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Reproductive Biology of the Rock Lizard (*Darevskia saxicola*, Reptilia, Lacertidae)

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Abstract—Data on the reproduction of the rock lizard (*Darevskia saxicola* (Eversmann 1834)) in the gorges of Bol'shaya Laba (Karachay-Cherkessia) and Malaya Laba (Krasnodar Territory) rivers are presented. Gravid females of this species were captured in nature and transported to the laboratory. The animals were kept in captivity until oviposition. All eggs were obtained between July 20 and August 20. Breeding females had a body length of 42.5–60.1 mm. Hatches comprised 1–4 eggs 11.2–18.0 × 5.8–8.5 mm in size and weighing 0.185–0.535 g. Incubation in the laboratory lasted 38–47 days. Young lizards after hatching had a body length of 21.6–30.8 mm, tail 39.9–60.4 mm long, and weight of 0.375–0.635 g. A comparison of the reproductive characteristics of *D. saxicola* and syntopic species (*D. derjugini* (Nikolsky 1898) and *D. pontica* (Lantz et Cyren 1919)) was carried out. The late oviposition and relatively low fertility in the rock lizards are compensated for by the large size of eggs and newborn lizards.

Keywords: rock lizard, *Darevskia saxicola*, reproduction, fertility, Northwest Caucasus

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INTRODUCTION

The rock lizard (*Darevskia saxicola* (Eversmann 1834)) is the type species of the genus *Darevskia* Arribas 1997 (Arribas, 1997, 1999), some of the representatives of which until recently were considered its intraspecific forms (Darevsky, 1967; Bannikov et al., 1977; Ananyeva et al., 1998). According to the modern view (Doronin, 2015), *D. saxicola* is a monotypic species, endemic to the Russian Federation, distributed in the North Caucasus, in Krasnodar krai (gorge of the Malaya Laba River), in the south of Stavropol, and in Karachai-Cherkessia and Kabardino-Balkaria (Tuniev, 1999). Most likely, it also lives in isolation in the Digorskii Gorge in North Ossetia (Udovkin and Lipkovich, 2000). Being a numerous species for most of its distribution, the rock lizard is of great importance in trophic chains (Darevsky, 1967; Timoshina et al., 2013). Despite the fact that the most common biotopes for *D. saxicola* are rocky outcrops in the mountain–forest and mountain–meadow belts, it is often syntopic not only with other petrophilic lizards (complex *Darevskia* (*caucasica*)), but also with forest species of the complex *Darevskia* (*praticola*) and the Artvin lizard (*D. derjugini* (Nikolsky 1898)). Most biological data on *D. saxicola*, including reproduction, were published in the period when up to five subspecies were considered within this species (Darevsky, 1967; Bannikov et al., 1977; Ananyeva et al., 1998), which are now recognized as independent species (MacCulloch et al., 2000; Tuniyev and Tuniyev, 2012; Doronin, 2015).

Thus, information on the reproductive biology of the rock lizard itself is difficult to separate from those for other closely related species. This communication allows us to characterize some poorly studied aspects of the reproduction of the rock lizard in the western part of the species range.

MATERIALS AND METHODS

Lizards were caught in the gorges of the Bol'shaya Laba River (the vicinity of the village of Rozhkao in the Urupskii district of Karachai-Cherkessia, 43°46′ N, 40°52′ E, 997 m a.s.l., hereinafter referred to as Rozhkao) and Malaya Laba River (environs of the village of Nikitino in the Mostovskii district of Krasnodar krai, 43°57′ N, 40°41′ E, 825 m above sea level, hereinafter, Nikitino) over several years (2011, 2013, 2014, 2016, 2017) in May, June, July, and August.

The distance between collection points in Rozhkao and Nikitino does not exceed 24 km, and there are no significant zoogeographic barriers. Therefore, we can assume that the samples of lizards from these localities belong to the same population. At the same time, differences in the conditions for collecting material (different heights and different years) made it necessary, in our opinion, to analyze each sample separately.

At both points *D. saxicola* is a massive syntopic species in the Malaya Laba gorge for the Artvin (*D. derjugini*) and Pontic (*D. pontica* (Lantz et Cyren 1919)) lizards. In the Bol'shaya Laba gorge, other species of lizards of the genus *Darevskia* Arribas 1997 living together with *D. saxicola* are not marked by us (*D. derjugini* in Karachai-Cherkessia was not found, and finds of *D. pontica* are known downstream along the Bol'shaya Laba River, at the mouth of the Grushevaya Balka River, in the villages of Aziatskii and Kurdzhinovo (Kidov and Matushkina, 2016)).

The captured adult females were transported to the laboratory, where they were kept according to the methodology repeatedly tested on other representatives of this genus (Kidov et al., 2015; Kidov, 2018). The eggs laid during the transportation of animals from the place of capture to the laboratory were used only to study their size and weight parameters. The lizards were placed one by one in polypropylene containers of the Samla brand (manufactured by IKEA, Russia) 39 × 28 × 28 cm in size. Fallen oak leaves were used as a substrate, laid in a layer of 1.0–1.5 cm. The source of light and ultraviolet radiation was Sylvania Reptistar T8 fluorescent lamps (Germany) with a power of 20 W. Daylight lasted 12 h. Local bottom heating was provided using a Repti Zoo RS7050 heating cable (China) with a power of 50 W. Plastic food containers with moistened pieces of foam rubber inside served as shelters for the lizards. Inlet openings were made in the container lids. To maintain the required humidity level to prevent the eggs from drying out, the containers were sprayed daily with warm water from a spray bottle.

Every other day the lizards were offered laboratory breeding insects, i.e., nymphs of the two-spotted cricket (*Grillus bimaculatus* (De Geer 1773)) and larvae of the large flour beetle (*Tenebrio molitor* Linnaeus 1758) and ash cockroach (*Nauphoeta cinerea* (Olivier 1789)). Before feeding, the insects were powdered with a mixture of feed chalk and TerraVit Pulver vitamin premix (manufacturer JBL GmbH & Co, Germany).

The substrate and shelters in the animal containers were inspected daily. In females, on the first day after oviposition, the body length (L) was determined using standard techniques (Bannikov et al., 1977) using an electronic Solar Digital Caliper (Xueliee, China) with an error of 0.1 mm, and using electronic laboratory scales Massa-K VK-300 (Massa-K, Russia) with an error of up to 0.005 g weight. The eggs were measured for length and width, as well as weight. Fatty, damaged, or deformed eggs were taken into account only when analyzing the fecundity of females and the weight of the entire clutch. The laid eggs were placed in ventilated food containers filled with moistened peat and transferred to the Herp Nursery II reptile incubator (Lucky Reptile, PRC). Further development of eggs before hatching of juveniles took place at a temperature of 27–28°C and a humidity of 75–80%. In newborn lizards, the body length (L), tail (Lcd), and weight were measured. Some of the lizards studied were subsequently released at the places of capture, and some are still kept in the laboratory.

Biometric processing of the data obtained was carried out using the Microsoft Excel software package. The arithmetic mean and standard deviation were calculated ($M \pm SD$), as well as the range of the feature (min–max).

RESULTS AND DISCUSSION

Lizards caught in Nikitino from the third ten-day period of April to the second ten-day period of May and in the third ten-day period of August did not lay eggs in the laboratory later. Most likely, productive mating and oviposition in this species occurs between these periods.

Females caught on July 27–28, 2016 in Rozhkao began to lay eggs almost immediately after capture, even during transportation to the laboratory, from July 30. Eggs received in common containers ($n = 37$) had a length of 11.4–17.5 mm (on average, 14.0 ± 1.45), a width of 6.7–8.5 mm (7.2 ± 0.39), and a mass of 0.285–0.520 g (0.429 ± 0.0656). Twelve pregnant females from Rozhkao brought to the laboratory eggs laid in the period from August 4–21 (Table 1). The body length of breeding females is 54.6–64.9 mm (60.8 ± 3.36), and the body weight immediately after oviposition is 2.715–3.490 g (2.912 ± 0.2557). Most of the clutches obtained (58.3%) contained three eggs, a smaller number of clutches had four (25.0%) or two (16.7%) eggs. The total mass of the clutch ($n = 12$) was 0.915–1.780 g (1.336 ± 0.3043). The laid eggs accounted for 31.3–62.3% (49.7 ± 10.59) of the female weight after oviposition.

From females caught on July 22–29, 2017, in Nikitino ($n = 37$), eggs were laid in the laboratory from July 30 to August 12. The body length of pregnant females ($n = 31$) was 42.5–60.1 mm (52.8 ± 4.47), and the weight after oviposition is 1.360–3.025 g (1.997 ± 0.4361). Here, 43.2% of clutches obtained in the laboratory contained two eggs; 37.8% of clutches, three eggs each; 10.8% of clutches, one egg each; and 8.1% of clutches, four eggs each. The mass of the entire clutch ($n = 37$) was 0.285–1.465 g (0.821 ± 0.3374) or 12.9–72.7% (41.3 ± 14.77) of the female body weight after oviposition.

According to Bannikov et al. (1977), *D. saxicola* sensu lato females from the end of June to the beginning of August lay 2–5 eggs 12–16 × 6–8 mm in size. Newborn juveniles have a body length of 22.2–28.5 mm. The data we obtained allow us to broaden

Table 1. Fertility, duration of incubation, and size indicators of eggs and hatchlings in *Darevskia saxicola*

Indicator		$\frac{M \pm SD}{\text{min–max}}$			
		Rozhkao	*n*	Nikitino	*n*
Number of eggs in a clutch		$\frac{3.0 \pm 0.74}{2–4}$	12	$\frac{2.5 \pm 0.80}{1–4}$	37
Egg sizes	Length, mm	$\frac{13.5 \pm 0.86}{12.3–15.9}$	36	$\frac{14.0 \pm 1.23}{11.2–18.0}$	36
	Width, mm	$\frac{7.2 \pm 0.30}{6.4–7.7}$	36	$\frac{6.9 \pm 0.74}{5.8–8.1}$	36
	Weight, g	$\frac{0.428 \pm 0.0635}{0.295–0.535}$	36	$\frac{0.379 \pm 0.0776}{0.185–0.500}$	36
Duration of incubation in the laboratory, days		$\frac{42.8 \pm 3.11}{40–47}$	5	$\frac{40.3 \pm 2.22}{38–43}$	4
Sizes of young	Body length, mm	$\frac{27.0 \pm 1.71}{22.7–30.8}$	46	$\frac{24.7 \pm 2.28}{21.6–27.5}$	6
	Tail length, mm	$\frac{47.9 \pm 4.11}{39.9–60.4}$	46	$\frac{46.5 \pm 1.09}{45.5–48.0}$	6
	Weight, g	$\frac{0.528 \pm 0.0619}{0.375–0.635}$	46	$\frac{0.417 \pm 0.0275}{0.385–0.460}$	6

Table 2. Comparative characteristics of the reproductive indices of syntopic species of lizards of the genus *Darevskia* Arribas 1997 in the gorge of the Malaya Laba River (Krasnodar krai, Russia)

Indicator		*Darevskia derjugini*	*Darevskia pontica*	*Darevskia saxicola*
Egg laying period		First ten days of June–last ten days of August	First through last ten days of June, extremely rarely–before the first ten days of August	Last ten days of July–last ten days of August
Number of eggs in clutch, pcs.		2–8	2–7	1–4
Egg sizes	Length, mm	9.3–14.8	9.0–12.2	11.2–18.0
	Width, mm	5.7–7.1	5.1–8.1	5.8–8.5
	Weight, g	0.230–0.280	0.210–0.450	0.185–0.535
Duration of incubation in the laboratory, days		41–48	40–47	38–47
Sizes of young	Body length, mm	22.4–26.4	20.1–26.5	21.6–30.8
	Mass, g	0.290–0.450	0.200–0.360	0.375–0.635

our understanding of the range of values of these features (Table 2).

Generally, *D. saxicola* in terms of reproductive indicators demonstrates great similarity with other representatives of the genus (Bannikov et al., 1977; Orlova, 1975; Tertyshnikov, 1992; Ananyeva et al., 1998), but their comparison is difficult, since the habitats of these species have different natural and climatic characteristics and the methods of this obtaining material (study of clutches from live individuals caught in nature or dissection of sacrificed lizards) are different. In this regard, it seems interesting to correlate the data obtained by us in the study of the reproduction of the rock lizard with the results of similar studies carried out in the same localities on syntopic species, i.e., Artvin and Pontic lizards (Kidov et al.,

2014, 2016, 2017, 2018; Kidov and Timoshina, 2017) (Table 2).

Despite the general similarity of reproductive indicators in the Artvin and Pontic rock lizards, each of these species, even when living in the same locality (Malaya Laba gorge), has characteristic features. *D. derjugini*, like some other reptiles of Colchis, that is, subtropical origin (Tuniev, 1990), has an extended breeding season, covering the entire summer period. *D. pontica* usually finishes laying eggs in June. *D. saxicola* begins to reproduce later than other species, at the end of July.

In the clutches of the rocky lizard, there are usually fewer eggs than in the Artvin and Pontic lizards, but they are, on average, larger, as are the juveniles hatching from them.

Considering the relatively late time of oviposition in *D. saxicola* and the duration of incubation in nature (according to Bannikov et al. (1977), 55–60 days), young lizards in Rozhkao and Nikitino should hatch until the end of October. Most likely, the larger size of the offspring in this species, in comparison with *D. derjugini* and *D. pontica*, should compensate for the short period for feeding and growth of juveniles before winter hibernation.

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COMPLIANCE WITH ETHICAL STANDARDS

Conflict of interest. The author declares no conflict of interests.

Statement on the welfare of animals. All applicable international, national, and/or institutional guidelines for the care and use of animals were followed.

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