Predatory behaviour of alpine (*Ichthyosaura alpestris*) and smooth (*Lissotriton vulgaris*) newts towards conspecific and heterospecific eggs and larvae

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Consumption of conspecific and heterospecific eggs and larvae is common in many animal taxa, including many amphibians. Adult newts (Amphibia Urodela) often co-occur temporally and spatially with conspecific and heterospecific newt eggs and larvae, and adult individuals may benefit from their consumption, but little is known on the degree of discrimination in the newts’ predatory behaviour towards them. We performed two laboratory experiments to examine whether adult male and female alpine, *Ichthyosaura alpestris* (Laurenti 1768), and smooth, *Lissotriton vulgaris* (Linnaeus 1758), newts discriminate between conspecific and heterospecific eggs and larvae in their predatory behaviour. In our study, eight out of 64 newts succeeded in consuming eggs, although 3 times as many attacked them. We found no differences in predatory behaviour towards conspecific and heterospecific eggs, or between males and females in either species. Similarly, we found no evidence for the occurrence of discriminative predatory behaviour towards conspecific and heterospecific larvae. In our experiments the criterion for whether a newt would consume a prey item (egg or larva) was not the prey’s identity (species), but the newts’ ability to detect, capture and/or ingest it. Our results suggest that newts of both species follow an opportunistic foraging strategy, consuming whatever prey of appropriate size they manage to capture.

**KEY WORDS:** egg predation, larva predation, oophagy, cannibalism, aggressive behaviour, opportunistic foraging strategy, alpine newt, smooth newt.

**INTRODUCTION**

Consumption of conspecific (cannibalism) and heterospecific eggs and larvae is common in many animal taxa, including many amphibians (e.g. Walters 1975; Polis 1981; Polis & Myers 1985; Polis et al. 1989; de Queiroz & Rodriguez-Robles 2006; Measey et al. 2015). Cannibalism is important in the ecology of many amphibian species, but sometimes it occurs opportunistically as a by-product of normal predatory behaviour (Polis & Myers 1985). Heterospecific egg consumption, although widespread,
is generally less well studied (Denoël & Demars 2008; but see de Queiroz & Rodriguez-Robles 2006; Measey et al. 2015).

During their prolonged breeding season, European newts (the former genus Triturus) migrate into aquatic habitats and remain there for several weeks or months (Griffiths & Mylotte 1987; Arntzen 2002). During this period, adult newts co-occur with newt eggs and larvae. Since the stored fat reserves of male and female newts decrease during their breeding period (Verrell 1985), breeding newts may benefit from the consumption of larvae and particularly eggs, which can represent a valuable food source (Kaplan & Sherman 1980; Denoël & Demars 2008). In breeding ponds where two or more newt species are syntopic, adult newts co-occur with conspecific as well as heterospecific eggs and larvae. Consumption of eggs and larvae by these adults can increase energy intake and alleviate density-dependent negative effects to larval development (Kaplan & Sherman 1980; Marshall et al. 1990; Scott 1994). Thus, consumption of eggs and larvae by adult newts could be expected to be frequent in the wild. Despite the aforementioned benefits, however, newt eggs and larvae were found to form only a minor part of an adult newt’s diet (Dolmen & Koksvik 1983; Griffiths 1986; Fasola & Canova 1992; Kuzmin 1999). In addition, little is known about whether newts discriminate between conspecific and heterospecific eggs and larvae in syntopic species.

Stomach-contents analyses have shown that adult newts consume conspecific eggs and larvae (Denoël & Andreone 2003; Denoël & Schabetsberger 2003; Katayama 2011). However, in studies applying this method in assemblages of different newt species, the identity (i.e. species) of consumed eggs and larvae is often not determined (Kuzmin 1990; Fasola & Canova 1992; Joly & Giacoma 1992). Thus, in order to evaluate the relative importance of conspecific and heterospecific consumption in the adult newts’ diet, detailed investigations under controlled conditions of their predatory behaviour towards conspecific and heterospecific eggs and larvae are required. Such investigations are currently lacking in the literature.

At our study site, a temporary pond in southern Greece, populations of two syntopic newt species gather during their breeding period. Our aim was to examine whether adults of these newts discriminate in their predatory behaviour between conspecific and heterospecific eggs and larvae. To this end we performed two laboratory experiments using adult newts to investigate the occurrence of (i) discrimination in exploratory and predatory behaviour towards different egg types, (ii) discriminative predatory behaviour towards conspecific and heterospecific larvae and (iii) inter- and intraspecific differences in the aforementioned predatory behaviours.

MATERIAL AND METHODS

Study site, collection and housing of animals

Two newt species, the alpine newt, Ichthyosaura alpestris (Laurenti 1768), and the smooth newt, Lissotriton vulgaris (Linnaeus 1758), are syntopic at our study site, a semi-natural temporary pond in northern Peloponnese, southern Greece (38°01’N, 22°02’E; about 800 m above sea level). Newts of both species return to this temporary pond each year during their breeding season, from early February to late May. Throughout their breeding period, adult newts co-occur in the pond with newt eggs and larvae (authors’ pers. obs.). A total of 64 adult individuals (16 per species and sex) were captured using dip-nets in two sampling sessions at the beginning of their breeding
season (12 and 18 February 2013) and transported to our lab at the Department of Biology of the University of Patras (a 75-min drive from the pond).

In the lab we split all males into two groups, with males of each species in separate aquaria (56 × 40 × 29 cm). Each female was kept individually in smaller plastic aquaria (34 × 19 × 12 cm). After a 3-day acclimatisation period we provided each female with oviposition material, which consisted of strips of filter paper (1 cm width, 7–10 cm length), fixed on thin wooden sticks. All females began depositing eggs soon after the paper strips were introduced into their aquaria; thus, mating in the laboratory was not necessary. The filter papers were replaced twice a week and all deposited eggs were kept, separately for each female, in small plastic aquaria (20 × 17 × 10 cm). For the duration of the study all newts were kept in the same room, with a natural photoperiod through large windows, and were fed ad libitum twice a week with frozen chironomid larvae (bloodworms; Ocean Nutrition Europe, Essen, Belgium). Dechlorinated tap water was used in all aquaria, and water temperature varied between 14 and 17 °C.

All experimental procedures were in accordance with national legislation for the care and use of laboratory animals. The use of animals was reviewed and approved by the appropriate animal care review committee (Bioethics Committee) at the University of Patras, where the experiments were carried out.

Experiment 1: predatory behaviour of adult newts towards different egg types

Each adult newt was placed in a plastic aquarium (34 × 19 × 12 cm) in which a wooden stick, similar to the ones in the females’ aquaria, was already fixed on one side halfway along the length of the aquarium. At the same height on each stick were three strips of filter paper, containing an alpine newt egg, a smooth newt egg and a plastic dummy egg, their position chosen at random in each trial. The offered newt eggs were of the same age, i.e. within 3 days after being deposited. We used the same strips of paper on which the eggs were deposited, but we partially unwrapped the eggs because adult newts have difficulty in consuming wrapped eggs (Miaud 1994; Gabor 1996). Females were not offered their own eggs to avoid any potential effects of kin avoidance on predatory behaviour (Gabor 1996; Tóth et al. 2011). The dummy egg was a small piece of plastic resembling a newt’s egg in size, shape and colour. It was fixed on the filter paper in such a way as to be impossible for the newts to detach it, in order to avoid injuries to the test animals (no plastic eggs were consumed during the experiment). We included this dummy egg to help us differentiate the effect of chemical and/or visual cues from the eggs on the observed predatory behaviour, in the event of similar predatory behaviour towards the conspecific and heterospecific egg. We recorded the behaviour of each newt for 60 min (between 09:00 and 18:00) with a video camera suspended above the aquarium. We analysed the video recordings and recorded the exploratory and predatory behaviour of each newt towards each egg type. A newt’s behaviour was defined as exploratory when the newt positioned its head 1 cm away or closer facing an egg for a period of time to investigate it; we measured (i) the number of investigations towards each egg and (ii) the duration of these investigations. A newt’s behaviour was defined as predatory when the newt attacked an egg; we measured (i) the number of investigations that resulted in an attack against the investigated egg (investigations leading to attack, ILA) and (ii) the number of attacks against each egg. We treated the number of ILA and the number of attacks separately because one investigation event may lead to multiple successive attacks (i.e. attempts to remove the egg from the filter paper). We used the number of attacks instead of number of consumed eggs as a measure of predatory behaviour, because similar to what was described in Gabor (1996) and Tóth et al. (2011), only a few individuals (12.5% of tested newts) managed to remove an egg from the filter paper and ingest it. Adult newts were not fed for 72 hr prior to testing to standardise hunger levels and to enhance the probability of eliciting a response from all individuals. Each newt was tested once and trials were performed between 14 March and 5 April 2013.

We analysed the four behavioural responses using the Scheirer–Ray–Hare extension of the Kruskal–Wallis test, as described by Dytham (2011). We used this test, which is analogous to a non-parametric two-way analysis of variance (ANOVA; Dytham 2011), because our data did not
conform to the requirements of parametric tests, even after transformations. We performed separate tests, with either species and egg type or sex and egg type as fixed factors. The four dependent variables were (i) the number of investigations, (ii) the duration of investigations, (iii) the number of ILA and (iv) the number of attacks. In these analyses we only included those individuals that had performed at least one investigation towards any of the offered eggs (Table 1).

To examine whether newts preferentially attacked one of the three egg types, we analysed the sequence of attacks using a modification of the method of Taplin (2007). This method assumes that when several prey items are offered simultaneously, the sequence, or order, in which they are consumed reveals information about preference, with prey consumed earlier being more preferred, and prey that were not consumed within the time limits of the experiment considered "tied for last" (Taplin 2007). We used the sequence of attacks instead of consumption, because few newts consumed eggs. The null hypothesis was that the sequence in which the three egg types were attacked was random. For each individual newt we ranked the three egg types by the order in which they were attacked. We then calculated a preference score for each egg type by taking the mean of these order values. Preference for an egg type was determined using Kruskal–Wallis tests to compare each individual’s preference scores for each egg type (Taplin 2007).

Experiment 2: predatory behaviour of adult newts towards conspecific and heterospecific larvae

Due to the similarity in morphology of alpine and smooth newt larvae, testing each adult newt with a larva of each species simultaneously would lead to confusion. Thus, for each trial one adult newt was placed in a small plastic aquarium (20 × 17 × 10 cm) with only one newt larva. Each trial lasted for 30 min and all trials were staged between 09:00 and 18:00. During each trial we recorded three parameters: (i) the number of attacks against the larva, (ii) whether the adult newt consumed the larva and (iii) the time elapsed to consume it. Each adult newt was tested twice, once for each larval species, with at least 10 days between testing of the same individual. All larvae were of the same age, i.e. within 5 days after hatching from eggs laid in the laboratory, and were able to swim. As in Experiment 1, females were not offered their own offspring, and all newts were not fed for 72 hr prior to testing. The test aquaria did not contain any items, because refuge availability may increase larval survival (Orizaola & Braña 2003b) and obscure the effect of larval species on the adults’ predatory behaviour. Trials for this experiment were performed between 29 March and 24 April 2013.

We defined consumption rate as the percentage of individuals that succeeded in consuming a larva after performing at least one attack against it. Consumption rate was calculated as the total

| Adult group | N | Number of investigations | Duration of investigations (sec) | Number of ILA | Number of attacks |
|-------------|---|--------------------------|-------------------------------|---------------|------------------|
| *I. alpestris* | | | | | |
| Females | 12 | 11.08 ± 3.496 | 90.67 ± 46.424 | 4.75 ± 2.871 | 24.67 ± 19.640 |
| Males | 12 | 15.33 ± 3.076 | 117.83 ± 46.320 | 6.25 ± 2.209 | 19.91 ± 9.949 |
| *L. vulgaris* | | | | | |
| Females | 9 | 11.11 ± 3.607 | 140.11 ± 57.028 | 3.89 ± 2.400 | 21.89 ± 14.561 |
| Males | 12 | 6.00 ± 3.574 | 47.00 ± 28.279 | 2.17 ± 1.902 | 5.75 ± 4.407 |

Table 1. The total (mean ± SE) number of investigations, duration of investigations (sec), number of investigations leading to attack (ILA) and number of attacks performed by alpine (*Ichthyosaura alpestris*) and smooth (*Lissotriton vulgaris*) newts towards the eggs offered for consumption. N denotes the number of individuals used in the analyses, i.e. those individuals that had performed at least one investigation towards any egg.
number of newts that succeeded in consuming a larva, over the total number of newts that attacked a larva. Mortality rate was calculated as the total number of larvae that were consumed, over the total number of larvae that were attacked by a newt. We used Pearson's chi square tests of association to examine whether males and females of each species differed in the consumption of conspecific and heterospecific larvae. Using three-way analysis of variance (ANOVA) we determined the effects of (i) species of adults, (ii) sex of adults and (iii) species of larvae, on the number of attacks against each larva and on the time elapsed to consume it. When necessary, we log-transformed data to meet assumptions of parametric tests.

No adult newts died during our experiments and all animals were returned to their pond shortly after the end of Experiment 2.

RESULTS

Experiment 1

Adult newts began investigating and/or attacking the eggs as soon as they were placed into the test aquaria. The total time (mean ± SE) expended investigating the eggs was 78.19 ± 25.35 sec for alpine and 57.03 ± 21.03 sec for smooth newts, while the respective time expended attacking the eggs was 16.72 ± 8.23 sec and 8.31 ± 4.53 sec. Therefore the duration of each trial (60 min) was sufficient in order to observe the predatory behaviour of newts towards the three offered eggs. Due to the long duration of the trials and the small overall amount of time invested by newts in investigating and/or attacking the three egg types, we can safely assume that the amount of time spent by an individual on one of the three eggs did not influence the time left to the same individual to spend on any of the other eggs.

Of the 64 adult newts tested, 19 individuals (29.7%) did not investigate or attack any egg. Of the remaining 45 individuals (Table 1), 23 performed at least one attack towards one of the eggs they investigated. Table 1 shows the total number of investigations, duration of investigations (sec), number of ILA and number of attacks performed towards all offered eggs; the number and duration of these behavioural responses towards each egg type are presented in the supplemental online material (Fig. S1). Only eight individuals (two of each group, i.e. species and sex) managed to consume one of the offered eggs, and one of these eight newts consumed two eggs. The four smooth newts consumed four conspecific eggs, while the four alpine newts consumed three conspecific and two heterospecific eggs. It wasn't necessary to end a trial in which an egg was consumed, since most of these eight newts continued investigating and attacking the filter paper on which the ingested egg had been attached (see Discussion).

In the alpine newt no significant differences were found in any of the four examined behaviours between males and females or between the three egg types (Scheirer–Ray–Hare, in all tests $P \geq 0.07$). In the smooth newt, females performed significantly more (Scheirer–Ray–Hare, $H_1 = 8.43, P < 0.01$) and longer lasting ($H_1 = 8.47, P < 0.01$) investigations than males, but there were no differences in ILA and number of attacks between males and females, or in any behaviour between the three egg types (in all tests $P \geq 0.22$).

Male alpine newts performed significantly more exploratory (number of investigations: $H_1 = 15.06, P < 0.001$; duration of investigations: $H_1 = 9.60, P < 0.01$) and predatory (number of ILA: $H_1 = 8.71, P < 0.01$; number of attacks: $H_1 = 8.25, P < 0.01$) actions than male smooth newts did. However, all of the aforementioned actions were performed with similar intensity towards all eggs, since egg type was not significant in
any test (in all tests $P \geq 0.31$). No significant effects of species or egg type were detected in females in either exploratory (in all tests $P \geq 0.081$) or predatory behaviour (in all tests $P \geq 0.40$).

Out of the 23 individuals that attacked the offered eggs, only two (8.7%) exhibited a preference (sensu Taplin 2007) for a specific egg type, determined using the sequence of attacks against the eggs.

**Experiment 2**

Of the 64 adult newts tested, 10 individuals (eight female smooth newts and two female alpine newts) completely ignored both larvae offered for consumption. Of the remaining 54 individuals, 26 consumed one larva and 14 newts consumed both larvae, while 14 newts failed to consume any of the offered larvae. Table 2 shows the consumption rate of each group as well as the mortality rate for each larval species. Overall, alpine newt larvae suffered greater mortality than smooth newt larvae (71% vs 55% mortality, respectively). Smooth newts were slightly more successful than alpine newts in consuming attacked larvae (67.5% vs 60%) and, in both species, more females than males managed to consume the larva they attacked (Table 2).

Males in both species consumed significantly more alpine newt than smooth newt larvae (Pearson’s chi square, male *I. alpestris*: $\chi^2 = 6.348$, df = 1, $P < 0.05$; male *L. vulgaris*: $\chi^2 = 4.571$, df = 1, $P < 0.05$), while females in both species consumed similar amounts of conspecific and heterospecific larvae (female *I. alpestris*: $\chi^2 = 0.508$, df = 1, $P = 0.476$; female *L. vulgaris*: $\chi^2 = 0.155$, df = 1, $P = 0.694$) (Fig. 1).

**Table 2.**

The consumption rate (i.e. the percentage of individuals that succeeded in consuming a larva after performing at least one attack against it) of alpine (*Ichthyosaura alpestris*) and smooth (*Lissotriton vulgaris*) newts, and the mortality rate of each larval species. Consumption rate was calculated as the total number of newts that succeeded in consuming a larva, over the total number of newts that attacked a larva. Mortality rate was calculated as the total number of larvae that were consumed, over the total number of larvae that were attacked by a newt.

| Adult group | N of newts that consumed a larva | N of newts that attacked a larva | Consumption rate (%) |
|-------------|---------------------------------|---------------------------------|----------------------|
| *I. alpestris* | 27                              | 45                              | 60.0                 |
| *L. vulgaris* | 27                              | 40                              | 67.5                 |
| *I. alpestris* Females | 14                              | 22                              | 63.6                 |
| *I. alpestris* Males | 13                              | 23                              | 56.5                 |
| *L. vulgaris* Females | 9                               | 11                              | 82.0                 |
| *L. vulgaris* Males | 18                              | 29                              | 62.0                 |

| Larval species | N of consumed larvae | N of attacked larvae | Mortality rate (%) |
|----------------|----------------------|----------------------|--------------------|
| *I. alpestris* | 32                   | 45                   | 71.0               |
| *L. vulgaris* | 22                   | 40                   | 55.0               |
A three-way ANOVA on the number of attacks performed by each adult group against each larval species revealed a significant effect of sex ($F_{1,120} = 20.010, P < 0.001$) and a significant species*sex interaction ($F_{1,120} = 15.331, P < 0.001$), but no significant effect of larval species ($F_{1,120} = 0.376, P = 0.541$); male smooth newts performed significantly more attacks than females against both larval species, while male and female alpine newts did not significantly differ in the number of attacks against either larval species (Fig. 2).

In those adult newts that succeeded in consuming a larva, a three-way ANOVA on the time to consume it revealed a significant species*sex interaction ($F_{1,46} = 6.234, P < 0.05$). Female alpine and male smooth newts took less time to consume an alpine newt larva than male alpine and female smooth newts did (Fig. 3A). Conversely, the time to consume a smooth newt larva was not significantly different between the four adult groups (Fig. 3B).

**DISCUSSION**

A potential resource that is highly valued by an individual is expected to give that individual a strong stimulus to acquire it (Arnott & Elwood 2008); eggs are such a resource because they appear in large numbers during a short time, they are easy to capture and have a high nutritional value (Kaplan & Sherman 1980; Denoël & Demars 2008). In the first
experiment we investigated the differences in exploratory and predatory behaviour of adult newts between different egg types, by simultaneously offering to food-deprived individuals one conspecific, one heterospecific and one plastic, dummy egg. Adult newts did not discriminate between the different eggs, since they investigated and attacked all eggs with the same intensity (Fig. S1). We also found no preference (sensu Taplin 2007) for any of the eggs, since for the majority of individuals (91.3%) the sequence in which they attacked the three eggs was random. The observed similar predatory behaviour towards both the newt and the dummy eggs is in agreement with the reported opportunistic foraging strategy with minimal food selectivity in several species of salamanders (Attar & Maly 1980; Toft 1985; Griffiths 1986; Griffiths & Mylotte 1987; Fasola & Canova 1992), in which any item of an appropriate size is a potential prey item.

Salamanders have well-developed senses of vision, olfaction and electrorreception (Himstedt 1982; Himstedt et al. 1982; Verrell 1986), which they use to detect prey (Martin et al. 1974). Chemical cues are expected to be more important for gathering information regarding the identity (i.e. species), edibility and nutrient value of immobile prey such as eggs. The lack of chemical cues from the plastic dummy egg did not seem to affect the adult newts’ behaviour towards it, since the dummy egg was investigated and attacked with similar frequency and duration as the newt eggs. However, the few individuals that ingested a newt egg continued attacking the filter paper on

Fig. 2. — The number of attacks (mean ± 95% Confidence Intervals) performed against both larval species by male and female alpine (*Ichthyosaura alpestris*) and smooth (*Lissotriton vulgaris*) newts.
which that egg had been attached. This suggests that the newts detected some chemical cues from the ingested egg on the filter paper, stimulating them to attack it. Thus, adult newts seem to evaluate chemical cues when investigating an egg, but in the absence of sufficient chemical cues (e.g. from the dummy egg), visual or other, yet unknown stimuli might trigger attacks.

Predatory behaviour towards all egg types did not significantly differ between males and females in both species. These results seem to contradict studies that have shown that female salamandrids consume eggs more frequently than males in the field (Marshall et al. 1990; Joly & Giacoma 1992; Denoël & Andreone 2003; Denoël & Schabetsberger 2003; Katayama 2011). However, the overall low egg consumption observed in our experiments makes it difficult to detect differences in egg consumption between males and females.

In the second experiment we investigated whether adult newts exhibit discriminative predatory behaviour towards conspecific and heterospecific larvae. For most of the duration of the trials the larvae remained motionless, a common antipredator

Fig. 3. — The time elapsed (sec; mean ± 95% Confidence Intervals) for male and female alpine (Ichthyosaura alpestris) and smooth (Lissotriton vulgaris) newts to consume (A) an alpine newt larva or (B) a smooth newt larva.
behaviour in amphibians (Stauffer & Semlitsch 1993; Mathis 2003), even in newly hatched, predator-naïve larvae (Rohr et al. 2002). However, when the adult newts approached them, the larvae tried to escape. As a result, there was no investigation phase, as in Experiment 1, and the adult newts simply tried to capture the larvae whenever they came in close proximity to them while moving in the small aquarium. In more than a few instances we observed the larva hiding beneath the adult newt, with the latter unable to spot it. Thus, the adult newts’ success in consuming a larva depended on both the newts’ ability to capture it and the larva’s ability to actively avoid predation. Conversely, the number of attacks performed against a larva was more directly related to the adult newts’ motivation to capture it, regardless of the outcome of the attempt. For this reason we consider the number of attacks towards each larval species, rather than the number of consumed larvae of each species, as a more suitable metric to investigate the occurrence of discrimination in the adult newts’ predatory behaviour towards conspecific and heterospecific larvae. We found that adult newts did not discriminate in their predatory behaviour between the two larval species, since the number of attacks against them did not differ significantly. However, alpine newt larvae suffered greater mortality than smooth newt larvae, due to the significantly greater consumption of alpine newt larvae by males in both species (Table 2; Fig. 1). In addition, although the species of the larva had no effect on the time elapsed to consume it, there were some inter- and intra-specific differences in the case of the alpine newt larvae (Fig. 3A). This may suggest the occurrence of differential predator-avoidance capabilities within and/or between the two different larvae, although we were not able to test this hypothesis. Another possible explanation for the observed differential larval mortality might be size-related predation. The larger sized alpine newt larvae suffered greater mortality than did the smaller sized smooth newt larvae (mean larval total length at hatching in the study-populations ± SE: I. alpestris: 11.09 ± 0.13 mm; L. vulgaris: 9.84 ± 0.05 mm; unpub. data). Since it was beyond the scope of this study to test the effect of newt larvae size on larval predation rates, further research is required before generalisations and hypotheses can be made. For example, contrary to our study, predation experiments in the alpine newt have revealed that smaller sized newt larvae suffered greater mortality by dragonfly larvae, a common predator of newt larvae (Schmidt & Van Buskirk 2005; Gvoždík & Smolinský 2015). As in the first experiment, our results provide no clear indication that adult newts show discriminative predatory behaviour towards conspecific and heterospecific larvae, which suggests an opportunistic foraging strategy in which adults consume whatever larvae they manage to capture.

In the first experiment, we partially unwrapped the offered eggs to elicit a stronger response from the newts. Newts of both species attempted multiple attacks against the unwrapped eggs, but had very little success at detaching and consuming them. This apparent difficulty in detaching deposited eggs might be related to the suction-feeding mechanism that these newts mainly use for capturing prey in aquatic habitats (Heiss et al. 2013, 2015). In similar laboratory experiments Gabor (1996) and Tóth et al. (2011) offered unwrapped conspecific eggs to female smooth newts and also reported a low frequency of egg consumption. Egg wrapping (i.e. folding plant material around deposited eggs) is very common in natural populations of many newt species (Miaud 1990; Orizaola & Braña 2003a). It decreases egg mortality (Miaud 1994; Orizaola & Braña 2003a) and is particularly effective against predation of eggs by adult newts (Miaud 1993). Thus it can be expected that the consumption rate of wrapped newt eggs in the field will be lower than that of unwrapped eggs in the laboratory (Gabor 1996; Tóth
et al. 2011; this study). The 128 trials of the second experiment resulted in 54 larvae being consumed. This larva consumption rate is rather low, given that our experimental design strongly favoured the adult newts; the test aquaria were small and did not contain any refuges to ensure that the adult newts would detect and respond to the larvae. Thus we would expect a lower consumption rate of newt larvae in the field, where they benefit from the availability of many suitable refuges that increase their survival (Orizaola & Braña 2003b). These observations help explain why newt eggs and larvae do not constitute a major part of adult newts’ diet in natural populations (Dolmen & Koksvik 1983; Griffiths 1986; Fasola & Canova 1992; Kuzmin 1999).

To our knowledge, this is the first laboratory experiment that investigates whether adult newts discriminate between conspecific and heterospecific eggs and larvae in syntopic newt species. We found that adult alpine and smooth newts do not discriminate between conspecific and heterospecific (or even dummy) eggs and larvae. Our results suggest that newts of both species follow an opportunistic foraging strategy, consuming whatever prey of appropriate size they manage to capture. Indeed, in both our experiments, the criterion for whether a newt would consume a prey item (i.e. an egg or a larva) was not the prey’s identity (species), but the newts’ ability to detect, capture and/or ingest it.

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DISCLOSURE STATEMENT

No potential conflict of interest was reported by the authors.

SUPPLEMENTAL DATA

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