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Egg predators of an endemic Italian salamander, *Salamandrina perspicillata* (Savi, 1821)

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Abstract. We report new aquatic predators feeding on Northern spectacled salamander eggs, *Salamandrina perspicillata*, an endemic Italian species. Eggs were preyed upon by the leech, *Trocheta bykowskii*, and the trichopteran larvae of *Potamophylax cingulatus* and *Halesus appenninus*.

Riassunto. In torrenti dell'Umbria e delle Marche è stata osservata la predazione di uova di *Salamandrina perspicillata* da parte di una specie di sanguisuga, *Trocheta bykowskii* e da larve di tricoteri appartenenti alle specie *Potamophylax cingulatus* e *Halesus appenninus*.

Keywords. *Salamandrina perspicillata*, egg predation, leeches, trichopterans, Urodela, Italy.

Among oviparous species that do not guard their eggs during incubation several environmental factors often cause high embryonic mortality: sinking into mud that may reduce respiration is among the commonest natural environmental risks for amphibian eggs (Miaud, 1994; Griffiths, 1995). Egg predation is the other main cause of amphibian embryo mortality (e.g., Miaud, 1993), particularly for eggs that are preyed upon by a wide range of specialized as well as occasional egg-consumers (see Romano and Di Cerbo, 2007, and references therein).

In this work we report new invertebrate predators feeding on Northern spectacled salamander eggs, *Salamandrina perspicillata* (Savi, 1821).

During 2005-2007, we surveyed 24 and 44 breeding sites of *Salamandrina* in Umbria and Marche regions respectively. Aquatic typologies of these breeding sites in Marche were reported in Fiacchini and Di Martino (2007), while the sites monitored in Umbria were slow running streams ($n = 15$) and drinking throughs ($n = 9$). One specimen of each kind of predator was collected during predation activity, stored in ethanol, and determined in the laboratory by taxonomic specialists. Eggs of this endemic Italian salamander were observed to be preyed upon by a macrophagous leech *Trocheta bykowskii* Gedroyc 1913, and by trichopteran larvae of *Potamophylax cingulatus gambaricus* (Malicky, 1971) and *Halesus appenninus* Moretti and Spinelli Batta 1979. All these three invertebrate species are widespread in both Marche and Umbria. The leech and the former caddisfly have been collected in a slow running stream in Umbria (see Spilinga et al., 2006 for a detailed description of this site), the latter trichopteran species was detected both in Marche (three slow running streams in Serra San Quirico, Genga and Sassoferrato municipalities, Ancona province) and in Umbria region (in the same site above mentioned).

For species with complex life cycles such as amphibians, early stages (i.e., eggs and larvae) represent the most vulnerable phases (e.g., Alford, 1999). If larvae may develop antipredator strategies (Alford, 1999), eggs are more exposed to predation and other potential risks, due to their immobility. Significant reduction in reproductive success due to predation on amphibian eggs has been shown by several studies (Henrikson, 1990; Axelsson et al., 1997; Richter, 2000) and, in many cases, predation upon eggs can lead to 100% embryo mortality (e.g., Petranka and Kennedy, 1999). Although some amphibians have also developed antipredator strategies to protect their eggs as wrapping behaviour of females during oviposition (Orizaola and Brana, 2003), unpalatability of eggs (Gunzburger and Travis, 2005), earlier hatching of the embryos (e.g., Warkentin, 1995; Vonesh, 2000; Chivers et al., 2001) or delayed hatching (e.g., Sih and Moore, 1993; Laurila et al., 2002; Schalk et al., 2002).

Feeding behaviour of trichopteran larvae on amphibian eggs is mainly reported for American species (Richter, 2000; Gunzburger and Travis, 2005, and references therein). For that concerns European species, data on egg predation by caddisfly larvae were scarcely available and refer mainly to anurans (Di Cerbo and Ferri, 1996; Majecki and Majecka, 1998). Similarly, *S. perspicillata* is the only European urodele for which eggs predation by leeches was recorded so far, while predation on European anurans was reported several times (see Romano and Di Cerbo, 2007 for a review).

Previous studies reported egg predation on Northern spectacled salamander by another species of caddisfly *Plectrocnemia conspersa* (Curtis, 1834) (Vignoli et al., 2001), and leech *Haemopsis sanguisuga* (Linnaeus, 1758) (Romano and Di Cerbo, 2007). Also Barbieri (2001) suggested the *Salamandrina* eggs were preyed by trichopterans, even if species were not mentioned. Furthermore, a record on *Salamandrina* eggs predation has regarded *Rana italica* tadpoles Dubois 1987 (Laghi and Pastorelli, 2006).

Amphibian eggs are not usual preys for leeches and trichopterans, and might be used as alternative food resource when preferred preys are scarcely available, as suggested by Gunzburger and Travis (2005). However egg predation by *Trocheta bykowskii*, *Potamophylax cingulatus gambaricus* and *Halesus appenninus* was observed several times during the study period, and, therefore, we can not considered it as occasional behaviour. Furthermore, the fact that *H. appenninus* was observed to prey on *Salamandrina* eggs both in

Marche and Umbria region, could suggest a widespread opportunistic feeding behaviour by this caddisfly where the two species are syntopic.

Egg predation by *Trocheta bykowskii* was observed in 1.5% of the surveyed sites where *Salamandrina* spawned and predation by *Potamophylax cingulatus gambaricus* and by *Halesus appenninus* was recorded in 1.5% and 5.9% of the surveyed sites respectively (n = 68). However it is worth to mention there was a different research efforts among different sites in the surveyed areas and predation was recorded only in the sites where a long term monitoring was applied. It is plausible, therefore, that these prey-predator relationships are spreader then here estimated.

Eggs predation in *Salamandrina* by other Vertebrata was previously reported only once (Laghi and Pastorelli, 2006), even though among vertebrates a lot of species have been reported to feed on eggs of many amphibian species (see for references Cicort-Lucaci et al., 2005; Orizaola and Brana, 2006; Romano and Di Cerbo, 2007). By contrast, eggs of Northern spectacled salamander highly suffer predation by invertebrates such as trichopteran larvae and leeches are (Vignoli et al., 2001; Romano and Di Cerbo, 2007; present paper), and *Salamandrina* seems to be the most preyed species by these invertebrate taxa of egg consumers (Gunzburger and Travis, 2005; Romano and Di Cerbo, 2007).

Females of *Salamandrina perspicillata* lay about 20-50 eggs, in groups of 5-15 each time, singularly disposed and never in clutches (Lanza, 1983; Corsetti, 1999) and attach eggs to a wide set of submerged substrates (stones, stems, dead leaves, vertical walls of drinking trough and so on, Zuffi, 1999; Della Rocca et al., 2005). *Salamandrina* females never guard their own eggs, and never provide any form of protection as it occurs in many other species of Urodela. For example, newts carefully wrap their eggs in leaves of aquatic plants usually folding a part of the leaf over the egg with the back feet for protection (e.g. Diaz-Paniagua, 1989; Duellman and Trueb, 1994; Griffiths, 1995; Miaud 1995). Therefore, the high number of invertebrate predators reported for the *Salamandrina perspicillata* eggs could also reflect the absence of any egg protection, peculiar to this species.

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