ($\bar{x}$= 3,7; SE=0,21; n= 6). Births were always observed from July to the end of August, but newborns were only rarely seen. Therefore a high mortality of the embryos can be hypothesized.

According to our data, *L.h.* seems to be clearly monoestrous (see also DE LUCA, 1992). Considering the quite low altitude of the studied population, it may be hypothesized that this rock lizard shows a similar behaviour all over its range. These considerations enable us to note that *L.h.* has a lower absolute reproductive potential than *P.m.* (see GRUSCHWITZ & BÖHME, 1986 for a review), considering both the medium clutch size and the number of annual oviposition. From this point of view *L.h.* fairly resembles *Lacerta (Z.) vivipara*, the species best adapted to cold climate among palaearctic *Lacertidae* (PILORGE, 1981; SHINE, 1983; DELY & BÖHME, 1984). However, while this latter is ovoviviparous, *L.h.* is exclusively oviparous.
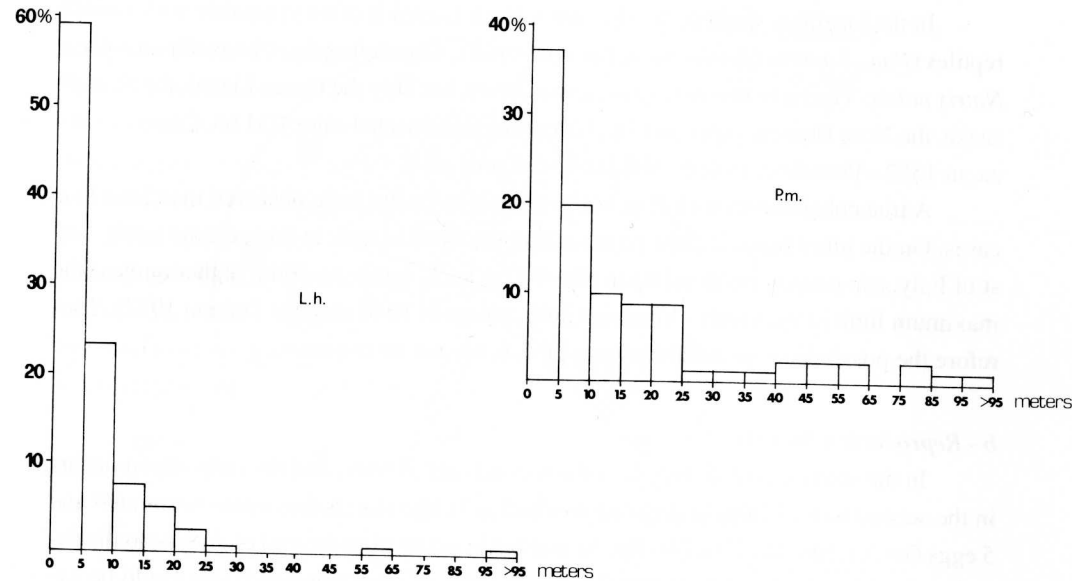
Fig. 7 - Annual displacements of syntopic *Lacerta horvathi* (n=120) and *Podarcis muralis* (n=81).
- *Spostamenti annuali di* Lacerta horvathi *(n=120) e* Podarcis muralis *(n=81) in condizioni di sintopia.*
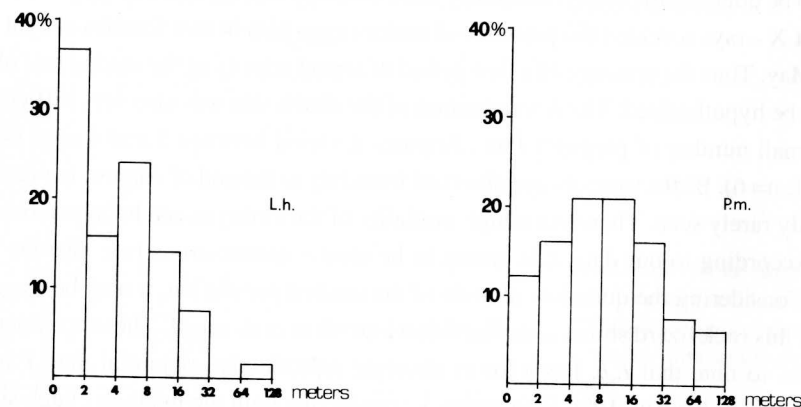

Fig. 8 - Logarithmic normalization of the data of fig. 7: in abscissae, distance classes on logarithmic base 2.
- *Normalizzazione logaritmica dei dati di fig. 7: in ascisse classi di distanze in scala logaritmica di base 2.*

c - Growth, moult, hibernation

The data on growth and moult obtained by capture and recapture of marked specimens are not very abundant. For *L.h.* they might be summarized as follows (see also figs. 4 - 5), while for *P.m.* they are clearly non sufficient to support any interpretation.

The births of *L.h.* usually occur at the beginning of September; snout/vent length of the newborns averages 26,3 mm (min= 24,5; max= 28,5; SE= 0,24; n=20). At the end of the first year of life they measure 38,6 mm (min= 35,5; max= 44,5; SE= 0,91; n=10) and at 22 months they reach 42,3 mm (min= 39; max= 45; SE= 0,55; n=12). At 33 months, their average length is 49,8 mm (min= 47,5; max= 54; SE= 1,01; n= 6). Sexual dimorphism becomes evident at the end of the first year of life and the first oviposition occurs around 50 mm of snout - vent length. From these data it must be argued that the sexual maturity of the females occurs in their third year of life.

Micro habitats	Vegetation Cover	Degrees
Bare rock or cement (sometimes covered by close musk)	No (lizards totally exposed to the sun)	0
Scattered pioneer vegetation	Low (lizards well exposed to the sun)	1
Grassland ecotones	High (lizards partially in the shade)	2
Meadowy and bushy habitats, undergrowth	Total (lizards completely in the shade)	3

Tab. I - Vegetation Cover Index.
- *Indice di Copertura Vegetazionale.*

Date	Lacerta horvathi				Podarcis muralis			
	No. of occurrences	V.C.I.=0	V.C.I.=1	V.C.I.=2	No. of occurrences	V.C.I.=0	V.C.I.=1	V.C.I.=2
14.6.'87	74	70 94,60%	4 5,40%	- -	16	10 62,50%	6 37,50%	- -
14.5.'88	55	50 90,90%	5 9,10%	- -	23	16 69,60%	6 26,10%	1 4,30%
21.6.'88	62	55 88,70%	7 11,30%	- -	16	11 68,70%	5 31,30%	- -
1.10.'88	98	91 92,90%	6 6,10%	1 1%	19	15 78,90%	3 15,80%	1 5,30%
7.5.'89	26	23 88,50%	3 11,50%	- -	14	9 64,30%	5 35,70%	- -
28.5.'89	36	35 97,20%	1 2,80%	- -	8	5 62,50%	3 37,50%	- -
15.7.'89	66	58 87,90%	7 10,60%	1 1,50%	10	5 50%	4 40%	1 10%
19.7.'89	47	47 100%	- -	- -	13	9 69,20%	4 30,80%	- -
13.8.'89	65	64 98,50%	1 1,50%	- -	15	12 80%	3 20%	- -
20.8.'89	69	67 97,10%	2 2,90%	- -	18	13 72,20%	5 27,80%	- -
Total	598	560 93,70%	36 6%	2 0,30%	152	105 69,10%	44 28,90%	3 2%

Tab. II - Analytical results of the application of the "Vegetation Cover Index" (V.C.I.) to 750 sighting spots of syntopic *Lacerta horvathi* and *Podarcis muralis*.
- *Risultati analitici dell'applicazione dell'"Indice di Copertura Vegetazionale" (V.C.I.) a 750 avvistamenti puntiformi di* Lacerta horvathi *e* Podarcis muralis *in condizioni di sintopia.*
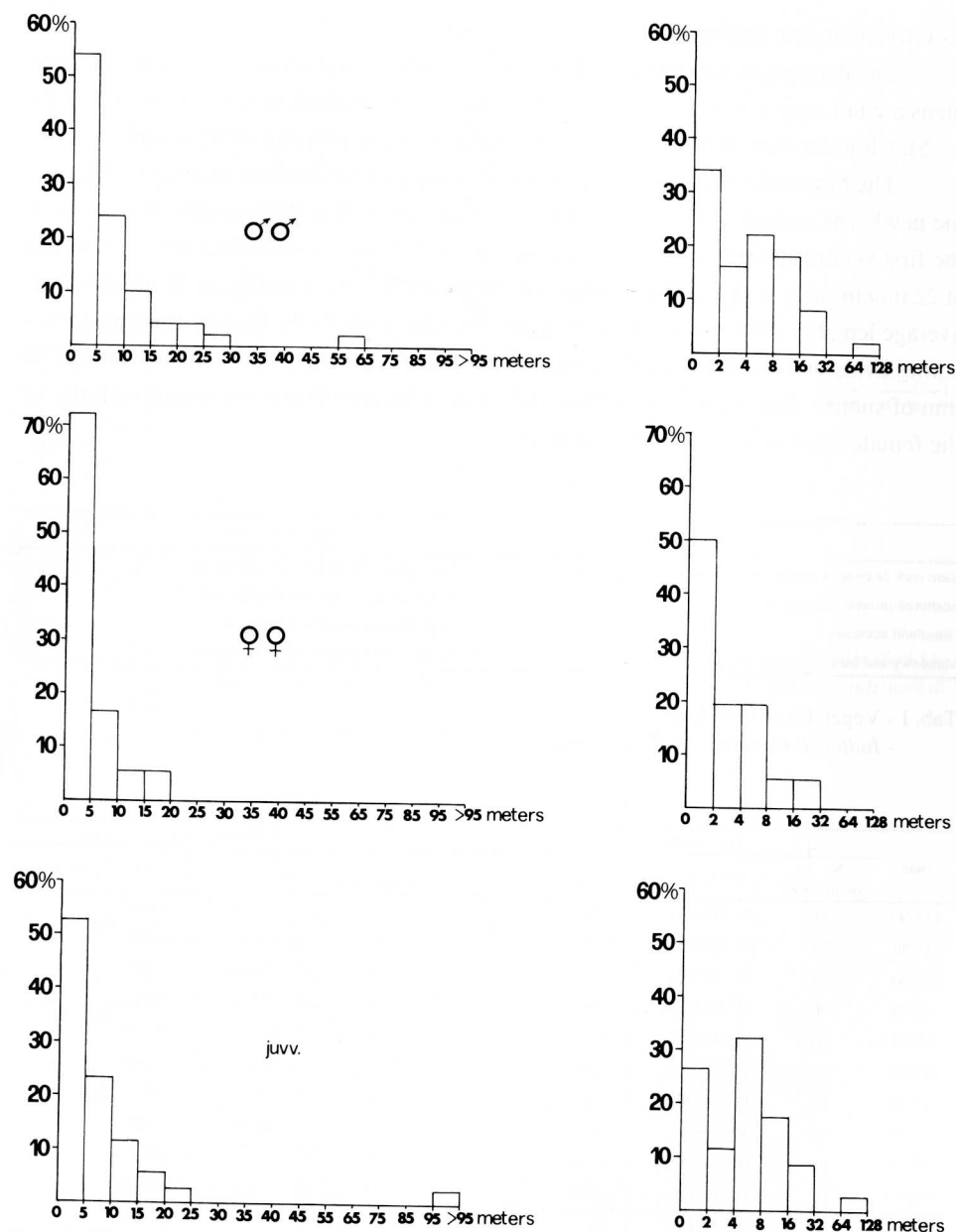
Fig. 9 - Annual displacements of 50 males, 36 females and 34 young ones of *Lacerta horvathi* before (left) and after (right) the same logarithmic normalization of fig. 8.

- *Spostamenti annuali di 50 maschi, 36 femmine e 34 giovani di* Lacerta horvathi *prima (a sinistra) e dopo (a destra) la stessa normalizzazione logaritmica di fig. 8.*

L.h. has a minimum of three moults per year: a spring moult (end of April - mid May), a summer moult (in July), and an autumn moult (mid September - mid October) (fig. 5), but other moults may be hypothesized for the younger specimens.

Hibernation lasts from the end of October - first decade of November to the end of February - first half of March (fig. 5) for both species. An uninterrupted hibernation probably occurs in the studied environment, since in winter these habitats are rarely exposed to the sun and they are often covered by snow.

d - Micro - habitat selection

The results of the application of the Vegetation Cover Index of tab. I (hereinafter V.C.I.) are analytically exposed in tab. II, while a graphic representation of the total results is given in fig. 6. Both lizards particularly select sunny micro - habitats with 0-1 V.C.I., but while *L.h.* is strictly bound to rocky vegetationless biotopes (V.C.I.= O in 93,65% of the sample), syntopic *P.m.* clearly operates a wider micro - habitat selection (V.C.I.= 0 in 69.08% of cases and V.C.I.= 1 in 28,95% of the sample). In our sample of sighting spots (relative to both species, for a total number of 750 individuals) only five lizards were observed in biotopes with V.C.I.= 2, while no lizard was observed in micro - habitats with V.C.I.= 3.

The difference of the habitat selection of *L.h.* and *P.m.* was then tested using a G test applied to the occurrences of the lizards in biotopes with 0 and 1 V.C.I. The results we-

	Podarcis muralis	*Lacerta horvathi*
Males	63.30; 20.50; 90.10; 40.70; 5.80; 8.70; 7.45; 12.40; 15.30; 3.10; 15.30; 16.80; 65; 9; 3.10; 8; 4.40; 7.10; 1.10; 3.75; 11.40; 1.90; 5.20; 10.40; 5.50; 24.40; 49.10; 2.30; 4; 2.90; 11; 3; 118.20; 35.50; 50.80; 8; 2.80; 22.20	0; 0.45; 0; 6 ;5 ;0 ; 24.30; 12.10; 2.90; 3; 7.90; 1.90; 1.90; 1.30; 10.70; 10.50; 2.10; 1.50; 9.40; 8.10; 15.80; 8.60; 1.45; 1.45; 4.60; 7.45; 2.05; 1.80; 4; 0.90; 0.85; 10.90; 7.80; 2.10; 5.90; 0; 10.10; 3.30; 4.10; 16.20; 64.20; 7.20; 1.40; 7; 8; 27.90
Females	4; 15.30; 1.50; 4.30; 4.30; 3.50; 30.90; 23.75; 16.40; 1.30; 3.20; 82.20; 8.30; 0; 80.20; 13.40; 6.30; 9.50; 3.30; 1.40; 17.50; 6.20; 4.30; 6.40; 1.40; 3; 3; 0; 8.40; 6; 18.40; 23; 25.10; 1.90; 41; 1.50; 2	0; 0; 0; 1.90; 0; 0.50; 7.10; 6.60; 1; 3.90; 2.40; 16.30; 0; 0; 6; 60; 1.65; 1.40; 0; 0; 0; 7.90; 12.60; 0; 2.10; 2.95; 2.10; 3.05; 17.30; 2.70; 0; 4.50; 6.50; 1.90; 1.25; 5.05; 10.20
Juvv.	21.50; 21.20; 14.70; 4.40; 10.10; 10.40	8; 1.50; 17.50; 0; 4.30; 11.85; 3.30; 8.70; 12.10; 14.80; 5.80; 1.70; 0.70; 5.90; 4.40; 4.70; 0.50; 7; 1.40; 11.90; 3.10; 9.80; 7.10; 3.90; 1.50; 4.10; 3.40; 0; 5.60; 17.60; 20.80; 0.60; 172.80; 4.10

Tab. III - Annual displacements of the studied lizards (in meters).
 - *Spostamenti annuali delle lucertole studiate (in metri).*

re significant (1987: G=4,778; d.f.=1; 0,02<P<0,05 - 1988: G=4,867; d.f.=1; 0,02<P<0,05) or highly significant from a statistical point of view (1989: G=18,889; d.f.=1; P<0,001). Highly significant statistical results were also obtained by performing the same test on the total results of tab. II (G= 27,397; d.f.=1; P<0,001).

Our results seem to show that the Horvath's Rock lizard should be considered as a stenotope species, with marked preferences for rocky (or stony) mountain vegetationless habitats. This is evidenced also by the study of the habitat selection of a syntopic population of *P.m.*, which clearly shows a wider environmental adaptability (fig. 6). This agrees with literature data (GRUSCHWITZ & BÖHME, 1986) and makes possible a true cohabitation between these lizards. The study of the diet of these lizards in the same biotopes has shown a great trophic niche overlap (RICHARD & LAPINI, 1993). Therefore the diversity of the habitat selection must certainly play an important role in the ecological niche segregation when these species are syntopic (see also SCHOENER, 1968). On the other hand, it must be noted that a better segregation of the ecological niche may be made easier also by some diversities in the cyrcadian or cyrcannual activities, or by a simple difference of thermal preferences. It must be in fact considered that *L.h.* has a quite low temperature of activity (DE LUCA et al., 1989; 1992).

e - Vagility

The measures of 120 successive annual displacements of *L.h.* and of 81 of *P.m.* are analitically exposed in tab. III. The Horvath's Rock lizard surely exhibits a general lower mobility (figs. 7 - 9 - 10). The difference in spatial behaviour of these syntopic lizards became more evident after a logarithmic normalization of the data: the data on the vagility of *P.m.* complexively show Gaussian trends (fig. 8), while those on the mobility of *L.h.* are more characterized (fig. 8). A G test analysis of the total results shows a statistical significance of the differences in general vagility of *L.h.* and *P.m.* (G= 9,829; d.f.= 4; 0,02<P<0,05).

In both species (figs. 9 - 10) the displacements of males and females show quite similar trends, and the females exhibit the lower vagility.

In the study area the medium recapture radium is 7,3678 m for *L.h.* ($\overline{x}$ ♂ ♂ (n=50): 7,318 m; $\overline{x}$ ♀ ♀ (n=36):3,5958 m; $\overline{x}$ juvv. (n=34):11,1897) and 15,6656 m for *P.m.* ($\overline{x}$ ♂ ♂ (n=38):20,25 m; $\overline{x}$ ♀ ♀ (n=37):13,031 m; $\overline{x}$ juvv. (n=6):13,716 m). The "Ideal Home Range" of *L.h.* may be on an average approximatively estimated in 170,453 sqm ($\overline{x}$ ♂ ♂=168,1568 sqm; $\overline{x}$ ♀ ♀=40,5995 sqm; $\overline{x}$ juvv.=393,1575 sqm), while that of *P.m.* is surely wider ($\overline{x}$= 770,59 sqm.; $\overline{x}$ ♂ ♂=1287,5962 sqm; $\overline{x}$ ♀ ♀=533,1938 sqm; $\overline{x}$ juvv.=590,7939 sqm). Besides it must be noted that in three years of research almost all the adult lizards (and particularly *L.h.*) have shown a marked preference for their activity area.

In the studied biotopes *L.h.* exhibits complexively a (4,52 times) lower mobility than *P.m.* (figs. 7 - 8), but it must be noted that the population density of the latter is fairly low. In such conditions, an increase in general mobility is already well known for the Wall lizard (GRUSCHWITZ & BÖHME, 1986).

In the study area, however, the higher vagility of *P.m.* surely favours a better repartition of the ecological resources making the cohabitation with *L.h.* still easier.

4. Conclusions

Our preliminary results enable us to make the following considerations:

1 - *Lacerta horvathi* is quite common in rocky mountain vegetationless biotopes of the Carnic and Julian Alps. In this area, its scattered relict distribution covers various cold montane and sub - montane environments from 480 to 2000 m a.s.l..
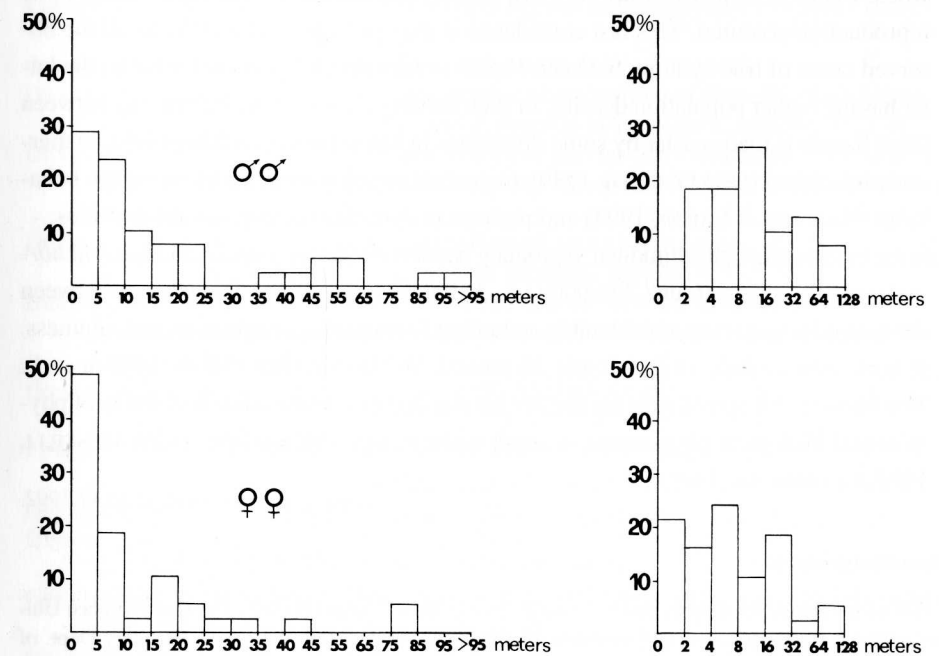

Fig. 10 - Annual displacements of 38 males e 37 females of *Podarcis muralis* before (left) and after (right) the same logarithmic normalization of fig. 8.
- *Spostamenti annuali di 38 maschi e 37 femmine di* Podarcis muralis *prima (a sinistra) e dopo (a destra) la stessa normalizzazione logaritmica di fig. 8.*

2 - *Lacerta horvathi* is a cold climate stenotope rock lizard. These ecological trends seem to be particularly evidenced by its monoestricity, small clutch size, very short reproductive cycle (DE LUCA, 1992; this work) and peculiar habitat selection (this work). Its low temperature of activity (DE LUCA et al., 1989, 1992), and its low vagility (this work) seem to support this interpretation, but it must be noted that the syntopy between *Lacerta horvathi* and *Podarcis muralis* in the study area may have extremized some ecological trends of both lizards.

3 - *Podarcis muralis* is potentially more competitive than *Lacerta horvathi* both in terms of absolute reproductive rate (see GRUSCHWITZ & BÖHME, 1986 for a comparison) and of capacity to utilize the trophic (RICHARD & LAPINI, 1993) and spatial (this work) resources, but its "colonizer" ecological strategy surely involves a relatively high(er) need of temperature to be compiutely realized (see also SAINT GIRONS & DUGUY, 1970). In the studied area, in fact, *Podarcis muralis* suffers a drastic reduction of the number of oviposition and perhaps a high mortality of the embryos due to the rigours of the climate.

4 - A true cohabitation between these lizards is possible only in cold climate habitats, where *Podarcis muralis* forms very low density populations due to the decrease in its reproductive potential. This last consideration may perhaps explain why in all the observed cases of true syntopy between *Podarcis muralis* and *Lacerta horvathi*, the latter has the higher population density. In such conditions, however, the syntopy between these lizards is made easier by some diversities in habitat selection (this work), in thermal preferences (DE LUCA et al. 1989), in general mobility (this work), in trophic behaviour (RICHARD & LAPINI, 1993) and perhaps in cyrcadian or cyrcannual activities.

5 - In the eastern Alps the altitudinal vicariancy between *Podarcis muralis* and *Lacerta horvathi* usually occurs around 700-900 m a.s.l., but the quote of possible syntopy between these reptiles may vary considerably according to orography, exposition and raininess. In north-eastern Italy, in fact, it may be potentially extended from 480 to 1640 m a.s.l.. This picture well agrees with the already known decrease in the altitudinal limits of physical and biological phenomena in south eastern Alps (MORANDINI, 1979; GENTILLI, 1989; LOVRENCAK, 1989).

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References

BISCHOFF W., 1984 - *Lacerta horvathi* Méhely 1904 - Kroatische Gebirgeidechse. In: BÖHME W. (ed.) - Handbuch der Reptilien und Amphibien Europas. Band 2/I, Echsen II. *AULA-Verlag*, Wiesbaden: 265-289.

BRELIH S., 1954 - Prispevek k poznavanju favne plazilcev slovenskega ozemlja. *Biol. Vestn.*, III: 128-131.

BRELIH S., 1962 - Plazilci Triglavskega narodnega parka in okolice. *Varstvo narave I, Studijski prispevek k poznavanju Triglavskega narodnega parka*, 8: 119-128.

BRUNO S., 1986 - Tartarughe e Sauri d'Italia. *Giunti Martello ed.*, Firenze.

CABELA A., GRILLITSCH H., HAPP H. & F. & KOLLAR R., 1992- Die Kriechtiere Kärntens. *Carinthia II*, 182./102.Jahrg.: 195-316, Klagenfurt.

CAPULA M., LAPINI L. & CAPANNA E., 1989 - The karyotype of *Lacerta horvathi* (*Reptilia, Sauria, Lacertidae*). *Genetica*, 79: 11-16.

CAPULA M. & LUISELLI L., 1991 - Notes on the occurrence and distribution of *Lacerta horvathi* Méhely, 1904 in Federal Republic of Germany. *The Herpetological Journal*, 9: 535-536.

CAPULA M. & LUISELLI L., 1993 - Northernmost Horvath's Rock Lizard populations, the *Vipera xanthina* complex, and the meaning of a correct herpetology: within what limits should author of science act ? *Die Eidechse*, 8 (in press).

CORBETT K., 1989 - The conservation of European Reptiles and Amphibians. *Cristopher Helm*, London.

DARSA M., 1972 - Anfibi e Rettili di Fusine. *Hyla, Notiz. U.E.I.*, 2 (1): 3-13.

DE LUCA N., 1989 - Taxonomic and Biogeographic Characteristics of Horvath's Rock Lizard (*Lacerta horvathi* Méhely, 1904, *Lacertidae, Reptilia*) in Yugoslavia. *Scopolia*, 18: 1-48.

DE LUCA N., 1992 - Notes on biology and ecology of the Horvath's rock lizard (*Lacerta horvathi* MÉHELY, 1904, *Reptilia: Lacertidae*). In: KORSOS Z. & KISS I. (eds.) - *Proc. Sixth Ord. Gen. Meet. S.E.H.*, Budapest: 129-135.

DE LUCA N. & DULIC B., 1988 - Karyotype of Horvath's rock lizard *Lacerta (Archaeolacerta) horvathi* Méhely, 1904 (*Reptilia: Lacertidae*). *Amphibia-Reptilia*, 9: 353-356.

DE LUCA N., KLETECKI E. & DULIC B., 1989 - Daily activity cycle and termoregulation of Horvath's rock lizard (*Lacerta horvathi* Méhely, 1904, *Lacertidae, Reptilia*) from the northern Velebit and Kanin. *Period. Biol.*, 91(1): 141.

DUNHAM A.E., MORIN P.J. & WILBUR H.M., 1988 - Methods for the study of reptile populations. In: GANS C. & HUEY R.B. (eds.) - Biology of Reptilia., 16. *Alan R. Liss Inc.*, New York.

FISHER R.A. & YATES F., 1974 - Statistical tables for biological, agricultural and medical research. *Longman*, Bristol.

GENTILLI J., 1989 - Cenni di bioclimatologia friulana. *Biogeographia*, 13: 25-40.

GIBBONS J.W. & GREENE J.L., 1979 - X-ray photography, a technique to determine reproductive patterns of freshwater turtles. *Herpetologica*, 35: 286-289.

GRILLITSCH H. & TIEDEMANN F., 1986 - *Lacerta horvathi* Méhely 1904 - Erstnachweis für Österreich. *Ann. Naturhist. Mus. Wien*, 88/89(B): 357-359.

GRUSCHWITZ M. & BÖHME W., 1986 - *Podarcis muralis* (Laurenti, 1768) - Mauereidechse. In: BÖHME W. (ed.) - Handbuch der Reptilien und Amphibien Europas. Band 2/II, Echsen III. *AULA-Verlag*, Wiesbaden: 155-208.

IACUZZI R. & VAIA F., 1981 - Clima e idrogeologia nei bacini prealpini tra Magnano in Riviera e Faedis (Friuli). *Gortania-Atti Mus. Friul. St. Nat.*, 2(1980): 5-48.

LA GRECA M., 1963 - Le categorie corologiche degli elementi faunistici italiani. *Mem. Soc. Ent. It.*, 43: 147-165.

LAPINI L., 1983 - Anfibi e Rettili (of the Friuli-Venezia Giulia). *Lorenzini publ.*, Tricesimo.

LAPINI L., 1984 - Catalogo della Collezione Erpetologica del Museo Friulano di Storia Naturale. *Pubbl. Mus. Fr. St. Nat.*, 30.

LAPINI L., 1988 - Osservazioni sulla fauna erpetologica (*Amphibia, Reptilia*) dell'alta Val Torre (Italia Nord-Orientale, Prealpi Giulie). *Gortania-Atti Mus. Friul. St. Nat.*, 9(1987): 201-222.

LAPINI L. & DOLCE S., 1983 - *Lacerta (Archaeolacerta) horvathi* MÉHELY, 1904 in Italia; nuove stazioni per le Alpi Carniche e Giulie. *Gortania-Atti Mus. Friul. St. Nat.*, 4(1982): 213-225.

LOVRENCAK F., 1989- The upper forest line in the Julian Alps. *Biogeographia*, 13: 113-118.

MAINARDIS G. & SIMONETTI G., 1991- Flora delle Prealpi Giulie nord-occidentali tra il Fiume Tagliamento ed il gruppo del M.te Canin. *Gortania-Atti Mus. Friul. St. Nat.*, 12(1990): 31-236.

MORANDINI C., 1979 - L'abbassamento dei limiti altimetrici dei fenomeni fisici e biologici in Friuli, con particolare riguardo alle Prealpi Carniche e Giulie, visto nelle sue cause. *Pubbl. Mus. Fr. St. Nat.*, 29.

PILORGE T., 1981 - Structure et Dynamique d'une Population du Lézard Vivipare. *Publ. Lab. Zool., E.N.S.*, 18: 1-152.

RICHARD J. & LAPINI L., 1993 - Trophic niche overlap in syntopic populations of *Lacerta horvathi* and *Podarcis muralis* (*Reptilia, Lacertidae*). *Atti Mus. Civ. St. Nat.*, Trieste, 45: 151-157.

ROSE B., 1982 - Lizard Home Ranges: Methodology and Functions. *J. Herpetol.*, 16(3): 253-269.

SAINT GIRONS H. & DUGUY R., 1970 - Le cycle sexuel de *Lacerta muralis* L. en plaine et en montagne. *Bull. Mus. Natn. His. Nat.*, Paris, 4: 609-625.

SHINE R., 1983 - Reptilian reproductive modes: the ovipary-vivipary continuum. *Herpetologica*, 39(1): 1-8.

SCHOENER T.W., 1968 -The Anolis lizards of Bimini: resource partitioning in a complex fauna. *Ecology*, 49: 704-726.

SOKAL R.R. & ROHLF J., 1981 - Biometry. The principles and practice of statistics in biological research. *W.H. Freeman and Company*, San Francisco.

SOCHUREK E., 1955 - Über die Warscheinlichkeit eines Vorkommers von *Lacerta horvathi* in Kärntens. *Carinthia II*, 65: 154, Klagenfurt.

STERGULC F., 1987 - Anfibi e Rettili della Foresta di Tarvisio. Osservazioni preliminari sul popolamento erpetologico di alcuni habitat forestali e montani. In: AA.VV. - Vertebrati della Foresta di Tarvisio I Saggio faunistico. *Ex A.S.F.D. di Tarvisio*: 19-61.

TIEDEMANN F., 1992 - Zur Verbreitung der Kroatischen Gebirgseidechse, *Lacerta horvathi* MÉHELY, 1904, in Österreich (Squamata: Sauria: Lacertidae). *Herpetozoa*, Wien, 5(1/2): 67-69.

TINKLE D.W. & WOODARD D.W., 1967 - Relative movements of lizards in natural populations as determined from recapture radii. *Ecology*, 48: 166-168.

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