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Feeding ecology of two newt species (*Triturus cristatus* and *Lissotriton vulgaris*) during the reproduction season

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ABSTRACT

Key-words: *feeding relations, resource partitioning, trophic niche, interspecific competition,* Salamandridae

The aim of this study was to provide an in-depth survey of feeding ecology and trophic interactions of two syntopic newt species (*Triturus cristatus* and *Lissotriton vulgaris*) inhabiting aquatic breeding habitats from the eastern Romanian Carpathian Mountains. We sampled 736 individuals from both species. The trophic spectrum was based mostly on Asselidae (>30%). Our results show that both species may be considered generalists because their niche breadth is higher than 0.5, with largely overlapping trophic niches (>70%), which may indicate food competition.

RÉSUMÉ

L'écologie alimentaire de deux espèces de tritons (*Triturus cristatus* et *Lissotriton vulgaris*) pendant la saison de reproduction

Mots-clés : *relations alimentaires, partitionnement des ressources, niche trophique, concurrence interspécifique,* Salamandridae

Le but de cette étude était d'analyser en profondeur l'écologie alimentaire et les interactions trophiques de deux espèces syntopiques de tritons (*Triturus cristatus* et *Lissotriton vulgaris*) vivant dans les habitats aquatiques dans l'est des Carpates roumaines. Nous avons échantillonné 736 individus des deux espèces. Le spectre trophique a été basé principalement sur les Asselidae (>30 %). Nos résultats montrent que les deux espèces peuvent être considérées comme des généralistes, car leur largeur de niche est supérieure à 0,5, en grande partie avec chevauchement des niches trophiques (>70 %), ce qui pourrait indiquer une concurrence alimentaire.

Amphibians are representatives for the current global biodiversity decline (Semlitsch, 2003; Stuart *et al.*, 2004). Many amphibian species require both terrestrial and aquatic habitats during their life cycle, which makes them particularly vulnerable to a wide range of detrimental factors (Alford *et al.*, 2001; Semlitsch, 2003). Newts (Order Caudata) occupy a variety of aquatic and terrestrial habitat types where they act as top-predators (Schabetsberger and Jersabek, 1995). Therefore, studies focused on their feeding ecology are necessary for

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a better understanding of freshwater trophic interactions as well as for future conservation measures (Hodar, 1996).

The great crested newt (*Triturus cristatus*) and the smooth newt (*Lissotriton vulgaris*) are two widely spread Eurasian species, living in various habitats (*e.g.* Cogălniceanu *et al.*, 2000). The two species differ in body size: *T. cristatus* is a large newt (up to 18 cm) and *L. vulgaris* is small to medium (up to 11−12 cm; Cogălniceanu *et al*., 2000). Although during the past decade many studies discussed the trophic ecology of newts (*e.g.* Covaciu-Marcov *et al.* 2010, Cicort-Lucaciu *et al*., 2005), most of them reported only dietary descriptions, whereas trophic interactions remained unapproached.

Here we aimed to quantify trophic niche characteristics of *T. cristatus* and *L. vulgaris*, with special emphasis on the niche breadth and niche overlap. Additionally, based on new information regarding diet preferences of the studied species, we assessed the ecological relationships between *T. cristatus* and *L. vulgaris* during their reproduction season, focusing on trophic resource partitioning.

We analysed the trophic spectrum of 498 specimens of *L. vulgaris* and 238 specimens of *T. cristatus* from a macrophyte-rich, shallow pond (0.2−1 m depth) located in the eastern Romanian Carpathian Mountains, near the town of Piatra Neamţ (geographical coordinates: 46° 53′ 22″ N; 26° 19′ 21″ E; altitude: 340 m ASL). The stomach contents were collected in two different years (1999 and 2000) in March and April, using the stomach flushing method (Joly, 1987). We used a stereo microscope to analyse the stomach content and to identify prey items to the lowest possible taxonomic level (order, family or genus, in some cases). To determine the importance of each taxonomical prey category in the newts' diet we used the frequency of occurrence (%F) (Fagade and Olaniyan, 1972). In order to estimate the niche breadth, we used the Levins-Hurlbert index (1968, 1978) and niche overlap was quantified through Pianka (1973) and MacArthur-Levins (1967) indices using EcoSim7 Version 7 (Gotelli and Entsminger, 2004).

Food was present in the tracts of 91% of *T. cristatus* and 85% of *L. vulgaris* individuals. The diet of both species was mainly based on isopod crustaceans (Asselidae), freshwater snails (Lymnaeidae) and earthworms (Lumbricidae). The frequency of Lumbricidae in the diet of *T. cristatus* varied greatly between the two study years (from 4.53% in 1999 to 38.46% in 2000) (Table I). The gastrointestinal content of the two species was dominated by representatives of Asellidae family (50.48% in 1999 and 29.92% in 2000 for *T. cristatus*; 50.79% in 1999 and 40.32% in 2000 for *L. vulgaris*) (Table I). *L. vulgaris* fed on a wider variety of food items than *T. cristatus*, although the frequency of occurrence of most of the items was very low (Table I). Previous studies documented the presence of the following invertebrate groups in the gastrointestinal content of *L. vulgaris*: cladocerans, copepods, ostracodes and nematocerans (*e.g.* David *et al*., 2009; Covaciu-Marcov *et al*., 2010). *T. vulgaris* feeds mostly on isopods, nematodes nematocerans and ephemeropteran larvae (*e.g.* Cicort-Lucaciu *et al*., 2005; David *et al*., 2009).

Both *T. cristatus* and *L. vulgaris* had trophic niche breadth values higher than 0.5 (Table II) and the degree of niche overlap (Pianka index) between the two species remained very high (>0.6) during the two years (Table IV). During the spring of 1999 the two species expressed the same high niche overlap upon each other (>0.9), but in 2000 the situation changed, and *L. vulgaris* exercised a higher pressure upon *T. cristatus* (0.75; Table III).

Comparative feeding ecology studies of the two species suggest that *T. cristatus* consumes larger prey than *L. vulgaris* due to a larger body size (Avery, 1968). Nevertheless, our data indicate that even if large body size enables a wider range of prey sizes to be consumed, both large (*T. cristatus*) and small newts (*L. vulgaris*) consume small prey of similar size. Apart from the size differences, our data confirm that both species of newts appear to be opportunistic feeders (Fasola and Canova, 1992; Kutrup *et al.*, 2005), consuming prey which is dominant in the pound and/or is easier to catch (Kopecky *et al.*, 2011; Stephens and Krebs, 1986). Other items which were often found in newts' stomachs are their own skin sloughs which are consumed mainly during the breeding season and this could be a consequence of the physiological shift connected with environmental shift (Kopecky *et al.*, 2011). Aquatic plant fragments

Table I
Frequency of occurrence of different prey items within the diet of T. cristatus *and* L. vulgaris *during the spring of 1999 and 2000. Legend: nsa – number of stomachs analysed.*

Trophic items		*Triturus cristatus*		*Lissotriton vulgaris*	
		Year			
Order	Family	1999	2000	1999	2000
Opisthopora	Lumbricidae	4.53	38.46	2.11	–
Rhynchobdellida	Glossiphoniidae	–	3.84	–	–
Bassomatophora	Lymnaeidae	13.59	38.46	6.87	4.3
Aranea	Araneidae	0.64	–	1.58	1.61
Decapoda	Astacidae	–	–	–	1.07
Isopoda	Asellidae	50.48	29.92	50.79	40.32
Ephemeroptera	Baetidae	2.58	11.53	2.11	–
	Agrionidae	1.29	3.84	4.23	–
Odonata	Coenagrionidae	–	–	1.05	–
Orthoptera	Acrididae	–	–	1.05	–
	Apionidae	0.64	–	–	1.07
	Hydrophilidae	–	7.69	–	2.15
	Dytiscidae	–	–	1.05	–
Coleoptera	Grynidae	–	–	1.05	–
Trichoptera	*	–	–	–	2.15
Lepidotera	Zygaenidae	–	–	1.05	–
	Ceratopogonidae	0.97	1.92	2.11	1.61
	Chironomidae	–	–	3.17	1.61
	Culicidae	–	–	1.05	2.68
	Dixidae	–	–	1.05	–
	Muscidae	–	–	2.11	3.22
	Ptychopteridae	–	–	1.05	–
	Syrphidae	–	–	–	2.15
Diptera	Tipulidae	–	–	1.05	2.15
Hymenoptera	Ichneumonidae	–	–	1.05	–
Cypriniformes	Cyprinidae	–	3.84	1.05	3.22
Caudata	Salamandridae	–	–	–	1.07
Anura	Ranidae	–	–	2.11	1.07
nsa		52	309	186	189

Table II
Niche breadth of T. cristatus *and* L. vulgaris *during the spring of 1999 and 2000.*

Species	1999	2000
T. cristatus	0.55	0.68
L. vulgaris	0.71	0.83

Table III
Niche overlap (MacArthur-Levins) for T. cristatus *and* L. vulgaris *during the spring of 1999 and 2000.*

	1999		2000	
Species	*T. cristatus*	*L. vulgaris*	*T. cristatus*	*L. vulgaris*
T. cristatus		0.97*		0.35
L. vulgaris	0.99*		0.75*	

* high overlap between the two trophic niches (>0.5).

Table IV
Niche overlap (Pianka) for T. cristatus *and* L. vulgaris *during the spring of 1999 and 2000.*

Niche overlap	1999	2000
T. cristatus vs. L. vulgaris	0.81*	0.6*

*high overlap between the two trophic niches (>0.5).

were also consumed by both species. Although the presence of these plant fragments in the stomach content of newts is common, these are most probably ingested accidentally. (*e.g.* Cicort-Lucaciu *et al*. 2005; Covaciu-Marcov *et al*. 2010). Newt eggs and sometimes larvae are usually found in the newts' diet (Cicort-Lucaciu *et al*., 2005), nevertheless these were not found in our study. *T. cristatus* has been known to consume adult *L. vulgaris* and the incidence of such predation may be high in certain populations (Hagström, 1979). However, we have not recorded such an occurrence in diet.

Both studied newt species may be considered generalists because their niche breadth is higher than 0.5 (MacArthur-Levins, 1967) and their feeding strategy is "active foraging" (Huey and Pianka, 1981). A high level of niche overlap such as the present case represents a high possibility for competition between two species (MacArthur-Levins, 1967; Pianka, 1976). However, niche overlap alone does not indicate competition unless it can be proved that resources are scarce for one or both species (Schoener, 1974; 2009). The high degree of niche overlap between the two species analysed may lead to a temporary competition for the resources or to food partitioning throughout the year according to their necessities.

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