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Reproduction of an isolated Iranian cichlid, *Iranocichla hormuzensis*

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ABSTRACT

The reproductive biology of the Iranian cichlid, *Iranocichla hormuzensis* Coad, 1988, was investigated for 13 consecutive months in lower Mehran River, from August 2008 through August 2009. Four hundred and eighty six individuals (252 males and 234 females) were captured using a seine net (5 mm mesh size). The observed sex ratio was 1M: 0.93F (χ^2, df = 1, P = 0.414). Mean ± SD of total length (TL) values in males and females were 70.34 ± 8.16 and 62.08 ± 6.51 mm, respectively. The frequency of 56-65 mm size class was higher in females and the 66-75 mm size class in males. A gonadosomatic index (GSI) analyses of females indicated that the reproductive period was during February-June, with a peak in March. Fecundity was best correlated with total body mass (M) (linear regression, $r^2 = 0.62$) condition factor (linear regression, $r^2 = 0.62$) and total length (TL) (linear regression, $r^2 = 0.56$). The absolute fecundity ranged between 48-167 eggs with a Mean ± SD of 107 ± 35.2. Egg diameters ranged from 0.58 to 2.93 mm.

Key words: Fecundity, Gonadosomatic index, Hormuzgan, Mehran River, Reproduction

INTRODUCTION

Cichlids are comprised of about 150 genera and 1300 species, making it the second largest perciform family (Nelson, 2006). Cichlid fishes have a worldwide distribution and they are found in fresh and brackish waters of Central and South America, Africa, Madagascar, the Levant, southern India, Sri Lanka and southern Iran. Due to cichlid's economic importance, they are becoming increasingly prominent in freshwater aquaculture at many regions of the world. Cichlids have a dazzling array of body shape and color, which makes them one of the most important groups of aquarium fishes (Berra, 2001). Cichlids exhibit a broad range of morphological, ecological and behavioral variations. The Iranian cichlid, *Iranocichla hormuzensis* Coad, 1982, is the only endemic species of cichlids in Iran (Coad, 1982; Berra, 2001). This species is found in the Hormuz basin (southern Iran) in rivers with warm and salty water (Esmaeili *et al*., 2008). They are recognized by the darkened rays and lack of spots in the pectoral fin and specially, by the single nostril opening on each side of the head (Coad, 1982). Trewavas (1983) placed Iranocichla in the genus Danakilia but also agreed with (Coad, 1982) who believed that Iranocichla and Danakilia might be related to the genus *Tristramella*. Esmaeili *et al*., (2008) investigated some aspects of reproductive biology of I. hormuzensis in the upstream of Mehran River. In this study we present information on sex ratios, reproduction, gonadosomatic index (GSI), hepato-somatic index (HIS), fecundity and condition factor of *I. hormuzensis* from lower Mehran River which is ecologically different from the upstream (e.g. higher salinity, higher temperature, etc.).

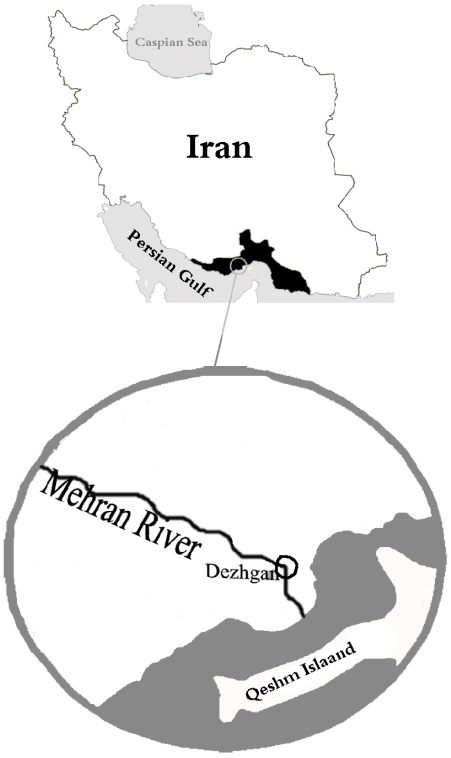

Fig. 1. Map of Iran, showing the collection site in Mehran River.

Materials and methods

The specimens were sampled from the Dezhgan in Mehran River at 26°52′53″N, 55°16′21″E (Hormuzgan Province) (Fig. 1). The bottom structure of sampling area was sandy-muddy. During August 2008 and August 2009, a total of 486 individuals were captured using seine net (8 m × 1 m, 5 mm mesh size), by searching the substrate for 120 to 150 minutes. During each collection, the temperature of the water surface was recorded once a month. Then, specimens were fixed into 10% formalin and transferred to the laboratory for further examination. Information recorded for each specimen were total length (TL) and standard length (SL), to nearest 1 mm and body mass (M) to the nearest 0.01 g. Condition factor was calculated according to the formula: K = (W/ L3) × 100, Where W = body mass in g and L = total length (TL) in mm (Bagenal, 1978, Ricker, 1975). The gonads and liver were removed and weighed with a digital scale to the nearest 0.001g. To determine the reproductive cycle and the breeding season, we measured five indices including gonadosomatic index (GSI = 100×Gonad Mass/Body Mass) (Nikolsky 1963), hepatosomatic index (HIS = 100 × Liver Mass/Body Mass), modified gonadosomatic index (MGSI =100×Gonad Mass /Fish Mass−Gonad Mass) (Nikolsky, 1963), Dobriyal index (DI =$\sqrt[3]{\mathbf{GW}}$) (Dobriyal *et al*. 1999) and reproductive condition. The ratio of gonad mass to the length, RC = GW/TL where GW is gonad mass in g and TL is total length in mm (Way et al., 1998) was calculated. The absolute fecundity, as the number of mature ova likely to be spawned, was calculated using ripe ovaries with higher gonadosomatic index (Batts, 1972). Fecundity was estimated from 15 fish in the ripe macroscopic stage. The ovaries were placed in Gilson's solution. The maximum length and width of oocytes in ovaries preserved in 4% formalin solution was measured using an ocular micrometer. Fertility co-efficient (FC) was estimated according to Riedel (1969): FC = E/TL3, Where E = number of eggs produced and TL = total length of female fish (mm). The regressions between fecundity (F) and total length (TL), body mass (M), condition factor (K) and ovary mass (GW) were calculated. All statistical analyses were carried out using SPSS ver. 15.

RESULTS

Monthly water temperature during this study varied from 16°C to 34°C, decreasing from August to February and then increasing from February to August (Fig. 2). Water temperature in reproductive season (March to May) was 23°C to 30°C with an average of 27°C. The salinity of water decreased from 37‰ in August to 34‰ in May. In March, the number of *I. hormuzensis* increased in deeper waters, and at that time, nests observed in shoreline with calm and clear water (Fig. 3a). The number of nests rapidly increased in April and May and decreased afterwards (Fig. 3b). These nests were usually observed on muddy-sandy bottoms in multiple groups (3-4). The length and width of these nests were about 20×25 cm.

A total of 486 specimens of *I. hormuzensis* with distinct gonads were examined. There were 252 (51.85%) males and 234 (48.15%) females. The sex ratio of the collected samples was 1Male:0.93Female. Overall Chi-square test (χ^2) showed an insignificant difference between the two sexes (χ^2, df = 1, P = 0.414), but in some months, sex ratio changed significantly (Table 1). There was a significant difference in the male/females ratio in the five size classes of *I. hormuzensis* (Table 2). The ovarian mass ranged between 0.0035 g and 0.4782 g. (Mean ± SD: 0.0350 ± 0.0568 g). Monthly variations in GSI revealed that both sexes follow nearly the same pattern. The gonadosomatic index (GSI) varied significantly in different months (ANOVA, df = 12 P = 0.0001) (Fig. 4). The GSI showed higher values for females (7.12 ± 1.0206) than males (0.8149 ± 0.1047) from February to June with a peak in March, while the lower ones occurred from July to January. There was an increase in spawning intensity in early March to end of May and lasted until the early June. The total number of ripe eggs in the ovary (absolute fecundity) ranged between 48-167 eggs with a Mean ± SD of 107 ± 35.2 for fish with total length range (TL) of 58-76 mm and a Mean ± SD egg diameter of 1.92 ± 0.73 mm (0.58–2.93 mm). Fecunidity was better correlated with total body mass (M), condition factor (K) and total length (TL) (Table 3). The Mean ± SD fertility co-efficient for this fish was 0.0003949 ± 0.00009246. Fertility co-efficient did not correlate with body mass and length, it showed the highest correlation with gonad mass (linear regression, r^2 = 0.4105).

The hepatosomatic index (HSI) is an indicator of annual morphological changes in the liver and associated with gonad development. The hepatosomatic index (HSI) showed a sharp decrease for both sexes, when GSI was elevated (from February to March) (Fig. 5). In April, HSI increased for males, but decreased for females. The hepatosomatic index (HSI) showed a general increase for males and females immediately following the end of the reproductive season. These data indicate that excess energy gained by *I. hormuzensis* is used for reproduction during February to May, and is stored as glycogen in the liver after the reproduction season.The monthly Mean ± SD condition factor for females and males ranged from 0.0696 to 0.5127 (0.1747 ± 0.0665) and 0.0412 to 0.4671 (0.1882 ± 0.0689), respectively. Condition factor values for females were the highest in April and October and the lowest in February and December. On the other hand, for males, the highest values were in November and December and the lowest in September and August.

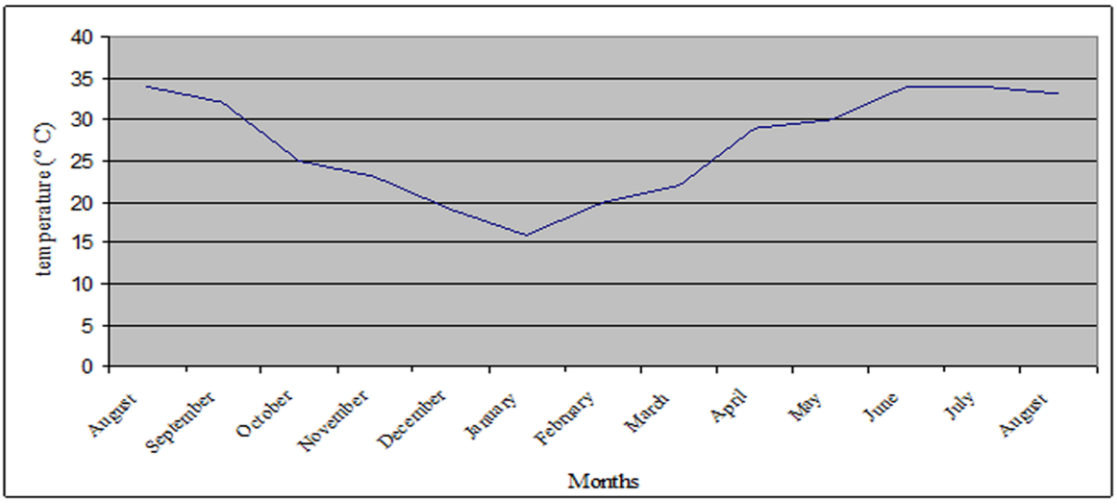

Fig. 2. Monthly water temperature in lower Mehran River during August 2008-August 2009.

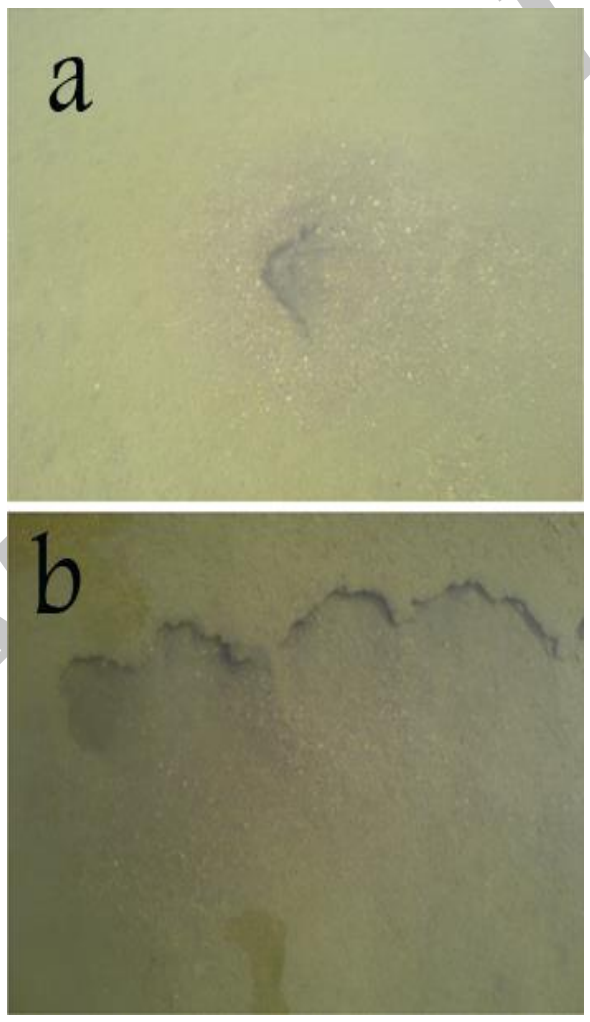

Fig. 3. Nest of *I. hormuzensis* in March (a) and April (b) in lower Mehran River.

Table 1. Monthly proportion of male and female *I. hormuzensis* in lower Mehran River.

Months	Male		Female		Male:Female ratio	χ^2
	Number (N)	%	Number (N)	%		
August	4	29	10	71	1:2.5	2.57
September	15	50	15	50	1:1	-------
October	29	78	8	22	1:0.3	11.92*
November	26	68	12	32	1:0.5	5.16*
December	20	53	18	47	1:0.9	0.11
January	22	55	18	45	1:0.8	0.40
February	27	68	13	32	1:0.5	4.90*
March	22	59	15	41	1:0.7	1.32
April	9	23	30	77	1:3.3	11.31*
May	16	29	40	71	1:2.5	10.29*
June	22	56	17	44	1:0.8	0.64
July	12	30	28	70	1:2.3	6.40*
August	28	74	10	26	1:0.4	8.53*

Table 2. Percentage of male and female *I. hormuzensis* in different size groups in lower Mehran River.

Size Group (mm)	Male		Female		Male:Female ratio	χ^2
	Number (N)	%	Number (N)	%		
46-55	11	23	37	77	1:3.4	14.08*
56-65	63	31	142	69	1:2.3	30.44*
66-75	111	71	46	29	1:0.4	26.91*
76-85	61	87	9	13	1:0.2	38.63*
86-100	6	100				

Table 3. Relationship between Fecundity and body mass, condition factor and total length in *I. hormuzensis*.

F= ax+b	r2	df	p
F=19.464M+3.17	0.62	15	0.05
F=399.75K+3.17	0.62	15	0.05
F=4.9555 LT211.81	0.56	15	0.05

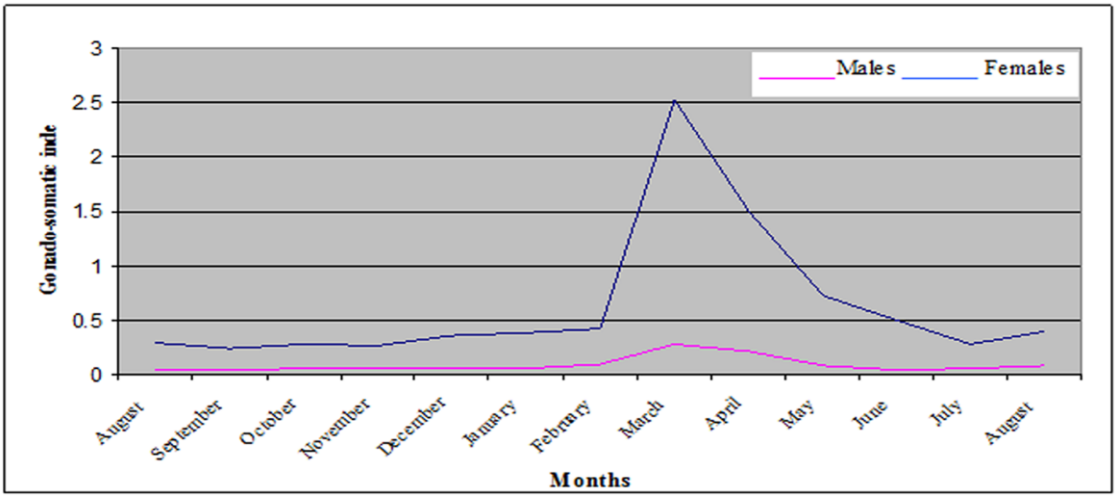

Fig. 4. Monthly variations in the gonado-somatic index of *I. hormuzensis.*

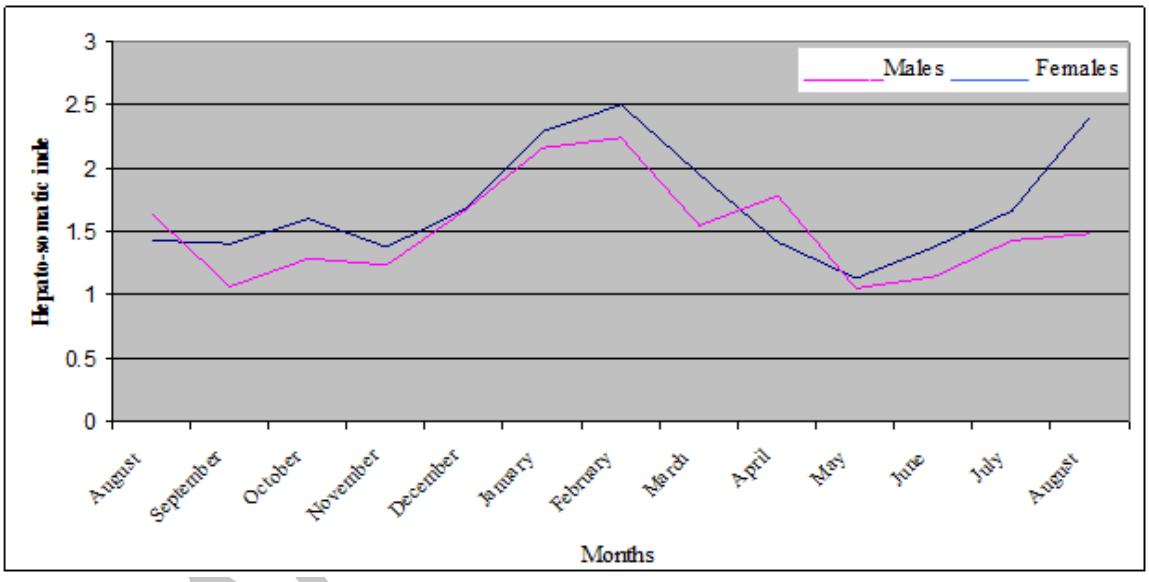

Fig. 5. Monthly variations in the hepato-somatic index of *I. hormuzensis.*

Discussion

The overall sex-ratio for *I. hormuzensis* in Mehran River was not significantly different from 1:1 ratio. Esmaeili *et al.,* (2008) have reported a ratio of 1:0.69, a significantly male biased ratio (χ^2, df = 1, p = 0.0001) from upper regions. It was found that in October, November and February, sex ratios were strongly biased in favor of males and in April, May and July in favor of females. Esmaeili *et al.* (2008) reported that sex ratio in May and June was strongly biased in favor of males. In this study the sex ratio was in favor of females in smaller sizes (45-65 mm) and in favor of males in larger sizes (66-75 mm). The observed seasonal variation in sex ratio is probably due to the completion of egg fertilization. Males possibly emigrate from spawning areas towards feeding grounds located in shallow part of the river (where they are captured). Females go towards submerged vegetation and rocky areas to avoid predators and to carry out the incubation and protection of offspring (Offem *et al.* 2007; Fryer & Iles 1972; Ugwumba, 1988; Galemoni de Graaf & Huisman, 1999; Peña-Mendoza *et al.,* 2005). The differences in the number of females in the small and large size classes may be due to differences in the rate

of activity between males and females (Anene & Okorie, 2008). Males dominance is common in cichlid populations, because they generally grow faster than females (Fryer & Iles 1972).

Gonadosomatic index for females was higher than males. Our data show that peak of the GSI values for both males and females occur in March and broods were present at the end of winter and beginning of spring and lasted till June. This suggests that most reproductive activities of *I. hormuzensis* in lower Mehran River occur from February to June. The breeding season for the Iranian cichlid was similar to that described by Esmaeili *et al.,* (2008), but they found a strong breeding peak in May and we found the highest breeding peak in March. This difference in peak of GSI may be due to environmental factors such as water temperature (Khara *et al.,* 2012, Mousavi-Sabet *et al.,* 2012) and salinity and this could be related to the geographical and ecological differences between the two populations of *I. hormuzensis* in upper and lower Mehran River or simply could be due to the sampling time. Other indices such as Dobriyal index (DI), modified gonadosomatic index (MGSI) and reproductive condition (RC), similar to the GSI, showed a general increase in gonad investment from February to June. The total number of ripe eggs in the ovary (absolute fecundity) ranged between 48-167 eggs (Mean ± SD: 107 ± 35.2 eggs) with an egg diameter ranged from 0.58 to 2.93 mm for fish with size range of 58-76 mm total length (TL). Esmaeili *et al.* (2008) reported the range of 38-151 eggs (Mean ± SD: 99.8 ± 33.8), from the upper Mehran River. They also noted that fecundity of *I. hormuzensis* is much lower than given for some other mouth-brooding cichlids, e.g., 324–1672 in Oreochromis esculentus (Lowe-McConnell, 1955), 56–489 in *O. leucosticus* (Welcomme, 1967) and 309–1158 in *O. niloticus* (Rana, 1988). Moyle & Cech (2000) mentioned that in mouth-brooding cichlids, the fecundity is considerably low because the parents assure the survival of the offspring; consequently, have less mortality. In the present study, fecundity was better correlated with total body mass than gonad mass and GSI as found in *Oreochromis niloticus* (Kariman & Salama, 2008). The hepatosomatic index in females was higher than males. Both sexes showed higher values in February and a rapid decrease in March. Lower values of HSI for males and females were in May. Poor somatic condition during the spawning season occurs in many fish species, and give an indication that the somatic growth decreases due to the development of gonads (Salgado-Ugarte, 1995). Condition factor values for males, were the highest in November and December and the lowest in September and August, while for females the highest values were in April and October and the lowest in February and December. This factor has not been studied before in *I. hormuzensis* to compare with, but usually it is higher in females and in non-spawning fish (Soofiani *et al.,* 2006, Asadollah *et al.,* 2014).

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تولیدمثل گونه جداافتاده گردک‌ماهی ایران (*Iranocichla hormuzensis*)

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چکیده

زیست‌شناسی تولیدمثل گردک‌ماهی ایرانی، *Iranocichla hormuzensis* Coad, 1988، به مدت ۱۳ ماه متوالی در پایین دست رودخانه مهران، از مردادماه ۱۳۸۷ تا مردادماه ۱۳۸۸ مورد بررسی قرار گرفت. چهارصد و هشتاد و شش قطعه ماهی (۲۵۲ نر و ۲۳۴ ماده) با استفاده از تور پره (با چشمه ۵ میلی‌متر) صید گردید. نسبت جنسی مشاهده شده برابر ۱نر:۰/۹۳ ماده بود (χ^2, df=۱, p=۰/۴۱۴). میانگین و انحراف معیار طول کل ماده‌ها و نرها به ترتیب ۶/۵۱ ± ۶۲/۰۸ و ۸/۱۶ ± ۷۰/۳۴ میلی‌متر بود. گروه طولی ۵۶-۶۵ میلی‌متر در بین ماده‌ها و ۶۶-۷۵ میلی‌متر در بین نرها، بیشترین فراوانی را داشتند. بررسی شاخص جنسی ماده‌ها نشان داد که زمان تولیدمثل آنها بهمن‌ماه تا خردادماه بوده و حداکثر آن در فروردین‌ماه است. هماوری بیشترین همبستگی را با وزن بدن (رابطه خطی، r^2 = ۰/۶۲)، ضریب وضعیت (رابطه خطی، r^2 = ۰/۶۲) و طول کل (رابطه خطی، r^2 = ۰/۵۶) دارد. هماوری مطلق بین ۴۸-۱۶۸ عدد تخم با میانگین ۳۵/۲±۱۰۷ بود. قطر تخمک‌ها از ۰/۵۸ تا ۲/۹۳ میلی‌متر متغیر بود.

* مولف مسئول