A note on terrestrial activity and feeding in the Spectacled salamander, *Salamandrina terdigitata* (Urodela, Salamandridae)

CARLO UTZERI[1], DAMIANO ANTONELLI[2] and CLAUDIO ANGELINI[1]*

[1] *University "La Sapienza", Dip.to di Biol. Animale e dell'Uomo, Viale dell'Università 32, I-00185 Roma RM, Italy*

[2] *Strada dei Benedettini 10, I-05100 Terni TR, Italy*

* Corresponding author: email: oppela@tin.it

ABSTRACT — At a low elevation site (ca. 200 m a.s.l.) in central Italy, the Spectacled salamander was observed to be active mostly in the open ground between 18:00 and 24:00 hrs, while daytime activity was seldom recorded. Activity was positively correlated with air temperature, but the internal temperature of salamanders was correlated to substrate temperature. Thirteen taxa of terrestrial arthropods were recorded from faecal pellets, the greater part of which (36%) was represented by Acarina.

THE Spectacled salamander, *Salamandrina terdigitata*, is a terrestrial urodele endemic to Italy. Although described more than two centuries ago, very little information has so far been published on its ecology. The species is reported to be active by night, or sometimes during daylight on cool, humid or rainy days (Ramorino, 1863; Lessona, 1868; Lanza, 1983; Bruno, 1973, 1983; Zagaglioni, 1978; Vanni, 1980; Barbieri, 1994; Zuffi, 1999), but nothing is otherwise known of its daily activity cycle. Cherchi (1953) provided some information on internal temperatures, and notes on food consumption were published by Ramorino (1863) and Vanni (1980).

In the framework of an extensive investigation on the population ecology of *S. terdigitata* in central Italy, we collected some data on the terrestrial activity of several specimens, which in light of the deficient knowledge on the ecology of this species we believe are worth publishing.

MATERIALS AND METHODS

We carried out field observations during five nights between 4th November 1996 and 3rd January 1997, in open ground on clay-based soil near a shallow well. This was excavated in 1982 and has since recovered to semi-natural conditions. The well is located in the garden of a house on the outskirts of Terni, Umbria, central Italy, at about 200 m a.s.l., and was used by *S. terdigitata* as an oviposition site. Occasional observations were also carried out at some breeding sites in the Lepini mountains, Latium, central Italy.

We recorded the number of salamanders active in the open while covering a fixed 50-metre transect four times a night, between 18:00–21:00, 21:00–24:00, 24:00–03:00 and 03:00–06:00 hrs. In order to avoid disturbing the salamanders, we did not record their ventral patterns – which are unique to individuals – and therefore cannot state the precise number of individuals concerned.

Internal (cloacal) temperatures of salamanders as well as air temperatures were recorded by a digital thermocouple thermometer on 11th December 1996, between 22:30 and 23:40 hrs, with cloudy sky, discontinuous light rain and no wind. For internal temperature, a probe of 0.5 mm in diameter was used. The humidity variation was given by the Meteorological Station 'Federico Cesi', Terni.

A few individuals were kept singularly in small terrariums (without food) for a few days and their faecal pellets ($n = 24$) collected for the purposes of identifying food remains. These were preserved in 70% aethylether and examined subsequently with the aid of optical binoculars.

Taxa	This note	References
Annelida		Vanni, 1980; Bruno, 1973, 1983
Gastropoda		Vanni, 1980; Bruno, 1983
Copepoda		Bruno, 1973, 1983
Isopoda	+	Vanni, 1980; Bruno, 1973, 1983
Aracnida		Vanni, 1980; Bruno, 1973
Pseudoscorpiones	+	Vanni, 1980
Aranee	+	Bruno, 1983
Acarina	+	Vanni, 1980
Miriapoda		Vanni, 1980; Bruno, 1973, 1983
Juliformes	+	Vanni, 1980
Collembola	+	Vanni, 1980
Orthoptera		Ramorino, 1863; Vanni, 1980
Notonectidae		Ramorino, 1863
Coleoptera		Vanni, 1980; Bruno, 1973, 1983
Staphylinidae	+	
Carabidae	+	
Curculionidae	+	
Anthicidae	+	
various larvae	+	Ramorino, 1863
Diptera	+	Vanni, 1980; Bruno, 1973, 1983
Hymenoptera		Vanni, 1980
Formicidae	+	

Table 1. Taxa identified in faecal pellets of *S. terdigitata*.

Since no pattern characteristics are available to distinguish between males and females – although on average males are smaller and more slender than females and possess a relatively larger head (Vanni, 1980; Angelini *et al.*, 2001) – we did not attempt identification of the sexes, and herewith treat them collectively.

RESULTS

Night activity – At the oviposition sites in the Lepini Mountains, we occasionally found salamanders active on the ground between 11:00 and 15:00 hrs, with clear skies and an air temperature of 11°C. However, at the site in Umbria, except for ovipositing females – which spent one or more days submerged in water – salamanders were only active at night, and always on moist ground. In total we made 230 observation records. Salamanders were active mostly between 18:00–24:00 hrs and there was a positive correlation between time of activity and average air temperature (Spearman coefficient r_s = 1.00; p = 0.00), and a negative – but not significant correlation – between activity and average air humidity (r_s = -0.80; p = 0.20) (Fig. 1).

Internal temperature – The cloacal temperatures of 12 active salamanders ranged from 7.6°C to 9.8°C (mean ± SE = 8.8 ± 0.2°C). All salamanders showed an internal temperature lower than air temperature, which was constant at 10°C throughout the observation period (average $\Delta t° \pm$ SE = -1.2 ± 0.2°C; range between -2.4 and -0.2°C), and was either slightly higher or lower than substrate temperature (average $\Delta t° \pm$ SE = -0.3 ± 0.2°C; range between -1.2 and 0.4°C), to which it was correlated ($r_{Spearman}$=0.66; p <0.02; n = 12) (Fig. 2). On one occasion in the Lepini Mountains we recorded a salamander walking on snow at 11°C, but we did not record its internal temperature.

Food – Among the undigested food from faecal pellets, we identified 13 taxa of terrestrial arthropods (Table 1). We also identified a fragment of a conch of a pulmonate mollusc, as

Taxa	*N*	%
Isopoda	2	10.5
Pseudoscorpiones	1	5.3
Aranee	3	15.8
Acarina	6	31.6
Juliformes	1	5.3
Staphylinidae	1	5.3
Anthicidae	1	5.3
Diptera	1	5.3
Formicidae	3	15.8
Total	19	100.2

Table 2. Diet composition of *S. terdigitata*, based on food remains from 14 faecal pellets.

well as various items alien to the salamander diet such as glass fragments, seeds, and small pieces of wood and grass, probably accidentally ingested together with prey. Some of the remaining materials, even though apparently of animal origin, could not be identified. Composition of the diet is presented in Table 2. Only once in the field did we observe a salamander quickly and repeatedly thrusting its tongue out and in as if feeding, but we were not able to identify any prey.

DISCUSSION

At the Umbria site, most salamanders were active during the first half of the night and only a very few individuals after midnight in the open ground. The usual increase of air humidity after sunset should be favourable to salamanders, while temperature decrease might cause the marked activity decline recorded between 24:00–06:00 hrs. However, it is possible that prey in the area was fairly abundant, and a few hours feeding were all that may have been necessary to sustain daily activity.

Cherchi (1953) conducted laboratory experiments to determine the maximum and minimum temperatures tolerated by *S. terdigitata* by keeping specimens at variable temperatures until their eventual death. He fixed at –17°C and 32–35°C, respectively, the minimum and maximum critical temperatures relative to the animals' survival. He also recorded daily cloacal and ambient (laboratory) temperatures, but not substrate temperature, of three specimens in the course of a month, and reported that the salamanders' internal temperature averaged lower than air temperature. Our findings (Fig. 2) agree to those of Cherchi (1953), but the significant, positive correlation between substrate and salamander cloacal temperatures suggests that substrate temperature most probably influences the salamanders' activity in the field.

With regard to diet, apparently only Ramorino (1863) and Vanni (1980) have provided original data based on the analysis of stomach content of adult salamanders. In the literature there are further reports of food records in *S. terdigitata* (Lessona, 1868; De Betta, 1874; Angel, 1949; Thorn, 1969; Hvass, 1972; Lanza, 1983, 1988; Bogliani & Barbieri, 1986; Di Tizio, 1986; Corsetti, 1994; Zuffi, 1999) but these probably refer to previous papers. Our data add some previously unreported items to the food spectrum of *S. terdigitata*, and this is particularly relevant because they were obtained from a very small sample (24 faecal pellets) using non-invasive methods. This suggests that the Spectacled salamander may feed on an even wider range of prey and that more information should be obtainable in the future from larger faecal samples and without sacrificing animals. The analysis of faecal pellets may preclude identification of prey species that typically leave behind only a few undigested fragments (e.g. earthworms and some insect larvae). However, unidentified prey remains have also been recorded from dissected stomachs (Vanni, 1980).

Ramorino (1863) and Bruno (1973, 1983) gave information on aquatic prey items (tab. 1), which considering the strictly terrestrial habits of *S.*

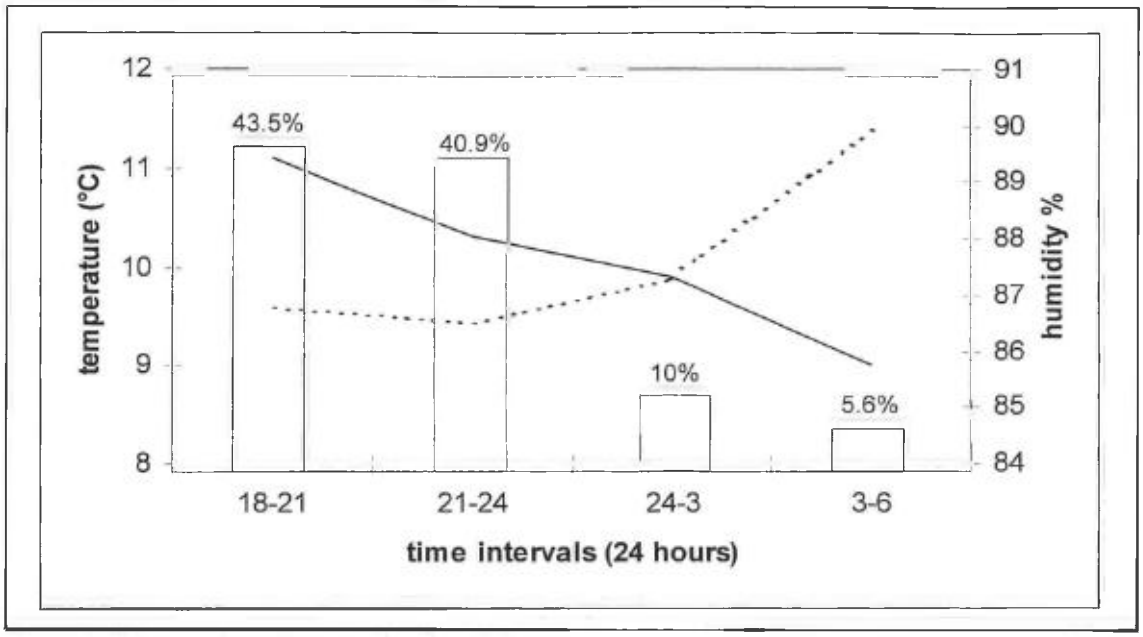


Figure 1. Relations of number of active *S. terdigitata* (n = 230) to air temperature (solid line) and humidity (broken line).

terdigitata is somewhat puzzling. Vanni (1980), Lanza (1983) and Zuffi (1999) state that only ovipositing females submerge, although Ramorino (1863) and Barbieri (pers. comm.) sometimes recorded males in water. In our experience, the female aquatic phase lasts no longer than the time needed to complete egg-laying. In fact the stomachs of Vanni's (1980) females, which he collected in water, were empty. Predation on aquatic organisms by this species would thus be usefully confirmed by further records.

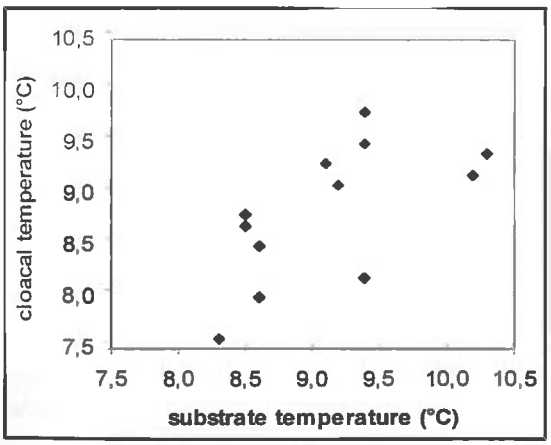


Figure 2. Correlation between internal temperature and substrate temperature of active *S. terdigitata* ($r_{Spearman}$ = 0.66; $p < 0.02$; n = 12). Air temperature kept at 10°C all throughout the observation session.

REFERENCES

Angel, F. (1949). *Petit Atlas des Amphibiens et Reptiles. I. Apodes, Urodeles, Anoures, Rhynchocephales, Cheloniens, Crocodiliens*. Paris: Ed. N. Boube. 129 pp.

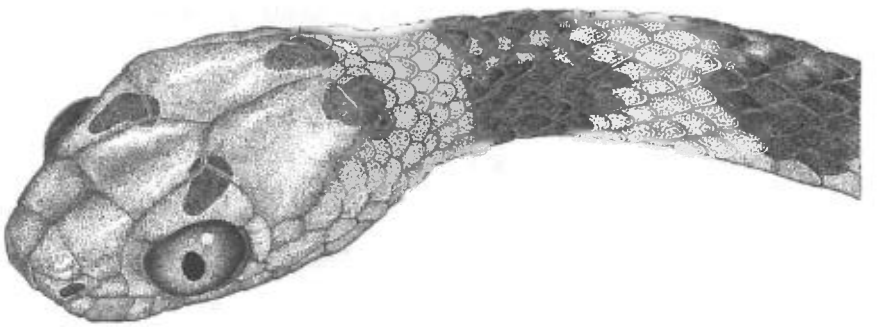
Angelini, C., Antonelli, D. & Utzeri, C. (2001). Aspetti della fenologia riproduttiva di *Salamandrina terdigitata* (Lacépède, 1788) in Italia centrale. In *Atti 3° Congr. naz. S.H.I. (Pavia, 2000), Pianura* **13**, 105–108.

Barbieri, F. (1994). Salamandrina dagli occhiali. *Salamandrina terdigitata* (Lacépède, 1788). In *Atlante degli Anfibi e Rettili della Regione Liguria*, pp. 40–41. Doria, G. & Salvidio, S. (Eds). Regione Liguria.

Bogliani, G. & Barbieri, F. (1986). *Anfibi e Rettili. Itinerari naturalistici in Provincia di Pavia*. Amm.ne prov.le di Pavia, Ass.to Igiene, Ecologia, Tutela Ambientale.

Bruno, S. (1973). Anfibi d'Italia: Caudata. (Studi sulla fauna erpetologica italiana, XVII). *Natura*

64(3–4), 209–450.
Bruno, S. (1983). Lista rossa degli anfibi italiani. *Riv. Piem. St. Nat.* 4, 5–48.
Cherchi, M.A. (1953). Termoregolazione in *Salamandrina terdigitata* (Lacépède). *Boll. Mus. Ist. Biol. Univ. Genova* **25**, 11-41.
Corsetti, L. (1994). Anfibi e rettili dei Monti Lepini. *Quad. Mus. St. Nat. Patrica (FR)* **5**, 1–190.
De Betta, E. (1874). Rettili ed Anfibi. In *Fauna d'Italia*, pp. 83-84. Cornalia, E., Salvadori, T., Canestrini, L. & De Betta, E. (Eds.). Milano: Vallardi Ed..
Di Tizio, L. (1986). *Salamandrina terdigitata*. *Aquarium* **2**, 89–90.
Hvass, H. (1972). *Reptiles and Amphibians in colour*. London: Blandford. 153 pp.
Lanza, B. (1983). *Anfibi, Rettili (Amphibia, Reptilia)*. Verona: Consiglio Nazionale delle Ricerche. 196 pp.
Lanza, B. (1988). *Salamandrina terdigitata* (Lacépède,1788): emblem of the Unione Zoologica Italiana. *Boll. Zool.* **55**, 1–4.
Lessona, M. (1868). Notes on *Salamandrina perspicillata*. Communicated by Mr. St. George Mivart. *Proc. zool. Soc. London*, **(1868)**, 254–256.
Ramorino, G. (1863). *Appunti sulla storia naturale della* Salamandrina perspicillata. Genova: Tipografia Sordo-Muti. 38 pp.
Thorn, R. (1969). *Les Salamandres d'Europe, d'Asie et d'Afrique du Nord*. Paris: Lechevalier. 376 pp.
Vanni, S. (1980). Note sulla salamandrina dagli occhiali [*Salamandrina terdigitata* (Lacépède, 1788)] in Toscana (Amphibia Salamandridae). *Atti Soc. Tosc. Sci. Nat., Mem.*, Serie B **87**, 135–159.
Zagaglioni, S. (1978). *Ricerche sulla biologia della salamandrina dagli occhiali (*Salamandrina terdigitata, *Lacépède) Anfibi Urodeli*. Unpubl. Thesis, Università di Firenze, Fac. Sc. Mat. Fis. & Nat..
Zuffi, M.A.L. (1999). *Salamandrina terdigitata* (Lacépède, 1788) - Brillensalamander. In *Handbuch der Reptilien und Amphibien Europas 4/I: Schwanzlurche (Urodela)*, pp. 229-246. Grossenbacher, K. & Thiesmeier B. (Eds). Wiesbaden: AULA-Verlag.



Head detail of *Imantodes tenuissimus*. Reproduced with kind permission of the artist/author, Julian C. Lee, from *The Amphibians and Reptiles of the Yucatán Peninsula* (Cornell University Press, 1996).