Food habits of *Zamenis longissimus* (Laurenti, 1768) (Reptilia: Serpentes: Colubridae) in Bieszczady (south-eastern Poland)

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> Abstract

The paper presents the results of research on the food contents of the Aesculapian snake *Zamenis longissimus* in Bieszczady (south-eastern Poland). Over the period of 20 years 43 dead individuals of the species of varied age were found in the valley of the San river at the foot of Otryt hills. 116 victims were recorded in 40 (93 %) stomachs filled with food contents, among which vertebrate, and in particular small mammals prevailed (e. g. *Sorex* sp., *Apodemus* sp., *Microtus* sp. and *Clethrionomys* sp.). Food of adult snakes (89–159.7 cm; $n = 32$) also included bird eggs. Food of individuals classified as young (27.5–67.5 cm; $n = 8$), apart from vertebrate (mainly Lacertidae) included invertebrate (Coleoptera and Oligochaeta). The research indicates that food contents of this relatively small population of the Aesculapian snake can be significantly diversified and dependent on age.

> Kurzfassung

Untersuchungsergebnisse über das Nahrungsspektrum der Äskulapnatter, *Zamenis longissimus,* in Bieszczady (Süd-Ost Polen) werden vorgestellt. Im Tal des Flusses San, unterhalb des Berges Otryt wurden innerhalb von 20 Jahren 43 tote Vertreter dieser Art, unterschiedlichen Alters gefunden. Bei 40 Schlangen (93 % der untersuchten Exemplare), deren Mägen Nahrungsreste enthielten, wurden 116 Beutetiere festgestellt. In den meisten Fällen waren es Wirbeltiere, vor allem kleine Säugetiere (u. a. *Sorex* sp., *Apodemus* sp., *Microtus* sp. und *Clethrionomys* sp.). Auch Vogeleier gehören zur Nahrung erwachsener Schlangen (89–159.7 cm; $n = 32$). In den Mägen der jungen Schlangen (27.5–67.5 cm; $n = 8$) wurden außer Wirbeltieren (meistens Lacertidae) auch Wirbellose (Coleoptera und Oligochaeta) festgestellt. Die Untersuchungen zeigen, dass das Nahrungsspektrum dieser kleinen Population der Äskulapnatter sehr unterschiedlich und vom Alter abhängig ist.

> Key words

Reptilia, Serpentes, Colubridae, Aesculapian snake, *Zamenis longissimus*, food habits, Bieszczady, Poland.

Introduction

The Aesculapian snake *Zamenis longissimus* inhabits a vast, yet dispersed area from the north eastern part of the Iberian Penninsula to the eastern coast of the Black Sea. The southern range of the species includes sites in Greece, several islands of the Mediterranean Sea and isolated locations in Caucasus, in north-eastern Turkey and north-western Iran. Northernmost isolated sites in Europe are located in Germany, Czech Republic and Poland (Böhme, 1993; Heimes & Waitzmann, 1993; Naulleau, 1997; Mikàtovà & Zavadil, 2001; Najbar, 2004; Edgar & Bird, 2006).

The Aesculapian snake, which is an endangered species in Poland (CR), inhabits mainly southern and south eastern parts of the country (Głowaciński & Szyndlar, 2001; Głowaciński, 2003). Most numerous populations occur in the valley of the San River in the Otryt (49°13'–49°18'N, 22°28'–22°42'E) range of the Bieszczady, where the number of snakes is estimated for approximately 100 individuals (Najbar, 2004).

All above mentioned authors stress that on many locations of the species, isolated populations are particularly endangered by extinction and hence any information concerning their biology and ecology is extremely precious.

The composition of the snake's food is not well recognized in Poland, the most exhaustive account con-

Fig. 1: International Biosphere Reserve "Eastern Carpathia". A – general perspective, B – //////// – study area.

cerning this is issue can be found in NAJBAR (1999). Other data relate either to more recent but not numerous field observations (NAJBAR, 2004), or information on isolated cases of individuals coming from Bieszczady and kept in breeding conditions (CAIS, 1963; JUSZCZYK, 1987).

Study area

Bieszczady area is located in south-eastern Poland, in the region of Eastern Carpathia, between the Łupkowska pass (640 m above sea level), the valley of the Osława river, Użocka pass (852 m above sea level) and the source of the San river on the border with Ukraine (KONDRACKI, 2001). It is a mountainous area of average height, whose highest peak – Tarnica is located at the altitude of 1346 m above sea level. The climate in the region is changeable due to both continental and oceanic impact (WOŚ, 1996). The average temperature is above 6.5 °C, in the winter half-year –1 °C and in the summer half-year 13 °C. Average annual temperatures on the altitudes above 800 m above sea level do not go beyond 4 °C. The vegetation period lasts between 190 and 210 days (MICHNA & PACZOS, 1972; ZEMANEK, 1989).

Bieszczady is one of the most dense forest areas in Poland, rich in terms of various geological forms and almost natural flora. *Fagetum carpaticum* is a dominating forest type. Deforested areas are overgrown by various forms of flora, most of them are at the stage of succession. The area is sanctuary of many rare species of fauna. Most of the region, due to its natural characteristics is subject to protection, and the area inhabited by the biggest population of the Aesculapian snake is located in the San Valley Landscape Park founded in 1992, part of the Bioshere Reserve "Eastern Carpathia" (Fig. 1) (ZZKPK, 2002).

Material and methods

The research material analyzed in this paper was collected between May and September in the years 1984–1987 and 1990–2005. The contents of snakes' stomachs was examined.

The gender of the snakes was established on the basis of calculation of the ratio of the total length to the length of the tail, the shape of base of the tail and probing the cloacae. In view of the fact that Aesculapian snakes attain sexual maturity once they have reached the length of approximately 90 cm (e.g. Beszkow, 1975; Najbar, 2000), apart from providing a general characteristics of the composition of the snake's food, the paper introduced the division into juvenile/subadult (27.5–67.5 cm) and mature (89–159.7 cm) individuals.

Results

The total number of 43 dead snakes (killed either by people or cars) were found and examined from the point of view of the contents of their stomachs. 3 (7 %) stomachs were empty, the remaining 40 (93 %) were filled with chime. 116 victims of the snakes were identified. Mammals constituted the most numerous group, out of which prevailed: common shrew *Sorex araneus*, yellow-necked mouse *Apodemus flavicollis*, orkney vole *Microtus arvalis*, shrews *Sorex* sp. and bank vole *Clethrionomys glareolus*. The second group of victims, in terms of quantity, included reptiles out of which prevailed viviparous lizard *Zootoca vivipara*, and slow-worm *Anguis fragilis*. In the researched region Aesculapian snakes also hunt for common bird species, in particular house sparrow *Passer domesticus* and spotted flycatcher *Muscicapa striata*. Other, not mentioned victims, which are enumerated in the table, had significantly less important, in terms of percentages, or even marginal share in the food contents of the snakes examined (Tab. 1).

The composition of the food of juvenile and subadult individuals (n = 8) was diversified. The following species prevailed among the victims: reptiles 45 % (Lacertidae 40 %, Anguidae 5 %), mammals 35 % (Soricidae 25 %, Muridae 10 %), invertebrate 15 % (Silphidae 10 %, Lumbricidae 5 %) and amphibians 5 % (Ranidae).

Invertebrate are sporadically devoured by young individuals. Remains of *Necrophorus* sp. were observed in a 27.5 cm long female, whereas remains of *Lumbricus* sp. were identified in a female, whose length was 49.7 cm.

No invertebrate were observed in the composition of the food of adult individuals (n = 32). Definitely prevailed mammals – 76 % (Muridae 45.8 %, Soricidae 18.7 %, Muscardinidae 4.2 %, Talpidae 2.1 %, unidentified remains of mammals 5.2 %), and then birds and their eggs - 13.6 % (Ploceidae 4.2 %, Muscicapidae 4.2 %, Motacillidae 2.1 %, Fringillidae 2.1 %, Paridae 1 %), reptiles - 9.4 % (Anguidae 6.7 %, Lacertidae 1.35 %, Colubridae 1.35 %) and 1 % amphibians (Ranidae).

The largest victims were observed in the stomachs of a 136.7 cm male (3 juv. *Myoxus* /*Glis*/ *glis*), a 144 cm long female (juv. *Talpa europaea*) and a 147.9 cm long male (ad. *M. glis* and ad. *T. europaea*).

Table 1. Food habits of *Zamenis longissimus* in the study area.

L.p.	Species		Share (%)
	Vertebrata		
1.	Mammalia	*Sorex araneus* L.	13.8
2.		*Apodemus flavicollis* Melchior	9.5
3.		*Microtus arvalis* Pallas	8.5
4.		*Sorex* sp.	7
5.		*Clethrionomys glareolus* Schreber	7
6.		*Apodemus agrarius* Pallas	4.3
7.		*Apodemus* sp.	4.3
8.		*Myoxus glis* L.	3.4
9.		*Microtus agrestis* L.	2.6
10.		*Microtus* sp.	1.7
11.		*Talpa europaea* L.	1.7
12.		n. det. Rodentia and Insectivora	5.2
13.		Total %	69
14.	Reptilia		
15.		*Zootoca vivipara* Jacquin	8.6
16.		*Anguis fragilis* L.	5.1
		Lacerta agilis L.	0.9
		Natrix natrix (L.)	0.9
17.		Total %	15.5
18.	Aves / ova		
19.		*Passer domesticus* (L.)	3.45
20.		*Muscicapa striata* Pallas; incl. 2 ova	3.45
21.		*Motacilla alba* L.	1.7
		Fringilla coelebs L.	1.7
		Parus major L.	0.9
22.		Total %	11.2
	Amphibia	*Rana temporaria* L.	1.7
23.		Total %	1.7
	Invertebrata		
	Arthropoda (Coleoptera)	*Necrophorus* sp.	1.7
24.		Total %	1.7
	Annelida (Oligochaeta)	*Lumbricus* sp.	0.9
		Total %	0.9
			100%

Discussion

The research indicates that food contents of the Aesculapian snake in Bieszczady can be diversified (Tab. 1).

The availability of victims in the environment is most probably subject to seasonal changes, but the specific periods when dead males and females were found did not vary (periods are understood here as particular months, irrelevant of the year in which snakes were found) (Kolmogorov-Smirnov test D = 0.048, $P > 0.10$, $N = 34$).

The length of the snakes in which food was observed did not differ from the length of the individuals with empty stomachs (test t, $t = 0.53$, $df = 41$, $P = 0.60$), and similarly the length of adult males did not differ from the length of adult females (test t, $t = 0.80$, $df = 30$, $P = 0.42$).

In the case of snakes in which food was observed it was checked whether the presence of particular types of victims (mammals, birds, reptiles or other groups i. e. amphibians or invertebrates) is connected with the length of the snakes. For this purpose four U tests were carried out and data was analysed taking into consideration Benferroni's correction at the $P = 0.0125$ significance level. The correlation between the length of the snakes and the presence of mammals, birds or reptiles in their stomachs was as follows: for mammals $Z = 0.30$, $P = 0.76$, for birds $Z = 0.87$, $P = 0.40$, for reptiles $Z = 1.48$, $P = 0.14$, and for amphibians and invertebrates $Z = 3.07$, $P = 0.0022$.

The data concerning the composition of the food of *Zamenis longissimus* in Bieszczady presented above suggests diversification and changes conditioned by the age of the snakes. Young individuals hunt mainly for lizards, fairly common in the region, which is compatible with the data provided by ARNOLD & BURTON (1979) or LUISELLI & ANGELICI (1996). They also eagerly hunt for small mammals, and the amount of the remains of such victims rises with the snakes age. Compared to various other European populations of the species it occurs that mammals (along with lizards and birds) constitute the basic element of the food of adult individuals, which has been observed by many researchers (e.g.: VASÁRHELYI, 1965; BRUNO *et al.*, 1973; BESZKOW, 1976; SZCZERBAK & SZCZERBAN, 1980; BRUNO & MAUGERI, 1990; REHÁK *et al.*, 1992; LUISELLI & RUGIERO, 1993; NAULLEAU & BONNET, 1995; CAPIZZI & LUISELLI, 1996). Some authors e. g. BARBADILLO (1987) or BRUNO & MAUGERI (1990) observe that in some regions of Europe young snakes devour also amphibians and invertebrate, which well corresponds to the results obtained in Poland. According to CAPIZZI *et al*. (1995) in case of this species, the composition of food is conditioned mainly by the density of the populations of victims in the environment.

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