ISSN 1330-061X
CODEN RIBAEG

UDK 597.9.08 (497.5)
Original scientific paper

MORPHOMETRIC CHANGES IN THE SMOOTH NEWT (*Triturus vulgaris*) DURING THE AQUATIC PHASE

T. Treer, D. Treer

Summary

The changes of length and mass of smooth newts (*Triturus vulgaris*) were investigated during the aquatic phase of their lives in a small pond of Croatian capital Zagreb. During their aquatic phase from March 19th to June 1st 1994 the ecological conditions in the pond were also checked regularly each week.

The changes of tail lengths were the most significant in the changes of total lengths in both sexes. However, while males became slightly longer (from 8,47+0,53 cm to 8,85+0,54 cm, $p>0.50$) and didn't change their mass (from 2,09+0,14 g to 2,06+0,22 g, $p>0.50$), females became significantly shorter (from 8,50+0,71 cm to 7,30+0,43 cm, $p<0.85$) and weighted less (from 2,03+0,31 g to 1,61+0,25 g, $p<0.75$). That can be explained by the usual tail fin decrease after the oviposition has been completed, by losing organic material and energy during the oviposition and probably as the result of the asynchronous oviposition in the newts.

The larvae of smooth newts expressed very fast growth (p), as they had to complete their transformation before the unsuitable summer conditions in the pond.

Key words: Smooth newt, Triturus vulgaris, morphometry, aquatic phase, Croatia

INTRODUCTION

As smooth newts are quite widespread they are also considered *Triturus vulgaris* species group, whose present geographical distribution and evolution could be partly understood through their morphological and behavioural study. Their speciation and subspeciation is due to several reasons, as for example geographical isolation as a result of glaciation and reproductive isolation as a

Prof. dr. Tomislav Treer, Dag Treer, Faculty of Agriculture, Department fo Fisheries, Beekeeping and Special Zoology, University of Zagreb, 10000 Zagreb, Svetošimunska 25, Croatia

result of different reproductive behaviour (Cogalniceanu and Venczel, 1992). That is why much effort has been put into understanding these differences better, i. e. by counting trunk vertebrae (Veith et al 1992) or studing their polymorphic loci (Crnobrnja et al., 1992).

So far, two subspecies of *T. vulgaris* are determined in Croatia: continental and Adriatic one. However, their life cycle is not sufficiently known, although it is the most widespread *Triturus* species in Croatia. In many places it is even endangered by human activities, as it is probably the case with the subspecies *T. vulgaris schreiberi* near Zadar (*Tvrtković*, 1981).

There is an opinion that smooth newts perform most feeding and annual growth during the aquatic phase of their lives (Verrell, 1987). That is why this research tried to detect the differences in their bodies occuring during this part of their annual cyclus. The investigation was performed in the pond, where there were no fish and other newt species, as possible predators of adult and larval smooth newts (Sih et al., 1992; Griffiths et al., 1994).

MATERIALS AND METHODS

The pond investigated, called Vrančeva pond, lays north–east of Jarun lake, near the river Sava in the Croatian capital, Zagreb. The altitude is about 100 m above the sea level. The central basin of the pond covers an area of about 500 m2, but the water can double its area during the spring rainfalls. Most of the time water is permanent all the year round, covering at least few m2 in the center, during the summer's peak, but occasionally it dries out completely. It last happened in August 1992.

As the smooth newts mate in spring, immigrating into the water in March (Baker, 1992) and mate in April and May (Tvrković, 1981) the investigation was performed from March 19th to June 1st 1994, each week, 11 times in all. In order to check the pond conditions each time the following analyses were done: water and air temperature, water depth, oxygen content as well as number and composition of zooplankton, by 80 μm plankton net. The representatives of benthic invertebrates were checked by pulling of the D–frame dip net.

Air temperature in shade was measured, water temperature was taken about 2 m from the shore at the depth of 50 cm, were also water for oxygen analysis (Winkler method) was taken. The marked spot at the root of one willow was taken as 0 m water depth.

The adult newts (13 specimens) were caught by the net near the beginning (April 3rd) and near the end (May 11th) of mating period. The lengths of head, trunk and tail were measured to the nearest mm and the mass to mg, by electronic scale. The newts' larvae (9 specimens) were also caught two times (on May 22nd and June 1st) and their total length was measured.

RESULTS

With the approach of summer the air and water temperatures were constantly rising, from 9 °C to 26 °C in the water (fig. 1). The excange of rainy and dry

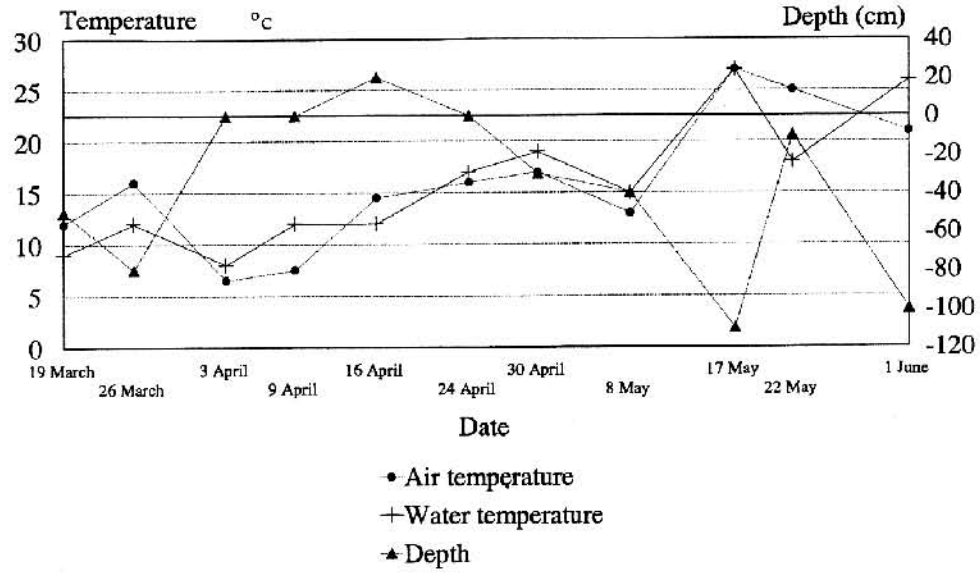

Fig. 1: Water temperature (°C) and depth (cm) in the pond during the investigatd period

Slika 1. temperatura vode (°C) i dubina (cm) u bari za vrijeme istrăživanja

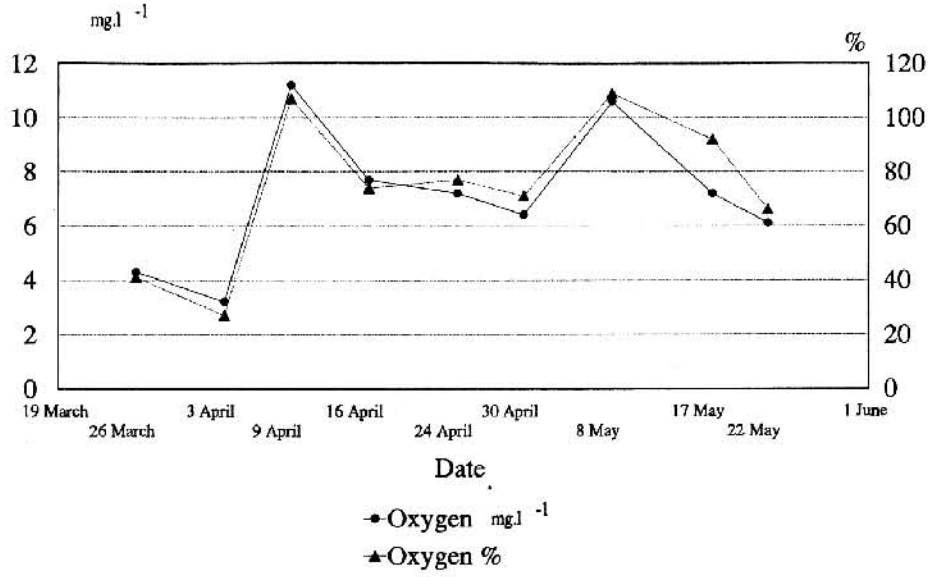

Fig. 2: Quantity ($mg.l^{-1}$) and percentage (%) of dissolved oxigen in the pond during the investigated period

Slika 2. Količina ($mg.l^{-1}$) ipostotak (%) otopljenog kisika u bari za vrijeme istrăživanja

days, caused quick changes of water depth and sudden changes of water temperatures accordingly. That is why these two parameters were in statistically significant ($p<0.05$) negative correlation. The mid-spring rainfalls in April caused the deepest water layer of the pond and resulted in high oxygen contents (fig. 2).

Zooplankton, as an important source of food for larval and adult newts, showed the expected changes of population dynamichs (fig. 3). At the beginning *nauplius* larvae of copepods created an outstanding population peak, while cladocerans were the most abundant towards the end of the investigation. Rotifers and adult copepods were never very numerous. The changes in water depth inversely correlated with the concentration of zooplankton.

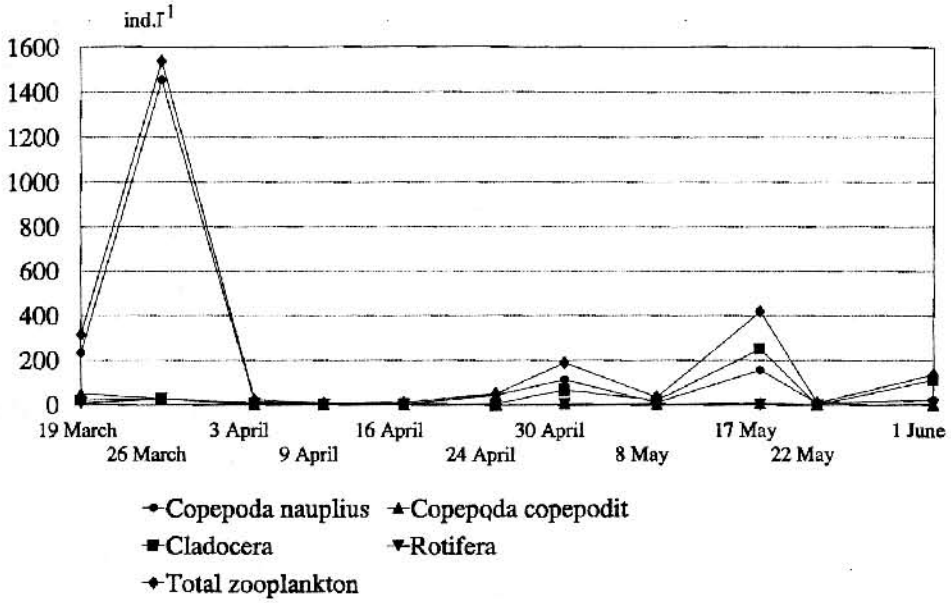

Fig. 3: Abundance (ind.l^{-1}) of systematic groups and total zooplanktonen in the pond during the investigated period
Slika 3. Brojnost (ind.l^{-1}) pojedinih sustematskih grupa i ukupnog zooplanktona u bari za vrijeme istraživanja

The other invertebrates found are typical for small ponds. Primarily, there were insect larvae of *Odonata, Ephemeroptera. Trichoptera* and *Diptera* groups, adult insects as *Coleoptera* and *Hemiptera*, then snails, *Isopada* crustaceans, *Tubifex* oligochaets and *Hirudinea*. Some of these animals created important food for newts, but some of them were serious predators.

The frogs (*Rana esculenta*) are common in the pond. The fish (*Cobitis sp.*) that had already been in the pond disappeared after the last draught in August 1992.

The length and mass changes of newts during the aquatic period differ as much among sexes, as among the different parts of their bodies (fig. 4). While males almost didn't change, females expressed significant losses in both

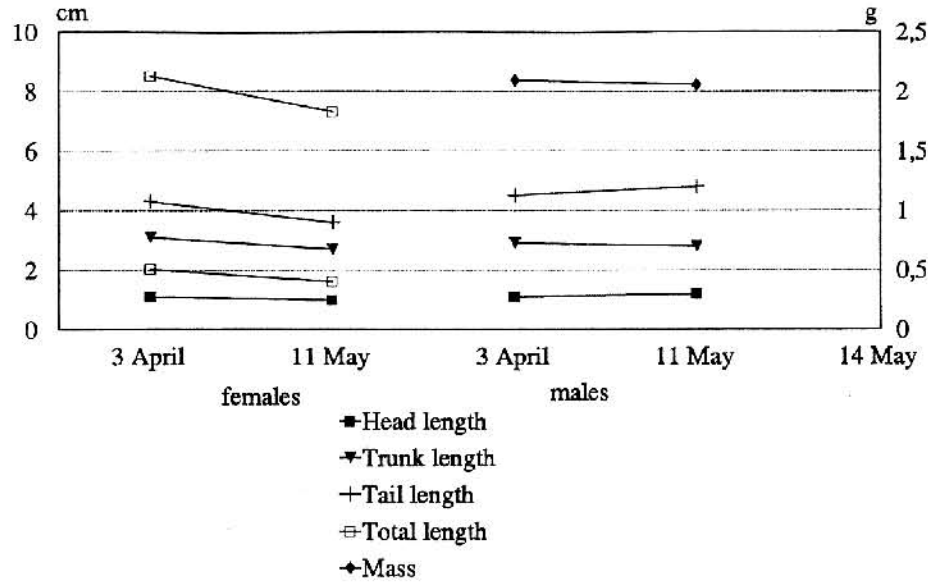

Fig. 4: Mean lenghts (cm) and masses (g) of adult females and males in the pond at the beginning and the near the and of the investigation
Slika 4. Srednja vrijednost dužina (cm) i masa (g) odraslih ženki i mužjaka o bari na početku i na kraju istraživanja

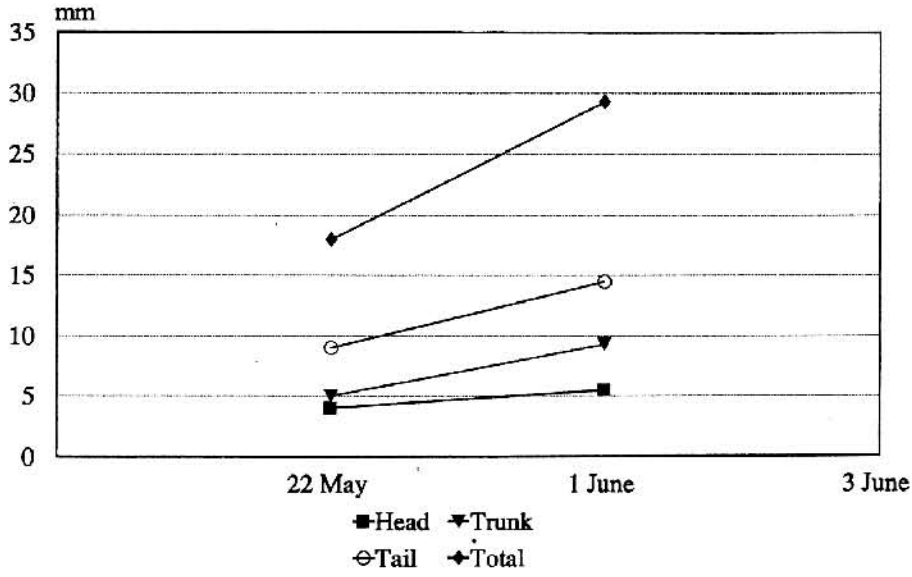

Fig. 5: Mean lengths changes (mm) of larval newts during ten days
Slika 6. Promjene srednjih vrijednosti dužina (mm) ličinaka vodenjaka u 10 dana

of these parameters. Total length of males changed from 8,47+0,53 cm to 8,85+0,54 cm ($p>0.50$) and females from 8,50+0,71 cm to 7,30+0,43 cm ($p<0.85$). Mass of males turned from 2,09+0,14 g to 2,06+0,22 g ($p>0.50$) and of females from 2,03+0, 31 g to 1,61+0,25 g ($p<0.85$).

The main reason for the changes of the whole body is the change in tail length. While in males it elongated ($p<0.45$), it became shorter in females ($p<0.85$). Even the length of trunk became somewhat shorter in female newts ($p<0.85$).

The newts larvae changed their total length for 63% (from 1,80+0,40 cm to 2,93+0,11 cm, $p<0.01$) in ten days (fig. 5). The tail and trunk lengths grew faster ($p<0.01$ and $p<0.05$, respectively) than the length of the head ($p<0.05$).

DISCUSSION

The ecological conditions in the investigated pond are typical for small still waters. The sudden and great changes of physical and chemical water parameters, as well as zooplankton dynamics, occur. The smooth newts are well adapted to such conditions, as they inhabit small ponds during their aquatic phase of life cycle.

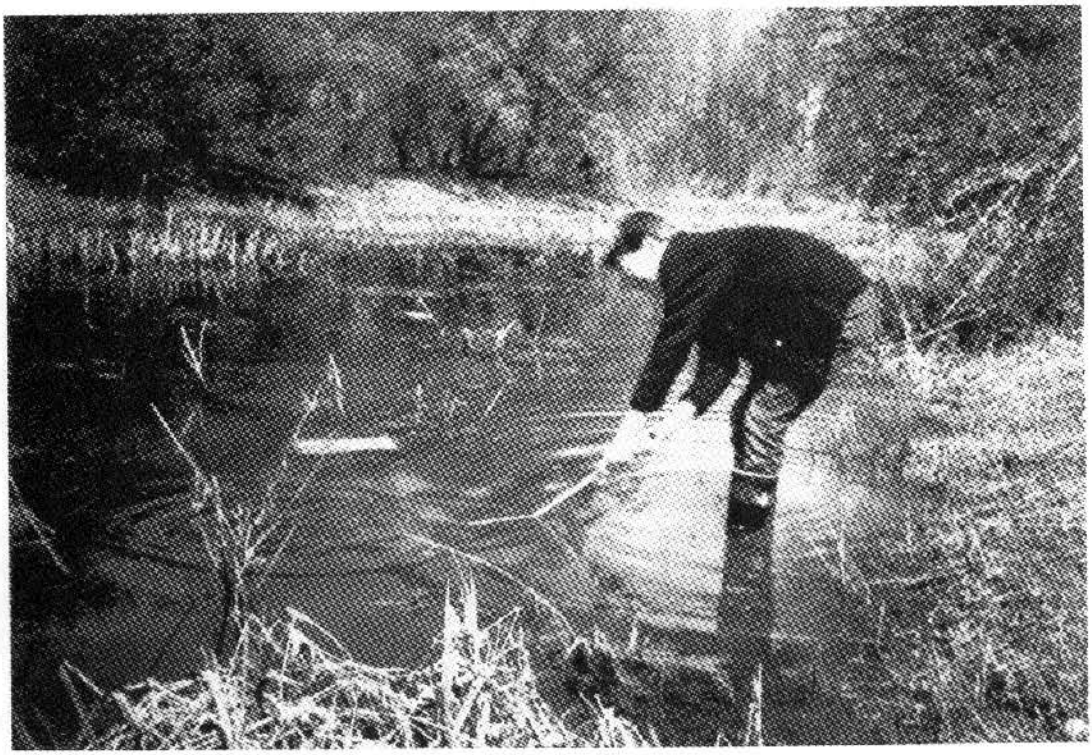

Fig 6. Taking the samples at Vrančeva pond
Slika 6. Uzimanje uzoraka u Vrančevoj bari

The total length (TL) of the female newts investigated was smaller than that of females from Milton Keynes in England by the end of oviposition period (Baker, 1992). The females from that pond had TL of 8,55+0,88 cm, what is 17% greater than 7,30+0,43 cm of the females from Vrančeva pond, but similar to that of females from Llysdinam pond in mid–Wales of 7,6 cm (Harrison, 1985). The mass of 1,61+0,25 g is smaller than 2,70+0,82 g of English newts, too. That also reflects on clutch size, as it is confirmed that among amphibians clutch size is positively correlated to female body size (i. g. Crump and Kaplan, 1979, Kaplan and Salthe, 1979, Howard, 1988, Woolbright, 1989, Baker, 1992).

What Verrell (1987) stated about adult smooth newts performing most of their annual growth during their aquatic phase was not confirmed by this research, at least as far as the females were concerned. The males, however, enlarged their TL for 0,38 cm, but that can be explained by the growth of their tail for courtship purposes (fig. 4). The mass remained almost unchanged. On the other hand, females expressed great losses in both, TL and mass. The same happened to the females from Welsh Llysdinam pond which lost 0, 30 cm in size. This can be explained by the usual tail fin decrease on completion of oviposition (Baker, 1992). The females can also lose the significant amount of organic material and energy during oviposition, and it is possible that they yolk up ova during the oviposition period (Harris, 1987). As the oviposition in the newts is asynchronous (Smith, 1973, Bell and Lawton, 1975, Hagström, 1980, Diaz–Paniagua, 1989) and as the smaller females have lower oviposition rate, while even larger juveniles migrate into the water (Baker, 1992), it is also possible that in the end only smaller specimens remained in water.

The larvae of smooth newts expressed very fast growth. It happened because they had to complete their transformation to the terrestrial shape before the conditions of life in water become unsuitable.

Summary

MORFOMETRIJSKE PROMJENE KOD MALIH VODENJAKA (*Triturus vulgaris*) ZA VRIJEME NJIHOVOG VODENOG RAZDOBLJA

Vodenjaci su vrlo slabo istraženi pripadnici vodene faune u Hrvatskoj. Na mnogim mjestima njihov je opstanak i bitno ugrožen čovjekovim aktivnostima, kao što je i vjerojatno uništenje endemične podvrste *Triturus vulgaris schreiberi* u Bokanjačkome blatu.

U svijetu su istraživanja naravno razvijenija, ali još postoje mnoge nepoznanice glede razvoja i ponašanja malih vodenjaka (*Triturus vulgaris*), te njihovih geografskih razlika. Zbog toga je provedeno ovo istraživanje promjena

u njihovoj vodenoj fazi u Vrančevoj bari istočno od Jaruna, u kojoj od posljednjeg presušivanja g. 1992. nema riba, kao ozbiljnih predatora vodenjaka.

Od 19. ožujka do 1. lipnja 1994. svaki tjedan, ukupno 11 puta, obavljana su ekološka uzrokovanja u ovoj bari, koja su pokazala tipične nagle i velike oscilacije fizikalnih, kemijskih i bioloških parametara. Mužjaci vodenjaka kroz ovo su razdoblje nešto povećali svoju dužinu (od 8,47+0,53 cm do 8,85+0,54 cm, p0.50) i zadržali masu (od 2,09+0,14 g do 2,06+0,22 g, p0.50), dok su ženke u oba ova pokazatelja znatno izgubile (od 8,50+0.71 cm, do 7,30+0,43 cm, p0.85 i od 2,03+0,31 g do 1, 61+0,25 g, p0.75). Glavni su razlozi za to, uz uobičajene morfološke promjene pred povratak u terestrijalnu fazu, gubitak tvari i energije za proizvodnju i polaganje jaja, a moguće i asinkrona ovipozicija, poznata u ovih životinja. Ličinke malih vodenjaka vrlo su brzo rasle (p 01), zbog nužnosti završetka transformacije prije ljetnog isušivanja ili nastanka nepovoljnih ekoloških uvjeta u bari.

Ključne riječi: mali vodenjak, Triturus vulgaris, morfometrja, vodena faza, Hrvatska

LITERATURA

Baker, J. M. R. (1992): Egg production in the smooth newt (*Triturus vulgaris*), Herpt. J., 2, 90–93.

Bell, G. & Lawton, J. H. (1975): The ecology of the eggs and larvae of the smooth newt (*Triturus vulgaris* (Linn.)). J. Anim. Ecol. 44: 393–424.

Cogalniceanu D. & Venczel M. (1992): The evolution of the genus *Triturus (Amphibia, Urodela)*, zoogeographical and behavioural data. Rev. Roum. Biol. 37, 57–65.

Crnobrnja, J., Kalezić, M. L. & Tučić, N. (1992): Multilocus structure of the smooth newt (*Triturus vulgaris, Caudata*) natural populations. Genet. Sel. Evol., 24, 385–392.

Crump, M. L. & Kaplan, R. H. (1979): Clutch energy partitioning of tropical tree frogs (*Hyalidae*). Copeia, 1979: 626–635.

Diaz–Paniagua, C. (1989): Oviposition behaviour of *Triturus marmotatus pygmaeus*. J. Herpet., 23, 159–163.

Griffiths, R. A. de Wijer, P. & May, R. T. (1994): Predation and competition with an assemblage of larval newts (*Triturus*). Ecography, 17, 176–181.

Hagström, T. (1980): Egg production of newts (*Triturus vulgaris* and *Triturus cristatus*) in Southwestern Sweden. ASRA Journal, 1, 1–8.

Harris, R. N. (1987): An experimental study of population regulation in the salamander, *Notophthalmus viridescens dorsalis* (*Urodela: Salamandridae*). Oecologia, 71, 280–295.

Harrison, J. D. (1985): Aspects of the ecology of amphibian larvae. Universitay of Wales, Ph. D. Thesis.

Howard, R. D. (1988): Sexual selection on male body size and mating behaviour in American toads, *Bufo americanus*. Anim. Behav., 36, 1796–1808.

Kaplan, R. H. & Salthe, S. N. (1979): The allometry of reproduction: an empirical view in salamanders. Amer. Nat., 113, 671–689.

Sih, A., Kats, L. B., Moore, R. D. (1992): Effects of predatory sunfish on the density, drift and refuge use of stream salamander larvae. Ecology, 73, 1418–1430.

Smith, M. (1973): The British Amphibians and Reptiles. (5th Ed.). Collins, London.

Tvrtković, N. (1981): Uključite se u akciju — upoznajmo vodenjake. Priroda, 70, 61–62.

Veith, M., Degani G. & Seitz, A. (1992): Discordance of genetical and morphological variation of *Salamandra salamandra* (L.) in Israel. Zool. Anz., 229, 63–72.

Verrell, P. A. (1987): Growth in the smooth newt (*Tritutus vulgaris*) during the aquatic phase of the annual cycle. Herpt. J., 1, 137–140.

Woolbright, L. L. (1989): Sexual dimorphism in *Eleutherodactylus coqui*: selection pressures and growth rates. Herpetologica, 45, 68–74.

Received 15. 10. 1995.