

## Further data on the reproduction of *Lacerta monticola cyreni* (Sauria, Lacertidae) in Central Spain

Benigno Elvira, Carlos R. Vigal

Unidad de Zoología Aplicada, Consejería de Agricultura y Ganadería, Comunidad Autónoma de Madrid, El Encín, Alcalá de Henares (Madrid, Spain).

**Abstract.** This study deals with several features of the reproductive biology of *Lacerta monticola cyreni*. It was carried out in a lizard population in the Sierra de Guadarrama (Central Spain). Owing to the hard weather conditions the lizards have a very short active season (nearly six months). The annual gonadal cycle of both sexes shows an unimodal distribution which demonstrates the existence of only one mating and only one clutch per year. Mating occurs in May-June. Females lay a clutch of 4 to 9 eggs, usually during July. Finally, hatching takes place in September, one month before the beginning of hibernation in October.

**Resumen.** El presente estudio analiza algunos aspectos de la reproducción de *Lacerta monticola cyreni*, a partir de una población de la Sierra de Guadarrama (España Central). Debido a las rigurosas condiciones meteorológicas el período de actividad anual es muy corto, aproximadamente de seis meses. El ciclo gonadal anual de ambos sexos presenta una distribución unimodal, lo que permite suponer un solo celo y una sola puesta al año. El celo tiene lugar entre mayo y junio. La puesta, formada por 4 a 9 huevos, en julio. La eclosión de los huevos ocurre en septiembre, poco antes de la hibernación que comienza en octubre.

### Introduction

The only known data on the reproduction of *Lacerta monticola cyreni* Müller & Hellmich, 1937, an endemic lizard of the mountains of Central Spain, were advanced by Palacios & Salvador (1974) and Melendro & Gisbert (1976). The former study, based on an analysis of 5 gravid females, provides data on clutch size and artificial incubation. The latter offers some remarks on egg-laying in nature and on gonadal development in both sexes. Otherwise, Bas (1982) provides some data on activity pattern and the mating season of *L. monticola cantabrica* Mertens, 1929.

The goal of this paper is to complete knowledge on several aspects of the reproductive biology of *L. m. cyreni*. A population of this lizard inhabiting the Sierra de Guadarrama (Central Spain) was studied. The observations were made on specimens watched or collected in nature, together with others kept in a terrarium.

This study is our second report on the biology of *L. m. cyreni*; a previous study dealt with its feeding ecology (Domínguez et al., 1982).

## Materials

The study area is placed in the Sierra de Guadarrama (Segovia province, Central Spain). It was visited by the authors once or twice per month during 1980. Our initial plan was to execute the study throughout 1981. This was impracticable, however, after the publication of the Royal Law of December 30th, 1980 in which *Lacerta monticola* was listed as a protected species in Spain. For this reason, our research which would have involved the capture of further specimens was suspended. The study of the gonadal cycle was made with adult specimens collected in 1980 together with 18 preserved specimens from our laboratory, which had been collected in 1970, 1972 and 1976 in the study area and adjacent zones (all of them within a 10 km<sup>2</sup>). A total of 109 specimens, 62 adults (26 males and 36 females) and 47 subadults, were studied.

## Biotope and Climate

The study area is alongside the road between the Puerto de los Cotos (1830 m) and the Puerto de Navacerrada (1860 m) and belongs to the terra typica of the subspecies. The field observations were carried out at altitudes ranging from 1830 to 1900 m. The soil is a Brown Ranker of silicious origin, essentially composed of granites and gneiss broken up as stones of variable size. The prevalent exposure of the slope is NW. The dominant vegetation is a forest of *Pinus sylvestris* with shrublayer of *Juniperus communis* and *Cytisus purgans*, belonging to the association Junipero-Cytisetum purgantis subass. pinetosum sylvestris.

The main climatic parameters are those of the Meteorological Station of Navacerrada within the study area. The climate is cold with a severe winter (the mean temperatures of the winter months are lower than 0°C) and with a very remarkable continentality, as the strong thermal fluctuation shows. The annual precipitation is high (mean 1516,6 mm) but there is a dry period during July and August (fig. 1). The mean wind speed is rather constant throughout the year with moderate values. Other important features of the climate are the high number of days of snow per year (mean 87,6); frosts are very frequent (mean 153,2 days per year), and the frost period is long (from September to June). The coldest months are January and February, and the hottest July and August with average temperatures above 15°C. The maximum absolute temperature recorded in the last 20 years was 29,8°C. The year 1980 shows similar values to those of the last two decades. However, the values of precipitation are slightly lower and they only represent 80,8% of the mean recorded in the period 1960-80. In fact, a serious drought started in this year and lasted for the following three years.

## Results

### *Gonadal cycle*

Owing to our intention to collect as small a number of specimens as possible, to minimise disturbance to the population equilibrium, specimens from several years have been included in this section. Most of the specimens studied here (36 of 54) came from the study area in 1980, but we have added some adult specimens from the same area from 1970 (10 specimens) and from two neighbouring sites: Siete Picos, 1970 (2 specimens) and 1972 (4 specimens) and Laguna de Peñalara, 1976 (2 specimens). Their size and gonadal development are very similar and may be compared with the specimens from 1980.

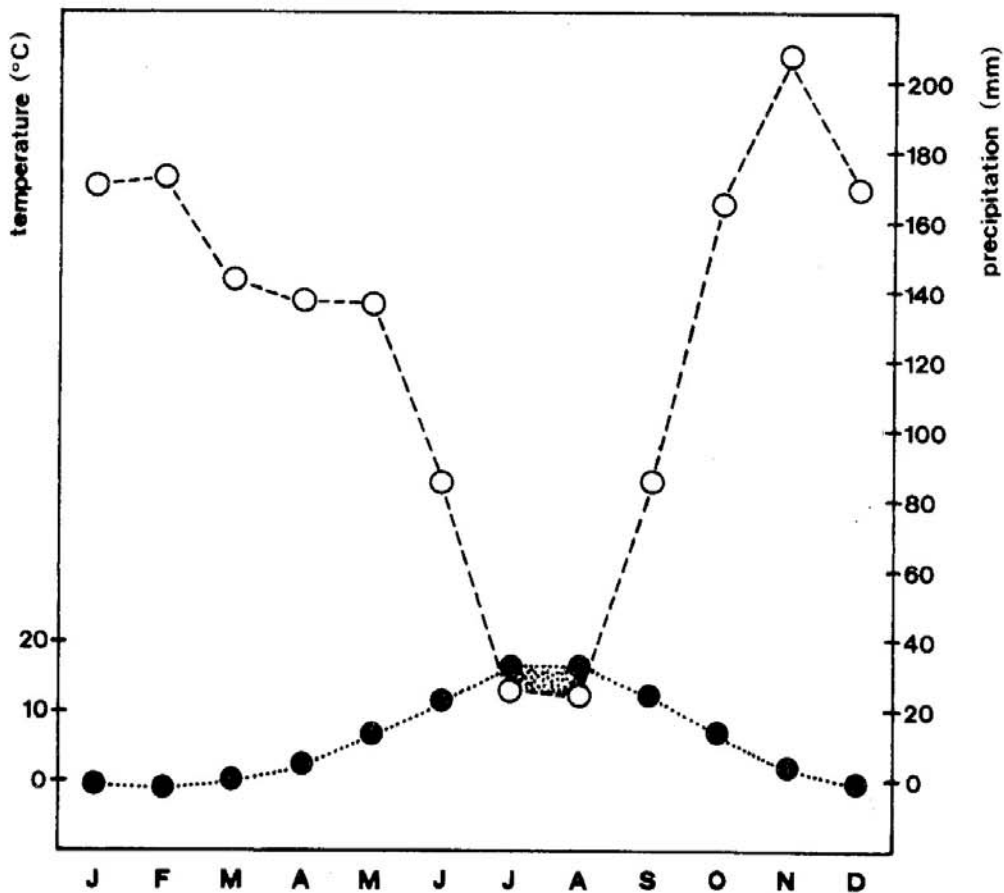


Fig. 1. Ombrothermogram of the Meteorological Station of Navacerrada, placed in the study area (means of the period 1960-80). Dotted area: dry period.

Both gonads of 54 adults (24 males and 30 females), at least 3 specimens of each sex per month, were analyzed. Length and width of each gonad were measured. Gonads were considered ellipsoidals and their volume was calculated on the basis of their length and width (figure 2).

The number of developing follicles did vary between 5 and 12 per gonad. In spite of their dispersed origin and the small number of specimens studied, the data point to the existence of only one mating and only one clutch per year. The greatest development of testes occurring in May suggests that mating and copulation take place in May-June.

The smallest female with well developed gonads was 65,8 mm in SVL (snout-vent length); it was collected in May and it could have produced eggs in June. The smallest gravid female studied was 67,3 mm in SVL. The smallest male with the testes, epididymis and seminiferous tubules developed was collected in May; it was 61,2 mm in SVL. We have not established the age of the specimens, because we do not know when they attain maturity. Nevertheless, during the mating period in May-June, we

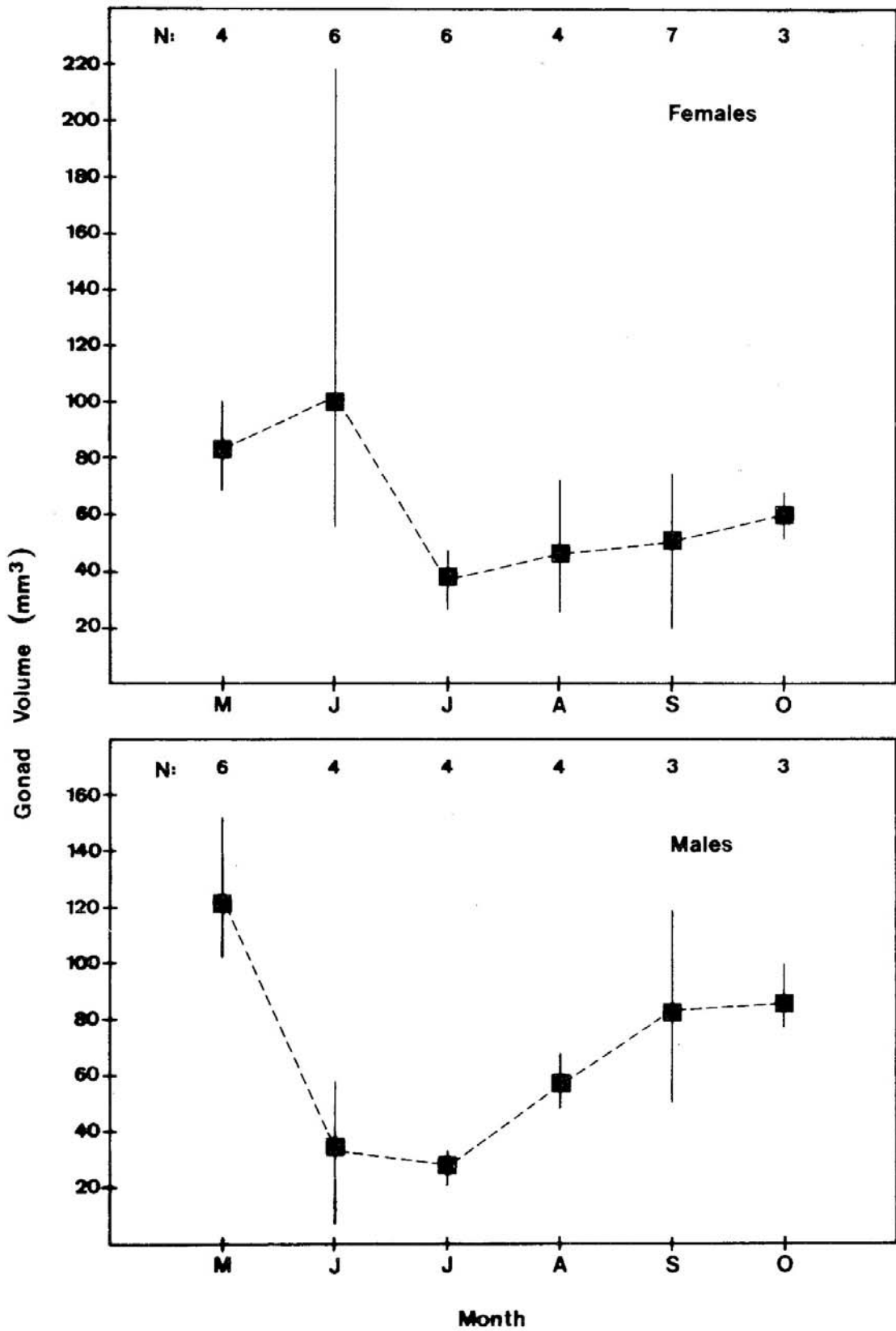


Fig. 2. Monthly variation in gonadal volume of *L. m. cyreni*. Values given as mean and range. N: sample size. The size homogeneity of the specimens allows to compare absolute values.

found that there were specimens of both sexes belonging to two size classes and smaller than the mature adults. If these two size classes correspond to two age classes, the mature specimens of those months would belong at least to the age class 3. Then they would have lived at least 3 winters.

### *Egg-laying*

Six adult females collected on 24 June 1980 bore developed eggs in their oviducts. On this date we found no adult female who had yet laid. However two out of six females collected on 13 July had laid because they had no eggs in the oviducts, which were still nevertheless very large. Four other females collected on this date laid in our terrarium on 15, 17 (two of them) and 18 July. Finally none of five females collected on 12 August bore eggs, because they had already laid. Thus, we can conclude that eggs are normally laid in July. Egg-laying may extend to the latter days of June and to the beginning of August.

With regard to clutch size we have examined 10 gravid females and four clutches in terrarium. The number of eggs varies from 4 to 9; the average clutch size is 6-7 eggs. The eggs are whitish in colour. A total of 61 eggs was measured. Their length and diameter varied from 10,5-15,0 x 6,6-9,2 mm (mean 12,60 x 7,59 mm). Eggs taken from gravid females weighed 0,22-0,39 g (mean 0,29 g, n = 31); those from clutches in our terrarium, at laying, 0,31-0,60 g (mean 0,45 g, n = 30).

### *Incubation*

All of the data in this section refer to artificial incubation in a terrarium. However, this incubation was carried out under conditions similar to the natural ones (cf. Melendro & Gisbert, 1976). The 30 eggs laid by the females in the terrarium were buried in sand, which was maintained constantly damp. Its temperature varied throughout incubation from 19°C to 24°C. We also measured at the same time the sand temperature in the study area where the gravid females were caught. Thermometers were buried about 50 mm under the soil surface, a place where gravid females of *L. m. cyreni* will have laid their eggs (Melendro & Gisbert, 1976). This temperature varied from 10°C to 26°C.

The eggs were removed weekly to measure any change in their dimensions. They increased their size from average values of 13,55 x 8,33 mm and 0,48 g at laying, to 18,89 x 12,41 mm and 1,58 g four days before hatching. Average weight increase was 1,10 g (229%). The progressive increase in size of a clutch comprising four eggs is shown in table 1.

Under the stated conditions, 9 of the 30 eggs hatched, 4 after 53 days and 5 after 50 days of incubation. This is 15 to 18 days faster than those artificially incubated by Palacios & Salvador (1974). Without any doubt this great difference is due to the different incubation conditions (pers. com. of Dr. F. Palacios).

**Table 1.** Dimensions (length and width in mm, weight in g) of a *L. m. cyreni* clutch composed by four eggs, through the incubation period.

		At laying	After 2 weeks	After 4 weeks	After 6 weeks	After 7 weeks
Length	Range	13,1-13,7	15,8-16,3	16,3-17,7	17,5-19,8	19,5-21,1
	Mean	13,55	16,10	16,90	18,65	20,28
Width	Range	7,9-8,1	10,1-10,7	10,4-11,4	11,5-12,3	11,9-12,9
	Mean	7,97	10,45	10,95	11,85	12,33
Weight	Range	0,44-0,48	0,94-0,98	0,97-1,22	1,24-1,61	1,57-1,90
	Mean	0,46	0,96	1,10	1,40	1,69

### Hatching

Hatching of artificially incubated eggs took place on the morning of 6 September. In nature no young were seen in visits up to 25 August, but they were present at a subsequent visit on 7 September. On that account we can conclude that hatching occurs in September.

Dimensions of newly-hatched are shown in table 2. Their colour and pattern have been stated by Müller & Hellmich (1937) and Palacios & Salvador (1974).

**Table 2.** Dimensions (weight in g and lengths in mm) of newly-hatched *L. m. cyreni*.

	Weight	Total length	Snout-vent length	Tail length	Head length	Sex
	0,62	66,9	25,9	41,0	7,3	♀
	0,58	63,5	26,6	36,9	7,3	♀
	0,56	65,7	26,4	39,3	7,4	♀
	0,51	58,2	24,9	33,3	6,7	♀
	0,49	62,2	26,0	36,2	7,2	♀
	0,60	66,0	25,5	40,5	7,4	♂
	0,59	62,6	25,8	36,8	7,2	♂
	0,57	67,4	26,1	41,3	7,6	♂
	0,50	67,1	26,0	41,1	7,7	♂
Range	0,49-0,62	58,2-67,4	24,9-26,6	33,3-41,3	6,7-7,7	
Mean	0,56	66,40	25,91	38,49	7,31	
Standard deviation	0,047	3,044	0,496	2,812	0,285	

### Discussion

The annual activity pattern and reproductive cycle of *L. m. cyreni* are strongly influenced by the weather conditions existing in the zones where it lives; the active period of the lizards is very short. We have recorded active lizards in the study area from 2 May to 15 October. The different reproductive events studied here—mating,

copulation, gestation, egg-laying, incubation and hatching—take place in these few months. Mating occurs in May-June, while egg-laying does in July. Egg-laying thus may be earlier than in the neighbouring Sierra de Gredos, where it occurs from mid-July to late August (Melendro & Gisbert, 1976). The incubation period lasts almost two months (50-53 days), being very close to or slightly shorter than in other small lizards from SW Europe (about two months in *Podarcis hispanica* and *P. bocagei* (Curt & Galán, 1982), 9-11 weeks in *P. muralis* (Rollinat, 1934; Angel, 1946)). Hatchling takes place in September. On that account, hatchlings have very little time to grow before hibernation, which occurs in mid-October.

Although we have not established the age of the lizards, we have already reported the possibility that they breed for the first time after 3 winters, in which case they would reach sexual maturity at the same age as *P. muralis* (Castanet & Roche, 1981), and one year later than *L. vivipara* (Pilorge & Castanet, 1981).

These features of the annual activity pattern and reproductive cycle obtained from wild populations are very different from those of captive lizards. Dr. B. Langerwerf (Waspik, The Netherlands) has commented on (personal communication) the activity and reproduction of *L. m. cyreni* in a terrarium. Annual activity in his terraria is much longer than in the natural habitat. The lizards are active from mid-February. With so long an active period and with constant good feeding, females may lay two clutches per year. Eggs incubated at 27-29°C hatched in approximately one month. If the young live with a constant temperature of 30°C, they attain sexual maturity in one year and half (pers. com. B. Langerwerf, in littera 30-III-1982).

In respect of other subspecies of *L. monticola*, data are only available on activity pattern and the mating season of one of them (*L. m. cantabrica*). According to Bas (1982), *L. m. cantabrica* from the Sierra de Caurel (NW Spain) have an annual activity from March to September, while mating takes place in March-April. Thus, its active season is longer than that of *L. m. cyreni*, because its emergence from hibernation is earlier. On that account, mating also occurs earlier.

With regard to the characteristics of the reproduction, the clutch size we have found, from 4 to 9 eggs, falls within the range recorded by Palacios & Salvador (1974) and Melendro & Gisbert (1976). These authors moreover found clutches composed of 2 and 3 eggs, produced by the smaller females. A correlation between clutch size and female size seems to be a general characteristic in lizards. In fact, larger and older females usually produce more eggs (Street, 1979). Avery (1975) found in *L. vivipara* that the biggest clutches occur in the largest lizards. It is possible that this is also the case in *L. m. cyreni*, but the sample size is too small to test this hypothesis. Egg size reported here is nearly coincident with the data of Palacios & Salvador (1974) and Melendro & Gisbert (1976).

The size of newly-hatched in our terrarium (SVL = 24,9-26,6 mm, mean = 25,91 mm, n = 9) is similar but of course slightly lower than size of hatchlings a few days old observed in nature in September (SVL = 25,7-28,5 mm, mean = 26,68, n = 6).

**Acknowledgements.** We are very grateful to Dr. R.A. Avery for critical reading of the manuscript. We are also indebted to Dr. B. Langerwerf and Dr. F. Palacios for their comments. Thanks also go to Dr. F. Elías for his support and assistance. This study was made possible by a grant from the ICONA-INIA for the research on populations of Spanish vertebrates.

## References

- Angel, F. (1946): Faune de France, 45. Reptiles et Amphibiens. Lechevalier, Paris, 204 pp.
- Avery, R.A. (1975): Clutch size and reproductive effort in the lizard *Lacerta vivipara* Jacquin. *Oecologia* **19**: 165-170.
- Bas, S. (1982): La comunidad Herpetológica de Caurel: Biogeografía y Ecología. *Amph.-Rept.* **3**: 1-26.
- Castanet, J., Roche, E. (1981): Détermination de l'âge chez le lézard des murailles *Lacerta muralis* (Laurenti, 1768) au moyen de la squelettochronologie. *Rev. Suisse Zool.* **88**: 215-226.
- Curt, J., Galán, P. (1982): Esos anfibios y reptiles gallegos. J. Curt Ed., Porriño (Pontevedra), 166 pp.
- Domínguez, L., Elvira, B., Vigal, C.R. (1982): Alimentación de *Lacerta monticola cyreni* Müller y Hellmich, 1937 en la Sierra de Guadarrama. *P. Cent. pir. Biol. exp.* **13**: 71-75.
- Melendro, J., Gisbert, J. (1976): Contribución al estudio de *Lacerta monticola* en la Sierra de Gredos (Avila, España). *Doñana, Acta Vert.* **3**: 89-92.
- Müller, L., Hellmich, W. (1937): Mitteilungen über die Herpetofauna der Iberischen Halbinsel. II. Zur Kenntnis der *Lacerta monticola*. *Zool. Anz.* **117**: 65-73.
- Palacios, F., Salvador, A. (1974): Primeros datos sobre la reproducción de *Lacerta monticola* en Iberia. *Bol. R. Soc. Española Hist. Nat. (Biol.)* **72**: 243-244.
- Pilorge, T., Castanet, J. (1981): Détermination de l'âge dans une population naturelle du Lézard vivipare (*Lacerta vivipara* Jacquin, 1787). *Acta Oecologica* **2**: 3-16.
- Rollinat, R. (1934): La vie des reptiles de la France centrale. Delagrave, Paris, 343 pp.
- Street, D. (1979): The Reptiles of Northern and Central Europe. B.T. Batsford Ltd., London, 268 pp.

*Received: October 20, 1983*