Environmental Resources Research
Vol. 3, No. 1, 2015

GUASNR

Population dynamics of freshwater crayfish (*Astacus leptodactylus*) in Aras reservoir, Iran

A. Mohsenpour Azari[1], M. Seidgar[1], F. Mohebbi[*1]
[1]Iranian Fisheries Research Institute, National Artemia Research Center, Agricultural Research, Education and Extension Organization, Urmia, Iran

Received: February 2014 ; Accepted: December 2014

Abstract

Aras dam is one of the important water reservoirs in Iran with a total area of nearly15000 ha. Population dynamics including length and weight composition, fecundity, sex ratio, molting time, and reproduction and capture times of freshwater crayfish (*Astacus leptodactylus*) of Aras reservoir was investigated during 2012-2013. The results revealed that the mean total length and weight of captured crayfish were 106.26 ± 12.89mm and 38.79 ± 15.54g, respectively. The largest crayfish had 171mm length and 216g weight. Mean number of ovarian and pleopodal eggs were 286 ± 82 and 246.31± 80.4, respectively (P≤ 0.05). In this study, male to female ratio was obtained as 1.21: 1. The male molting at 16 º C was started from late April and ended in late May, when the water temperature reached 18 º C. The second molting of males and the first molting of females occurred simultaneously at 18 º C water temperature in September. Matting of *Astacus leptodactylus* was started from November and continued until May. Harvesting period was from May to late November. The results showed that the number of eggs were variable (from 200 to 400 eggs) and depended on spawner size, environmental condition and available food. Besides, crayfish with higher lengths and weights had increased fecundity with a direct positive correlation. A ban on fishing during the reproduction season, use of appropriate nets and proper management should be performed to preserve the stocks of this species.

Keywords: Freshwater crayfish, *Astacus leptodactylus*, Fecundity, Aras dam

*Corresponding author; ali1345176@gmail.com

1. Introduction

Freshwater crayfish is one of the aquatic animals with high economic and nutritional values and is considered as eutrophic water scavengers. Therefore, it has long attracted interests in scientific research (Holdich and Lowery, 1988). Freshwater crayfish is considered a valuable fishery resource as well, as there are no other commercially important species of Crustacea found in fresh waters in Iran. Aras reservoir is the habitat of *Astacus leptodactylus leptodactylus* (Mohammadi *et al.*, 2007). The Aras reservoir is the main crayfish source and also supports Iran's natural crayfish yield. In Iran, the first crayfish introduction was carried out in 1988 by the Iranian Fisheries Research Organization from Anzali Lagoon into Aras, which has plenty of benthic organisms (Karimpour *et al.*, 2011). A total of 20000 crayfish (15–25 g in weight) were used for stocking. The next project was performed between 1997 and 1998 on the determination of population dynamics and MSY (maximum sustainable yield) by Karimpour and Hosseinpour (1999). The findings of the project revealed that the first crayfish introduction was successful.

Population dynamics is the branch of life sciences that studies short-term and long-term changes in the size and age composition of populations, and the biological and environmental processes influencing those changes. Population dynamics deals with the way populations are affected by birth and death rates, and by immigration and emigration, and studies topics such as ageing populations or population decline. The purpose of this study was to describe the population characteristics of *leptodactylus* in Aras reservoir under fishing exploitation.

2. Materials and methods

Samples were collected by funnel nets of 34 mm mesh size (stretched mesh) at five different localities in the Aras reservoir (Figure 1). Randomly captured *Astacus leptodactylus* samples from each site were transferred to laboratory and their sex were determined using morphological characteristics and presence of monopods according to Holdich and Lowery (1988) and their total length and weight were measured with 0.1 mm caliper and 0.1g digital scale, respectively. Also, absolute fecundity (number of eggs in the abdomen) and working fecundity were determined. Absolute fecundity was determined by heating *A. leptodactylus* and counting the eggs that existed in the ovary. Working fecundity was determined by separating and counting of eggs under the abdomen (Karimpour *et al.*, 1991). The propagation period and capture season were determined from the time of first egg observation under phyllopod until the release of miniatures to aqueous environment and from release of miniatures until copulation and occurrence of eggs under phyllopods, respectively. Also, appropriate molting time of freshwater crayfish was determined in the Aras reservoir. For this, in early October female samples were taken and their absolute fecundity was determined. Each *A.*

leptodactylus was biometrically evaluated and then boiled and their ovaries were taken out and their eggs counted.

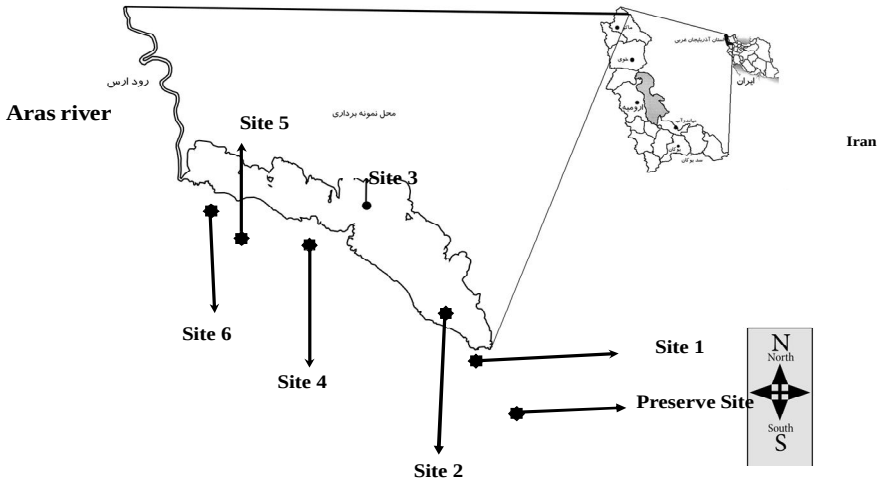

Figure 1. Location of Aras reservoir and sampling sites

3. Results

Average length of *Astacus leptodactylus* samples from Aras reservoir was 106.26 mm (± SD 12.89; max. 171.13 mm; min. 65.11 mm; n= 11750). Average weight of *A. leptodactylus* samples from Aras reservoir was 38.79 g (± SD 15.54; max. 216 g; min. 12g; n= 11750). Average length of males was 109.76 mm (± SD 19.49; n= 6060) and average length of females was 106.28 mm (± SD 11.48; n=5003). Average weight of males was 46.67 g (± SD 20.59; n= 6060) and average weight of females was 35.03 g (± SD 20.8; n= 5003). The relation between length and weight of *A. leptodactylus* is shown in Figure 2 (R^2 = 0.734, n= 11068).

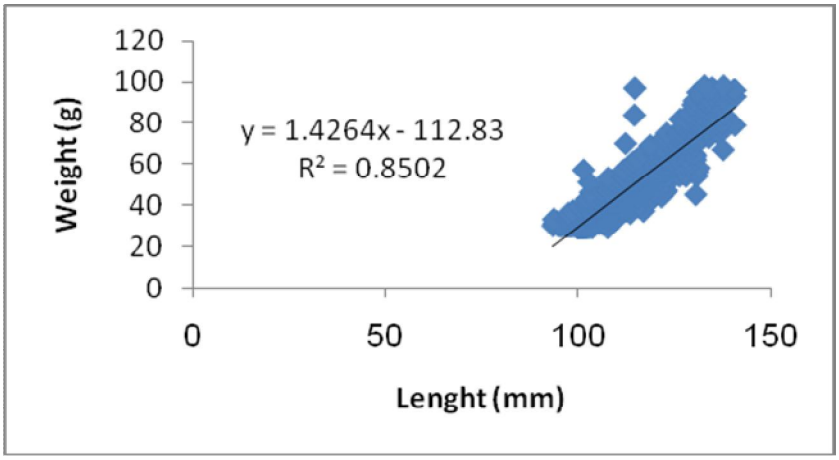

Figure 2. The power relationship between length and weight of *A. leptodactylus* from Aras reservoir

Mean maximum and minimum absolute fecundity were 286±82 mm, 485mm and 126 mm eggs. Also, their mean, maximum and minimum weight were 36.19±8.95 g, 58.86 g and 16.36 g, respectively (n=67). The relation between *A. leptodactylus* length and absolute fecundity is shown in Figure 3 (n=67, R^2=0.358, Fa= 3.869, TL- 118.4).

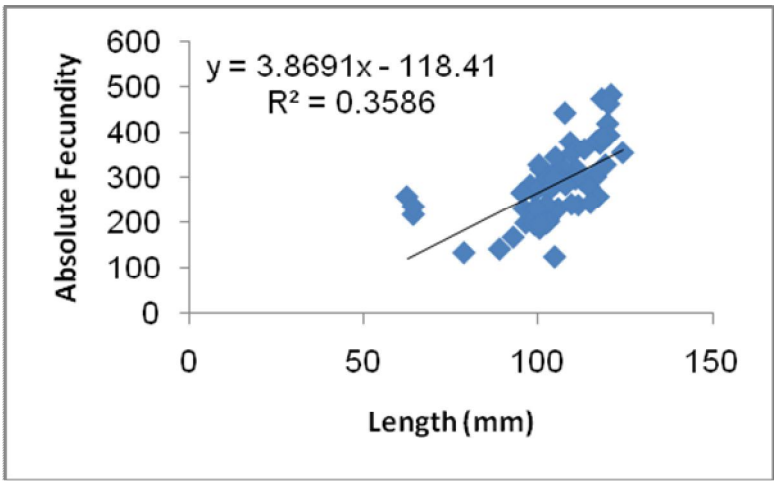

Figure 3. The power relationship between length and absolute fecundity of *A. leptodactylus* from Aras reservoir

The corresponding R^2 value between weight and absolute fecundity was obtained as depicted in Figure 4 (n=67, R^2 = 0.639).

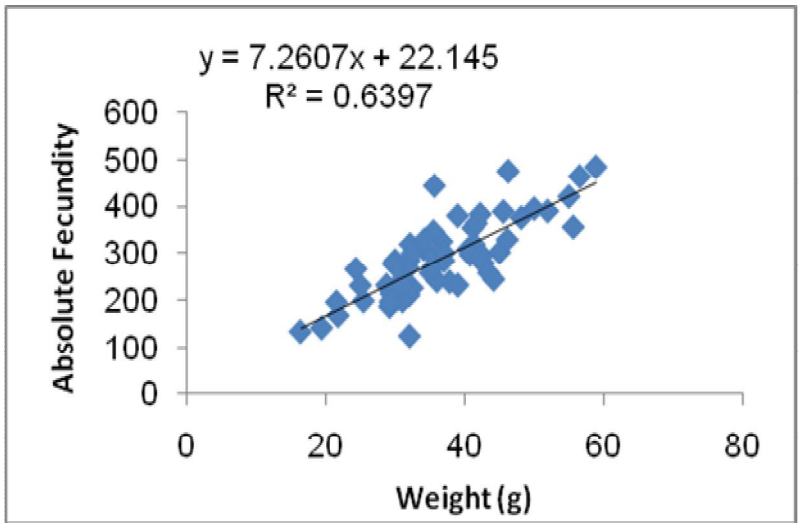

Figure 4. The relation between weight and absolute fecundity of *A. leptodactylus* from Aras reservoir

In early May, female samples were taken to determine working fecundity. All *A. leptodactylus* samples containing egg were measured biometrically and the eggs were isolated and counted. The corresponding R^2 value between *A. leptodactylus* length and working fecundity for 91 samples were R^2= 0.458 (Figure 5). In this study, the mean, maximum and minimum absolute fecundity were 286± 82, 485 and 126 eggs, respectively. The mean, maximum and minimum total length of female samples were 104.47±12.49 mm, 124.11 mm and 62.39 mm and the mean, maximum and minimum weight of samples were 36.19± 8.95 g, 58.86 g and 16.36 g, respectively (n= 67)

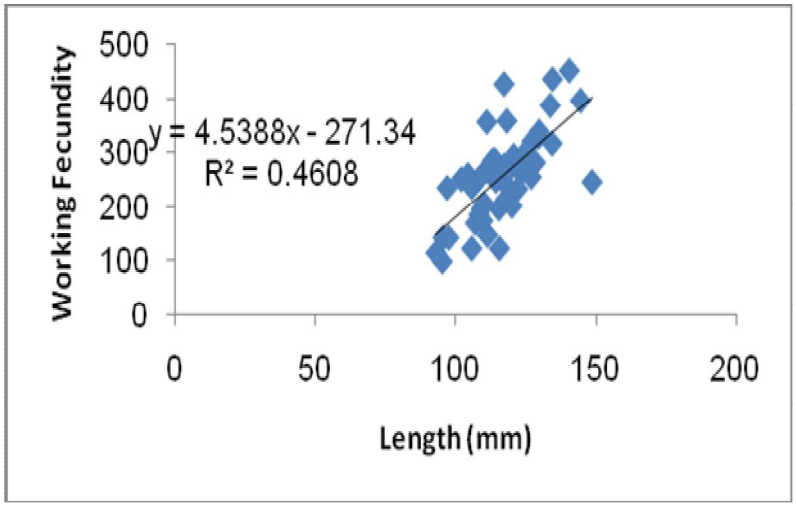

Figure 5. The relation between length and working fecundity of *A. leptodactylus*

The relationship between weight and working fecundity of *A. leptodactylus* is shown in Figure 6 (n= 91, R^2 = 0.450).

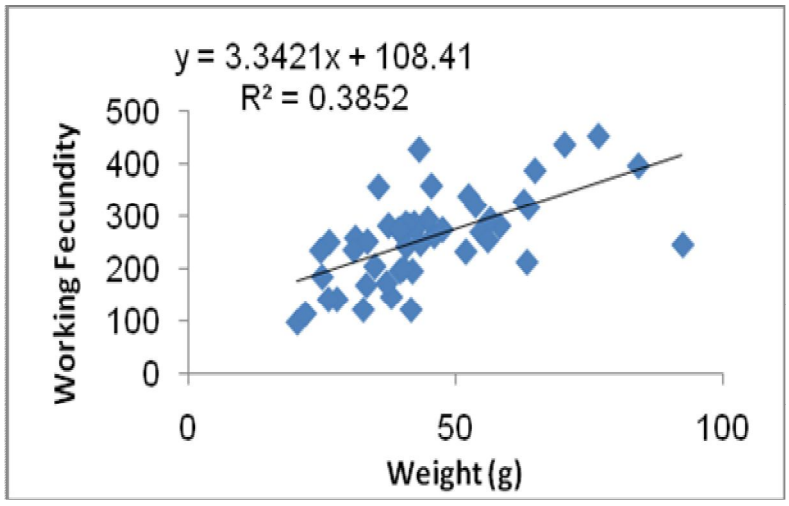

Figure 6. The relation between weight and working fecundity of *A. leptodactylus*

The results showed that there is a significant difference between the means of absolute and working fecundities ($P<0.05$). Also, male to female ratio was 1.21:1

(6060:5003, n=11063). At mid November with water temperature around 8°C, below abdomen of females were whitened (calcification). This suggested that they were ready for mating.

4. Discussion

The seasonal Physical – chemical parameters in Aras dam is shown in Table 1.

Table 1. Seasonal Physical – chemical parameters in Aras dam

Season / Parameter	Aras dam				
	Spring	Summer	Fall	Winter	Mean
Air Temp(°C)	27	30	15	7	20
Water Temp(°C)	20	26	14	6	16.5
PH	7.5	8.5	8.5	8.8	8.3
Do (ppm)	9.4	9.8	10.7	15.2	11.3
TN (ppm)	1.85	1.87	3.39	4.86	2.99
TP (ppm)	0.1	0.074	0.09	0.068	0.082
Ca (ppm)	25.3	30.9	54.3	54.5	41.2
Hardness (ppm)	293	300	426	393	353
Chl-a ($\mu g l^{-1}$)	26.2	17	19.8	24.2	21.8

The first females containing eggs were observed in late December with water temperature 4°C and then in January at 3°C all females copulated and contained eggs below abdomen. In mid May, when the water temperature was 18° C, the first females containing miniatures were observed. With increasing water temperature to 20°C in mid-June, all females contained miniatures and some had released their miniatures. In mid June and with increasing water temperature to 20°C, females released miniatures. Therefore, the propagation time of *A. leptodactylus* in Aras reservoir were determined from early December to mid June (nearly 6 months) and capture period were determined from early June to late November. Males molting began in late April, when water temperature reached 16°C, and finished in late May. The second molting of males took place in mid September when the water temperature reached 18°C. Molting of females was simultaneous to the second molting of males and took place in mid September at 18° C water temperature. A comparison was made between W.F. and A.F. in the present and other studies.

Table 2. Comparison between W.F and A.F in the present study and some other studies

Reference	Location	Working fecundity	Absolute fecundity
Present study	(Aras reservoir Iran)	246	286
Karimpour and Hosseinpour (1997)	(Iran)Aras reservoir	322	420
Karimpour et al (1991)	(Anzali lagoon Iran)	249	---
Karimpour et al (2003)	Aras reservoir (Iran)	211	358
Rumyanteseva (1989)	Caspean sea (Russia)	---	276
Abdolmaleki (2009)	Shorabil Lake (Iran)	311	---
Koksal (1979)	Europe	183	210
Stypinskaya (1972)	Lake Dlnzek (Poland)	---	374

The mean total length and total weight of captured *A. leptodactylus* from Aras reservoir in 2008 were reported as 106.43±7.94 mm and 35.81± 10.86 g, respectively (Mohsenpour Azari *et al.,* 2011). There was a significant difference between W.F of the studies presented in Table 2 ($P<0.05$). Also, a significant variation was observed between A.F of the present study with other studies ($P< 0.01$, Table 2). Among these studies, the results of our study showed an average level of fecundity which shows a relatively suitable condition of crayfish population reproduction in Aras reservoir.

The mean and maximum total length and weight of *Astacus leptodactylus* from Aras reservoir in 1996 had been reported as 120.51±0.69 mm, 186 mm and 54.68± 1.53 g and 239.4g, respectively (Karimpour and Hosseinpour, 1997). In Shorabil lake of Ardabil the mean total length of freshwater crayfish had been reported as 133.8±14.6 mm and their mean weight were reported as 82.5±32.4 g and maximum length and weight were 196mm and 328 g, respectively (Abdolmaleki *et al.,* 2009).

There was no significant difference in the length of W.F between the present study and other studies (Table 3). Though, there was a significant variation in the length of A.F between present study and other studies ($P<0.05$). This shows that the length of W.F in Aras crayfish population in the present study was lower than that of other studies. Reduced length of Aras crayfish population may be attributed to overfishing in the few last seasons. Maximum total length of Turkish freshwater crayfish has been reported as 145 mm (Koksal, 1988). Also, in Egirdir Lake of Turkey, the average range of captured freshwater crayfish has been reported as 40 to 150 mm (Balik *et al.,* 2005). Maximum length of freshwater crayfish from Anzali lagoon has been reported as 135 mm (Karimpour *et al.,* 1991). As noted, freshwater crayfish from Shorabil Lake of Ardabil had larger size compared to other reported lakes, perhaps due to lack of large capture operations.

Table 3. Comparison between length of W.F and A.F in the present study and some other studies

Reference	Location	Length in W.F	Length in A.F
Present study	(Aras reservoir Iran)	113	101
Karimpour and Hosseinpour (1997)	(Iran)Aras reservoir	---	122
Karimpour et al (2003)	Aras reservoir (Iran)	118	120
Koksal (1979)	Europe	120	---
Rumyanteseva (1989)	Caspean sea (Russia)	---	110
Stypinskaya (1972)	Lake Dlnzek (Poland)	---	115

The best and most common management method to prevent over capture of *A. leptodactylus*, has been reported as increasing minimum size and restriction of capture season (Karimpour *et al.*, 2003). If over capture of small sized *A. leptodactylus* took place or capture season was not considered, the mean size of captured freshwater Cray fish could have decreased and even reached the pre adult size. In such cases, the stocking would be severely at risk (Momot, 1985). Unfortunately, during last decades, the stocking rate of *A. leptodactylus* in Aras reservoir has been severely decreased that could be due to over capture of stocks, out of season capture, unsuitable ecological condition and recent droughts.

The most important factor for estimating the production potential of a population is determination of its fecundity. *Astacus leptodactylus* enjoys a high fecundity and its working fecundity fluctuates between 200 to 400 eggs (Koksal, 1988). The mean absolute fecundity and total length of *Astacus leptodactylus* in 1996 in Aras reservoir were 420.41±42.51 eggs and 121.93±4.27mm (Karimpour and Hosseinpour, 1997). The mean absolute fecundity of *Astacus leptodactylus* from Aras reservoir in 2002 were reported as 358.61±12.92 eggs with maximum and minimum of 599 and 133 eggs and the mean total lengths of 119.40 ± 1.55 mm (Karimpour *et al.*, 2003). Stypinskaya (1972) in Diuzak Lake of Poland determined the range of the absolute fecundity of freshwater crayfish with total length of 95-135 mm as 210 to 410 eggs while mean absolute fecundity of freshwater crayfish in Mazurian Lake in the same country was 374 eggs. In Egridir Lake of Turkey, the mean absolute fecundity was 210.08±8.73 eggs. Also, the smallest female with total length of 89 mm had 148 eggs and the largest female with total length of 132mm had 474 eggs (Koksal, 1979). In Turkmenistan waters, absolute fecundity of freshwater crayfish of the Caspian Sea was reported as 276 eggs (Rumyanteseva, 1989). The mean working fecundity in 1996 was 322.04± 29.61eggs with maximum and minimum of 786 and 112 eggs (Karimpour and Hosseinpour, 1997). The mean working fecundity in 2002, were 248.98±9.12 eggs with mean total length of females as 118.50±1.26 mm and maximum and minimum egg number of 591 and 92, respectively (Karimpour *et al.*, 2003). The mean,

maximum and minimum working fecundity of Anzali freshwater crayfish were reported as 211±22, 413 and 92 eggs, respectively (Karimpour *et al.*, 1991). In Shorabil Lake of Ardabil, the mean working fecundity has been reported as 311.11±22.92 eggs (Abdolmaleki *et al.*, 2009). In Egridir Lake of Turkey, the mean absolute fecundity was 183.06± 9.05 eggs and the smallest female with total length of 90 mm had 101 eggs and the largest female with total length of 150 mm had 369 eggs under the abdomen (Koksal, 1979). The number of eggs varies in different sub-species and populations of one species (Cobb and Wang, 1985). Populations of one species of freshwater crayfish have different fecundities under different environmental and geographical conditions (Morrissy, 1976). When the population density is high in an aquatic system, its fecundity is decreased due to feeding competition (Momot and Growing, 1972). The decreased egg number or scarcity of freshwater crayfish containing eggs in one population is a reaction to nutritional deprivation in an aquatic system (Abrahamsson, 1972). Absolute and working fecundities strongly depended on the size of freshwater crayfish (Lindqvist and Lahti, 1983; Abrahamsson, 1972). The difference between absolute and working fecundity were calculated as 13% in Turkey (Koksal, 1988), 21% in Aras (Karimpour and Hosseinpour, 1997), 17.5% in Caspian freshwater crayfish of Anzali port beaches (Karimpour et al, 2003), nearly 30 % in north Caspian sea freshwater crayfish (Baradaran Naviri, 2001, Matinfar, 2007), 21% in Aras *Astacus leptodactylus* (Karimpour *et al.*, 2004) and 15% in this study, which differed from previous studies on Aras reservoir *Astacus leptodactylus*. This difference can be attributed to inability of attachment of fertilized eggs to phyllopods and or un-fertilization of eggs during passage through spermatic chamber (Abrahamsson, 1972).

4. Conclusion

The relationship between egg number and size of freshwater crayfish was found to be linear as affirmed by Mehraban (1999). We found that the rate of fecundity is be increased by increasing length and weight in *Astacus leptodactylus* (Baradaran Naviri, 2001: Vladykov, 1964). It is the case in Aras reservoir's *Astacus leptodactylus* where a direct positive correlation between length and fecundity was observed. The reproductive cycle of freshwater crayfish is dependent on climatic conditions of habitat. In our study also, the reproductive success of freshwater crayfish was influenced by water temperature. The propagation time and temperature condition for *Astacus leptodactylus* in Aras reservoir was found to be identical to that of Turkey (Koksal, 1988). Copulation and appearance of eggs under the abdomen and release of miniatures in Anzali Lagoon's crayfish occurred earlier than that of Aras reservoir (5th November). We could reaffirm that hatching of eggs require a temperature upper than 15 ºC (Abrahamsson, 1972). We believe

that the most relevant factor for this event could be the difference in water temperature of these two geographical regions (Karimpour *et al.*, 1991).

References

Abdolmaleki, Sh., Ghani nezhad, D., Nahrvar, R., Sayadrahim, M., Khedmati, K., Nouroozi, H., and Rastin, R. 2009. Population dynamic and reproductive fecundity of freshwater crayfish in Shorabil Lake of Ardabil. Iranian Journal of Fisheries Sciences. 18(3): 109-118 (In Persian).

Abele, L.G. 1982. The Fossil Record and Biogeography of Crustacea. Academic Press, New York.

Abrahamsson, S.A.A. 1972. Fecundity and growth of some population of *Astacus leptodactylus* in Northern Sweden. Reproduction. Institute of Freshwater Resources, Drottningholm. 52: 23-37.

Balik, I., Cubuk, H., Ozok, R., and Uysal, R. 2005. Some biological characteristics of crayfish (*Astacus leptodactylus* Eschscholtz, 1823) in Lake Egirdir. Turkish Journal of Zoology. 29: 295-300.

Baradaran Naviri, Sh. 2001. The length and weight comparison of *Astacus leptodactylus* in two habitats of Caspian Sea and Aras reservoir. Pashohesh va Sazandegi. 52: 94-97. (In Persian)

Bowman, T.E., and Abele, L.G. 1982. Classification of the Recent Crustacea. Academic Press, NewYork.

Cobb, J.S., and Wang, D. 1985. Fisheries biology of lobsters and crayfishes. Ch. 3. pp. 167-247. In, A.J. Provenzano (ed.), the Biology of Crustacea. 1: 206-208.

Harlioglu, M.M. 2004. The present situation of freshwater crayfish, *Astacus leptodactylus* (Eschscholtz, 1823) in Turkey, Aquaculture. 230 (1): 181-187.

Holdich, D.M., and Lowery, R.S. 1988. An Introdaction. In Freshwater Crayfish (eds: Holdich and Lo wery). Croom Helm, London. pp 1-7.

Karimpour, M., Hosseinpour, S.N., and Haghighi, D. 1991. Some studies on Anzali lagoon crayfish. Iranian fisheries corporation plan and program publication, Tehran.

Karimpour, M., and Hosseinpour, S.N. 1997. Length structure, Sex ratio, and CPUE of *Astacus leptodactylus* of Aras reservoir. Iranian Journal of Fisheries Sciences, 9(1): 49-64 (In Persian).

Karimpour, M., Khanipour, A., and Taghavi Motlagh, S. 2004. Some biocharacters of *Astacus leptodactylus* eichwaldi Bott, 1950 in Anzali port beaches. Iranian Journal of Fisheries Sciences. 13(1): 129-148 (In Persian).

Karimpour, M., Taghavi, S., Yousefzadeh, A., Sayadrahim, M., and Zahmatkesh, M. 2003. Final project report of monitoring the *Astacus leptodactylus* of Aras reservoir. Anzali Lake Bony fish Research Center, 44pp (In Persian).

Koksal G. 1979. Biometric analysis on freshwater crayfish (*Astacus leptodactylus*) which is produced in Turkey. Relationship between the major body component and meat yield. Journal of the Faculty of Veterinary Medicine, University of Ankara. 26: 94-114.

Koksal, G. 1988. *Astacus leptodactylus* in Europa. Freshwater. Croom Helm, London. pp. 365-400.

Lindqvist O.V., and Lahti E. 1983. On the sexual dimorphism and condition index in the crayfish *Astacus astacus* in Finland. Freshwater Crayfish. 5: 3-11.

Matinfar, A. 2007. Guideline program of freshwater crayfish. Iranian Fisheries Research Organization Press. 121pp.

Mehraban, H. 1999. Absolute fecundity of labester, B.Sc. Thesis. National Resources University of Zabol, 33 pp.

Mohammadi, Gh.H., Keyvan, A., Vosoghi, Gh.H., and Matinfar, A. 2007. Comparition of merestic characteristics of Astacus leptodactylus leptodactylus in Anzali lagoon and Aras reservoir habitates . Pazhohesh and sazandegi. 75: 171-180.

Mohsenpour Azari, A., Yahyazadeh, M.Y., Mohebbi, F., Ahmadi, R. Moniri, Y., Ganji, S., Shiri, S. 2011. The study of environmental factors effects of Aras lake and reservoir on development of *Astacus leptodactylus*. Final project report. Iranian Fisheries Research Organization Press, 172 pp (In Persian).

Momot, W.T., 1985. Production and exploitation of the crayfish *Orconectes virilis* in north climates. Journal of Fisheries and Aquatic Science. 22:1-10.

Momot, W.T., and Growing, G.H. 1972. Differential seasonal migration of the crayfish *Orconectes virilis* in Marl Lake. Ecology, 67:1167-1179.

Morrissy, N.M. 1976. Aquaculture of Marron, *Cherax tenuimanus*. Fisheries Research Bulletin. Wes. Australia.

Rumyanteseva, V.D. 1989. The riverin crabs of Caspian Sea (In Russian) Translated to English: Holch. ik, Zh.,Translated to Persian: Hosseinpour, S.N., (1990) p:12. (In Persian)

Stypinskaya M. 1972. Variabilities of the fecundity crayfish (*Astacus leptodactylus*) in Lake Dlnzek depending on the body length and weight. Rocz. Nauk Roln., H–l. pp: 98-103 (In polish).

Vladykov, V.D. 1964. Inland Water Fisheries Resources of Iran and especially of the Caspian Sea with Special Reference to Sturgeon, 51. FAO Report, 1818. Rome.