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Notes on biology and ecology of the Horváth's rock lizard (*Lacerta horvathi* Méhely, 1904, Reptilia: Lacertidae)

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Lacerta horvathi is a relatively poorly known species assigned to a taxonomically problematic group of lacertid lizards – Archaeolacerta. It is present with scattered mountain populations in the Julian Alps of Slovenia, in the Ucka Mountain and the northern Dinarid Mountains of Croatia, in northeastern Italy, in southwestern Austria, and in southern Germany (LAPINI & DOLCE 1983, GRILLITSCH & TIEDEMANN 1986, DE LUCA 1989, CAPULA & LUISELLI 1990). Much of data on distribution and taxonomy of this species were presented during the past few years (e.g. the papers cited above, DE LUCA & ĐULIĆ 1988, CAPULA et al. 1989). However, the comprehensive data regarding biology and ecology of *L. horvathi* are still missing. In this paper some new data on daily and seasonal activity patterns, thermoregulation, reproduction and food composition, are presented.

Material and methods

The data presented here were obtained during a two-year investigations (1985-1986) carried out on the localities of northern Velebit (Croatia) and Kanin (Julian Alps, Slovenia). The stations were scattered between 900 and 1650 m above the sea level, and between 650 and 1050 m above the sea level, respectively. The animals were observed and captured on typical habitats – calcareous rocks rich in crevices and partially covered with petrofileous vegetation, often surrounded by beech forest. The daily activity pattern was observed during whole-day periods from May to October. The temperatures of air (Ta, 5-10 cm above the ground), rocks (Tr), rocky crevices (Tc, depth about 10 cm) as well as the cloacal temperatures of the animals (Tb, N= 44) were measured using a termistor. The total of 50 females from the northern Velebit were autopsied to find out their reproductive conditions. Permission for sampling was obtained from the Ministry of Science, Technology and Informatics of the Republic of Croatia. The clutch sizes were determined from the subsamples of 34 females captured in the northern Dinarids and Julian Alps, respectively. From the two localities of the northern Velebit, the total of 81 faecal pellets was collected, and remains of prey species in each of them were isolated and determined.

Results and discussion

Daily activity and thermoregulation

The daily activity cycle was strongly dependent on weather conditions, particularly on ambient temperature and insolation; the animals were visible only during the periods of sunshine. During May and October the daily activity pattern was unimodal with the peak during the warmest part of the day, from about 10:00 a.m. to 4:00 p.m. During summer, the animals were active between 8:30 a.m. and 12:30, and from 2:00 to 5:30 p.m. Hence, the activity during the warmest period of the year was bimodal. The means, the standard deviations, and the ranges of habitat temperatures were as follows: Ta= 25.39°C, 4.29°C, 16-34°C, Tr= 30.65°C, 5.67°C, 16-42°C; Tc= 19.23°C, 1.54°C, 16-23°C. The mean, the standard deviation and the range of body temperature (Tb) obtained from the sample of 44 animals were 28.69°C, 3.57°C and 20-35°C, respectively. Tb showed a highly significant correla-

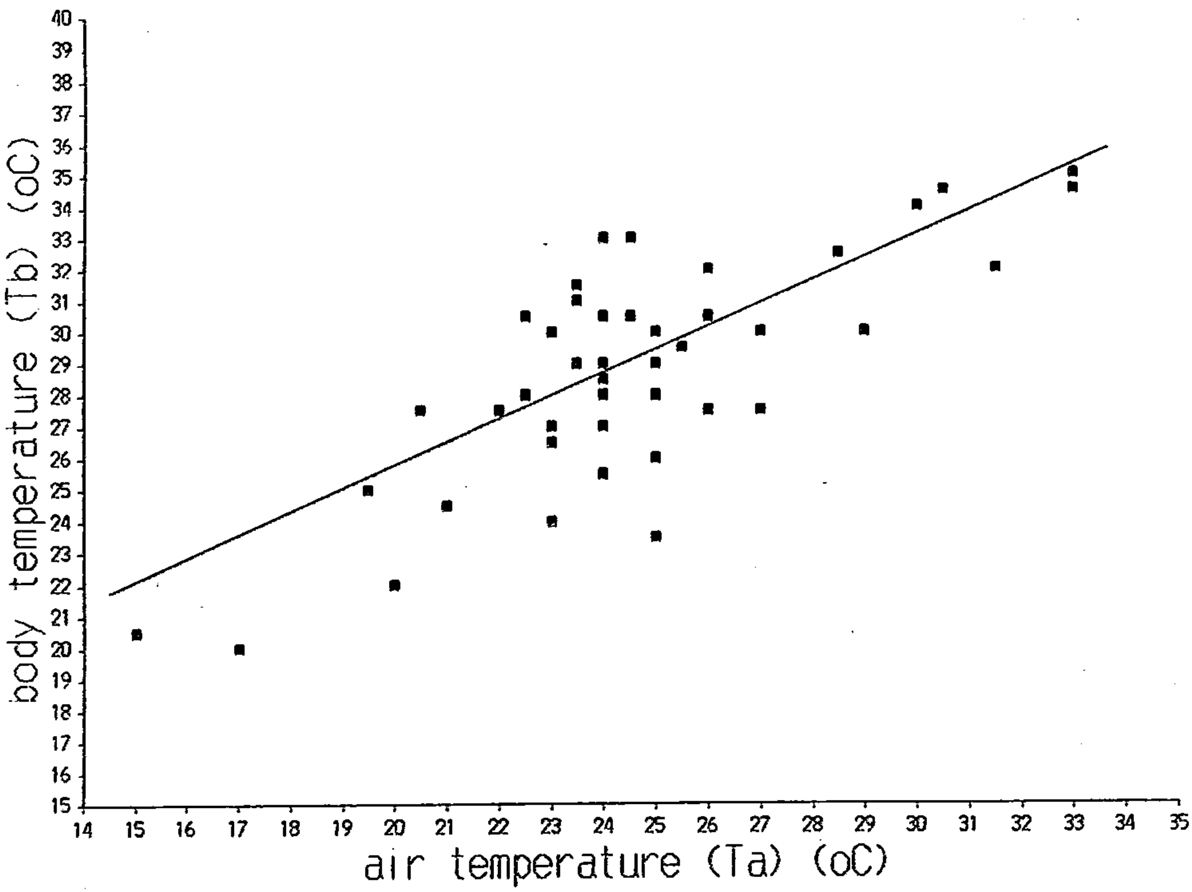

Fig. 1. Relation between body (Tb) and air (Ta) temperature in *L. horvathi* (N= 44) ($r= 0.77$, $p<0.001$, $Tb= 0.76\ Ta + 9.89$)

tion with Ta ($r = 0.77$, $p < 0.001$; Tb= 0.76 Ta + 9.89, Fig. 1), and weaker, but significant correlations with Tr ($r = 0.64$, $p < 0.001$; Tb= 0.55 Tr + 13.04) and Tc ($r = 0.58$, $p < 0.001$; Tb= 0.67 Tc + 15.17). One can see that the slopes of the regression lines are very steep which indicates strong connection to ambient temperatures, and suggests maybe adaptive thermoregulation only to a minor point (DAMME et al. 1990). The shuttling behaviour, which is achieved by moving between the illuminated and shaded parts of the rocks, is likely to be the principal way of thermoregulation. In this respect, there is no difference to the majority of the European lacertids (SPELLERBERG 1976, AVERY 1979). On the other hand, the mean, the minimum and the maximum Tb of *L. horvathi* are considerably lower than the values known for any other European lacertid (SPELLERBERG 1976, AVERY 1978, DAMME et al. 1990). Obviously, this represent important ecological adaptation to cold climate of the high mountains.

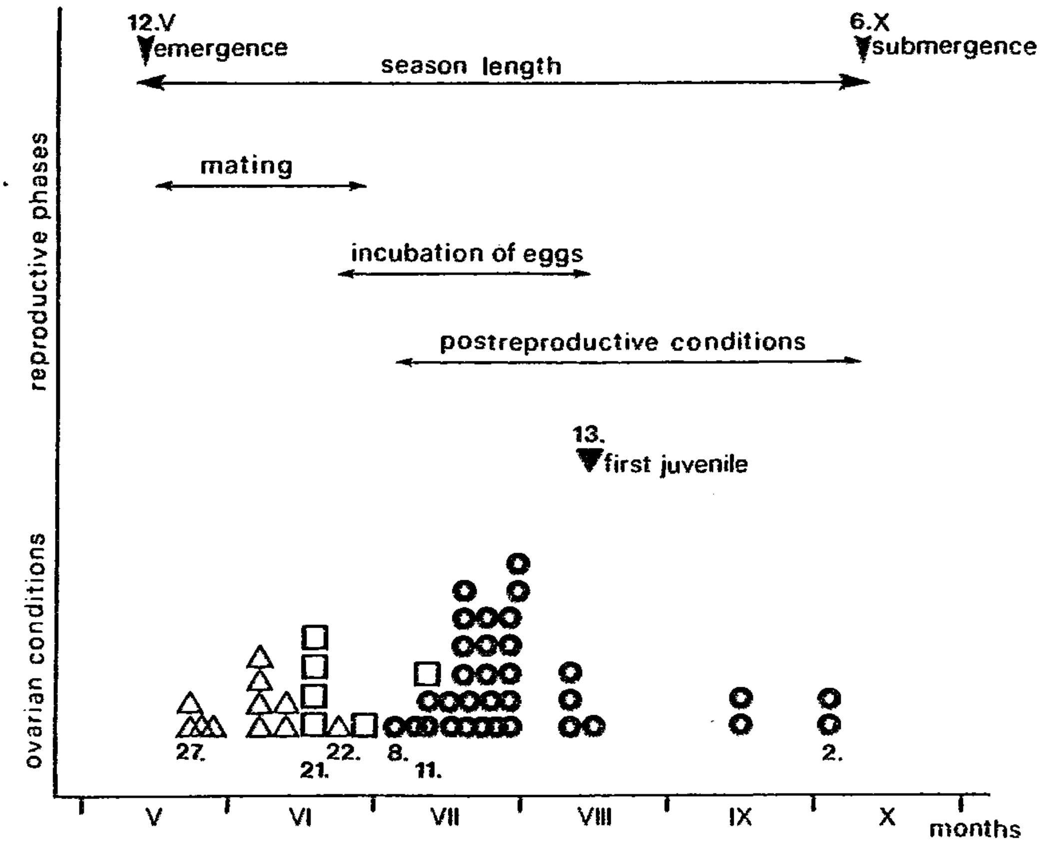

Fig. 2. Seasonal activity cycle and reproduction of *L. horvathi* from northern Velebit (triangles – females with enlarged preovulatory follicles, rectangles – fèmales with oviductal eggs, circles – females in postreproductive conditions)

Seasonal activity and reproductive cycle

The animals came out of the winter dormancy during the first half of May and went back in the hibernation by the middle of October (Fig. 2). Therefore, the seasonal activity lasted for about 5.5 months and corresponded with length of season without snow. It is shorter than in the majority of the European lacertids, with the exception of some high mountain and northern populations of *L. vivipara* (DELY & BÖHME 1984). From the end of May to the end of June the females had enlarged preovulatory follicles. Thereafter, until the first half of July, the oviductal eggs (mean size 15 mm×8 mm) were present. Following that period, all the females were observed only in postreproductive conditions. The first juveniles appeared in the field during the first half of August. These data indicates that the mating and fertilization occurs between the middle of May and the end of June, while the incubation of eggs takes place from the end of June until the middle of August, with only one clutch per year being produced. Neither the hypothesis of two

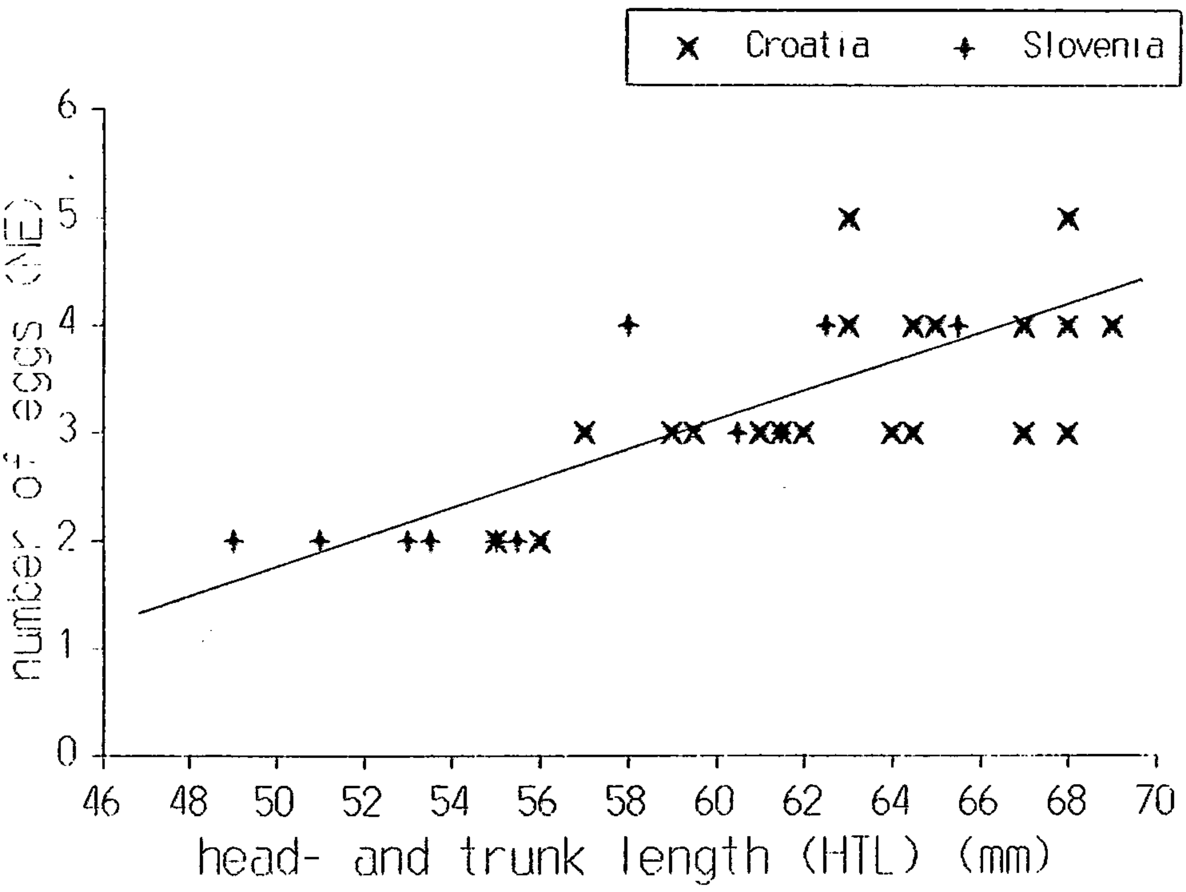

Fig. 3. Relation between number of eggs (NE) and head and trunk length (HTL) in *L. horvathi* (N= 34) (r= 0.82, p<0.0001, NE= 0.13 HTL – 4.82)

clutches per year (BISCHOFF 1984) nor the opinion on the facultative ovoviviparity of some alpine populations (BRELIH 1962) have been verified so far. Therefore, the reproductive strategy of *L. horvathi* seems to be similar to the majority of the European oviparous lizards (DUVALL et al. 1982). The females deposit from 2 to 5 eggs (most of them have 3 eggs). The clutch size increased significantly with their head and trunk length ($r= 0.82$, $p< 0.0001$; Fig. 3). Since the females from Croatia are significantly larger than those from Slovenia (DE LUCA 1989), they showed somewhat greater clutch size. Such intraspecific difference has already been reported for *P. muralis* (STRIJBOSCH et al. 1980)

Food analysis

In the faecal pellets of *L. horvathi* the remains of 56 different taxa, assigned to five classis of invertebrates (Gastropoda: Clausilidae, Crustacea: Isopoda, Arachnida, Diplopoda, Insecta) were determined. The most dominant were Insecta

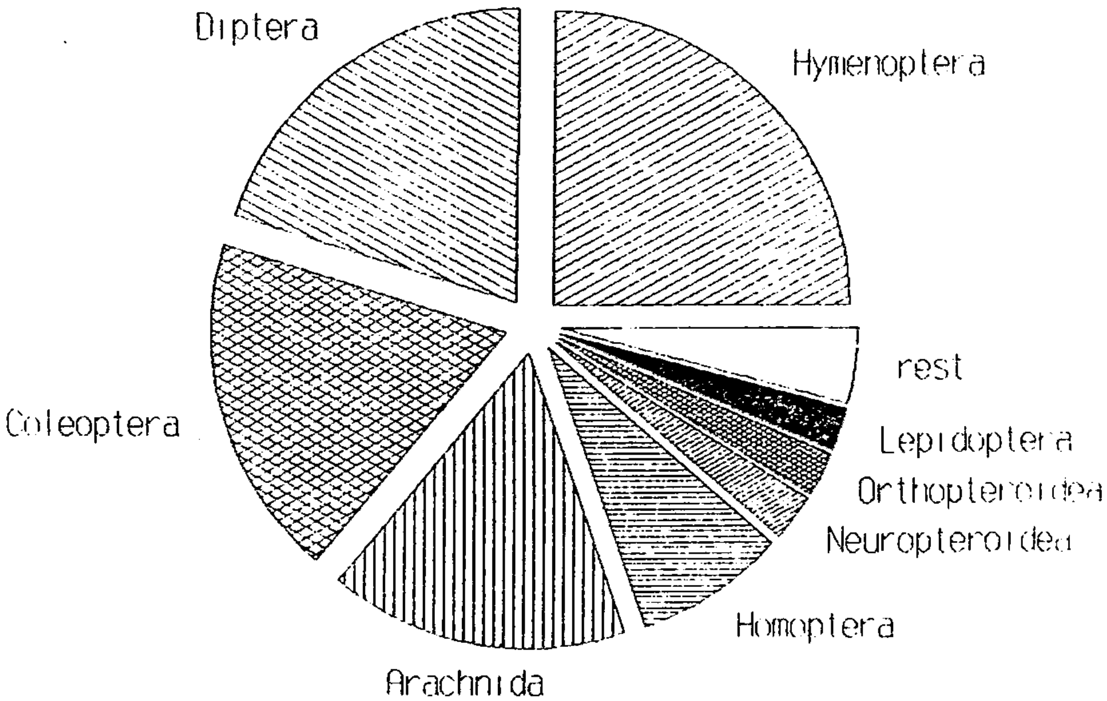

Fig. 4. Food composition of *L. horvathi* from the northern Velebit according to the prey taxa

(83.12%), particularly Hymenoptera (24.96%), Diptera (20.19%) and Coleoptera (18.96%). Also, considerable percentage of faecal remains belonged to Arachnida (16.38%) (Fig. 4). The prey sizes varied from 1 mm (Aphidoidea) to 5 cm (larvae of fam. Lasiocampidae). Neither the remains of vertebrates nor the remains of plants were found. One can conclude that the food equally consist of good flyers, such as Hymenoptera and Diptera, and of terrestrial invertebrates that occur in the rocky crevices such as Aranea, Opiliones, Blattoidea, Carabidae, Curculionidae and Formicoidea. Catching the prey within the rocky crevices probably diminish the risk of the predators or overheating. Also, significant differences between the summer and the autumn samples were observed; during summer, greater portions of Coleoptera (18.31% against 6% in autumn) and Diptera (25.92% to 10%) were observed. On the contrary, during autumn, greater portions of Arachnida (31% to 14.65%), Orthopteroidea (9 % to 0.28%) and Hymenoptera (36% to 23.94%) occurred. Basically, these differences are caused by the fluctuations in the population densities of the invertebrate species during the annual cycle. It can be concluded that *L. horvathi* is very unselective as far as food is concerned and takes all the prey that is available. This is, in fact, the case with many of other lizards (STRIJBOSCH et al. 1980, DELY & BÖHME 1984).

In conclusion, the Horváth's rock lizard is a typical petrofileous, high-mountain species, in some characteristics similar to *L. vivipara*, and in the others to *P. muralis*. The sympatry occurs on habitats only with *P. muralis*. Being only scarcely known at present, the problems of competition and sympatry among these two species merit further investigations.

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