

## Diet and Parasitic Helminths of Dice Snakes from the Volga Basin, Russia

ANDREY BAKIEV, ALEXANDER KIRILLOV & KONRAD MEBERT

**Abstract.** The diet and helminth fauna of 32 dice snakes from the Volga Basin, the Republic Kalmykia and the provinces of Samara, Saratov, Volgograd and Astrakhan were investigated. A total of 33 fish items were retrieved belonging to at least 11 species (*Alburnus alburnus*, *Esox lucius*, *Lota lota*, *Misgurnus fossilis*, *Perca fluviatilis*, *Rutilus rutilus*, *Percottus glenii*, *Cottus gobio*, *Carassius carassius*, *Cyprinus carpio*, *Neogobius melanostomus*, and some unidentified species). In addition we found 5 tadpoles (*Pelophylax ridibundus*, and from unidentified ranids); 1 snake (*Vipera berus*) and one individual of gastropoda (*Lymnaea stagnatilis*). In Samara, Saratov, Volgograd and Astrakhan provinces 142 snakes have been investigated by complete helminthological dissection. A total of 20 species of parasites were found: 10 species of trematodes (*Leptophallus nigrovenosus*, *Encyclometra colubrimurorum*, *Astiotrema monticelli*, *Macrodera longicollis*, *Telorchis assula*, *Paralepoderma cloacicola*, larval stages of *Strigea sphaerula*, *S. strigis*, *Alaria alata* and *Pharyngostomum cordatum*), 1 species of cestode (*Ophiotaenia europaea*), 8 species of nematodes (*Rhabdias fuscovenosus*, *Strongyloides mirzai*, *Camallanus truncatus*, *C. lacustris*, larval stages of *Streptocara crassicauda*, *Spiroxys contortus*, *Contracaecum* sp., 1 unidentified nematode), and 1 species of acanthocephalan (*Centrorhynchus aluconis*, larvae). Comments are made on the ecological correlation between composition of the helminth fauna and the semi-aquatic lifestyle and diet of the dice snakes.

**Keywords.** Dice snake, *Natrix tessellata*, diet, helminths, Volga River Basin

### Introduction

Several studies have been published on the diet of the dice snake, *Natrix tessellata*, from the Volga Basin (MARKUZE 1964, KIREEV 1983, BAKIEV & KIRILLOV 2000, BAKIEV et al. 2004, SHLYAKHTIN et al. 2005). According to these data, the principal diet of *Natrix tessellata* in this region consists of fish, as elsewhere in its global range (GRUSCHWITZ et al. 1999). Also consistent with these accounts are various older records from the former Soviet Union that frogs and tadpoles are less common, whereas small rodents, reptiles and insects are accidental (see refs. in LAŇKA 1978, GRUSCHWITZ et al. 1999, GÖCMEN et al. 2011).

There was a pronounced interest to study the helminth fauna of dice snakes from the Volga Basin for over half a century with research focused on the Volga Delta of Astrakhan (DUBININ 1949, 1952, DUBININA 1950, 1951, 1953, IVANOV 1952, 1954, SUDARIKOV 1960, 1962, MARKOV et al. 1962, 1969). More recently, helminthological research on dice snakes was published from the provinces of Samara (KIRILLOV & EVLANOV 1999, BAKIEV & KIRILLOV 2000, KIRILLOV 2000) and again Astrakhan (IVANOV & SEMENOVA 2000). Overall, these studies reported 26 species of helminths in dice snakes from the Volga Basin (BAKIEV & KIRILLOV 2007): 14 species of trematodes, 2 species of cestodes, 8 species of nematodes, and, 2 of acanthocephalans. We present here the combined results of our investigation on the diet and helminths of the dice snake from the Volga Basin.

### Materials and Methods

Field work was conducted between 1995 and 2009 in the provinces of Samara (SAM), Astrakhan (AST), Saratov (SAR), Volgograd (VOL), and Kalmykia (KAL). Stomach contents of 284 snakes were collected either during the helminthological dissection ( $n = 142$ ) or by using a non-invasive method ( $n = 142$ ) such as palpating the snake's venter to enable it to regurgitate its prey. Thirty-one stomach contents of variously aged snake individuals were retrieved and analysed.

Complete helminthological analysis followed methods by SKRYABIN (1928). Processing of parasitological material was performed by standard techniques described by IVASHKIN et al. (1971), and BYKHOVSKAYA-PAVLOVSKAYA (1985). Trematodes, cestodes and acanthocephalans were fixed in 70% ethanol, stained using acetic carmine, immersed in a series of gradually increasing ethanol concentrations, and finally mounted with Canada balm. Clarification was performed using dimethylphtalate and clove oil (SUDARIKOV 1965). Nematodes, after fixation in Barbagallo liquid, were clarified in a solution of lactic acid and mounted in a glycerine-gelatinous mix.

### Results and Discussion

#### Diet

From the 284 snakes analyzed, 89.1% ( $n = 253$ ) contained no prey. The high proportion of empty stomachs probably is related to the period of sampling in the early

spring. In this season, dice snakes often have not begun feeding as the water is still very cold (LAŇKA 1978, LENZ & GRUSCHWITZ 1993).

Among the 32 stomach contents, a total of 33 individual fish have been collected (number and origin of prey items in parenthesis; abbreviations in Tab. 1): *Alburnus alburnus* (1-SAM), *Esox lucius* (1-SAM), *Lota lota* (1-SAM), *Misgurnus fossilis* (1-SAM), *Perca fluviatilis* (4-SAM, 1-AST, 1-SAR), *Rutilus rutilus* (2-SAM), *Perccottus glenii* (1-SAM), *Cottus gobio* (1-VOL), *Carassius carassius* (1-VOL), *Cyprinus carpio* (1-KAL), *Neogobius melanostomus* (7-SAM), juvenile fishes of uncertain species (10-SAM). Other vertebrates recorded in the stomach contents were following: tadpoles of *Pelophylax ridibundus* (4-SAR), tadpole of unidentified ranid sp. (1-SAM); juvenile *Vipera berus* (1-SAM), and one individual of the gastropod *Lymnaea stagnatilis* (1-SAM) (Fig. 1). Certainly, the viper is an unusual find and how it became a prey of a juvenile dice snake remains speculative. But *Vipera berus* do occasionally cross water bodies (e.g. SCHIEMENZ 1987, MÄRTSON et al. 2001, and see topic discussion in RAUK 2005). In such a situation, the vipers' swimming movement may attract a dice snake and induces an inborn feeding reflex, similar as was suggested for the consumption of a peach pit (MEBERT 2011). Generally, reptiles have been found rarely as diet of dice snakes, but a few consumed lizards have been reported, e.g. DZAFARO (1949, cit. in LAŇKA 1978), references in GRUSCHWITZ et al. (1999), and more recently GÖCMEN et al. (2011). Latter found also a *Lymnaea* sp. in the stomach of one dice snake from Turkey as in this study.

In this study, adult dice snakes contained fish and the single gastropod, whereas fish, tadpoles and the single snakes were retrieved from juvenile snakes. The number of food item per stomach was as following: 28 snakes contained one item; 4 snakes yielded several items, of which 2 stomachs rendered three to four unidentified young fishes, and 2 stomachs yielded each 2 tadpoles of *Pelophylax ridibundus*. Cases of dice snakes consuming

decayed fish were reported from the Samara province (Y. KUCHERA pers. comm.).

KIREEV (1983) studied the diet composition of *Natrix tessellata* in Kalmykia and found it to be season-dependent. Adult amphibians represented the principal prey during the spring and autumn, whereas fish and tadpoles were the more common prey during the summer. KIREEV (1983) found that dice snakes from Kalmykia consumed also rarely mice, *Mus musculus*, besides the usual fish and amphibians. Similar results were found by SHLYAKHTIN et al. (2005) in the Saratov province, where the diet of dice snakes consisted of 90% fish, 9% amphibians, and 1% small rodents and insects.

### Helminths

We found 20 species of helminths in the dice snake: 10 species of trematodes, 1 cestode, 8 species of nematodes, and 1 acanthocephalan (Tab. 1). Of those, 11 species of parasitic worms use dice snakes as the final host, whereas 9 species of helminths parasitize the snakes during their larval stages. Nine species are specific parasites of the snake families Colubridae and Viperidae. They are: *Leptophallus nigrovenosus*, *Encyclometra colubrimurorum*, *Astiotrema monticelli*, *Macrodera longicollis*, *Telorchis assula*, *Paralepoderma cloacicola*, *Ophiotaenia europaea*, *Rhabdias fuscovenosus*, *Strongyloides mirzai*. Five species are non-specific parasites of reptiles (larval stages of *Strigea strigis*, *S. sphaerula*, *Pharyngostomum cordatum*, *Alaria alata*, *Centrorhynchus aluconis*) and 6 species are casual parasites of dice snakes (*Camallanus truncatus*, *C. lacustris*, larval stages of *Spiroxys contortus*, *Streptocara crassicauda*, *Contracaecum* sp., *Nematoda* sp.).

The revealed helminthofauna is in close interrelation with the ecology of the dice snake, in particular, with its semi-aquatic life style and diet. Ingestion of adult and larval amphibians by dice snakes are probably responsible for the infection by all adult trematodes *Astiotrema monticelli*, *Encyclometra colubrimurorum*, *Telorchis assula*, *Macrodera longicollis*, *Paralepoderma cloacicola* and *Leptophallus nigrovenosus*, and also by the cestode *Ophiotaenia europaea*. The larvae of trematodes *Strigea strigis*, *S. sphaerula*, *Pharyngostomum cordatum* and *Alaria alata* reflect the host's terrestrial habit along the shoreline, where the ecological conditions are set for the larvae of these helminths to penetrate through the snakes' integument. Larval trematodes indicate a significant role of these reptiles in transferring such parasites to mammals and birds, which likely prey on the snakes. For example, the final hosts of *Strigea sphaerula* are corvid birds (crows and magpies). *S. strigis* ends its development also in predatory birds. *Pharyngostomum cordatum* and *Alaria alata* reach sexual maturity in predatory mammals of the families Felidae and Canidae (SHAPILO 1976).

Nematodes of the genus *Camallanus* are typical fish parasites and likely found their way into the snakes



Fig. 1. Gastropod *Lymnaea stagnatilis* as a stomach content of a dice snake from Samara, Volga basin, Russia.

Tab. 1. Helminths of dice snakes, *Natrix tessellata*, from the Volga Basin. Prevalence rate = proportion of snake infected; intensity = min. – max. number of parasites per infected snake; and abundance = mean number of parasites per snake (refers to all snakes in an area). Abbreviations: SAM (Samara), SAR (Saratov), VOL (Volgograd), AST (Astrakhan).

| Parasite                                | Prevalence rate ± standard deviation (intensity) |                                   |             |                                  |
|-----------------------------------------|--------------------------------------------------|-----------------------------------|-------------|----------------------------------|
|                                         | Abundance ± standard deviation                   |                                   |             |                                  |
|                                         | SAM (n = 65)                                     | SAR (n = 18)                      | VOL (n = 1) | AST (n = 58)                     |
| <i>Leptophallus nigrovenosus</i>        | –                                                | 83.3 ± 16.7 (1–10)<br>4.2 ± 1.7   | –           | –                                |
| <i>Encyclometra colubrimurorum</i>      | –                                                | –                                 | –           | 19.0 ± 5.2 (1–8)<br>0.8 ± 0.3    |
| <i>Astiotrema monticelli</i>            | –                                                | –                                 | –           | 8.6 ± 3.7 (1–4)<br>0.2 ± 0.1     |
| <i>Macrodera longicollis</i>            | 23.1 ± 5.3 (1–3)<br>0.2 ± 0.1                    | –                                 | –           | 25.9 ± 5.8 (1–13)<br>1.2 ± 0.7   |
| <i>Telorchis assula</i>                 | 58.5 ± 6.2 (1–55)<br>9.2 ± 2.4                   | 66.7 ± 21.1 (2–34)<br>11.7 ± 5.7  | 43          | 89.7 ± 4.0 (3–129)<br>20.7 ± 5.2 |
| <i>Paralepoderma cloacicola</i>         | 12.3 ± 4.1 (6–13)<br>0.7 ± 0.2                   | –                                 | 5           | –                                |
| <i>Strigea sphaerula</i> , larvae       | 7.6 ± 3.3 (1–40)<br>1.7 ± 1.0                    | 50.0 ± 22.4 (2–32)<br>6.0 ± 5.2   | –           | 43.1 ± 6.6 (2–86)<br>10.2 ± 2.7  |
| <i>Strigea strigis</i> , larvae         | 20.0 ± 5.0 (1–197)<br>4.2 ± 1.4                  | –                                 | –           | 72.4 ± 5.9 (2–820)<br>77.6 ± 9.8 |
| <i>Alaria alata</i> , larvae            | 3.1 ± 2.2 (1–4)<br>1.7 ± 1.0                     | 16.7 ± 16.7 (6)<br>1.0 ± 1.0      | 60          | 6.9 ± 3.4 (3–10)<br>0.4 ± 0.2    |
| <i>Pharyngostomum cordatum</i> , larvae | 23.1 ± 5.3 (1–66)<br>3.7 ± 1.6                   | 50.0 ± 22.4 (3–56)<br>16.8 ± 10.3 | –           | 37.9 ± 6.4 (2–530)<br>46.6 ± 9.1 |
| <i>Ophiotaenia europaea</i>             | 60.0 ± 6.1 (1–36)<br>8.2 ± 2.5                   | 16.7 ± 16.7 (5)<br>0.8 ± 0.8      | 1           | 87.9 ± 4.3 (1–38)<br>6.7 ± 2.8   |
| <i>Rhabdias fuscovenosus</i>            | 80.0 ± 5.0 (2–135)<br>22.2 ± 8.7                 | –                                 | –           | 75.9 ± 5.7 (1–110)<br>9.9 ± 2.1  |
| <i>Strongyloides mirzai</i>             | –                                                | –                                 | –           | 8.6 ± 3.7 (1–4)<br>0.2 ± 0.1     |
| <i>Camallanus truncatus</i>             | 24.6 ± 5.4 (1–4)<br>0.5 ± 0.2                    | 16.7 ± 16.7 (1)<br>0.2 ± 0.2      | –           | –                                |
| <i>Camallanus lacustris</i>             | –                                                | –                                 | –           | 1.7 ± 1.7 (1)<br>0.02 ± 0.02     |
| <i>Streptocara crassicauda</i> , larvae | 4.6 ± 2.6 (1)<br>0.1 ± 0.1                       | –                                 | –           | –                                |
| <i>Spiroxys contortus</i> , larvae      | –                                                | –                                 | –           | 51.7 ± 6.6 (1–68)<br>9.3 ± 3.2   |
| <i>Contracaecum</i> sp., larvae         | –                                                | –                                 | –           | 10.4 ± 4.0 (1–2)<br>0.10 ± 0.06  |
| <i>Nematoda</i> sp., larvae             | –                                                | –                                 | –           | 5.2 ± 2.9 (1–8)<br>0.2 ± 0.1     |
| <i>Centrorhynchus aluconis</i> , larvae | –                                                | –                                 | –           | 3.5 ± 2.4 (1)<br>0.04 ± 0.04     |
| <b>Total number of species</b>          | 11                                               | 7                                 | 4           | 16                               |

through their diet (SHARPILO 1976). The nematode *Rhabdias fuscovenosus* infects dice snakes, as well as other reptiles, via the mouth and percutaneously in a humid environment (BRANNIAN 1984). Infection of snakes by larval stages of the nematodes *Spiroxys contortus* (final host – turtles), *Streptocara crassicauda* (final host – shore birds) and *Contracaecum* sp. (final hosts – piscivorous birds and mammals) probably occurs by casual swallowing of intermediate hosts of these parasites, such as aquatic invertebrates (cyclopes, larvae of insects), fishes, amphibians and reptiles. The dice snake is considered the reservoir (or even an abortive) host for these helminths (SHARPILO 1976). We suggest that for these parasites the dice snake is an ecological deadlock. At the same time, since dice snakes spend a lot of time on quite humid soil, helminths with a direct cycle of development, such as *Rhabdias fuscovenosus* and *Strongyloides mirzai*, may infect the snakes via their skin and mouth.

The detection of *Centrorhynchus aluconis* larvae, a widespread parasite of reptiles, suggests that the dice snakes accidentally or intentionally ingest coleopterans, as the snakes are intermediate host of this acanthocephalan. Final hosts of this parasite are diurnal and nocturnal predatory birds (SHARPILO 1976). Hence, dice snakes appear to represent in this case a reservoir host.

Five species of helminths are reported herewith for the first time from the Volga Basin: *Leptophallus nigrovenosus*, *Strongyloides mirzai*, *Camallanus lacustris*, *Streptocara crassicauda* and *Centrorhynchus aluconis*. Thirteen other species of helminths that were recorded by other researchers in dice snakes from the Volga Basin have not been found in our study. They are the trematodes *Opisthioglyphe ranae*, *Plagiorchis elegans*, *Codonocephalus urnigerus*, larval *Neodiplostomum attenuatum*, larval *Neodiplostomum spathoides*; larvae of the cestode *Spirometra erinaceieuropaei*; the nematodes *Eustrongylides excisus*, *Oswaldocruzia goezei*, *Polydelphis dalmatina*, larval *Agamospirura natricis*, *Dracunculus oesophagea*; larval acanthocephalans *Corynosoma strumosum*, and *Sphaerirostris teres*.

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## Authors

ANDREY BAKIEV, ALEXANDER KIRILLOV, Institute of Ecology of the Volga River Basin of Russian Academy of Sciences, Komzina str. 10, Togliatti, 445003, Russia, e-mail: [herpetology@list.ru](mailto:herpetology@list.ru); KONRAD MEBERT, Siebeneichenstrasse 31, 5634 Merenschwand, Switzerland.