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The diet of the Slow Worm, *Anguis f. fragilis* LINNAEUS, 1758, in the Tarvisio Forest (Carnic Alps, NE Italy)
(Squamata: Sauria: Anguidae)

Die Nahrung der Blindschleiche, *Anguis f. fragilis* LINNAEUS, 1758, im Wald von Tarvisio (Karnische Alpen, NO Italien)
(Squamata: Sauria: Anguidae)

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ABSTRACT

Data on diet composition of Slow Worms, *Anguis f. fragilis* LINNAEUS, 1758, living in alpine regions of north-eastern Italy (Tarvisio Forest, province of Udine) are given. All information comes from an analysis of gut contents of specimens found dead in the field.

Slow worms preyed on a wide variety of invertebrates, essentially earth-worms (33.33% of the prey individuals) and slug-snails (35.41%) The high incidence of these prey types in the diet of *A. fragilis* probably depends on the activity pattern of this lizard, which is active mainly after rain, in the first daylight hours and in the twilight. The *A. fragilis* specimens investigated preyed on both very small (shorter than 5 mm in length) and larger (more than 40 mm in length) invertebrates, but most (70.8%) of the prey individuals were found to measure more than 10 mm in length.

KURZFASSUNG

Es werden Angaben zum Nahrungsspektrum der Blindschleiche, *Anguis f. fragilis* LINNAEUS, 1758, aus der Gebirgsregion Nordostitaliens (Wald von Tarvisio, Provinz Udine) gemacht. Alle Daten resultieren aus der Untersuchung von Darminhalten tot im Felde gefundener Individuen.

Die untersuchten Blindschleichen ernährten sich von einer Vielzahl verschiedener Wirbelloser, hauptsächlich Regenwürmer (33,33% der Nahrungstier-Individuen) und Nacktschnecken (35,41%). Der hohe Anteil dieser Art von Nahrungstieren hängt wahrscheinlich mit dem Verlauf der Tagesaktivität von *A. fragilis* (Maxima nach Regenfällen und bei Dämmerung) zusammen. Die untersuchten *A. fragilis* ernährten sich sowohl von sehr kleinen (kürzer als 5 mm Länge) als auch von größeren (bis 40 mm) Wirbellosen, doch überwiegend (in 70,8% der Fälle) von Beutetieren über 10 mm Länge.

KEYWORDS

Anguis f. fragilis, diet, prey, ecology, alpine environment, NE Italy

INTRODUCTION

The Slow Worm, *Anguis f. fragilis* LINNAEUS, 1758, a lizard widely distributed all over great parts of Europe and SW Asia (ARNOLD & BURTON 1978), is extremely common in the alpine regions of northern Italy, from the low valleys up to about 1800 - 2000 m a. s. l. (MARCUZZI 1976; LAPINI 1983). Moreover, together with the lacertid *Podarcis muralis* it is the most common reptile species in the kitchen gardens, cemeteries and tourist residences of the alpine villages (personal observation).

Despite its abundance the ecology of the Slow Worm populations living in the Italian part of the Alps has been poorly studied until now. The comprehensive publications of PETZOLD (1971) and DELY (1981) report data on various biological aspects of this species (including its feeding habits), but only from other parts of its wide geographic range.

MATERIAL AND METHODS

Study area and period

Data given here were obtained from a mountainous region situated at the border area of Italy, Austria and Slovenia (Tarvisio Forest, Carnic Alps, Province of Udine) and collected in the months of July and August from 1987 to 1991. This was done simultanously to field research work on ecology, especially population dynamics, of the Adder, *Vipera berus* LINNAEUS, 1758.

All specimens utilized come from sites close to the edges of Swiss Mountain Pinewoods (*Pinus mugo*), at about 700 - 1200 m altitude.

Slow Worms were collected mainly from the following localities:

1. Forest road connecting the village "Fusine Valromana" and "Fusine lakes" (700 - 900 m a. s. l.);
2. Forest road connecting the villages "Cave del Predil" and "Sella Nevea" (850 - 1200 m a. s. l.);
3. Forest road connecting the village "Camporosso Valcanale" and the pass "Prati del Bartolo" (700 - 1000 m a. s. l.).

Locality 1. is represented on the chart F° 14_A III N. E. ("Fusine in Valromana"), locality 2 on F° 14 III N. O. ("Cave del Predil") and 14 III S. O. ("Sella Nevea"), locality 3. on F° 14_A IV S. O. ("Camporosso in Valcanale") from the Italian "Istituto Geografico Militare (IGM), and scaled 1:25.000.

In all of the localities cited above, as well as in the whole Tarvisio Forest, *A. fragilis* is one of the most common reptile species, inhabiting practically the entire gradient of alpine environments from the cultivated low valleys to the timber line at about 1800 m altitude (LAPINI 1983). This anguid was frequently found sympatric with the reptile species *Lacerta vivipara, Coronella austriaca, Natrix natrix, Vipera berus*, and with the amphibians *Bufo bufo, Rana temporaria,* and *Salamandra salamandra.*

Methods

Only specimens found dead were used for this study. In the course of my investigations for adders I often found Slow Worms apparently killed by the farmers' mowing activities, by excursionists, or by cars. Most of these specimens were too damaged for a useful examination, but some were recent enough to be well suited for this purpose. A sample consisting of 24 adult *A. fragilis* (11 males, 5 non-pregnant, and 8 pregnant females) was examined. These specimens were dissected in the field, their guts were removed and placed in ethanol (70%) while their bodies were left in the field. Individuals in perfect condition were preserved in ethanol (70%) and stored in the private collection of the author or in the Herpetological Collection of the Zoological Museum "La Specola" in Florence.

The prey items were spread in a Petri dish and identified to order or family level. The numbers of individuals of each prey type were recorded and the proportional share of each prey type (taxon) was estimated.

Food niche breadth (B) was calculated by a standardized equation transformed from LEVINS' (1968) formula with its values ranging from 0 (maximum specialisation) to 1 (maximum opportunism):

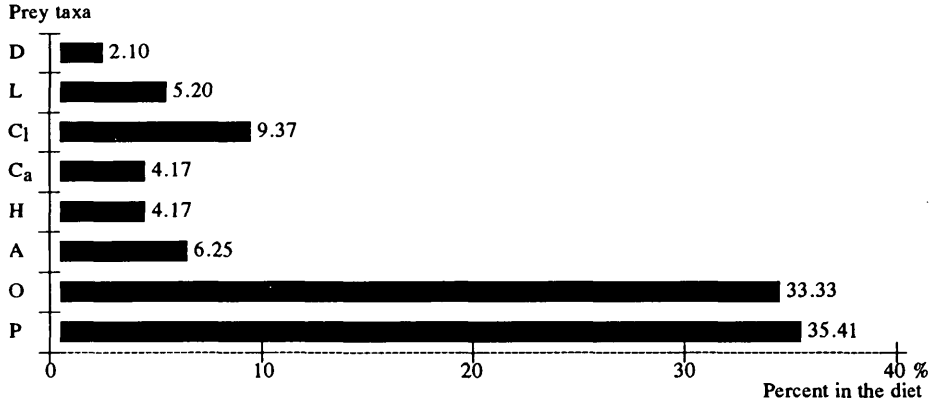
$$B = \frac{\left[\sum_{i=1}^{N} (P_i^2)\right]^{-1} - 1}{N}$$

where P_i is the proportional share of the prey type i in the total diet, and N is the total number of prey types. This statistical approach was chosen assuming that (1.) the studied populations are finite, and (2.) that tr resource (prey) does not vary in abundance.

There is no simple statistical method for establishing limits of confidence of such estimates (RICKLEFS & LAU 1980).

Fig. 1: The diet of *Anguis f. fragilis* in the Tarvisio Forest (NE Italy). Percentages are referred to the total number of identified prey items (n = 96). D - Diptera; L - Lepidoptera (larvae); C_l - Coleoptera (larvae); C_a - Coleoptera (adults); H - Homoptera; A - Araneidae; O - Oligochaeta; P - Gastropoda (Pulmonata - slug-snails).

Abb. 1: Die Nahrung von *A. f. fragilis* im Wald von Tarvisio (NO Italien). Die angegebenen Prozentsätze beziehen sich auf die Gesamtzahl identifizierter Nahrungsobjekte (n = 96). D - Diptera; L - Lepidoptera (Larven); C_l - Coleoptera (Larven); C_a - Coleoptera (Imagines); H - Homoptera; A - Araneidae; O - Oligochaeta; P - Gastropoda (Pulmonata - Nacktschnecken).



RESULTS AND DISCUSSION

Since the results of the present paper should be recognized as preliminary, just to provide a basis for further investigations, it seems legal to present results and discussion within one chapter.

From the sample specimens (comp. Methods) I obtained a total of 106 prey residues ($\bar{x}$ = 4.42 prey residues per stomach), 10 out of which (9.44%) remained unidentified. No empty stomachs were found, which means that all of the gravid females of the sample had fed during pregnancy. This is not true for other West European reptiles, essentially snakes, in which gravid specimens avoid feeding (e. g. *Vipera seoanei* - BRAÑA & al. 1988; *V. aspis francisciredi* - LUISELLI & AGRIMI 1991).

The Slow Worms' diet (Fig. 1) consisted of a variety of invertebrates including insects, spiders, earth-worms and slug-snails. No residues of vertebrates were found, although *A. fragilis* is reported to prey on small lizards (*L. vivipara, A. fragilis*) and juvenile snakes (*N. natrix*) occasionally (FRETEY 1987).

Apparently many animals of prey of *A. fragilis* are nocturnal, or active on the surface after rainfall. These animals (slug-snails and earth-worms) were eaten by Slow Worms significantly more frequently than any other kind of prey (X^2-test with 95% of confidence, $p < 0.01$). This is probably due to the peculiar diurnal activity pattern of *A. fragilis*, a partly fossorial lizard which is rarely seen in the open (SMITH 1964; PATTERSON 1990) and which is more active after rain or during the first daylight (07.00 - 10.00 a. m.) and crepuscular hours (06.30 - 09.30 p. m.) than at midday (LUISELLI & ANIBALDI unpublished).

The value of the standardized niche breadth calculated according to the equation above (B = 0.42) is far from the highest possible value (B = 1), and seems to describe well some specialisation in the choice of prey by this lizard. However, firm conclusions cannot be drawn yet, because I cannot provide with quantitative estimates of the potential prey spectrum at the lizard's sites during their active phases.

One cannot exclude, in fact, that Slow Worms prey mainly on earth-worms and slug-snails, simply because they form the most abundant kind of prey on the

ground at times when the lizards are active.

In the adult Slow Worms there was no clear preference concerning the size of the food taken: Slow Worms preyed on both larger organisms (e. g. earth-worms longer than 40 mm) and small animals (e. g. Homoptera less than 5 mm long). In general, however, Slow Worms seem to prey on larger organisms than other sympatric lizards like *L. vivipara*. The average prey length of the latter was observed to be 4 - 6 mm (PILORGE 1982; HEULIN 1986), while that of the present *A. fragilis* sample was more than 10 mm in 70.8% (n = 68) of the identified animals of prey. However, the size-dependent choice in the food taken cannot usefully be discussed without knowing the potential prey size variety in the area.

Unfortunately I cannot give a precise estimate of the food niche breadth relative to the prey size, because most of the ingested remains were partially damaged in the slow worm guts, and, therefore could not be measured with accuracy.

These preliminary informations on food habits of Slow Worms in the south-eastern Alps might provide a basis for further comparative studies on possible differences in the diet of this lizard in different alpine environments. Such differences may occur since alpine habitats significantly vary in several ecological characteristics (e. g. climate, exposure, vegetation, and animal communities). Even the potential prey communities may be of drastic divergency comparing various environments, thus, affecting the diet composition of the predators (LUISELLI & ANIBALDI 1991). Moreover, it would be of some interest to investigate the degree of possible food competition of Slow Worms against other syntopic small predators which may use the same trophic resources (e. g. *Salamandra atra* and *S. salamandra*).

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