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First Description of Egg Sacs and Early Larval Development in Hynobiid Salamanders (Urodela, Hynobiidae, *Batrachuperus*) from North-Eastern Iran

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Abstract. - Here we present the first life history data from a natural habitat on the clutch and from the laboratory on the early embryonic development of an Iranian hynobiid salamander (the Eastern nominal taxon, *Batrachuperus gorganensis*). We compare these observations with those of other hynobiid species. The egg sac of *B. gorganensis* varied from 80 to 182 mm (mean 132.5), and in width from 16 to 22.5 mm (mean 18.9). Single sacs, the largest known for the genus, contained 31-52 eggs (mean 37.4) in four rows per cross section. Egg sac data are more similar to those of *Ranodon sibiricus* (and *B. mustersi*) than to Eastern *Batrachuperus* (*longdongensis*, *tibetanus*, *pinchonii*, *karlschmidti*, *yenyuanensis*), which have strings of single eggs. As is typical of all *Batrachuperus*, eggs of *B. gorganensis* are non-pigmented. Embryonic *B. gorganensis* larvae may exhibit rudimentary balancers, possibly like those of *Ranodon sibiricus*, but further investigation is necessary. Detailed morphometric measurements of the larvae of *B. gorganensis* and color photographs of some developmental stages are presented.

Key words. - Hynobiidae, *Batrachuperus*, *Batrachuperus gorganensis*, *Batrachuperus persicus*, *Batrachuperus mustersi*, *Ranodon sibiricus*, Iran, egg sacs, embryonic development, larvae, balancer, taxonomy, morphometrics.

Introduction

The southwestern-most representatives of the salamander family Hynobiidae occur within the narrow, East-West oriented Hyrcanian Corridor (= Hyrcania) of Northern Iran. The corridor is a "unique relict biogeographic area," which is "well defined as the south-western and southern shores of the Caspian Sea ..." and is "one of the most clearly defined and delineated provinces in the Irano-Turanian region" (Fet, 1994). The Persian mountain salamander, *Batrachuperus persicus* Eiselt and Steiner, 1970, was based on larvae collected from the western part of Hyrcania (NW-Iran, mountains near Asalem, Gilan province; Eiselt and Steiner, 1970). Subsequently, specimens that metamorphosed in captivity were described and several additional localities were reported (see Schmidtler and Schmidtler, 1971; Steiner, 1973).

The second nominal taxon, *Batrachuperus gorganensis* (Clergue-Gazeau and Thorn, 1979), was described from a single adult male type discovered in a cave from the eastern edge of the Hyrcanian Corridor (Clergue-Gazeau and Farcy, 1978). Baloutch and Kami (1995), Kami and Vakilpoure (1996) as well as Kami (1999, 2004) published additional data on the biology and distribution of Iranian hynobiid salamanders, all assigned to *B. persicus*. Stöck (1999) provided a flow-cytometric DNA measurement (34.77 pg, but based on GC-biased DAPI-staining, see also Litvinchuk et al., 2004) and a Giemsa-stained karyotype (2n = 62) of topotypic *B. gorganensis* (i.e. the eastern taxon). Stöck also described external larval changes during the development from 40 mm until metamorphosis (100 mm), and reviewed previous papers (see also map with geographic coordinates of all previously published localities – Stöck, 1999: Fig. 1). After examination of topotypic subadults and larvae of both taxa as well as morphometric comparisons with *B. mustersi, B. pinchonii,* and *Ranodon sibiricus*, Stöck considered a clinal variation of characters between the western (*B. persicus*) and the eastern nominal taxon (*B. gorganensis*) possible (see also Thorn and Raffaëlli, 2001: 122). However, molecular and cytogenetic data as well as a continuous examination of the morphological variation throughout the Hyrcanian corridor are lacking.

Both nominal Iranian taxa (cf. Anderson, 1985; Brame, 1985: 567; Duellman and Trueb, 1986: 497; Thorn and Raffaëlli, 2001) are considered two out of currently nine species of the genus *Batrachuperus* (Frost, 2002). Risch (1984) regarded *gorganensis* to belong to a separate genus (*Paradactylodon*; see Reilly, 1987). While the molecular phylogeny of eastern

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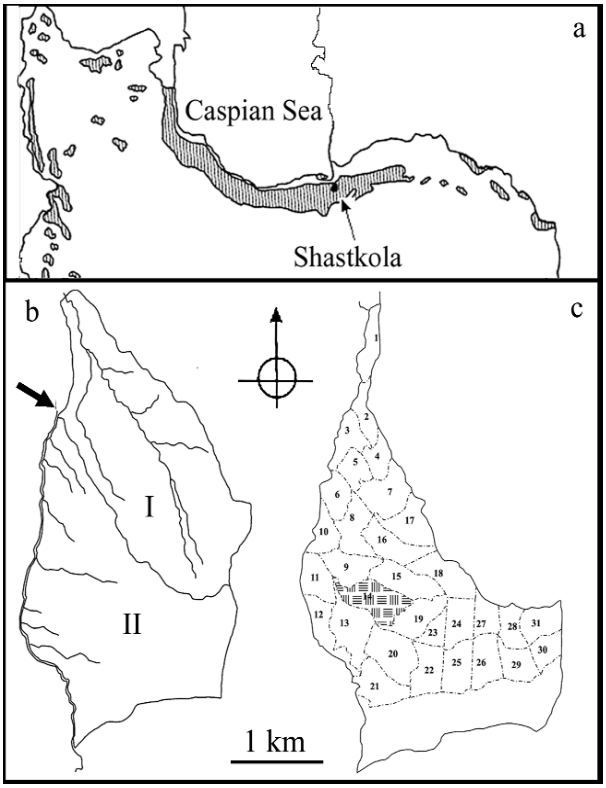

Figure 1. Locality: **a**. Sketch map of northern Iran with its forested regions and the study area, the educational forest of Shastkola; **b**. Shastkola forest with districts I and II and streams. The left arrow marks the Shastkola river; **c**. District II of Shastkola forest shown in (b) with its 31 land parcels, the spring of Manzoulak is situated in parcel 14.

Batrachuperus has been examined (Fu et al., 2001), molecular comparisons of their relationships with Western *Batrachuperus* and *Ranodon* as well as between the latter taxa are not yet available. However, unpublished results (Macey et al. in prep., with phylogram presented in Larson et al., 2003: 44, Fig. 2.4) provide evidence that Iranian *Batrachuperus* may be more closely related to *Ranodon* (Kazakhstan, China) and *B. mustersi* (Afghanistan) than to the Eastern *Batrachuperus* species (Tibet, China). *Ranodon sibiricus* has five toes on the hind limbs while *B. mustersi,*and *B. persicus*/*B. gorganensis* have only four. However, the intraspecific variation found by Reilly (1983) in *B. mustersi*, which sometimes has five instead of four toes, demonstrates how ambiguous this character can be.

In general, there is still a lack of biological data on the Iranian taxa, e.g., their egg sacs and early larvae have never been examined. Only remains of egg cases of *B. persicus* were found by Steiner (1973) in late July in the Central Elburz range and the reports on larvae start from a minimum size of 22.7 mm (Central Iran; Steiner, 1973) and "about 30 mm" (NW-Iran, Schmidtler and Schmidtler, 1970). Here we present the first data on the clutch of the Eastern Hyrcanian hynobiid taxon (*B. gorganensis*) from a natural habitat. We add some data on its development in the laboratory and compare these observations with the features known from other hynobiid species.

Results and Discussion

Spawning site. - All clutches (Table 1) were found in Cheshme-ye (= spring of) Manzoulak (36°42′ N, 54°21′ E), which flows into an artificial pond (3.20 x 2.15 x 1.25 m). Its bottom is covered with a thick layer (*ca.* 15 cm) of tree leaves. Some crabs (*Potamon* sp.) and larvae of Odonata, Trichoptera, Coleoptera, Ephemeroptera were observed. Manzoulak spring is one of the important water resources of the Shastkola educational forest (3716 ha), which is situated 13 km South-West of Gorgan city between 36° 41′- 36° 45′ N and 54° 20′ - 54° 24′ E, on the northern slopes of the Elburz mountains (Fig. 1). These mountains reach elevations ranging from 240 m, above the Caspian Sea in the North to 2168 m (Gholle-ye-leila Kouh). Shastkola forest is divided into two organizational units, districts I (1698.6 ha) and II (2017.4 ha). The spring is situated in II [Fig. 1c, land parcel 14 (75 ha), 650 m to 830 m]. Outcrops consist mainly of a sequence of sandstones and schist in the lower part and Triassic sand stones in the upper parts. Shastkola forest has a Caspian climate, and the nearest climate station is Gorgan (155 m a.s.l.). However, local climate at the breeding site differs considerably from that at the foothills and we currently have no detailed climatic data on the site. Water temperature during collection was below 10°C. The forest tree and shrub species include *Fagus orientalis, Carpinus betulus, Parrotia persica, Ruscus hyrcana, and Ilex aquifolia* (for further information: Azadfar, 1994; Azadfar and Darghahi, 2002), which adds to the accumulating evidence that the Iranian hynobiid taxa inhabit humid regions mainly overgrown with the plant assemblage *Fagetum hyrcanum* in lower elevations in the West of their range: *Parrotio-Carpinetum*; in eastern parts of the Elburz N-slope: *Carpinetum orientalis*, *Quercus macranthera*; see also ref. in Stöck, 1999).

Description of clutches, eggs and larvae. - About 70 clutches and four adult salamanders were discovered when leaves were removed from the pond by G. Yolmeh on January, 28, 2002, but only two of the clutches and one adult specimen (total length: 211 mm) were sent to the Museum of Zoology of Gorgan University (ZMGU). In the following year on February, 8, 2003, one complete and two incomplete clutches were collected in the same pond by M. Ebrahimi and G. Soltanpour. We presume that spawning, at least at this site, happened between the second half of January and the first days of February.

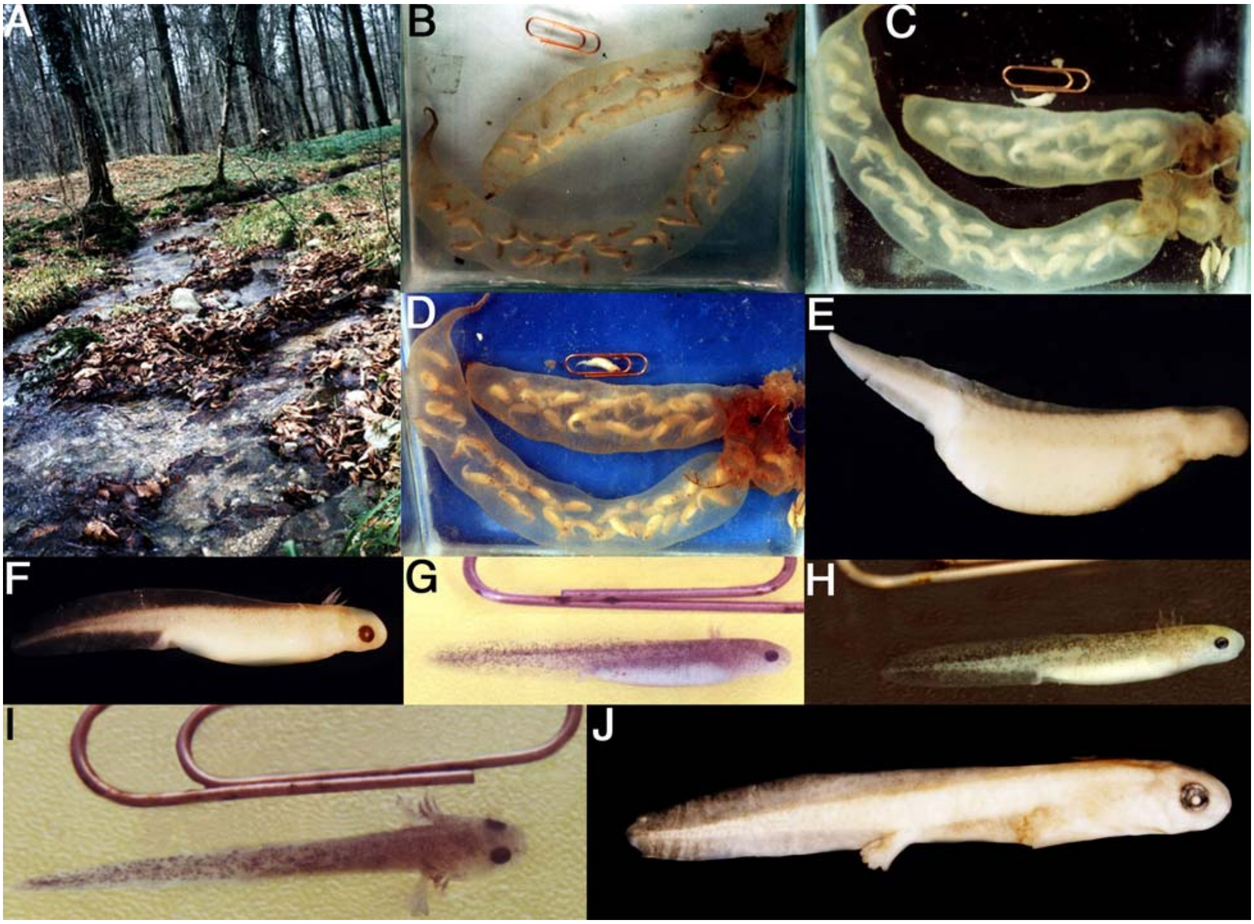

Figure 2 (A-J). **A**. Natural habitat of *Batrachuperus gorganensis*. Stream near Manzoulak spring, photograph taken: March, 10, 2003. **B**. Clutch, preserved, collection date: March, 10, 2003, photograph taken: April, 6, 2003. **C**. Clutch, collection date: March, 10, 2003, photograph taken: April, 4, 2003. **D**. The same clutch as in C, collection date: March, 10, 2003, photograph taken: April, 4, 2003. **E**. Fixed embryo, 7 days before hatching, photograph taken: October, 9, 2003. **F**. Fixed larva, 4 days after hatching, photograph taken: October, 9, 2003. **G**. Living larva, 18 days after hatching, photograph taken: April, 6, 2003. **H**. Living larva, 18 days after hatching, photograph taken: April, 6, 2003. **I**. Living larva, 24 days after hatching, photograph taken: April, 6, 2003. **J**. Fixed larva, 34 days after hatching, photograph taken: October, 9, 2003.

However, in general, the breeding season in both Iranian nominal taxa might last as long as in some other Hynobiids (e.g. in *Ranodon sibiricus* from the end of April until the beginning of August - Kuzmin, 1995: 111; from May to beginning of August in *B. karlschmidti* - Liu, 1950: 91).

During collection, some egg sacs broke. Originally, the clutches were attached by their stalks to a stone at the corner of the pond; no egg sacs were observed on its walls. As is usual in *Batrachuperus*, each clutch consisted of two asymmetrical, colorless, cylindrical gelatinous sacs that were connected by gelatinous filaments forming an attaching stalk and had free filaments at their nonanchored conical ends. As in *Ranodon sibiricus* (see Kuzmin, 2001: 40), egg sac data varied between and within clutches (see Fig. 2 B-D; Table 1). Each cylindrical gelatinous sac contained four rows of eggs per cross section and each egg was surrounded by a spherical gelatinous envelope. As is known from *Ranodon sibiricus* (see Kuzmin and Thiesmeier, 2001: 42 and ref. therein), these four egg rows produce a tetrahedral shape immediately after clutch deposition. However, as the result of an ingress of water, sacs later strongly increase in size. We believe that all discovered clutches had already finished this first swelling, which usually gradually continues throughout the embryonic development leading to a considerable enlargement of the sacs until hatching. Tables 2 and 3 show comparisons of egg sac length and width of eight hynobiid species. Data on length and width should be evaluated with some reservations, because the number of specimens examined or time after clutch deposition is imperfectly known. However, egg sacs of *B. gorganensis* probably are larger than those of any of the close relatives of the taxon (with the possible exception of *B. longdongensis*) and appear to contain among the highest number of eggs per

Table 1. Overview of described clutches of *Batrachuperus gorganensis*.

Date of collection	Number of egg sacs	Length of gelatinous egg sac (mm)		Maximum width of gelatinous egg sacs	Total number of eggs per sac		Date of hatching	Live hatched larvae	
		Left	Right		Left	Right		N	%
January, 28, 2002	1	95	102	16.5	9+9+10+11=39	9+9+8+9=35	Fixed	-	-
	2	80	81	15.8	34	35	Fixed	-	-
February, 2, 2003	1	150.5	172.6	-	31	38	March, 19 to 24, 2003	51	74
	2	182.5	destroyed	20.8	32	40	All died	-	-
	3	181	181.8	22.4	38	52	March, 19 to 24, 2003	64	71.1
	4	-	-	-	Small part of an egg sac,	18	Fixed	-	-
	5	100.9	-	-	Small part of an egg sac,	30	March, 21 to 24, 2003	28	93.3

sac (Table 4). In addition, *R. sibiricus* and *B. gorganensis* share the common feature of four rows of eggs per cross section in an egg sac, while all Eastern taxa (*B. longdongensis, B. tibetanus, B. pinchonii, B. karlschmidti, B. yenyuanensis*) seem to have only a single row of eggs in an egg case (judging from photographs and Zhao and Hu, 1988: 32). This feature remains obscure in *B. mustersi*, since neither Reilly's (1983) description nor Nawabi's (1965) photograph resolve the question satisfactorily, but more than a single row appears to be present. Egg number may be a taxonomic character but might not affect fecundity since some species seem to deposit more than one clutch per breeding period (Liu, 1950; Reilly, 1983).

The diameter of the initially yellowish (as in all *Batrachuperus* and *R. sibiricus*) eggs varied from 4.10 to 5.00 mm (mean 4.56; n = 10) when the clutch was found. The early eggs had a white animal pole whereas the vegetal pole was pigmented gray. Unfortunately, early eggs were not photographed. The separation of eggs in a row was less than the diameter of an egg. Egg number varied from 7 to 11 per row (2 egg sacs examined) and from 31 to 52 in each sac (see Table 1). The eggs have substantial amounts of yolk, as also is typical of stream-breeding *R. sibiricus* (Kuzmin and Thiesmeier, 2001).

Three complete clutches and one incomplete clutch were kept in a refrigerator at 5-7°C (for conditions see Stöck, 1999). The first larvae to hatch were found on March, 19, 2003, and the latest specimens to hatch were observed on March, 25, 2003 (i.e. 40 to 46 days after discovery, respectively). Some larvae at different developmental stages were fixed in 4% formalin and 70% alcohol and measurements were taken from all specimens (summarized in Table 5). We report some larval developmental traits and link them by inserting the approximate stage (see inserted number in […]) of normal development for *Ranodon sibiricus* drawn by Kuzmin and Thiesmeier (2001: 46, after the description of Lebedkina, 1964).

Hatching larvae [stage 1] exhibited limb buds (Fig. 2F). Although no balancers were observed in hatched larvae (Fig. 2F), we believe that a rudimentary structure observed in an embryo fixed 7 days before hatching (Fig. 2E) could be a balancer. These enigmatic, ephemeral larval organs, found in three of the ten families of salamanders (Crawford and Wake, 1998), are present in many species of Hynobiidae (Crawford and Wake, 1998: 115). In the presumed close relative of the Iranian hynobiids, *B. mustersi* (see introduction), distinct balancers are well documented (Nawabi, 1965, see also Reilly, 1983). Although such a well developed

Table 2. Egg sac length of eight* hynobiid species, comparison of available data on *Batrachuperus mustersi* from Nawabi (1965), Reilly (1983), and Sparreboom (1979); on *R. sibiricus* (from Brushko and Narbaeva 1988, cited from Kuzmin and Thiesmeier 2001); *B. gorganensis* (our data); *B. longdongensis*, *B. tibetanus*, *B. yenyuanensis* from Fei and Ye (2001), *B. pinchonii* and *B. karlschmidti* from Liu (1950) and Fei and Ye (2001); in *R. sibiricus* numbers in parentheses show rare values in late stages of embryonic development (* some authors synonymized *B. karlschmidti* with *B. tibetanus*, but see Fu et al. 2001 and Frost 2002).

	B. gorganensis	*R. sibiricus*	*B. mustersi*	*B. longdongensis*	*B. pinchonii*	*B. karlschmidti*	*B. tibetanus*	*B. yenyuanensis*
Mean	**132.48**	?	**96.62**	-	-	**96.6**	-	-
Max	182	100 (390)	150	200	96	96	140	125
Min	80	65 (100)	60	-	65	75	102	70
N	10	10	13	-	-	5	-	-

Table 3. Egg sac width of eight hynobiid species, comparison of available data; same sources as in table 2; the only available value for *R. sibiricus* is from an egg sac of 72-75 mm length.

	B. gorganensis	*R. sibiricus*	*B. mustersi*	*B. longdongensis*	*B. pinchonii*	*B. karlschmidti*	*B. tibetanus*	*B. yenyuanensis*
Mean	**18.88**	**(23)**	**21.02**	-	-	**16.6**	-	-
Max	22.4	-	27.0	15	12	19	10	8
Min	15.8	-	13.2	-	19	14	12	15
N	10	-	13	-	-	5	-	-

organ is absent in *Ranodon sibiricus* (cf. Crawford and Wake, 1998: 115), the presence of rudimentary balancers in the species appears possible. Regel (1968: 17, see "pb" in her Fig. 7, transl. from Russian) wrote on *R. sibiricus* larvae in developmental stage 3 (15-17 mm): "On the lateral surface of the distal end of the palatinoquadratum cartilage an excrescence develops, which is a rudimentary proc. balancer (Rusconi's hook)". Although balancers are not cartilaginous structures, Kuzmin and Thiesmeier (2001: 43) quote this as an indication of rudimentary balancers in *Ranodon*. Based on these observations, we believe that at least rudimentary balancers will be found in *B. gorganensis* (and *B. persicus*?), and we recommend further comparative investigation with histological methods. Secondary loss of well developed balancers may be an adaptation of the "limnophilous mountain brook type" of larvae in *B. gorganensis / B. persicus* (discussed in Stöck, 1999: 237). According to available data, balancers may be absent in all species of *Batrachuperus* from China and Tibet (Table 4).

In larvae eight days after hatching (d.a.h.) [stage 2-3], the head had differentiated and forelimbs had a shovel-like form, but only hind limb buds were visible. The yolk sac regressed and was very small in larvae 14 d.a.h. (April, 2nd, 2003). In larvae 16-18 d.a.h. [stage 6-7] (Fig. 2G-H), the yolk sac had disappeared, dark spots became visible at the back, and the tail fin developed, although development of the digits was incomplete (April, 4, 2003). In larvae 24 d.a.h. [stage 8-9] (Fig. 2I), digits were well developed in forelimbs, but the toes of hind limbs were still incomplete (April, 12, 2003). In larvae 34 d.a.h. [stage 12] (Fig. 2J) the forelimbs were completely developed, digits were clearly distinguishable, and tips of all digits and toes exhibited brown horny claws. The ventral surface had a milky color, the upper part of the tail and the tail fin showed dark spots, and the eyes appeared completely developed. Through time, the dark spots became more abundant at the tip of tail, and the mouth. Darkly pigmented dots appeared on part of the head and trunk, the flanks, the upper parts of the tail, and the upper tail fin. At this stage, larvae were fed with nauplius larvae of *Artemia*. In larvae 46 d.a.h., the belly remained spotless, but the flanks, dorsal body parts and upper parts of the tail showed dark spots. Larvae 62 d.a.h. exhibited brownish spots on the body and dark spots became rarer (larger larvae had golden dots on the gills and on parts of the body). The anterior part of the upper tail fin extended to the occiput.

In addition to the clutches described above, more than 20 large larvae with a total length of almost 10 cm were collected in the leaves of the breeding pond, but only one adult specimen was found. The pond was searched completely, but no larvae smaller than about 10 cm were found. Therefore, we conclude that all these large larvae apparently stemmed from the preceding year. The growth rate data of the larvae hatched from the clutches in our laboratory fit well with the later developmental stages reported by various previous authors from natural habitats (summarized in Stöck, 1999: Tab. 3).

Table 4. Number of eggs per sac, number of egg rows per cross section and presence of a balancer of eight hynobiid species, comparison of available data; same sources as in table 2, except for *B. longdongensis* in which the character was inferred from the ovary of voucher MVZ 208610.

	B. gorganensis	*R. sibiricus*	*B. mustersi*	*B. longdongensis*	*B. pinchonii*	*B. karlschmidti*	*B. tibetanus*	*B. yenyuanensis*
Mean	**37.40**	**23.00**	**22.23**	-	-	-	-	-
Max	52	44	31	-	23	12	25	13
Min	31	7	13	-	5	7	16	6
N	10	150	13	-	-	5	-	-
Rows of eggs per cross section	4	4	>2	1(-2)?	1	1	1?	1?
Balancer	rudimentary	rudimentary?	well developed	No?	No?	No	No?	No?

d.a.h.		total length	head length	body length1	body length2	tail length	head width	eye diame-ter	min. dist. eye to snout	foreleg length	hind leg length	distance between feet	max hight dorsal fine	distance snout to ant. point dorsal fin	number of recognized costal grooves	mass (g)
1	MEAN	19.28	2.40	11.05	11.63	7.49	2.54	0.73	0.89	0.65			1.04	4.01		0.05
1	MIN	19.05	2.25	10.80	11.40	7.06	2.00	0.67	0.77	0.50			1.00	3.50		0.05
1	MAX	19.61	2.50	11.40	11.80	7.80	2.95	0.80	0.97	0.80			1.05	5.00		0.05
1	SD	0.28	0.11	0.25	0.17	0.37	0.40	0.06	0.09	0.15			0.03	0.67		0.00
	N = 4 (1)															
4	MEAN	19.30	2.67	11.00	11.73	7.37	2.45	0.77	0.90	0.65			1.12	3.50		0.05
4	MIN	18.50	2.40	10.50	11.20	7.00	2.30	0.70	0.90	0.55			1.10	3.00		0.04
4	MAX	19.79	2.90	11.40	12.10	7.60	2.65	0.85	0.90	0.80			1.15	4.00		0.06
4	SD	0.70	0.25	0.46	0.47	0.32	0.18	0.08	0.00	0.13			0.03	0.50		0.01
	N = 3 (1)															
8	MEAN	21.76	2.79	12.11	12.73	8.86	3.19	0.96	1.06	1.34			1.33	5.09		0.07
8	MIN	21.27	2.25	11.80	12.20	8.40	2.75	0.90	0.90	1.00			1.10	4.75		0.06
8	MAX	22.20	3.60	12.50	13.00	9.40	3.50	1.02	1.22	1.70			1.50	5.50		0.08
8	SD	0.30	0.53	0.27	0.29	0.37	0.26	0.04	0.11	0.23			0.12	0.23		0.01
	N = 8 (1)															
14	MEAN	24.61	3.28	13.68	14.44	10.15	3.61	1.03	1.22	2.14	0.70	7.97	1.45	5.90		0.10
14	MIN	23.13	2.65	12.76	13.50	9.50	2.90	0.95	1.00	1.50	0.55	7.45	1.35	4.00	11	0.09
14	MAX	25.53	3.70	14.00	14.90	10.70	4.10	1.10	1.45	2.60	0.90	8.25	1.60	8.00	14	0.12
14	SD	0.92	0.39	0.41	0.53	0.44	0.47	0.06	0.14	0.35	0.14	0.26	0.09	1.29		0.01
	N = 7(1)															
16	MEAN	27.06	4.03	14.65	15.54	11.47	3.86	1.19	1.36	2.72	1.39	8.37	1.49	6.56		0.12
16	MIN	26.45	3.25	14.10	15.10	10.36	3.50	0.95	1.00	2.00	1.00	8.15	1.40	5.05	12	0.11
16	MAX	27.93	4.40	15.54	16.65	12.00	4.00	1.30	1.55	3.10	1.55	8.60	1.55	8.15	14	0.15
16	SD	0.43	0.35	0.41	0.48	0.53	0.17	0.10	0.16	0.32	0.19	0.16	0.05	0.86		0.01
	N = 9															
19	MEAN	24.87	3.28	13.83	14.56	10.09	2.83	1.08	1.08	1.86	1.41	8.56	1.22	5.29		0.06
19	MIN	20.90	2.35	11.80	12.50	8.00	2.00	0.75	0.75	0.75	0.25	7.25	0.95	3.00	13	0.04
19	MAX	36.90	5.40	19.79	20.53	16.28	5.30	1.80	1.70	5.20	4.00	9.70	2.15	8.00	14	0.21
19	SD	4.28	0.80	2.04	2.10	2.32	0.88	0.29	0.28	1.21	1.22	0.88	0.30	1.69		0.04
	N =15 (3)															
24	MEAN	26.67	3.70	14.75	15.63	10.77	3.11	1.09	1.18	1.78	0.60	8.93	1.30	4.94		0.08
24	MIN	22.94	3.00	13.30	14.10	8.90	2.65	0.90	0.85	1.25	0.50	8.00	1.10	3.50		0.07
24	MAX	30.15	4.80	16.40	17.20	13.00	3.75	1.30	1.65	2.50	0.75	9.70	1.50	7.75		0.11
24	SD	2.58	0.76	1.26	1.22	1.49	0.43	0.17	0.27	0.44	0.13	0.86	0.14	1.53		0.02
	N = 6 (2)															
34	MEAN	30.46	4.68	16.33	17.12	13.10	4.15	1.43	1.67	3.15	1.91	8.95	1.58	6.92		0.13
34	MIN	29.04	4.20	15.20	16.10	12.10	3.80	1.25	1.50	2.30	0.80	8.40	1.50	6.00	12	0.11
34	MAX	32.74	4.90	16.90	17.60	14.20	4.50	1.65	1.80	3.80	2.85	9.50	1.70	8.50	12	0.16
34	SD	1.71	0.25	0.60	0.53	0.79	0.26	0.16	0.13	0.62	1.00	0.42	0.08	0.97		0.02
	N = 6 (2)															
46	MEAN	31.69	4.42	16.58	17.56	13.95	4.18	1.40	1.59	3.53	2.19	8.92	1.45	7.83		0.10
46	MIN	28.12	4.00	16.00	16.80	12.30	3.30	1.15	1.20	2.10	1.00	8.50	1.25	7.00		0.07
46	MAX	33.80	4.75	17.57	18.68	15.30	5.00	1.60	1.90	4.55	3.70	9.50	1.65	9.00		0.13
46	SD	2.03	0.25	0.56	0.68	1.12	0.72	0.17	0.27	1.03	1.24	0.48	0.15	0.67		0.02
	N = 6 (3)															
54	MEAN	31.78	4.71	17.24	18.13	14.08	4.23	1.35	1.53	3.32	1.72	8.66	1.61	7.23		0.13
54	MIN	25.90	3.35	14.90	15.70	10.50	3.00	1.05	1.25	1.95	0.50	7.60	1.40	5.00	12	0.08
54	MAX	36.20	5.50	19.24	20.35	16.66	5.50	1.65	1.90	4.75	4.10	9.40	2.05	9.50	13	0.22
54	SD	3.69	0.73	1.65	1.78	2.26	0.94	0.22	0.26	1.03	1.14	0.51	0.22	1.57		0.05
	N = 8 (3)															
62	MEAN	34.65	5.50	18.52	19.43	15.60	4.90	1.38	1.53	4.12	2.40	9.40	1.92	7.90		0.24
62	MIN	31.82	4.60	16.70	17.60	13.50	4.30	1.15	1.25	3.35	1.60	8.70	1.55	7.50	12	0.16
62	MAX	37.20	6.00	20.35	21.27	16.65	5.40	1.50	1.75	4.60	3.20	10.00	2.25	8.60	12	0.32
	SD	2.70	0.78	1.83	1.84	1.82	0.56	0.20	0.26	0.67	0.80	0.66	0.35	0.61		0.08

Table 5 (previous page). Morphometric data on early larvae of *Batrachuperus gorganensis*.
d.a.h. = days after hatching; SD = standard deviation; Min = minimum; Max = maximum;
N = number of larvae measured (the value in parentheses shows from how many clutches the measured larvae originated)

According to these studies, larvae from the first season may reach a total length of 30 to 62 mm (*persicus*, between June and August) and 41 to 50 mm (*gorganensis*, mid of June), respectively, and must overwinter before they form "large larvae", which can enter metamorphosis in the following year.

Conclusions and Future Research

Our initial studies support the relationship of the three taxa *Ranodon sibiricus*, *Batrachuperus mustersi* and the Iranian hynobiid(s), i.e. *B. persicus* and *B. gorganensis*. These taxa have apparently more features in common than with the *Batrachuperus* taxa East of Tibet. In addition to the essential need for molecular data, it would be valuable and interesting to study egg deposition in the natural habitats in more detail and to collect data throughout the range of the Iranian hynobiid salamanders, especially from the central and western portions. During proof reading, one of us (HGK) provided information that MMTT 452, 453, and 454 are eggs of *B. persicus*, found near the road from Asalem to Khalkhal, collected May, 20, 1975, by M. Thireau, R. Khazaie and R. G. Tuck.

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