

## Egg Characteristics of the Narrow-Clawed Crayfish *Astacus leptodactylus* under Natural Conditions in Iran

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**Abstract:** This study was carried out with the aim of examining the seasonal fecundity and developmental characteristics of the eggs of the female narrow-clawed crayfish *Astacus leptodactylus* from Aras Dam Lake, Western-Azerbaijan, Iran. Ovarian and pleopodal fecundity, egg diameter and egg weight were measured in a total of 45 mature size females on November 2011 and January 2012. A positive correlation was found between both ovarian and pleopodal fecundity and female size. The mean value of ovarian eggs was (206.55). Pleopodal fecundity was 37.3% lower than ovarian fecundity. The value of the gonadosomatic index (GSI) of females' sampled on November was 13.53% (11.63-15.91%). The average size of pleopodal eggs was 2.2 mm (1.07-6.59 mm). The number of eggs attached to 3<sup>rd</sup> and 4<sup>th</sup> pairs of pleopods was significantly higher than other pleopods. The egg number and gonadosomatic index increased significantly by increasing female size.

**Key words:** *Astacus leptodactylus* • Pleopodal Fecundity • Ovarian Fecundity • Egg Weight • Egg Diameter

### INTRODUCTION

*Astacus leptodactylus* is a widespread species distributed throughout Europe, eastern Russia and the Middle East [1]. Due to their large size and commercial interest, *Astacus leptodactylus* have been stocked in a large number of water bodies, particularly during the last century [2]. In Iran, the narrow-clawed crayfish *A. leptodactylus* was reported not only in the Iranian coast of Caspian Sea up to 5-10 km offshore [3] but also in some freshwater inland reservoirs [4]. *A. leptodactylus* lives in cold and clear water of Anzali lagoon and Aras Dam Lake in northern Iran, naturally. Although this species has been introduced to some other reservoirs throughout Iran in recent years [5], however there have been some fluctuations in the production of *A. leptodactylus* in the recent decade. The export of crayfish in Iran increased remarkably after 1996. The exports of crayfish increased from 32.5 tons in 1998 to 84.7 tons in 1999 [4].

Although some biological performances has been surveyed widely in different kinds of fish [6, 7] and crustaceans in Iran [8-10], however fecundity and egg characteristics have mostly measured in shrimp [11] and crayfish *A. leptodactylus* [12-15].

Fecundity is described as the egg number or female offspring [12]. The freshwater crayfish, especially Astacidae family, shows the lowest fecundity between crustaceans [13]. The average pleopodal fecundity of some *A. leptodactylus* populations in Iranian inland waters have stated by some previous authors which differed from 221 to 251 eggs for Anzali lagoon [14, 15] and 322 eggs for Aras Dam Lake [14]. The difference between pleopodal and ovarian fecundity has reported as 21% for Aras Dam Lake, 19% for Anzali lagoon [16] and 30% for northern coasts of the Caspian Sea [17].

The current study was aimed to comprehensively survey between the ovarian and pleopodal fecundity of the narrow-clawed crayfish under Aras Dam Lake conditions.

## MATERIALS AND METHODS

The sampling was conducted seasonally on 6 November, 2011 and 13 January, 2012 in the “Aras Dam” Lake in Qare-Ziaoddin region, Western-Azerbaijan Province, Iran. The sampling area is located between 231°20' and 231°25' N latitudes and between 225°25 and 225°50'E longitudes, around Aras town in Qare-Ziaoddin region in west-northern border of Iran.

A total of 20 and 25 mature size females were collected on November and January, respectively. Total body length was measured to the nearest 0.1 mm with a caliper, from the rostral apex to the posterior median edge of the telson and ranged between 53.4 and 148.1 mm. The carapace length ranged between 35.0 and 62.3 mm. The wet weight was measured to the nearest 0.1 g and ranged between 42.9 and 92.4 g.

Right after sampling, carapaces were lifted away and ovaries were dissected out. The gonads were weighed via an electronic digital scale to the nearest 0.001 g. The GSI was evaluated as follows;  $GSI = \frac{\text{ovarian wet weight}}{\text{total body weight}} \times 100$  [18]. The dissected out ovaries placed in 4 % formalin and then the ovarian eggs were counted [19].

The eggs extruded in the beginning of January. Crayfish were transferred to the laboratory complex of Islamic Azad University by air in a Styrofoam box containing meshed ice, where the pleopodal fecundity was evaluated. The eggs were removed from the pleopods and the number of ripe eggs was counted.

The mean  $\pm$  standard error (SE) and linear regression of the data in the current study were done by Microsoft Excel 2003 and Statistica software. Mean values and SE of the data were evaluated via ANOVA and subsequent Duncan's multiple range tests. The pair wise comparison was performed by LSE test. ANCOVA test showed the difference between ovarian and pleopodal fecundity in

which total body length of female considered as a covariance. Linear correlations were performed for the ovarian and pleopodal fecundity. Data were shown as mean  $\pm$  SE, with  $p < 0.05$  presented as significant difference.

## RESULTS AND DISCUSSIONS

The mean pleopodal eggs of each pair of pleopods and their statistical comparison has presented in the Table 1. A statistically significant difference was found ( $p < 0.05$ ) between the number of eggs carried on each pair of pleopods. The highest egg number was attached on the 4<sup>th</sup> and 3<sup>rd</sup> pair of pleopods with  $34.45 \pm 15.82$  (6-69) and  $30.75 \pm 15.76$  (4-57) eggs, respectively. The lowest egg number was attached on the 1st pair and the abdominal surface around of pleopods with  $5.38 \pm 4.38$  (0-14) and  $9.45 \pm 6.65$  (0-30) eggs, respectively (Table 1). The mean diameter of eggs attached to the pleopods was  $2.2 \pm 1.26$  mm (1.07-6.59 mm) (Table 2).

A positive significant correlation was found between the female size and both ovarian and pleopodal fecundity.

The mean total body length and mean total body wet weight of 25 mature size females trapped in November were  $74.41 \pm 22.79$  (50.08-107.39) mm and  $42.95 \pm 12.67$  (31.86-65.03) g, respectively. The mean value of ovarian fecundity was calculated to be  $206.55 \pm 38.08$ , ranging from 132 to 275 eggs. The ovarian fecundity relative to the total body length have presented in a linear regression (Fig. 1A,  $r^2 = 0.2302$ ;  $p > 0.05$ ). The mean egg diameter and the mean egg weight were measured as  $1.00 \pm 0.11$  mm (0.83-1.25 mm) and  $0.026 \pm 0.005$  g (0.018-0.035g) respectively (Table 2). The largest females didn't present the highest amount of GSI, as well (11.63-15.91%). The average gonadosomatic index of females was found to be  $13.53 \pm 5.11\%$ .

Table 1: The mean number of eggs connected to each pairs of pleopods. Means in the second row with different superscript were significantly different ( $P < 0.05$ )

	1 <sup>st</sup> pair	2 <sup>nd</sup> pair	3 <sup>rd</sup> pair	4 <sup>th</sup> pair	5 <sup>th</sup> pair	Others	Total
Mean $\pm$ SE	$5.38 \pm 4.38^c$	$24.63 \pm 13.96^b$	$30.75 \pm 15.76^a$	$34.45 \pm 15.82^a$	$24.88 \pm 13.73^b$	$9.45 \pm 6.65^c$	$129.51 \pm 65.87$
From min.							
to max.	0-14	1-44	4-57	6-69	2-52	0-30	16-244

SE; Standard Error

Table 2: The mean and range of total body length of females, egg number and egg weight

	Total number of Crayfish	Total body length		Egg number		Egg diameter		Egg weight	
		Mean $\pm$ SE	Range(mm)	Mean $\pm$ SE	Range	Mean $\pm$ SE	Range(mm)	Mean $\pm$ SE	Range (g)
Ovaries (November)	25	$74.41 \pm 22.79$	50.08-107.39	$206.55 \pm 38.08$	132-275	$1.00 \pm 0.11$	0.83-1.25	$0.026 \pm 0.005$ g	0.018-0.035
Pleopods (January)	60	$114.12 \pm 23.45$	99.25-124.44	$129.51 \pm 65.87$	16-244	$2.20 \pm 1.26$	1.07-6.59	$0.044 \pm 0.036$	0.10-0.162

SE; Standard Error

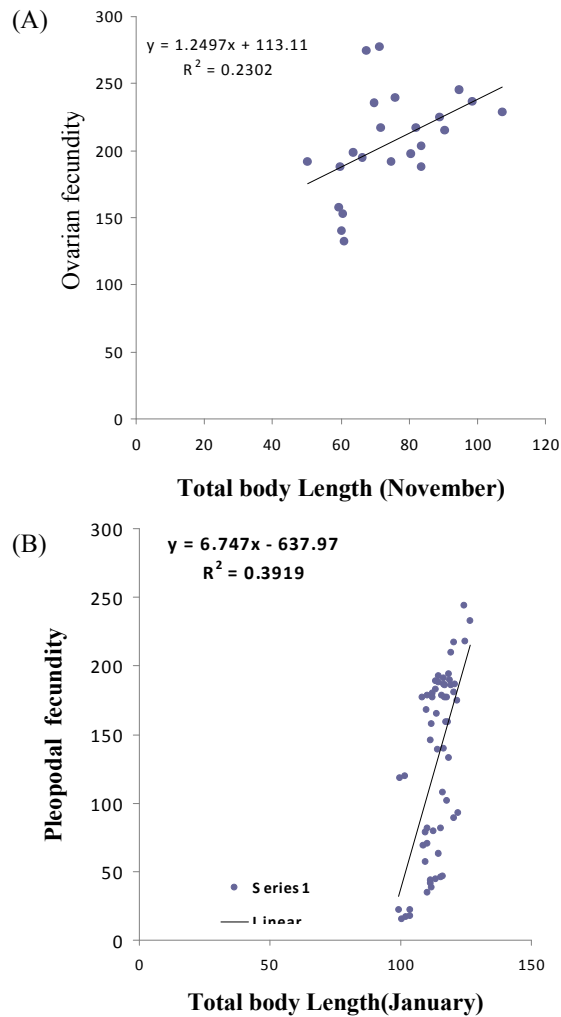


Fig. 1: (A) The linear regression between female size and ovarian egg numbers, November 2011 in 20 mature size individuals of (*A. leptodactylus*). (B) and between female size and number of pleopodal eggs, January 2012, in 25 mature size individuals of (*A. leptodactylus*), Aras Dam Lake, Western Azerbaijan, Iran.

The mean total body length and mean total body wet weight of 60 mature size females trapped in January was  $114.12 \pm 23.45$  mm (99.25-124.44 mm) and  $57.18 \pm 21.13$  g (42.29-73.07 g), respectively. The mean pleopodal fecundity was found to be  $129.51 \pm 65.87$  (16-244) eggs. The pleopodal fecundity presented a linear regression (Fig. 1B,  $r^2 = 0.3919$ ;  $p > 0.05$ ) to the body length. The estimated pleopodal fecundity was 37.3 % lower than the estimated ovarian fecundity. According to the result of ANCOVA test, there was a significant difference between ovarian and pleopodal fecundity when female size considered as a covariance ( $p < 0.05$ ).

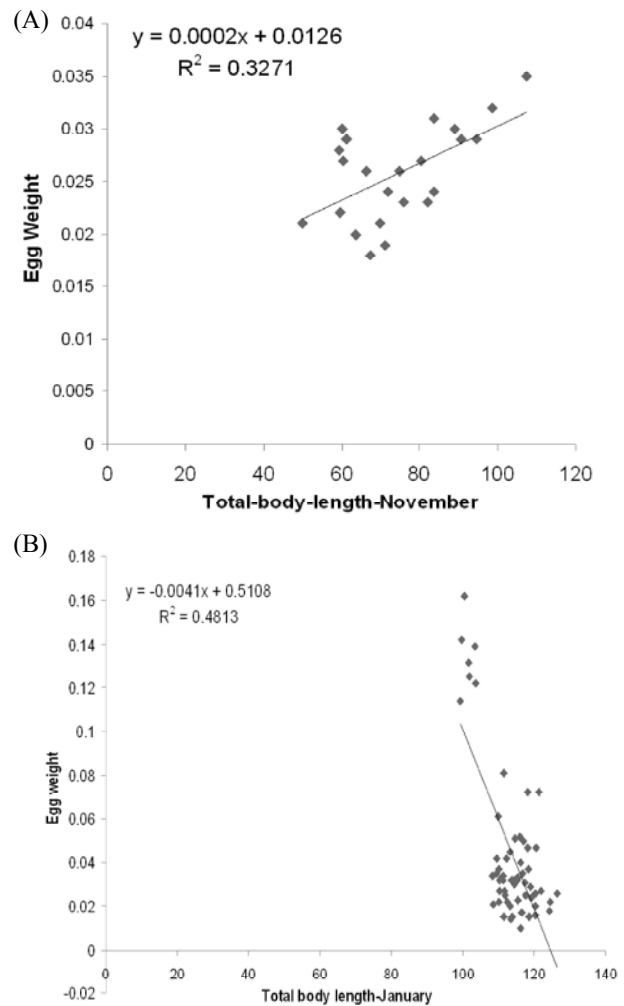


Fig. 2: (A) The linear regression between female size and egg weight, November 2011 in 20 mature size individuals of (*A. leptodactylus*). (B) and between female size and egg weight, January 2012, in 25 mature size individuals of (*A. leptodactylus*), Aras Dam Lake, Western Azerbaijan, Iran.

The values of egg number and egg weight are shown in Table 2. Both egg diameter and egg weight of the November sampled females positively correlated to the female size (Figs. 2A, 3A), while there were a negative correlation between the mentioned characteristics and the females sampled on January (Figs. 2B, 3B).

The influence of female size on egg number of some crayfish species has been demonstrated by previous authors [19-21]. However the published data about ovarian fecundity of different populations of *A. leptodactylus* was in an extended range including of 211 eggs per female for Egridir Lake in Turkey [22], 276 eggs for the northern coast of the Caspian Sea [17],

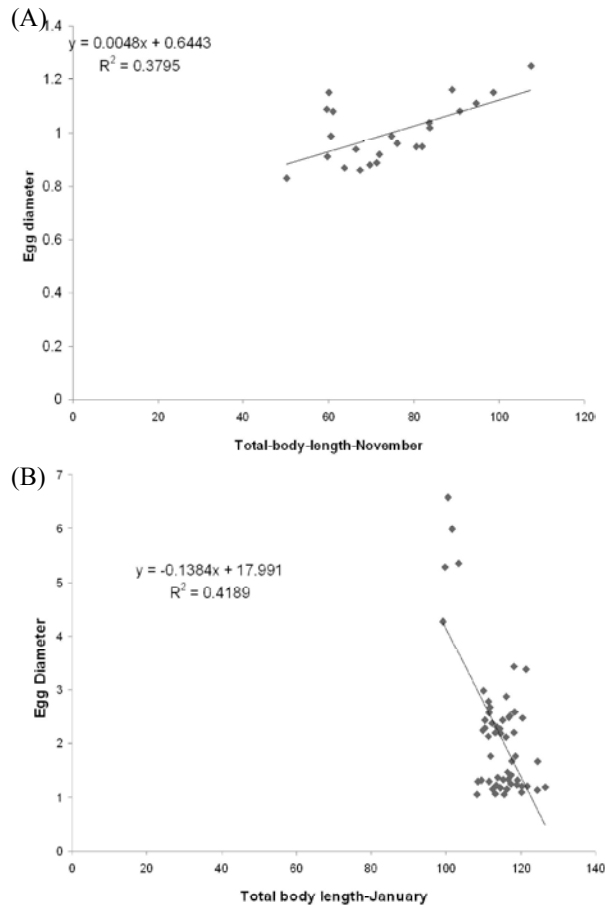


Fig. 3: (A) The linear regression between female size and egg diameter, November 2011 in 20 mature size individuals of (*A. leptodactylus*). (B) and between female size and egg diameter, January 2012, in 25 mature size individuals of (*A. leptodactylus*), Aras Dam Lake, Western Azerbaijan, Iran.

210-410 eggs for Divzak Lake population and average 374 eggs for Mazurian Lake population in Poland [23] and 204, 210 and 139 eggs for three populations in Norway, Finland and Lithuania Lakes per female, respectively [24]. Similar various egg numbers of the narrow-clawed crayfish (*A. leptodactylus*) were reported by early authors in the Iranian inland waters [14-16, 24].

Reynolds *et al.* [25] showed various egg numbers between different populations of the same crayfish species. It could be due to the genotype differences of various populations or may reflect the quality of environmental conditions. In this case, the mean pleopodal (129.5 eggs) and ovarian fecundity (206.5 eggs) of females is observed in the current study, while Karimpour and Hosseinpour [16] reported 322 pleopodal

eggs per female and Karimpour and Taghavi [24] reported 420 ovarian eggs per female for the same population of crayfish in Aras Dam Lake. Regards to the similar female size of the current and previous studies, the causes for these differences are unknown, but such differences may be attributed to influences of different genotypes in various *A. leptodactylus* populations and/or to different environmental parameters during the last decade.

The significant difference obtained between ovarian and pleopodal fecundity in the current study may reflect the oocytes that couldn't be fertilized, oocytes that failed to attach to the pleopods after laying eggs [26], egg losing through the incubation course, because of unsuitable quality of environmental parameters [27, 28] and egg losing through the conflict between females carrying eggs [29].

Similar to results of the present study, in Turkish populations of crayfish *A. leptodactylus*, mean pleopodal eggs was affected by female size, significantly [30]. In other hand Kozak *et al.* [28] reported that female size was correlated significantly with GSI and egg number of spiny-cheek crayfish *Orconectes limosus*. Similarly in the present study, the GSI and fecundity of the crayfish *A. leptodactylus* increased significantly with female size.

Results of the present study showed a positive correlation between both egg diameter and egg weight with total body length of November sampled females; however these factors correlated negatively with total body length of January sampled females. Compared to the present study, the results for other crayfish species such as *Astacus astacus* [31], *Pacifastacus leniusculus* [31, 32] and *Combaroides japonicus* [33] and even another population of the same species [34] were different from this study.

In Summary, the present study showed that both ovarian and pleopodal fecundity positively correlated with female size. Both November and January sampled females produced more eggs compared with smaller ones. In addition, females on January reproduced larger and heavier eggs than those of November sampled ones. The larger and heavier eggs might reproduce larger and more resistant juveniles. These factors suggest larger females as broodstock for hatcheries.

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