Reproduction characteristics of the *Vimba vimba persa* (Pallas, 1811), in coastal waters of the Caspian Sea

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Abstract

Some reproduction characteristics of the Caspian Vimba, *Vimba vimba persa*, were studied from Oct. 2008 to Sep. 2009 in coastal waters of the Caspian Sea (Mazandaran province). 994 specimens were monthly collected from 6 fish landing sites of Ramsar, Tonekabon, Chalus, Mahmood Abad, Sari and Behshahr. The fecundity was measured using 92 specimens. This species was found to have more abundance in spring (especially April and May). The samples composed of 397(42.6%) male, 537(57.4%) female; the sex ratio was M: F = 1:1.35. The advanced stages of maturity (4th & 5th) were found in April and May. The highest Gonadosomatic Index in females was in May and the lowest one was in July. The average of absolute and relative fecundities was 17198±7710 and 171.85±48.8, respectively.

Keywords: Caspian Vimba, *Vimba vimba persa*, Fecundity, GSI, Sex ratio, Caspian Sea

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Introduction

There is a gap in the knowledge of population biology, and catch assessment of some species in the Caspian Sea (Karimzadeh et al., 2010). The enclosed Caspian Sea is the world's largest brackish water body, comprising nearly 40% of the earth's continental surface water (Dumont, 1998). The Caspian Sea is the biggest enclosed body of water on Earth, between latitudes 47.07'N and 36.33N and longitudes 45.43 E and 54.20E. Its surface level at the moment is around –26.5 m below MSL. At this level, its surface area is 386,400 km2. The water of the Caspian Sea is slightly saline; if we compare the Caspian water with oceanic water, it contains 3 times less salt (Caspian Sea Biodiversity, 2010).

The Caspian Sea possesses various commercially important fish species. Caspian Vimba, *Vimba vimba persa* (Pallas, 1811) locally called "Siah cooli"- is one of them. Caspian Vimba catch over the whole Caspian Sea basin was less than 100 tons per year in the 1980s (Kuliev, 1988). In The past five years, the maximum amount of catch was recorded 474 tons in 2009-10 and the minimum was 9 tons in 2005 -06 (Iranian Fishery Organization, 2010). Kiabi et al., 1999 considered this species to be near threatened in the southern Caspian Sea basin according to IUCN criteria. Weirs are a problem for this species in the Caspian Sea, as they block the spawning migration, the fish massing below the obstruction, causing re-absorption of eggs and sperm (Holčík and Oláh, 1992). Not much information on the biology of this fish is available in the area. The present study has been conducted to determine the fecundity, spawning season, length of maturity and sex ratio of this fish in the Iranian waters of the Caspian Sea (Mazandaran province).

Materials and methods

The biological specimens were randomly collected by different fishing gears of beach seine (30 and 33 mm), gill net (20 and 28 mm) and cast net at six landing sites of Ramsar,Tonkabon, Chalus, Mahmood Abad, Sari and Behshahr, from Oct. 2008 to Sep. 2009 (Fig. 1). Fish samples were selected randomly from landing sites. At least 70 specimens were randomly collected per month. Then they were transported in iceboxes to the laboratory for further biological measurements.

Laboratory works

The whole wet weight was recorded to 0.01g and their fork length was measured to the nearest 1mm. The relationship of weight to length was calculated with:

$$W = a.L^b$$

Where W is the total weight (g), L the fork length (Cm), a is constant and b is slope (Ricker, 1975; Kaymaram et al., 2010).

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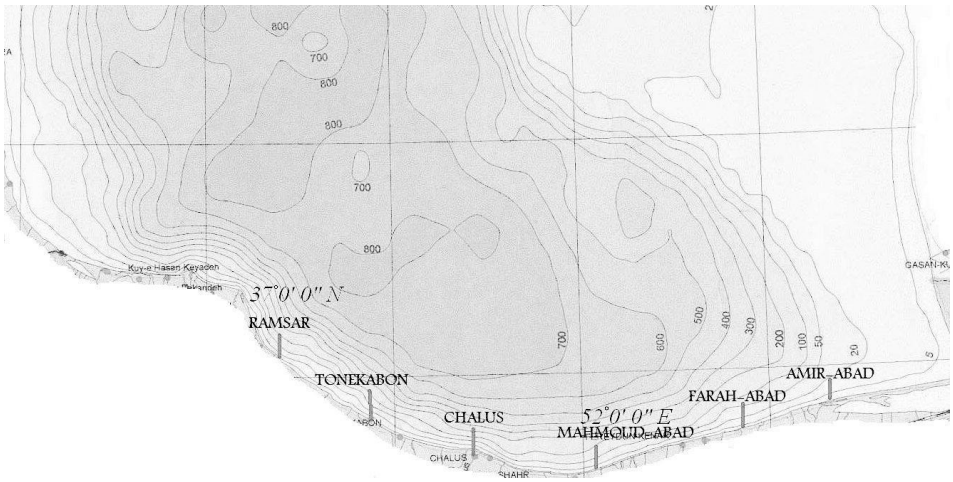

Figure 1: Geographical location of sampling sites for *Vimba vimba persa*
(Taken from www.statemaster.com)

If the calculated number for "b" does not have a significant difference with 3, the species has isometric growth. To test this difference, the below equation was used (Pauly, 1984).

$$t = [(s.dx) / (s.dy)] \times [(\left| b-3 \right|) / (\sqrt{(1-r2)})] \times [\sqrt{(n-2)}]$$

s.d(x) = Std. fork length

s.d(y) = Std. weight

R^2 = Coefficient of determination

n= sample number

The maturity stages of ovaries were also determined. They were based on seven macroscopic distinguishable stages in ovarian development as defined by Kesteven (1960) method cited in Biswas (1993).

The length of the females at first maturity was determined by plotting the percent number of matured females (3^{rd}-6th stage) to the total number of fishes examined in a particular size group (King, 2007).

A logistic function was fitted to the proportion of the mature individuals by size class using a non-linear regression. The function used was:

$$P = \frac{1}{1+e^{(-r(L-Lm))}}$$

Where P is the mature proportion in each size class, r is a parameter controlling the shape of the curve, and Lm is the size at 50% maturity (Saila et al., 1988).

Monthly gonad somatic index means (GSI) were calculated for both sexes using the following formula (Biswas, 1993)

GSI = (Gonad weight (g) / Total body weight (g)) ×100

The gonads were removed and weighed (0.001g). The spawning time was established by plotting of fish by maturity

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stages and gonad-somatic index against the sample period (Biswas, 1993).

Samples from the ovary were kept in modified Gilson's solution (100mL of 60% ethyl alcohol, 880mL of distilled water, 15mL of 80% nitric acid, 18mL of glacial acetic acid and 20 g of mercuric chloride) until oocytes were completely dissociated (Biswas, 1993).

Absolute fecundity (AF) was determined by using this formula (Bagenal and Tesch, 1978):

AF =OVA×GW;

OVA: oocyte number per ovary gram

GW: gonad weight (g)

Relative fecundity was estimated using the formula (Bagenal and Tesch, 1978):

RF = AF/BW

AF: absolute fecundity

BW: body weight (g)

Sex ratio was examined using Chi-square ($\chi 2$) goodness of fit tests. Independent tests were conducted to determine whether sex ratio differed significantly from unity for the whole sample. The probability level was set at 0.05.

Results

A total of 994 specimens were collected (Fig. 2) ranging in size from 95 to 234 mm. The mean fork length was measured 168.4 ±26mm, with the highest abundance in 170-180 mm lengths range.

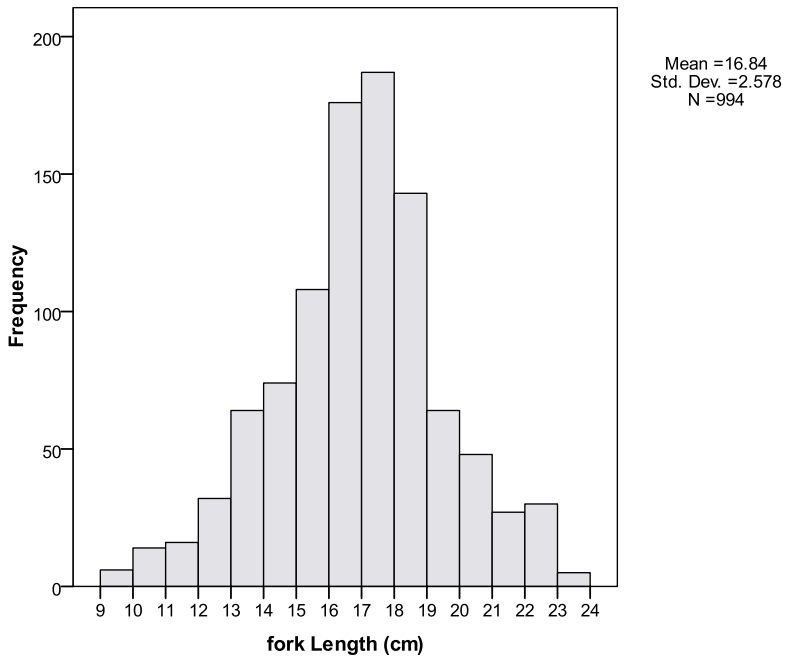

Figure 2: Length frequency of *Vimba vimba persa* in south of the Caspian Sea (2008-2009)

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The b parameter value in the length-weight relationship model $W=0.012\ L^{3.047}$, $R^2=0.955$ that are close to 3 for samples, indicate isometric growth (Fig. 3). The t-test was used for b parameter correctness evaluation with a comparing to table value. The "b" value indicated no significant difference (P>0.05).

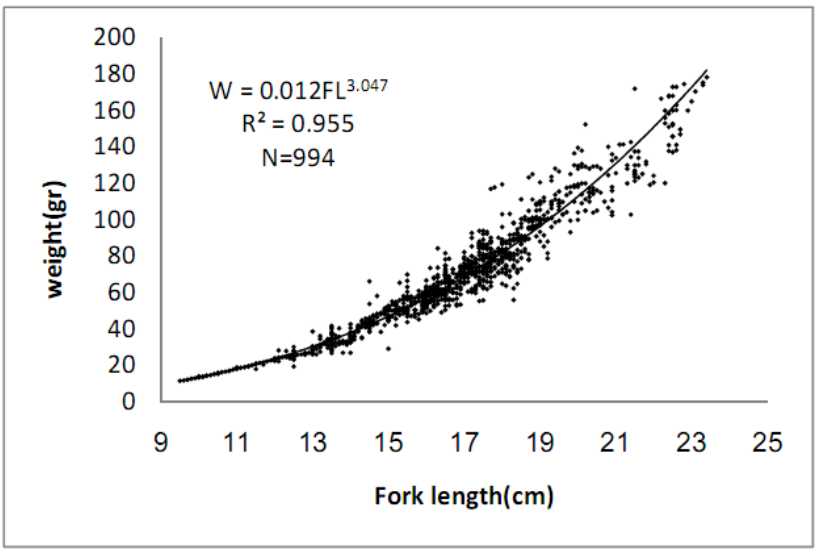

Figure 3: Length-weight relationship of *Vimba vimba persa* in the Southern Caspian Sea waters (2008-2009)

The sample was composed of 397 (42.6%) male, 537 (57.4%) female. According to the results, the sex ratio of the samples varied throughout the year. Less male in comparison with female were encountered in the samples (From April to January) (Fig. 4). The sex ratio in the samples M: F = 1: 1.35 was significantly different ($p < 0.05$) in the overall male to female sex ratio 1:1 (χ^2 test).

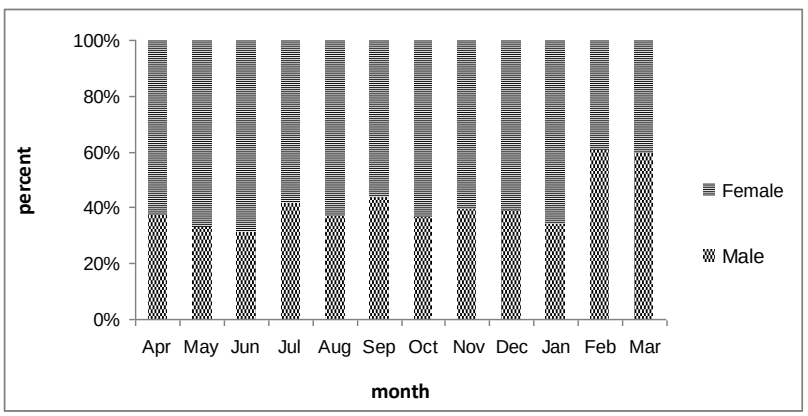

Figure 4: Sex ratio percentage of *Vimba vimba persa* in south of the Caspian Sea (2008-2009)

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The highest Gonadosomatic Index for females was found 12.7 in May and gradually decreased in later months, reaching its lowest level in July (Fig. 5).

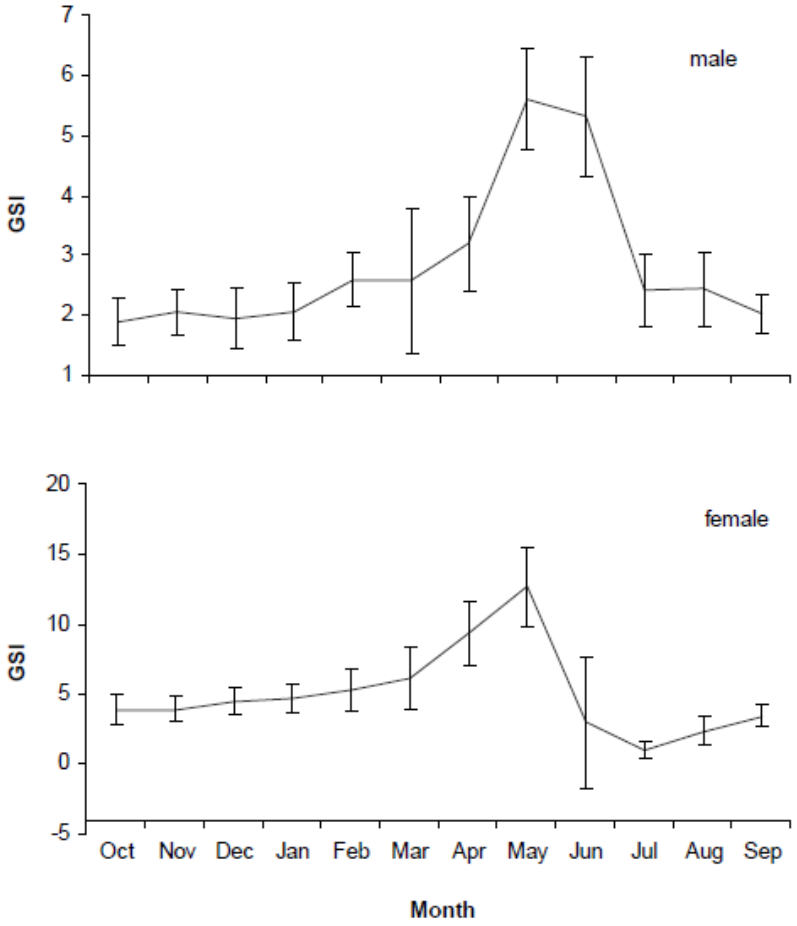

Figure 5: Monthly variation of Gonadosomatic Index for males and females of *Vimba vimba persa* in south of the Caspian Sea (2008-2009)

The highest Gonadosomatic Index for males was found 5.6 in May and gradually decreased in later months, reaching its lowest level, 1.9 in Oct (Fig. 5). This fish was considered to be a spring spawner.

Having various length groups as well as percentage of high stage maturity groups, LM50 curve was drawn, which showed the first maturity for 50% of the sampled females, which occurred at 170 mm (Fig. 6). Regarding fecundity, the maximum absolute and relative fecundities were found to be 34636 and 260.9, respectively; the minimum absolute and relative fecundities were 5400 and 94.5, respectively. Results from biometry of 92 specimens showed exponential relationship between fork length and fecundity (Fig. 7).

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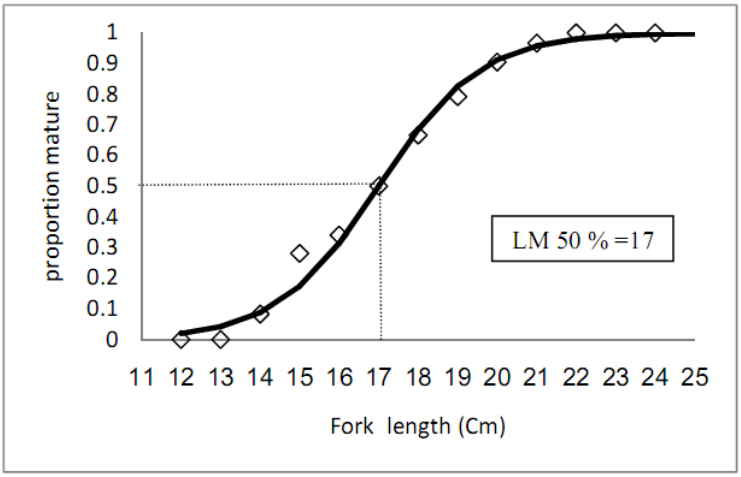

Figure 6: Female Length of maturity of *Vimba vimba persa* in south of the Caspian Sea (2008-2009)

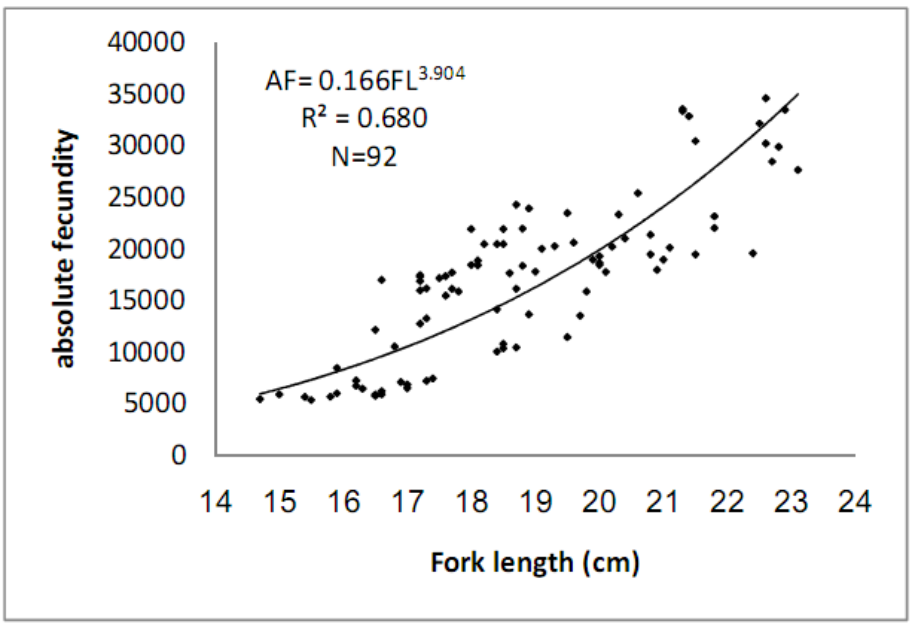

Figure 7: Length - absolute fecundity relationship of *Vimba vimba persa* in south of the Caspian Sea (2008-2009)

Various stages of female gonad development frequency have been shown. More of the samples were in high maturity stages (5-7) from April to June. The samples were in second and third maturity stages on September and October (Fig. 8).

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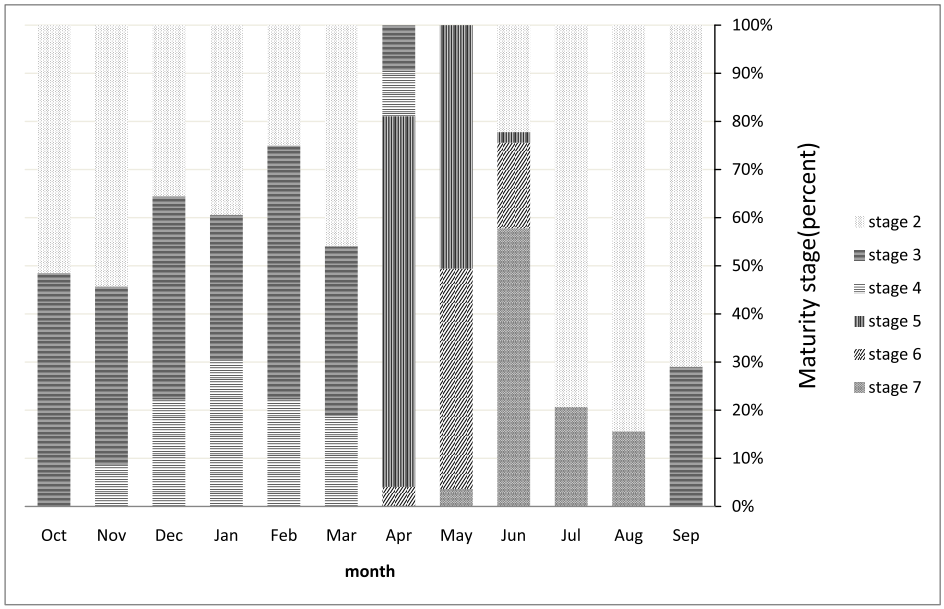

Figure 8: Various stages of female gonad development frequency of *Vimba vimba persa* in south of the Caspian Sea (2008-2009)

Discussion

The maximum recorded fork length for this fish was 234 mm in the present study, but Yektan et al. (2004) reported the maximum fork length, 217 mm in the Caspian Sea waters. The maximum lengths of 230 mm (Abbasi et al., 2002) and 200 mm (Arzpeyma et al., 2001) have also been reported for this species from other water bodies in Guilan province. The maximum total length of 262 mm (Tarkan et al., 2006) has also been reported for *Vimba vimba* (Linnaeus, 1758) from Lake Sapanca in Turkey.

The maximum-recorded weight for this fish in the present study was 178.3 g but the maximum weight; 148.7 g had earlier been reported from the Caspian Sea waters (Yektan et al., 2004). The maximum weights of 173.2 g (Abbasi et al., 2002) and 122 g (Arzpeyma et al., 2001) have also been reported for this species from other water bodies in Guilan province. The maximum weight of 2330 g (Machacek, 2006) has also been reported for *Vimba vimba* from Weser River in Germany.

The highest gonadosomatic index was recorded in May and the lowest was in July (Fig. 5). Besides GSI, the advanced stages of maturity (4^{th}, 5^{th}) were in April onward (Fig. 8), it could be assumed that spawning of *Vimba vimba persa* occurred in May and June. Shikhshabekov (1979) and Kuliev (1988) studied reproduction in the Kyzylagach Bay of the southwestern Caspian Sea and the waters of Dagestan respectively. Spawning took place at the end of April, continuing until the end of May or into June. Abbasi et al. (2002) found that the Sefid Rud population Spawning occurred from late May to late June. In studies conducted in Gorgan Rud of the southeastern Caspian Sea, the spawning of this fish was reported to occur

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in May and June (Rahmani et al., 2000), which corresponded with this study.

The high stages (3 to 6) of gonad maturity variation in relation to fish length indicated that the length of maturity in female occurred at 170 mm (F.L) (Fig. 6). Most fish length on the spawning migration into Anzali lagoon was from 170-250 mm (Holčik and Oláh, 1992). In Kyzylagach or Imeni Kirova Bay of Azerbaijan most spawning females are 16-23 cm and males 13-19 cm (Shikhshabekov, 1979; Kuliev, 1988). *Vimba vimba persa* on the spawning migration of Sefid Rud had a fork length of 116-208 mm in males and 122-222 mm in females (Abbasi et al., 2002).

Sex ratio varied from one species to another. According to obtained results, the sex ratio of *Vimba vimba persa* relatively varied throughout the year (Fig. 4), but an overall sex ratio of 1 : 1.35 was estimated that significantly differed from the sex ratio of 1:5.64 (Shoormadj et al., 2002) reported from the southern part of the Caspian Sea between Mahmood Abad and Miankaleh coasts. The sex ratio of 1:1.3 (Rahmani et al., 2000) and 1: 0.99 (Yektan et al., 2004) were reported for the same species from Gorganrud and Ramsar to Tonekabon coastal waters, respectively.

The maximum recorded absolute fecundity for this fish in the present study was 34636, but the maximum absolute fecundity, 31579, was earlier reported from the Caspian Sea waters (Yektan et al., 2004). The maximum and minimum absolute fecundity of (45098) and (11634) had also been reported respectively for this fish from the southern Caspian Sea between Mahmood Abad and Miankaleh coasts (Shoor madj et al., 2002). The maximum absolute fecundity of 120000 (Billard, 1997) and 136400 (Hliwa and Martyniak, 2002) have also been reported for *Vimba vimba* from France and Poland respectively. The mean absolute fecundity of *Vimba vimba persa* found in this study (17198 ± 7710) corresponded with the one (15157± 5721) reported from GorganRud (Rahmani et al., 2000), and the minimum absolute fecundity (5400) found in this study corresponded with the (5046) reported from GorganRud (Rahmani et al., 2000). The maximum and minimum absolute fecundity of 20000 and 15000 had also been reported respectively for *Vimba vimba* from Turkey (Balik, 1995). The minimum, maximum and mean relative fecundity recorded for this fish in the present study was 94.5, 260.9 and 171.85±48.8 respectively. The maximum, minimum and mean relative fecundity of 93.7, 393.3, 200.4 ± 60.3 respectively had earlier been reported from the Caspian Sea waters (Yektan et al., 2004).

With due attention to the kind of ovary and its GSI variation, process of ovary development in Caspian Vimba follows an annual rhythm. Caspian Vimba was found to have a synchronous ovary. Ovary synchrony in *Vimba vimba* has also been reported from Terek and some sub alpine lakes with spawning in Apr (Kottelat and Freyhof, 2007) and from France (Billard, 1997) and Turkey (Balik, 1995) with spawning in April till June. Ovary synchrony in this species has also been reported from GorganRud (Rahmani et al., 2000).

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ویژگی های تولید مثل ماهی سیاه کولی *Vimba vimba persa* (Pallas, 1811) در آبهای ساحلی دریای خزر

علیرضا چایچی*[1]، غلامحسین وثوقی[1]، فرهاد کیمرام[2]، شهلا جمیلی[1و2] و حسن فضلی[3]

چکیده

برخی از خصوصیات تولید مثلی ماهی سیاه کولی (*Vimba vimba persa*) از مهر ماه سال ۱۳۸۷ تا شهریور ماه سال ۱۳۸۸در آبهای ساحلی دریای خزر (آبهای استان مازندران) مورد مطالعه قرار گرفت. تعداد کل ۹۹۴ نمونه ماهی به صورت ماهانه از ۶منطقه صیادی رامسر ، تنکابن ، چالوس ، محمود آباد ، فرح آباد و امیرآباد جمع آوری گردیدند که از میان آنها هماوری ۹۲ نمونه مطالعه شد . بالاترین میزان فراوانی این آبزی در فصل بهار (بالاخص فروردین و اردیبهشت) تعیین گردید. از نظر جنسیت نسبت جنسی M : F = 1 : 1.35 محاسبه شد. مرا حل باروری پیشرفته (مرا حل ۴ و ۵) در فروردین و اردیبهشت بدست آمد . بالاترین شاخص گنادوسوماتیک جنس ماده در اردیبهشت ماه و حداقل آن در تیر ماه بود. حداکثر میزان هم آوری مطلق و نسبی بترتیب ۳۴۶۴۰ و ۲۶۰/۹ محاسبه گردید .حداقل میزان هم آوری مطلق و نسبی بترتیب ۵۴۰۰ و ۹۴/۵ بود. میانگین هم آوری مطلق و نسبی به ترتیب ۷۷۱۰±۱۷۱۹۸ و ۴۸/۸±۱۷۱/۸۵بود .

واژگان کلیدی : ماهی سیاه کولی، *Vimba vimba persa*، هم آوری، GSI، نسبت جنسی، دریای خزر، ایران

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