

SOME ASPECTS OF REPRODUCTIVE BIOLOGY OF *Zootoca vivipara* (JACQUIN, 1787) IN THE ASIAN PART OF ITS AREA

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Keywords: *Zootoca vivipara*, fecundity, body size, variability.

INTRODUCTION

Zootoca vivipara is the lacertid lizard with a large area in the northern part of Eurasia. This species is the only lacertid that has both oviparous and viviparous populations. Oviparous allopatric populations were found in the extreme south-western part of the species area, in the Pyrenean mountains, in Aquitaine in southwest France, and in northwest Spain (Lantz, 1927; Brana and Bea, 1987; Heulin, 1988). Recently the same populations were described from Slovenia, Lower Austria (Carinthia), and Italy (Böhme et al., 1999; Heulin et al., 2000; Mayer et al., 2000). Ovoviviparous populations have a vast distribution from Central France, the British Isles to the North Cape in Scandinavia, eastwards as far as eastern Siberia, Sakhalin Island and Hokkaido Island, Japan (Ananjeva et al., 1998). Thus, most part of the area is on territory of the former USSR, where there occur only ovoviviparous populations. In spite of this the biology of viviparous lizards, including reproductive characteristics, is insufficiently studied, especially in the eastern part of the area (Orlova, 1975; Sedalishchev and Belimov, 1978; Kuranova, 1983, 1998; Korotkov and Levinskaja, 1978; Korotkov, 1985; Tagirova, 1997; Dujsebaeva and Orlova, 2002). In the western part of the area, the biology of *Z. vivipara* is known in detail (see references in: Dely and Böhme, 1984; Heulin, 1985, 1988; Khodadoost et al., 1987; Pilorge, 1987; etc.).

MATERIAL AND METHODS

The reproduction of viviparous lizard was studied in the Perm' Oblast', on the West Siberian plain (Tomsk Oblast') and in the Kuznetskii Alatau mountains, North and North-East Altai [up to about 1200 m above the sea level (a.s.l.)]. In addition, we used the materials of the Zoological Museum of the Moscow State University, collected in Southern Altai (Markakolskaya Depression, 1500 – 1600 m

a.s.l.; foothills of Kuruchumskii Ridge up to 800 m a.s.l.), Novgorod Oblast', and the Southern Urals. A total of 375 females from 13 populations, with eggs in oviducts at different stages of development including the last ones, were used to estimate the fecundity. The maturity was determined by the gonad status of females in spring, and by the presence of mature spermatozoa in testicles and epididymes of males. Skeletochronological technique was used for age determination of sexual maturity (Smirina, 1974). The statistical processing of material was conducted with the spreadsheets MS Excel 7.0 and the statistical package STATISTICA 6.0. Differences of means were estimated by criterion of Mann – Whitney (*U*-test), degree correlation of indexes was estimated with help of rank correlation of Sperman (r_s).

RESULTS AND DISCUSSION

The earliest appearing of lizards after the hibernation was noted in the second – third decades of April. Females appear in 6 – 9 days to 2 – 3 weeks after males, depending on physical and climatic environmental parameters. After the hibernation, there were mature spermatozoa in large testicles of males. The minimum body length of sexually matured males was 44 – 46.0 mm. The active spermatogenesis lasts until the beginning of June, when the size and weight of testicles are the highest. The degradation of testicles starts after the breeding season. By the end of August, testicles increase in size again (up to 3.8 × 1.8 mm), which is connected with the preparation for the next season of reproduction.

The gonad development in the females also starts at the end of the hibernation, because 7 – 13 large (2.3 – 4.2 mm) yellow oocytes were contained in ovaries at the very first days of activity. The right ovary functions more intensively than the left one. In the end of May – middle of June mature oocytes 6 – 7.5 mm in diameter enter the oviduct. The egg size in June increases to (12 – 14) × (9 – 10) mm, and in July they contain well-formed embryos 15 – 21 mm

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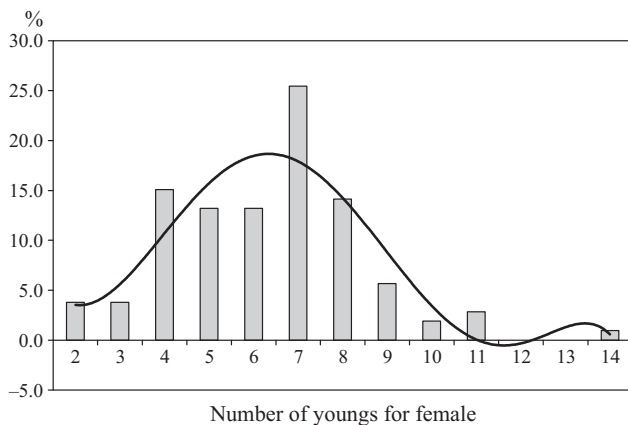


Fig. 1. Number of females (%) of viviparous lizard, *Zootoca vivipara* with the different brood size ($n = 106$, Tomsk area).

in length. After the birth of young animals (during July) the ovaries contain follicles 0.7 – 1.3 mm in diameter.

Reproductive parameters. The results obtained by the method of skeletochronology revealed that females have survived not less than 2 – 3 hibernations to participate in reproduction (Kuranova, 1998). Their body length was 45.6 – 77.3 mm (59.3 ± 0.49 ; $n = 227$), and the fecundity was 2 – 14 (6.1 ± 0.14) with mean values 3.6–8.6 embryos or young per 1 female in different populations. Progenies of 41.5% females consisted of 4 – 6 young, those in 25.5% — of 7 (Fig. 1). The most variable brood size

was observed in populations of the southern taiga plains (Tomsk) while less variable — in Chudnoe Lake population. A positive correlation was observed between fecundity and female size ($r_s = 0.68$; $df = 239$, $p < 0.001$). It was shown for oviparous and viviparous populations of the viviparous lizard from different parts of its range. Pregnant females have significantly more embryos in the right oviduct, than in the left one ($n = 100$; U -test, $p \leq 0.05$).

The average fecundity in Tomsk population was 5.6 – 7.1 (6.3 ± 0.21 ; $n = 106$) in different years. In two localities of Northeast Altai (Artybash and Kebezen) a similar situation was recorded (Table 1). It was demonstrated, that all females had survived three hibernations in Artybash population, i.e., had been born in 1997. It is likely, that small size of females and their low fecundity were caused by the drought during the second half of summer in 1998, which induced dramatic fall of water level in low-mountain rivers and, consequently, reduction food resources. Females from Markakolskaya depression were smaller than others and demonstrated the most variable body length. Their fecundity was less than the total mean. Their fecundity was less than the total mean, while the females from Kuruchum Mountains foothills was the largest. Different situation was observed in Kuznetskii Alatau Mountains, where the largest females with the maximal fecundity occurred in middle mountains (Chudnoe Lake, 1170 m a.s.l.). The lizards from the low mountains of Kuznetskii Alatau have smaller size and their fecundity is

TABLE 1. Populational Variability of Body Size and Fecundity of Females of *Zootoca vivipara* in Asian Part of Area

No.	Investigated regions	Years	Body length, mm			Number of embryos or young for one female		
			n	$x \pm m_x$	limits	n	$x \pm m_x$	limits
1	South Altai, Markakolskaya depression, Uspenka, 1500 – 1550 m a.s.l.	1988	28	54.3 ± 0.94	46.0 – 68.0	28	4.7 ± 0.21	2 – 7
2	South Altai, Markakolskaya depression, Urunhaika, 1500 – 1600 m a.s.l.	1988	11	54.7 ± 1.12	50.0 – 60.5	11	5.2 ± 0.40	4 – 8
3	South Altai, foothills of Kuruchumskii ridge, up to 800 m a.s.l.	1988	5	62.1 ± 1.03	59.5 – 64.5	5	8.2 ± 0.38	7 – 9
4	North Altai, 900 – 1100 m a.s.l.	2001	9	59.6 ± 1.80	46.8 – 64.8	9	7.7 ± 1.00	3 – 13
5	North-East Altai, Pryteletskii region, Artybash, 450 – 500 m a.s.l.	2000	7	55.9 ± 0.80	53.4 – 59.8	7	3.6 ± 0.30	3 – 5
6	North-East Altai, Kebezen, 450 – 550 m a.s.l.	2002	4	58.7 ± 1.74	55.3 – 63.4	4	5.8 ± 0.63	4 – 7
7	Kuznetskii Alatau, Gavrilovka, 550 – 600 m a.s.l.	1978	24	61.4 ± 0.70	52.0 – 67.6	24	6.0 ± 0.32	3 – 10
8	Kuznetskii Alatau, Chudnoe lake, 1170 m a.s.l.	2001	11	73.2 ± 1.08	64.6 – 77.3	11	8.6 ± 0.31	7 – 10
9	Tomsk Oblast', Prichulyum'e, Teguldet, 350 m a.s.l.	2000	7	59.5 ± 1.11	55.4 – 63.2	7	5.1 ± 0.99	2 – 10
10	Suburbs of Tomsk, 90 — 160 m a.s.l.	1978 – 1989	58	58.9 ± 0.81	45.6 – 70.2	27	7.1 ± 0.41	4 – 11
		2001	15	60.5 ± 1.25	51.8 – 71.5	15	5.6 ± 0.77	2 – 14
		2002	64	59.9 ± 0.61	46.2 – 71.1	64	6.1 ± 0.23	2 – 10
11	Perm Oblast'	1962	25	61.4 ± 0.97	52.0 – 73.0	22	5.4 ± 0.31	3 – 9
12	Novgorod Oblast'	1977	8	57.6 ± 1.24	53.2 – 63.2	8	4.9 ± 0.52	4 – 8
13	South Urals	1938, 1982	5	62.8 ± 1.87	57.1 – 67.7	8	6.6 ± 0.68	5 – 9

by 1.4 times lower (Table 1). Thus our data did not show any clear correlation between the number of offsprings and the position of the population in respect to the sea level. But in two lizards (*Darevskia valentini* and *D. caucasica*) the body length in females and the size of clutch increased in populations from high altitudes (Darevsky, 1967). While the fecundity of *Lacerta strigata* is two times lower in high mountain population in comparison to plain population (Melkumyan, 1983). Additional investigations on representative samples are necessary to solve this question.

The comparison of obtained results with earlier published data did not reveal the connection between the size of the offspring and the climate. However, some authors (Terentjev and Chernov, 1949; Lazareva, 1999) indicate that the number of newborns decreases northward and eastward. According to our data, the average population and individual fecundity in the north is not lower than in southern populations as marginal populations of the Markakolskaya depression, where the average fecundity is 4.9 ± 0.25 (2 – 8). The fecundity values of the viviparous lizard in Yakutia do not differ from those in the females from the Western Siberia and Ural region, but higher, than in the populations from Novgorod and Perm' Oblast's (Sedalishchev and Belimov, 1978). In the north and east of the Asian part of the area, the values of individual fecundity range within the same limits as in the European part of the area.

Our data correspond well to the results obtained on the mountain population of viviparous lizard (Pilorge and Xavier, 1981), as well as to the population-ecological parameters of European Lacertidae (Bauwens, 1999). In these studies the inter-year variations result from fluctuations in weather and amount of food. Thus, the main reproductive characteristics (female size and fecundity, etc.) seem to be affected by ecological factors in habitats.

Acknowledgments. This work was supported by Russian Foundation for Basic Research (grant No. 02-04-48611) and Federal Objects Program "The Integration of Science and high education in Russia, 2002 – 2006."

REFERENCES

- Ananjeva N. B., Borkin L. Ya., Darevsky I. S., and Orlov N. L. (eds.) (1998), *Encyclopedia of Russian Nature. Amphibians and Reptiles*, ABF, Moscow [in Russian].
- Bauwens D. (1999), "Life-history variation in lacertid lizards," *Natura Croat.*, **8**, 3, 239 – 252.
- Böhme W., Heulin B., and Bischoff W. (1999), "First data on a second oviparous population of the viviparous lizard *Zootoca vivipara* Jacquin, 1787 (Squamata: Lacertidae) from NW Slovenia," in: *Abstrs. of the 10th Ord. Gen. Meet. Soc. Eur. Herpetol.*, Irakleio (Greece), pp. 34 – 35.
- Brana F. and Bea A. (1987), "Bimodalité de reproduction chez *Lacerta vivipara*," *Bull. Soc. Herpetol. Fr.*, **44**, 1 – 5.
- Darevsky I. S. (1967), *The Rock Lizards of Caucasus*, Nauka, Leningrad [in Russian].
- Dely O. and Böhme W. (1984), "*Lacerta vivipara* Jacquin, 1787 — Waldeidechse," in: Böhme W. (ed.), *Handbuch der Reptilien und Amphibien Europas. Band 2/1*, AULA, Wiesbaden, pp. 362 – 393.
- Dujsebaeva T. N. and Orlova V. F. (2002), "On distribution and ecology of viviparous lizard *Zootoca vivipara* (Jacquin, 1787) in Markakolskaya Depression (South Altai)," in: *Zool. Res. in Kazakhstan: Present Situation and Perspectives. Proc. of Int. Sci. Conf., March 19 – 21, 2002*, Almaty, pp. 165 – 166 [in Russian].
- Heulin B. (1985), "Maturité sexuelle et âge à la première reproduction dans une population de plaine de *Lacerta vivipara*," *Can. J. Zool.*, **63**(8), 1773 – 1777.
- Heulin B. (1988), "Données nouvelles sur les populations ovipares de *Lacerta vivipara*," *C. R. Acad. Sci. Paris*, **306**, 63 – 68.
- Heulin B., Guillaume C. P., Vogrin N., Surget-Groba Y., and Tadic Z. (2000), "Further evidence of the existence of oviparous populations of *Lacerta vivipara* in the NW of the Balkan Peninsula," *C. R. Acad. Sci. Paris*, **323**, 461 – 468.
- Khodadoost M., Pilorge T., and Ortega A. (1987), "Variations de la densité et de la taille corporelle en fonction de la londance et de la composition du peuplement de proies dans trois populations de lézards vivipares du mont Lozère," *Rev. Ecol.*, **42**(2), 193 – 201.
- Korotkov J. M. (1985), *Terrestrial Reptiles of the Far East*, Dal'nevostochnoe Knizhnoe Izd., Vladivostok [in Russian].
- Korotkov J. M. and Levinskaja I. K. (1978), "Ecology of Amphibians and Reptiles of the Sakhalin island," in: *Ecology and Zoogeography of Some Vertebrates Terrestrial of the Far East*, Vladivostok, pp. 3 – 15 [in Russian].
- Kuranova V. N. (1983), "Some aspects of activity and behavior of *Lacerta vivipara* Jacq. in Tomsk Oblast'," in: *Ecology of Vertebrates at Siberia*, Izd. TGU, Tomsk, pp. 128 – 138 [in Russian].
- Kuranova V. N. (1998), *The Fauna and Ecology of Amphibians and Reptiles of the South-Eastern Part of Western Siberia. Author's Abstract of Candidate's Thesis*, Izd. TGU, Tomsk [in Russian].
- Lantz L. A. (1927), "Quelques observations nouvelles sur l'herpetologie des Pyrénées centrales," *Bull. Hist. Nat. Appl.*, **8**, 54 – 61.
- Lazareva O. G. (1999), "Reproductive biology of the common lizard, *Lacerta vivipara* (Sauria, Lacertidae) in reserves of the forest zone of Russia," in: *Abstrs. of the 2nd Conf. of Volga Region Herpetologists*, Tol'yatti, pp. 27 – 29 [in Russian].
- Mayer W., Böhme W., Tiedemann F., and Bischoff W. (2000), "On oviparous populations of *Zootoca vivipara* (Jacquin, 1787) in south-eastern Central Europe and their phylogenetic relationship to neighbouring viviparous and South-west

- European oviparous populations,” *Herpetozoa*, **13**(1/2): 59 – 69.
- Melkumyan L. S.** (1983), “The growth of *Lacerta strigata* in lowland and mountains,” *Zool. Zh.*, **62**(4), 580 – 584 [in Russian].
- Orlova V. F.** (1975), *Systematics and Some Morpho-Ecological Peculiarities of Lizards of the genus Lacerta. Author's Abstract of Candidate's Thesis*, Izd. MGU, Moscow [in Russian].
- Pilorge T.** (1987), “Density, size structure and reproductive characteristic of three populations of *Lacerta vivipara* (Sauria, Lacertidae),” *Herpetologica*, **43**(3), 345 – 356.
- Sedalishchev V. T. and Belimov G. T.** (1978), “Materials on ecology of the viviparous lizard (*Lacerta vivipara* Jacq.) in Yakutia,” *Biol. Nauki*, **10**, 59 – 66 [in Russian].
- Smirina E. M.** (1974), “Age determination,” in: Yablokov A. V. (ed.), *Sand Lizard*, Nauka, Moscow, pp. 239 – 245 [in Russian].
- Tagirova V. T.** (1997), *Reptilia of Khabarovsk Oblast'*, Khabarovsk [in Russian].
- Terentjev P. V. and Chernov S. A.** (1949), *Field Guide of Reptiles and Amphibians*, Sovetskaya Nauka, Moscow [in Russian].