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Some Comments on the Breeding Biology of *Pelodytes caucasicus* Boulenger, 1896 (Anura: Pelodytidae) from Uzungöl, Northeast Anatolia

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Abstract: Observations during 2001 and 2002 at Uzungöl Lake (Trabzon), situated within the distribution area of *Pelodytes caucasicus* in the Eastern Black Sea region of Turkey, established that the usual breeding season of the species extended from mid July to mid September. Periodic day and night measurements of some ecological characteristics of the lake (temperature, pH, dissolved oxygen) were recorded during the breeding season. The first spawning was observed during the night of 22 July 2001. Clutches (egg masses) were laid in the deeper parts of the lake, on submerged vegetation. The clutches contained between 446 and 492 eggs. The first larvae hatched 5 days after the spawning. They completed their metamorphosis in 31-35 days and then emerged on land. After the first (2001) breeding season, non-metamorphosed hibernating larvae were seen during the winter and spring months.

Key Words: Eastern Black Sea Region, Caucasian Parsley Frog, *Pelodytes caucasicus*, Anura, Breeding Biology

Kuzeydoğu Anadolu, Uzungöl'de Yaşayan *Pelodytes caucasicus* Boulenger, 1896 (Anura: Pelodytidae)'un Üreme Biyolojisi Üzerine Bazı Yorumlar

Özet: *Pelodytes caucasicus*'un Doğu Karadeniz Bölgesi'ndeki dağılışı içinde yer alan Uzungöl (Trabzon)'de 2001-2002 yılları arasında (2 yıl) yapılan gözlemlere göre, türün üreme döneminin Temmuz ortalarından Eylül ortalarına kadar sürdüğü saptanmıştır. Üreme periyodunda periyodik olarak suyun ekolojik özellikleri (temperatür, pH ve oksijen) ile ilgili gece ve gündüze ait ölçüm değerleri alınmıştır. İlk yumurta bırakımı 22 Temmuz 2001 gecesi gözlenmiştir. Yumurta kümeleri gölcüğün en derin kısmında, su yüzeyine ulaşmayan vejetasyon üzerine bırakılmıştır. Bırakılan her bir yumurta kümesinin 446-492 yumurta içerdiği tespit edilmiştir. İlk yumurta bırakımından 5 gün sonra larvaların çıktığı, oldukça hızlı gelişen larvaların 31-35 gün sonra metamorfozunu tamamlayarak sudan karaya çıktıkları gözlenmiştir. Bir sonraki üreme mevsiminde kış ve ilkbahar aylarını hibernasyon halinde geçiren metamorfozunu tamamlamamış örnekler gözlenmiştir.

Anahtar Sözcükler: Doğu Karadeniz Bölgesi, *Pelodytes caucasicus*, Anura, Üreme Biyolojisi

Introduction

Endemic to the Caucasus region, the Caucasian parsley frog, *Pelodytes caucasicus* (Boulenger, 1896), is known in Turkey only from the Eastern Black Sea region. The other well-known species of the genus (and of the family Pelodytidae), *P. punctatus* (Daudin, 1803), is widely distributed in a large area of western Europe (Toxopeus et al., 1993), but the taxonomic status of its westernmost populations on the Iberian Peninsula has recently changed. Sánchez-Herraiz et al. (2000)

described a new species, *P. ibericus*, from Portugal and southern Spain.

There are several works on the morphology, osteology, ecology, and distribution of *P. caucasicus* (Chanturishvili, 1940; Nikolsky, 1962; Steiner, 1968; Darevsky et al., 1971; Lukina and Koneva, 1977; Golubev, 1985; Engelmann et al., 1986; Tuniev, 1989; Chubinishvili et al., 1995; Tarkhnishvili, 1996; Baran et al., 1997; Baran and Atatür 1998; Franzen, 1999; Tarkhnishvili and Gokheshvili, 1999), which also

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mention that they spawn in pools formed by mountain streams, and have both a long breeding period and hibernating larvae. A population from the Nedzura River Canyon, Georgia, has been reported to have a breeding period from mid May to the end of September (Chubinishvili et al., 1995). As Başoğlu et al. (1994) wrote, there is little information on the breeding biology of *P. caucasicus*, and the aim of the present study was to clarify the breeding biology of the Uzungöl (Trabzon) population, situated within the distribution area of the species in the Eastern Black Sea region of Turkey.

Materials and Methods

This study was carried out at Uzungöl Lake, at an altitude of 1100 m in the Eastern Black Sea region of Turkey, during the breeding periods (June-September) of 2001 and 2002 (Figure 1).

Uzungöl is a lake of approximately 1000 × 500 m, with a depth of 15 m. Its typical flora consists of *Equisetum fluviatile* and *Catabrosa aquatica*. *E. fluviatile* covers most of the lake (Figure 2). Haldizen Brook, a branch of the Solaklı River, feeds the lake. Due to structural differences stemming from climate and geomorphology, varied vegetation encircles the lake. Above 1000 m, the lake is surrounded by *Picea orientalis*, *Fagus orientalis*, *Pinus sylvestris*, *Alnus glutinosa*, *Abies nordmanniana*, and various bushes, such as *Coryllus*

avellana, *Buxus sempervirens*, *Rhododendron ponticum*, and *Cornus sanguinalis*. Above this woody terrain, alpine and subalpine grasslands are present (Seçmen and Leblebici, 1997). The lake's shore is rich in *Tetelia speciosa* and *Rhododendron ponticum*.

During the study, data on the breeding biology were collected from natural shoals not exceeding a depth of 1 m and which contained rich vegetation of *Equisetum fluviatile* (Figure 2), and also from a small natural pool southeast of Uzungöl (Figure 3).

During the breeding period, day and night temperatures, pH, and dissolved oxygen values of the lake water were measured with a Multi P3 pH/oxi set; the air and water temperatures were measured at 12⁰⁰-13⁰⁰ and 01⁰⁰-02⁰⁰ hours.

Morphometrical measurements of the eggs and larvae were obtained with a dial caliper of 0.01 mm sensitivity.

Results

General Characteristics of the Species

Pelodytes caucasicus is a slender frog. Ground color of the dorsum is olive green to gray-brown with overlying blackish branching or slightly vermiculate maculation. The skin has variously sized porous warts. The venter is smooth and whitish; only the pelvic area is slightly granulated. Swimming webs are reduced. It has small



Figure 1. General view of Uzungöl (Trabzon).



Figure 2. *Pelodytes caucasicus* biotope, covered with *Equisetum fluviatile*.



Figure 3. A spawning pool southeast of Uzungöl, where larval development was observed.

inner metatarsal tubercles on the hind legs at the base of the first toe. The presence of an inner voice sac, longer and stronger forelegs, the appearance of black tubercles, especially on the venter during the breeding season, differentiates the males from the females. The snout-vent length (SVL) of sexually mature males is 45.06-52.08 mm; that of females is 46.70-49.62 mm. *P. caucasicus* is

a nocturnal species that usually hides under leaves and stones in shade and dark places within the woody vegetation south and southwest of Uzungöl during the daytime. Dissected urogenital systems of mature male and female specimens are shown in Figures 4 and 5, respectively .

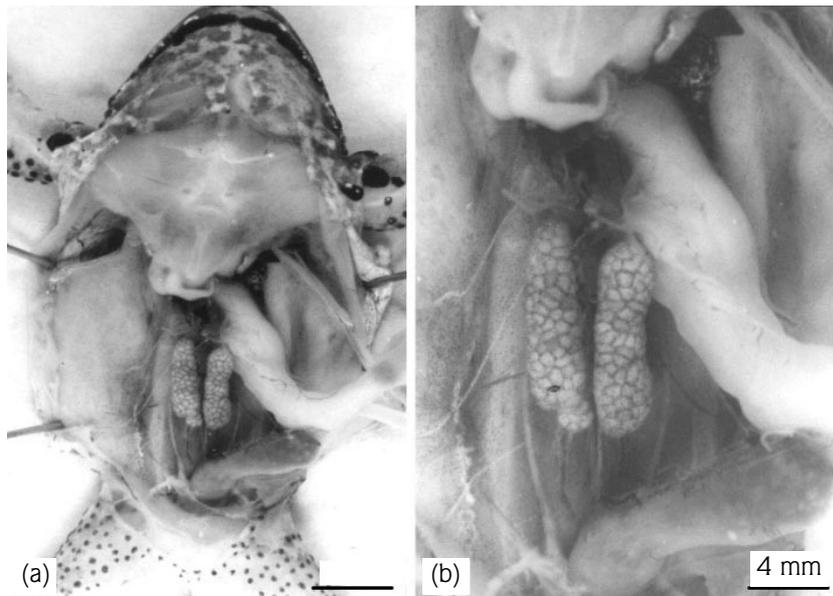


Figure 4. Urogenital system in a ventrally dissected mature male specimen.

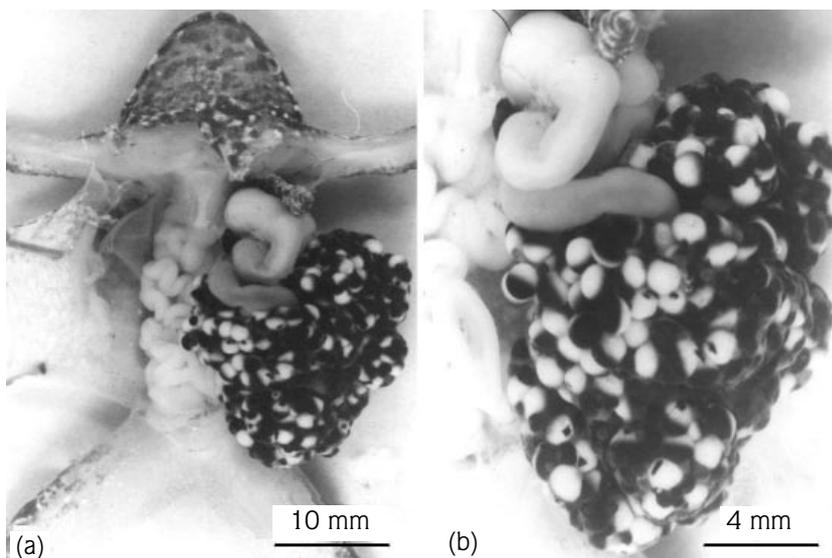


Figure 5. Urogenital system in a ventrally dissected mature female specimen.

Breeding and Spawning

During the first fieldwork during 13-17 June 2001, no specimens were observed on land or in the water; while the start of the breeding seasons of sympatric *Bufo bufo* (Linnaeus, 1758), *Hyla arborea* (Linnaeus, 1758),

Rana ridibunda (Pallas, 1771), and *Mertensiella caucasica* (Waga, 1876) were established. During that time, the day/night air temperatures were 13-15/10-12 °C; the day/night water temperatures were 9-10/7-8 °C (Table 1).

Table 1. Data on *P. caucasicus* specimens and on some ecological particulars.

	No Specimens Seen 13-30 June 2001	First Specimens in Water 1 July 2001	First Amplexus 19-22 July 2001	Larval Development 1-30 August 2001
Day Air Temperature	13-15 °C	20-22 °C	22-24 °C	24-30 °C
Night Air Temperature	10-12 °C	18-20 °C	18-20 °C	22-28 °C
Day Water Temperature	9-10 °C	16-18 °C	17-18 °C	24-26 °C
Night Water Temperature	7-8 °C	14-16 °C	14-16 °C	20-24 °C
pH	6.5	6.5	7	6.5
ppm O ₂ (mg/l)	9	8	9	9

The first *P. caucasicus* specimens were observed on land near the lake on 1 July 2001. The day/night air temperatures were 20-22/18-20 °C and water temperatures were 16-18/14-16 °C (Table 1).

During the initial breeding behaviors of the species (19 July 2001), the males were observed to leave their daily hiding places (Figure 6) and move into the water at around 22⁰⁰ hours, turn towards the shore, and emit interrupted, weak vocalizations. The vocalizations of the other anurans (*H. arborea*, *R. ridibunda*) in the same area were much louder. The females left their hiding places and moved towards the water 1-1.5 h later (around 23⁰⁰ hours). No amplexus formation was observed during the night of 19 July. The first amplexus was seen the

following night (20 July), and that behavior continued until the night of 15 August. *P. caucasicus* demonstrates an inguinal amplexus, sometimes a female may be in amplexus with 8-10 males. Data on these and related topics are given in Table 1.

The first egg release was observed during the night of 22 July. The eggs were laid in masses (clutches) on the submerged branches and leaves of *Equisetum fluviatile* (Figure 7). The freshly laid eggs were grayish black at the animal poles and dirty white at the vegetative poles; within a few days they began to uniformly darken (Figure 8).

The number of eggs in a clutch varied from 446 to 492, depending on the size of the female, and, in some



Figure 6. A view of the daily hiding places of the species.



Figure 7. A freshly spawned clutch.

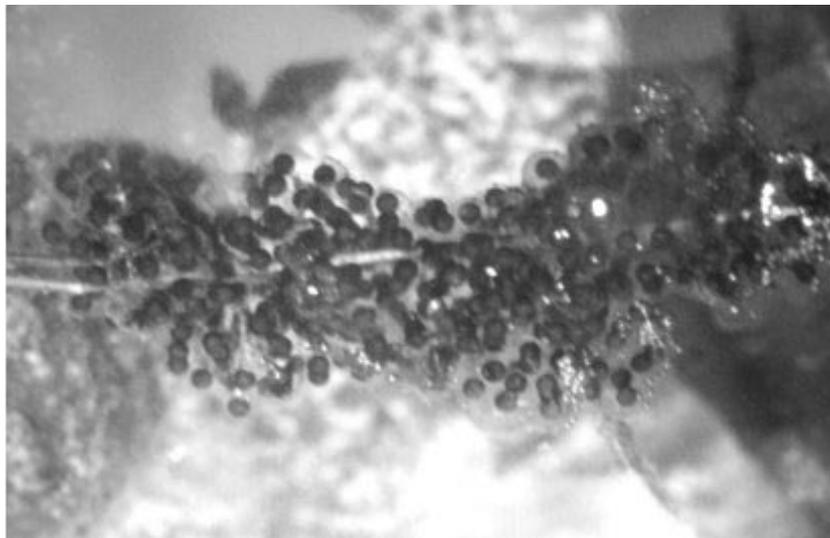


Figure 8. A darkened clutch laid a few days earlier.

dissected females, 122 to 574 eggs were observed. The diameter of the eggs within the gelatinous sheath varied from 1.50 to 1.90 mm (mean: 1.71 mm). Spawning continued until 24 August.

Larval Development

Three days after the first egg release (25 July), the gelatinous sheath surrounding the eggs began to disintegrate and the eggs sunk to the bottom, where they

stayed together in still water (Figure 9). Five days after the egg release (27 July), the first larvae began to emerge and the water/air temperatures were approximately 15/24 °C. On 28 July, a whole clutch of eggs was seen to complete development and produce larvae. Similar observations in 2002 established that the last egg release was on 23 August and the emergence of the larvae on 30 August, with approximate water/air temperatures of 22/26 °C (Table 1).

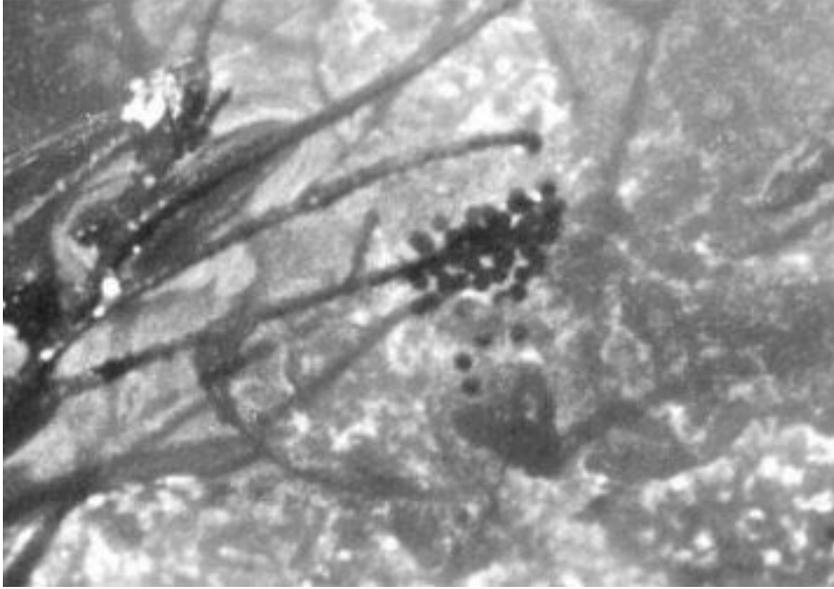


Figure 9. A view of the beginning of larval development after the shedding of the gelatinous sheath.

The larvae fixed themselves in masse on the gelatinous egg sheath remains and stayed this way (approx. 5 days) until they were ready to swim freely (Figure 10). Those in water eddies or exposed to rain water were seen to attach randomly to submerged

pebbles and stones. Obviously, larval development is rather rapid in *P. caucasicus*; after emergence from the eggs, the larvae complete their metamorphosis in 31-35 days and move onto land. The related data are given in Table 2.

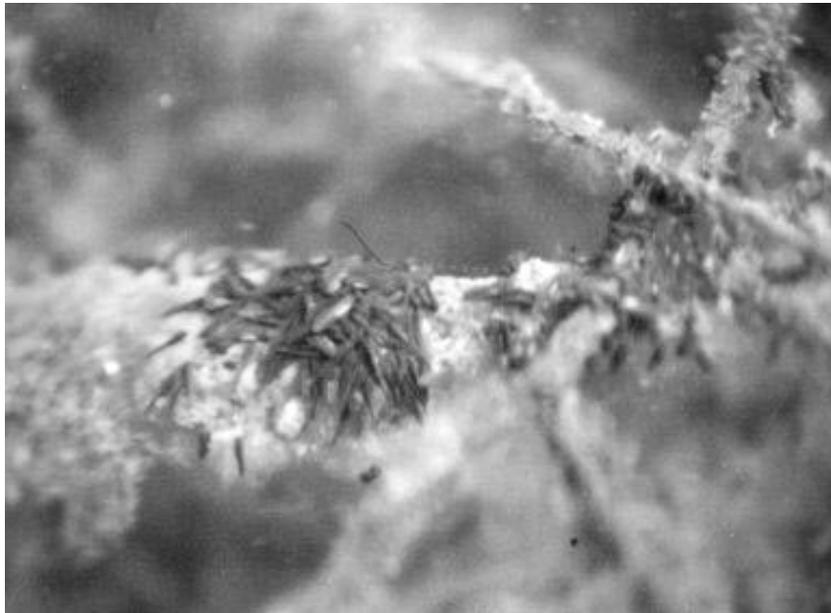


Figure 10. After hatching, the first larvae of stage 26.

Table 2. The mean lengths (in millimeters) of developing *P. caucasicus* larvae, with their standard errors (SE).

Days	N	Date	Mean Total Length \pm SE
1	10	27 July	5.34 \pm 0.22
2	10	28 July	6.39 \pm 0.33
3	10	29 July	7.05 \pm 0.04
4	10	30 July	7.18 \pm 0.14
5	10	31 July	8.00 \pm 0.12
6	10	1 August	9.63 \pm 0.26
7	10	2 August	10.5 \pm 0.08
8	10	3 August	11.0 \pm 0.75
9	10	4 August	11.9 \pm 0.73
10	10	5 August	13.0 \pm 0.36
15	10	10 August	14.2 \pm 0.45
21	10	16 August	17.1 \pm 0.67
22	10	17 August	22.44 \pm 1.88 (4-legged stage)
31-35	10	26-30 August	15.74 \pm 1.81 (SVL)

In field conditions, the gill development stages of the larvae are given in Figure 11, the development of hind leg stages in Figure 12, the development of teeth rows in Figure 13, and the loss of tail stage in Figure 14.

Discussion

Of the Palearctic herpetofauna, *Pelodytes* is one of the least known genera from the viewpoint of breeding biology, and the breeding season of its 2 other species, *P. punctatus* and *P. ibericus* (formerly as *P. punctatus*), extends from mid March to mid May (Toxopeus et al., 1993). According to several authors (Chanturishvili, 1940; Bannikov and Drozdov, 1975; Lukina and Koneva, 1977; Golubev, 1985; Tuniev, 1985; Vysotin and Tertchnikov, 1988; Kuzmin, 1995; Gokhelasvili, 1998), most *P. caucasicus* populations from the Caucasus have a typically lengthened breeding period. Chubinishvili et al. (1995) reported that its breeding season extended from the second half of May to the end of September in a population from Borjomi Canyon, western Caucasus. According to Tarkhinishvili and Gokhelasvili (1999), the breeding season extends from May to November at Sochi, on the coast of the Black Sea, and at altitudes higher than 1500 m the spawning continues during July and August, while at an altitude of 2000 m, only in August. In the Uzungöl population, the same season extended from the mid July to mid September.

P. caucasicus demonstrates an inguinal amplexus, similar to that of *Pelobates syriacus* (Boetger, 1889) reported by Çaydam (1974).

Chubnishvili et al. (1995), and Tarkhinishvili and Gokhelasvili (1999) reported a positive correlation between a female's size and the number of eggs in a clutch. The mean number of eggs in a clutch of *P. punctatus*, the smaller sized species of *Pelodytes*, is 360 (Toxopeus et al., 1993). It was also reported that the number of eggs spawned by a *P. caucasicus* female changed with altitude, e.g., fewer eggs near sea level and more eggs in higher environments (Lukina and Koneva, 1977; Tuniev, 1989). Franzen (1999) reported 58-223 eggs within the clutches of *P. caucasicus*. The present study established the number of eggs spawned by Uzungöl females at an altitude of 1100 m to be 440-492, depending on the female's size, a finding in accordance with the results reported by Chubinishvili et al. (1995), and Tarkhinishvili and Gokhelasvili (1999).

Diameter of the Uzungöl eggs was 1.50-1.90 mm (mean 1.71 mm), which is close to the values given for *R. ridibunda* and *P. syriacus*, smaller than those of *B. bufo*, and larger than those of *B. viridis* (Laurenti, 1768) and *H. arborea* (Çaydam, 1974).

In *P. punctatus*, which was reported to have rather rapid embryonic and larval development, the embryonic development until hatching took 4-14 days, depending on the ambient temperature, and metamorphosis was completed in approximately 70 days (Diaz-Paniagua, 1988; Toxopeus et al., 1993). According to Tarkhinishvili and Gokhelasvili (1999), and Franzen (1999), in *P. caucasicus* populations of the western Caucasus, at water temperatures of 12-15 °C, larval development begins 7-10 days following spawning, usually proceeds to Gosner stages 31-35, then the larvae hibernate until spring-summer months of the following year. In the Uzungöl population, with approximate air/water temperatures of 24/15 °C, the larvae hatched 5 days after spawning and completed their metamorphosis in 31-35 days, and then moved onto land. However, some non-metamorphosed larvae were observed near the edges of spawning pools at the beginning of the breeding season (July); obviously, they were hibernating larvae of the previous season. Notwithstanding this observation, compared with the majority of other Palearctic anurans, it appears that embryonic and larval development is usually quite rapid in *P. caucasicus*.

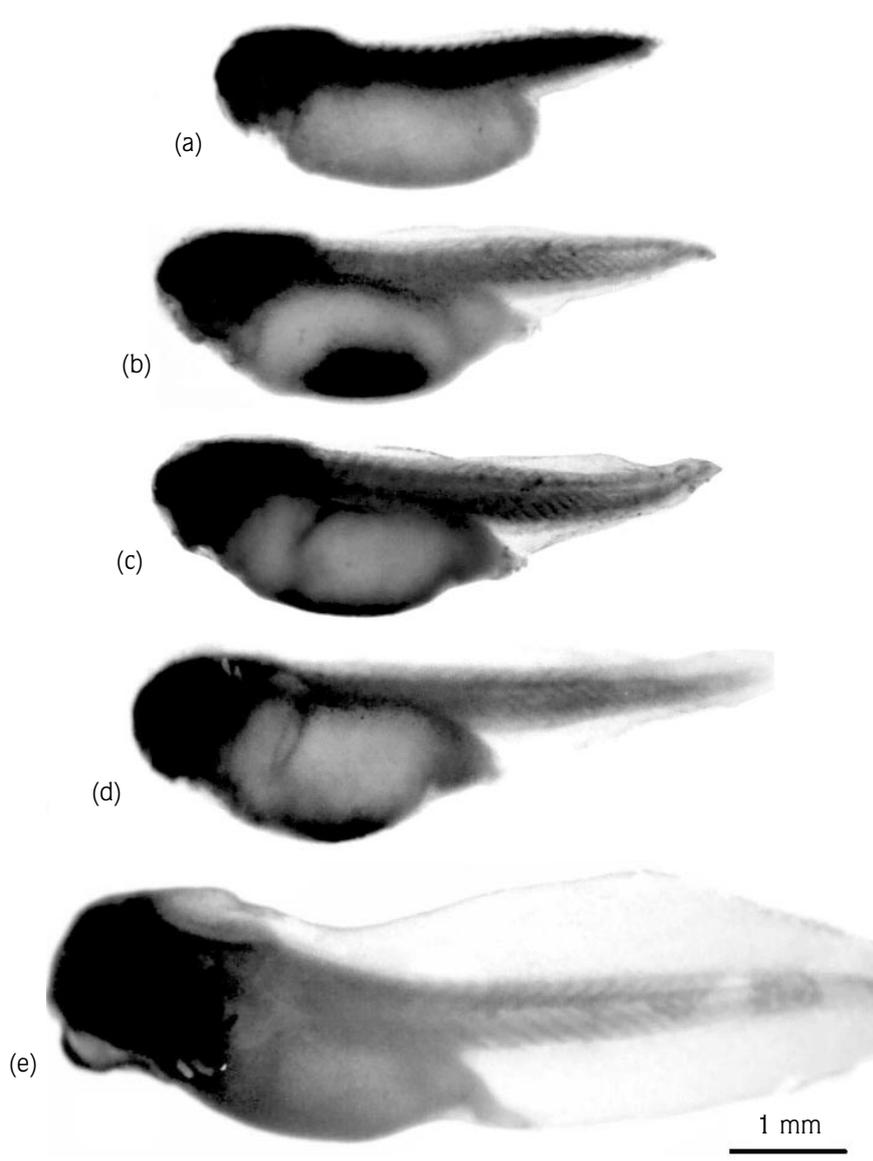


Figure 11. Some stages of embryonal development. (a): stage 18, the initial muscular response; (b): stage 19, the initial heartbeat; (c): stage 21, transparent cornea is visible (day 4); (d): stage 22, blood circulation is visible in the tailfin (day 5); (e): stage 24, operculum is beginning to form (day 7).

Last but not least, we would like to point out the necessity of conserving the breeding grounds of *P. caucasicus*, an endemic species, which is found in Turkey only in the Eastern Black Sea region. The environment of

the crowded Uzungöl population is an optimal breeding ground for the species; therefore, conservation of the natural structure of Uzungöl is of vital importance for the future survival of the species.

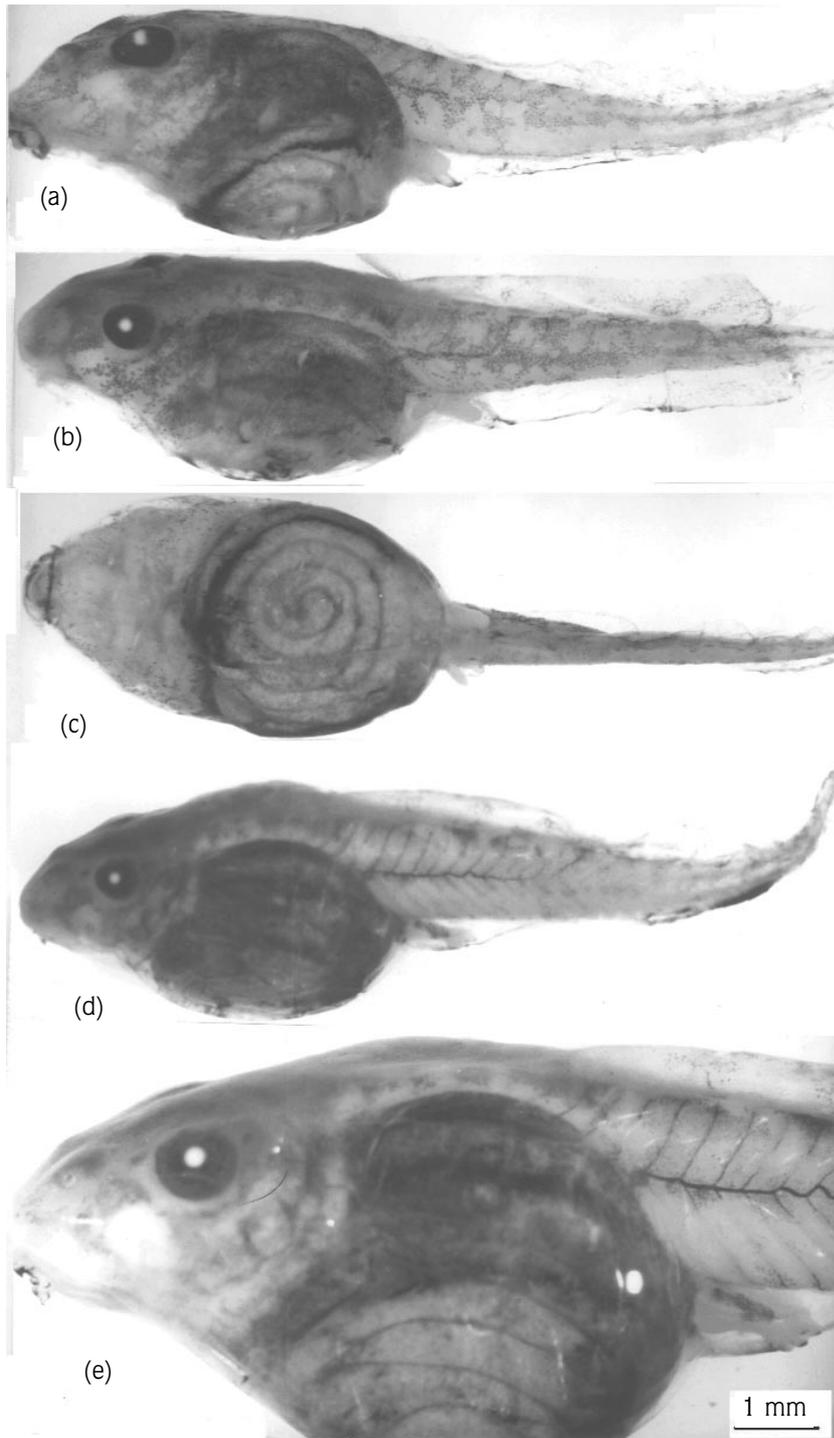


Figure 12. Some stages of larval development. (a): stage 27, the hind leg bud is visible; (b): stage 30, hind leg bud length is twice its diameter; (c): stage 31, no interdigital indentation visible in hind leg bud; (d): stage 35, indentation visible between the first and second digits; (e): stage 36, first and second digits fused, the others separate.

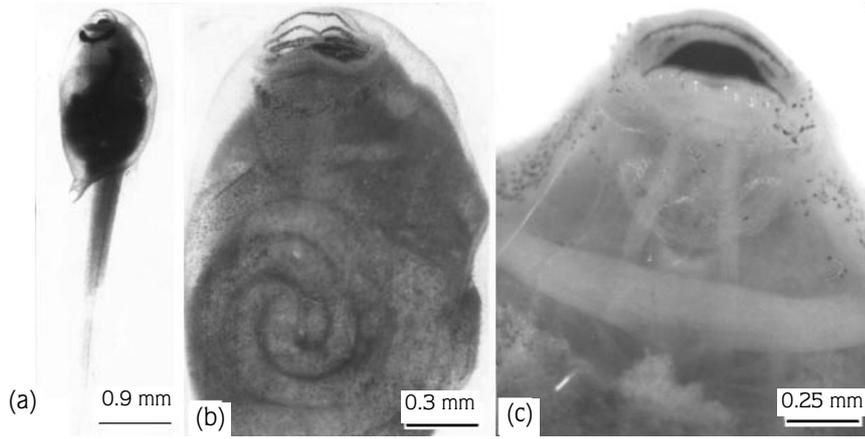


Figure 13. Some stages of the late larval development. (a): stage 41, mouth cilia, attachment apparatus, and foreleg buds are visible under a transparent skin cover; (b): teeth rows at the end of stage 41, foreleg buds develop; (c): teeth rows at stage 42.

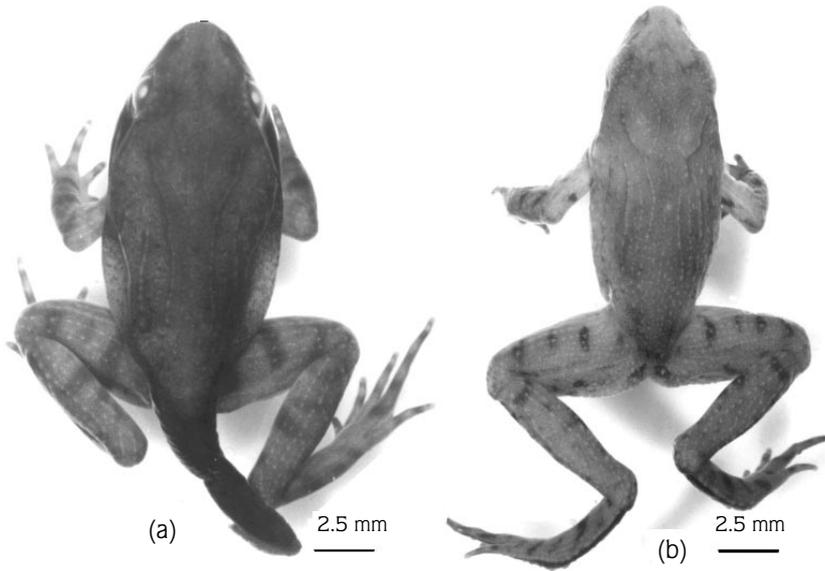


Figure 14. Dorsal aspects of (a): stage 43 tailed larva (day 35) on land; (b): newly metamorphosed stage 46 tailless juvenile.

Acknowledgments

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