The endemic Iranian Cave-fish, *Iranocypris typhlops*: two taxa or two forms based on the mental disc?

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Abstract. The objective of this study was to investigate morphometric and meristic characteristics of *Iranocypris typhlops*, comparing new material having a mental disc with those lacking a disc. 24 morphometric and 9 meristic variables were measured. Statistical analyses used cluster and discriminant methods, which showed significant morphometric differences between the two groups (Wilk's Lambda, $p<0.05$). Additionally, fish with a disc had less pectoral and pelvic rays compared to fishes without a disc. Fishes without a disc generally had a bipartite swimbladder; in contrast, fishes with a disc had unipartite and bipartite swimbladders in an equal ratio. There may also be some differences in feeding habits between these two groups. Fish with a disc can attach to and graze on the substrate. A significantly longer intestinal length in fishes with a disc may also be indicative of a detrital feeding habit.

Key words. Iranian cave-fish, *Iranocypris typhlops*, mental disc, morphology, multivariate analysis.

Introduction

The Iranian Cave-fish *Iranocypris typhlops* (Persian name Mahi-ye Kur-e ghar) belongs to the family Cyprinidae and was discovered by E. W. KAISER in 1937 (BRUUN & KAISER 1944). It is found in a well-like pool, the natural outlet of a subterranean limestone system of the Zagros Mountains in the Ab-e Sirum or Ab-e Serum Valley near Tang-e Haft railway station in Lorestan Province, south-west Iran (BRUUN & KAISER 1944, SMITH 1953, MOVAGHER 1973, GREENWOOD 1976, COAD 1996, PROUDLOVE 1997). The pool is at 33°04'N, 48°36'E and lies at an altitude of 740 m in an oasis named Baq-e-lavan or Bagh-e Loven. The pool lies in the Dez River drainage of the Tigris River basin.

These fishes have a pink body colour, are without eyes, have a rounded body and the head is somewhat flattened. They have two pairs of barbels; the first pair located on the upper lip and the other on the joint line between the upper and lower lips near the mouth corner. The mouth is sub-terminal. The body has scattered cycloid scales and an ill-defined lateral line. It is recognised as a vulnerable species according to the IUCN Red Data Book (IUCN 2007).

Recent observations have revealed the presence of a mental disc in some specimens. We decided to investigate morphometric and meristic characteristics of this species with and without a mental disc, in order to find out whether analysis of the two forms warrants designation of two taxa.

Material and methods

A total of 44 fishes were collected on three trips to the cave system and fixed in 96% ethanol. Nine specimens had a mental disc. Fig. 1 shows the heads of two fishes, with and without a disc.

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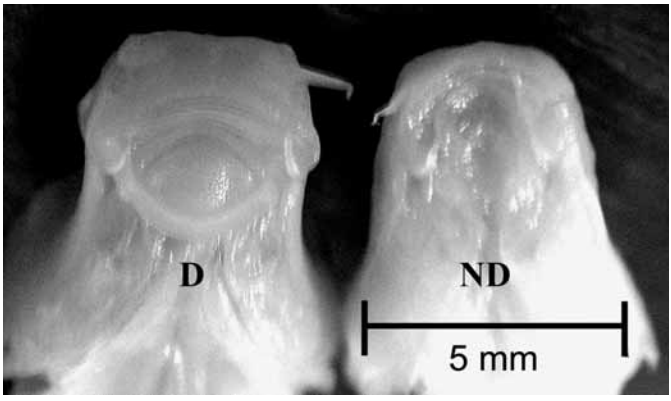

Fig. 1. Ventral view of fish head, with disc (D) and without disc (ND).

The sampling area is located 0.5 km from Baq-e-Lavan or Bagh-e Loven, 11 km from Tang-e Haft (Fig. 2).

Morphometric and meristic characteristics were used based on ABDOLI (2000). Morphometric variables and their abbreviations were as follows: Standard length (SL); head length (HL); snout length (SNL); head width (HW); head depth (HD); body depth [maximum] (H); distance between nostrils (INA); predorsal length (PD); prepectoral fin length (PP); preanal fin length (PA); preventral fin length (PV); postdorsal fin length (POD); length of dorsal fin (LD); depth of dorsal fin (HDO); length of anal fin (LA); depth of anal fin (HA); length of pectoral fin (LP); length of ventral [pelvic] fin (LV); depth of caudal peduncle (HPC); length of caudal peduncle (LPC); distance between pectoral fin base and ventral fin base (P-V); distance between ventral fin base and anal fin base (V-A); and distance between base of anal fin and base of caudal fin (A-C). The number of soft and hard rays of the anal, pectoral, ventral and dorsal fins were counted as meristic variables. In addition, the type of swimbladder (1 or 2 parts) and intestinal length (IL) were determined.

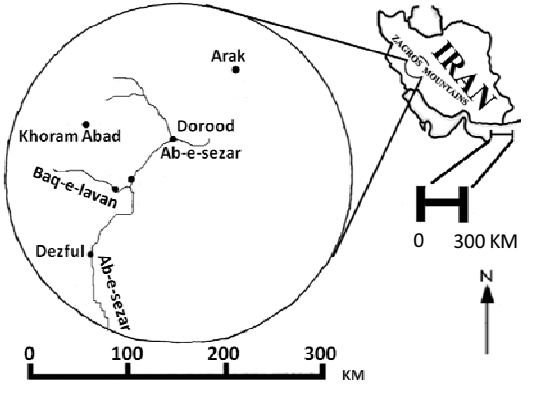

Fig. 2. Pool locality which is near Tang-e Haft railway station in Lorestan Province, south-west Iran.

Table 1. Comparison between SL/morphometric variable ratios via independent sample t-tests. The comparisons are between males and females which have a disc (D) or are without a disc (ND), respectively. NS: p>0.05; *: p<0.05; **: p<0.01; ***: p<0.001.

Variable	Sex	Mean ± standard deviation of the groups				Comparisons		
						Between genders, within groups		Between groups
		With disc (D)	Range (D)	Without disc (ND)	Range (ND)	(D)	(ND)	(D) (ND)
SL/HL	♂	3.34±0.25	3.12-3.73	3.13±0.22	2.69-3.32	NS	NS	NS
	♀	3.64±0.19	3.38-3.82	3.27±0.17	2.92-3.62			NS
SL/SNL	♂	7.70±0.52	6.81-8.10	8.08±0.75	6.80-8.97	NS	NS	NS
	♀	7.49±0.73	6.81-8.31	7.97±0.51	6.91-9.18			*
SL/HW	♂	4.97±0.10	4.84-5.08	4.73±0.25	4.21-4.96	NS	NS	NS
	♀	5.17±0.15	5.00-5.37	4.78±0.27	4.34-5.44			NS
SL/HD	♂	5.82±0.24	5.58-6.21	5.86±0.44	4.91-6.32	NS	NS	NS
	♀	5.10±0.24	5.76-6.23	5.90±0.37	5.35-6.92			NS
SL/H	♂	4.96±0.15	4.77-5.11	5.30±0.37	4.49-5.58	NS	NS	NS
	♀	5.10±0.40	4.80-5.64	5.34±0.50	4.51-7.24			*
SL/INA	♂	11.86±0.60	11.46-12.86	12.09±0.92	10.35-13.19	NS	NS	NS
	♀	12.21±1.02	11.19-13.26	11.66±0.64	10.23-12.85			NS
SL/PD	♂	2.56±1.79	1.50-5.75	1.88±0.14	1.61-2.04	NS	NS	NS
	♀	1.95±0.08	1.86-2.03	1.92±0.07	1.79-2.09			NS
SL/PP	♂	3.51±0.36	3.17-4.06	3.16±0.21	2.71-3.40	NS	NS	**
	♀	3.58±0.23	3.60-4.10	3.31±0.18	3.05-3.69			NS
SL/PV	♂	1.78±0.03	1.73-1.82	1.76±0.10	1.54-1.85	NS	NS	NS
	♀	1.81±0.06	1.75-1.86	1.78±0.05	1.70-1.86			NS
SL/POD	♂	2.83±0.19	2.57-3.10	2.59±0.97	0.42-3.10	NS	NS	NS
	♀	2.75±0.17	2.61-3.00	2.93±0.12	2.70-3.21			**
SL/LD	♂	6.94±0.53	6.34-7.49	6.50±0.36	5.73-6.76	NS	NS	NS
	♀	7.39±0.49	6.79-7.92	6.79±0.42	6.37-8.03			NS
SL/HDO	♂	4.73±0.39	4.38-5.38	4.48±0.23	4.03-4.69	NS	NS	NS
	♀	5.10±0.47	4.46-5.57	4.59±0.26	4.18-5.24			NS
SL/LA	♂	11.06±0.40	10.62-11.67	11.43±0.53	10.35-11.90	NS	NS	NS
	♀	11.12±0.31	10.70-11.42	11.45±0.54	10.13-12.34			*
SL/HA	♂	6.2±0.53	5.81-7.02	6.10±0.34	5.74-5.60	NS	NS	NS
	♀	6.77±0.67	5.98-7.45	6.20±0.40	5.77-5.95			NS
SL/LP	♂	4.98±0.20	4.78-5.32	5.33±0.29	4.71-5.60	NS	NS	*
	♀	5.27±0.05	5.19-5.31	5.35±0.39	4.90-6.91			NS
SL/LV	♂	6.15±0.41	5.70-6.81	6.43±0.35	5.67-6.74	NS	NS	NS
	♀	6.82±0.33	6.50-7.23	6.45±0.40	5.69-7.11			NS
SL/HPC	♂	10.50±0.20	10.27-10.68	10.31±0.66	9.91-11.28	NS	NS	NS
	♀	11.03±0.80	9.52-11.83	10.80±0.61	9.76-12.84			*
SL/LPC	♂	5.68±0.32	5.17-5.93	6.16±0.48	5.12-6..49	NS	NS	NS
	♀	5.51±0.51	5.10-6.23	6.08±0.35	5.20-6.54			**
SL/P-V	♂	3.23±0.49	2.42-3.66	3.54±0.14	3.26-3.69	NS	NS	NS
	♀	3.17±0.34	2.95-3.67	3.64±0.13	3.40-3.84			**
SL/V-A	♂	5.28±0.26	4.93-5.54	5.09±0.36	4.33-5.35	NS	NS	NS
	♀	5.26±0.29	4.90-5.53	5.25±0.32	4.81-6.19			NS
SL/A-C	♂	3.92±0.15	3.69-4.08	4.07±0.28	3.50-4.36	NS	NS	NS
	♀	3.79±0.21	3.61-4.08	4.02±0.19	3.73-4.39			**
SL/PA	♂	1.34±0.02	1.32-1.37	1.32±0.07	1.16-1.39	NS	NS	NS
	♀	1.36±0.01	1.35-1.37	1.30±0.26	0.13-1.42			NS
SL/IL	♂	0.30±0.09	0.18-0.41	0.69±0.07	0.56-0.77	NS	NS	***
	♀	0.21±0.07	0.16-0.32	0.66±0.20	0.35-1.34			***

Table 2. Meristic variables and their frequency in each group [with (D) and without (ND) a disc] and each gender. Comparisons were derived by a Mann-Whitney U-test. NS: p>0.05; *: p<0.05; **: p<0.01; ***: p<0.001. ++ = First row, for every variable, diversity of observations and frequency are registered below them for groups and genders.

Pectoral fin soft rays		12++	13	14	15	16	N	Within group and between genders	Between groups ♂	Between groups ♀
D	♂	--	3	2	--	--	5	NS	**	**
	♀	1	2	1	--	--	4			
ND	♂	--	--	1	5	1	7	NS		
	♀	--	4	--	13	6	23			
Pectoral fin hard rays		**1**								
D	♂	5					5	NS	NS	NS
	♀	4					4			
ND	♂	7					7	NS		
	♀	23					23			
Ventral fin soft rays		**6**	**7**							
D	♂	4	1				5	NS	**	NS
	♀	3	1				4			
ND	♂	--	7				7	NS		
	♀	8	15				23			
Ventral fin hard rays		**1**								
D	♂	5					5	NS	NS	NS
	♀	4					4			
ND	♂	7					7	NS		
	♀	23					23			
Ventral fin soft rays		**5**								
D	♂	5					5	NS	NS	NS
	♀	4					4			
ND	♂	7					7	NS		
	♀	23					23			
Ventral fin hard rays		**3**								
D	♂	5					5	NS	NS	NS
	♀	4					4			
ND	♂	7					7	NS		
	♀	23					23			
Anal fin soft rays		**7**	**8**							
D	♂	5	--				5	NS	*	NS
	♀	4	--				4			
ND	♂	2	5				7	NS		
	♀	14	19				23			
Anal fin hard rays		**3**								
D	♂	5					5	NS	NS	NS
	♀	4					4			
ND	♂	7					7	NS		
	♀	23					23			
Swimbladder		**1**	**2**							
D	♂	2	3				5	NS	NS	**
	♀	2	2				4			
ND	♂	--	7				7	NS		
	♀	1	22				23			

The equation $M_{adj} = M(L_s/L_0)^b$ for correction of size in the samples was used (ELLIOT et al. 1995): M_{adj}: corrected size of the measured distance, M: real size of the measured distance, L_S: mean standard length of the whole samples, L_0: standard length of one sample, b: regression slope of log M to log L_0 for all fishes in the whole samples.

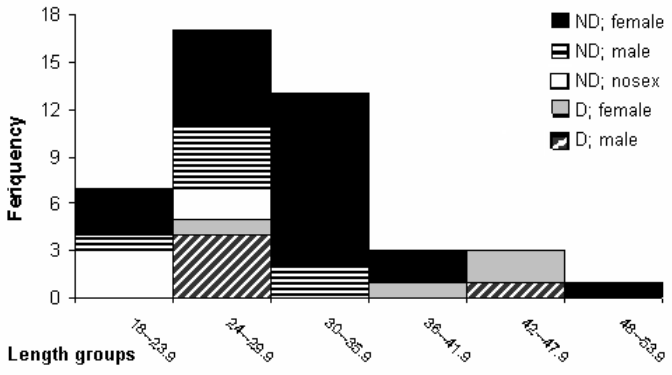

Fig. 3. Length frequency of male and female specimens with and without a disk.

The Ward method was used for dendrogram clusters by means of squared Euclidean distance. For analysing the effect of variables, a Principle Components Analysis (PCA) and, for the evaluation of correctness of classifications, discriminant methods were used. To compare normal morphometric variables between groups, t-tests and, for meristic variables, a Mann-Whitney U-test, were used. Statistical analyses were carried out with SPSS 11.5 and charts were drawn in Excel. PC-ORD software was used for derivation of PCA.

Results

Of 9 fishes with a disc, 5 were male and 4 female. Of 35 fishes without a disc, 7 were male, 23 were female and in 5 the sex was undetermined. Fig. 3 shows the length frequency distribution for all fishes by gender and also indicates the presence or absence of a disc. The most frequent length group was 24.0-29.9 mm.

The dendrogram cluster of morphometric and meristic characteristics is shown in Fig. 4. Fishes with a disc were separated in the dendrogram of morphometric variables (Fig. 4b) but this separation was less for meristic variables (Fig. 4a). However, all fishes with a disc fell in one branch together with five fishes without a disc.

In a PCA, components one and two were 88.98% of variance of data in morphometric variables and 74.96% in meristic ones. Except for POD, the other variables had a high coefficient, an indicator of their proper selection. The distribution of components one and two is shown in Fig. 5, indicating differences between species with and without a disc.

The results of discriminant analyses showed that classification of data according to the presence and absence of disc and also gender is appropriate for 97.4% of morphometric data (Wilk's Lambda = 0.005; p=0.000) and 59% of meristic data (Wilk's Lambda = 0.396; p=0.002). Canonical functions are shown in Fig. 6. Fishes with, and without, a disc were well differentiated according to morphometric data, but meristic data showed more overlap.

There were no significant differences between relative mean values of morphometric and meristic variables regarding gender in each group with and without a disc (Table 1–2). The standard length to SNL, H, POD, LPC, LA, HPC, P-V, A-C and IL ratio among females in

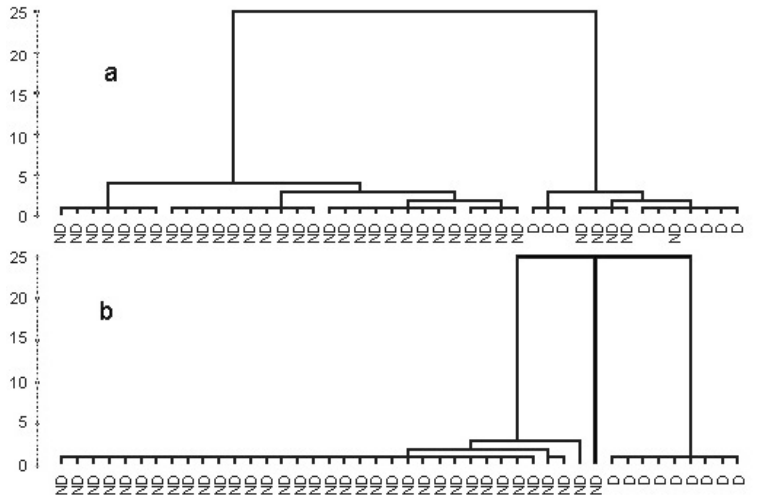

Fig. 4. Dendrogram for the fish specimens (a = meristic variables; b = morphometric variables).

the two groups and to PP, LP and IL among males, showed a significant difference (Table 1). Also, in meristic variables the number of soft rays in the pectoral fin was significantly different both in males and females of the two groups. The number of soft rays in the ventral and dorsal fins in males and the shape of swimbladder in females were different between the two groups (Table 2).

From among 35 fishes without a disc, only one had a unipartite swimbladder. In contrast, in fishes with a disc, the proportion of unipartite swimbladders to bipartite ones was equal (Table 2).

Discussion

The meristic characteristics which have been reported by BRUUN & KAISER were not much different from ours, although the similarity is more regarding ventral and pectoral fins between samples without a disc. It seems there is a tendency for reduction in soft rays in specimens with a disc.

The existence of a mental disc makes it possible for fish to attach to a substrate and graze on it. Considering the situation in a cave and its lack of floating vegetable and animal food, this structure can facilitate feeding on a substrate. On the other hand, the intestinal length in fishes with a mental disc is significantly longer than that in fishes without a disc (Table 2), which is further evidence for a difference in nutritional condition among the two groups (MONTGOMERY & POLLACK 1988). This is because an increase in the length of the digestive system will lead to an increase in the retention time for food and its digestion and absorption, especially detritus (MONTGOMERY 1977, RIBBLE & SMITH 1983). A shallow and long caudal peduncle in fishes with a disc may also help for more stability when feeding on the substrate.

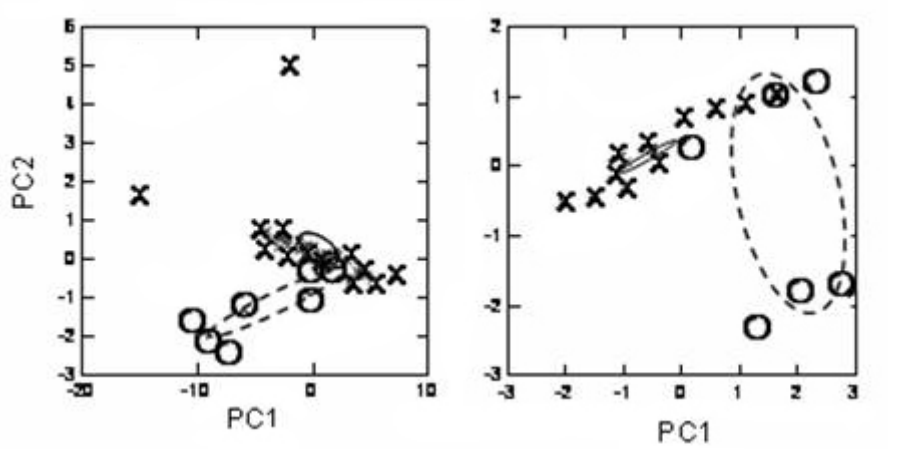

Fig. 5. Principal Components Analysis from morphometric (left) and meristic (right) data of the specimens with (circles) and without (crosses) disc.

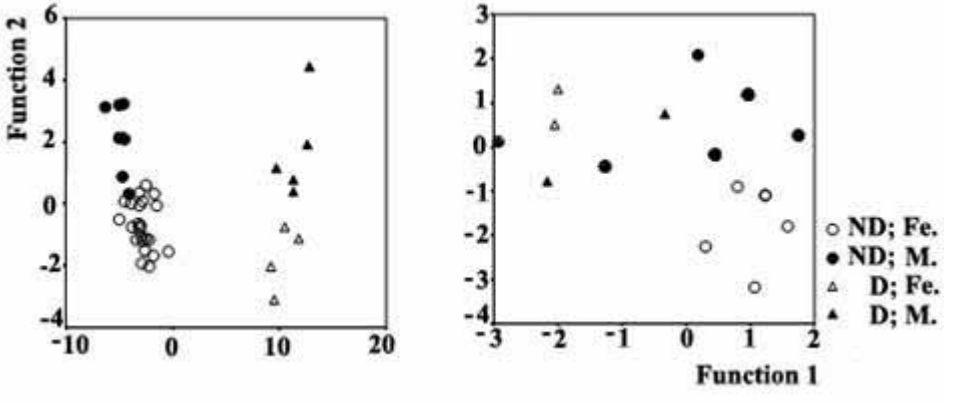

Fig. 6. Canonical Functions extracted from morphometric (left) and meristic (right) data of the specimens with disc (D) and without disc (ND). Open symbols: females; solid symbols: males.

The distribution graph of canonical functions and the discriminant analysis shows the separation of these two groups, especially in morphometric data (Fig. 6). However, it should be taken into consideration that these results are based on a limited number of specimens.

BRUUN & KAISER (1944) make no mention of the presence or absence of a mental disc. However, an Iraqi cave-fish, *Typhlogarra widdowsoni*, has a mental disc and is considered to be related to the genus *Garra* (MARSHALL & THINES 1958). *Garra rufa* is a common fish in rivers of this part of Iraq and Iran. Small *Garra rufa* may lack a fully-developed disc and its absence in most adult *Iranocypris typhlops* may be an example of paedomorphosis. It seems

improbable that two, closely-related taxa exist in a single cave system and the observed variation is the result of reduced selection pressure in an enclosed and protected ecosystem.

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