Australian Journal of Basic and Applied Sciences, 4(11): 5571-5577, 2010
ISSN 1991-8178

Fecundity reproductive cycle of a local population of *Gammarus Pulex* in Sepidan (Fars Province, Iran)

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Abstract: *Gammarus pulex* reproductive was studied in Komehr spring, in Komehr village Fars province, South of Iran. Specimens were collected using a net with 1 mm mesh size. Water temperature, DO, PH, No2, No, Po4, Ec, K, Mg, Total hardens and TDS were measured. Biological parameters including length and wet weight of males and females, number of female having eggs, number of eggs presented in moraspum sac of female, sex ratio, egg size, fecundity and reproductive effort was studied. Mean length of both sex and mean wet weight of males increased in autumn, decreased in spring and increased again in summer. Number of eggs in marsopium sac, female's wet weight, fecundity, and reproductive effort increased from autumn toward summer and egg volume increased in autumn and winter and reduces a little with increasing in egg's number in spring and summer. All reproductive factors showed significant differences throughout the year.

Key words: Gammarus, reproductive indices, fecundity, reproductive effort, sex ratio, Fars

INTRODUCTION

Gammarus pulex (L.) is an extremely widespread and abundant crustacean which may occur at high densities and forms an important component of the diet of a number of fish (Guven *et al*., 1999).

Intra-specific variation in female fecundity can be linked to various internal factors such as size, body condition, age, experience, or social rank (Cooke *et al.,*1995, Holekamp *et al*., 1996; Roff, 1992).

Amphipods of the genus Gammarus successfully occupy a wide variety of freshwater habitats throughout the northern hemisphere (Karaman and Pinkster, 1977; Barnard and Barnard, 1983). One reason for the successful this genus is its adaptability to various habitats, which differ considerably in characteristics such as light availability, temperature fluctuation and food resources. Thus, Gammarus could play a dominant role in the functioning of the spring and stream communities it inhabits (Glazier, 1991; Crane, 1994). There are a large number of investigations undertaken on *G. pulex* biology, such as breeding (Mortensen 1982), preference of habitat (Dahl and Greenberg 1996; Elliott, 2002), temperature effect on sex ratio (Lockwood, 1968), light effect on sex ratio (Bulnheim, 1978), feeding behavior (Kelly et al., 2002), population composition (Kelly et al., 2003), growth rate estimation by model (Duran, 2004), and research of diurnal and nocturnal habitat preference (Elliott, 2005).

Some special characteristics of Gammarids like their food values, growth rate and reproduction rate, wide distribution in Iranian inland waters, high percentage of (more than %40) protein in body mass. (Moghaddasi, 2000; Zamanpour, 2003), vitamins, enzymes, minerals like Mg (Glazier et al, 1992) and Ca (Florkin, 1960; Schram, 1986), cartenoid pigments (Lorenz, 1998), suitable body size in different life stage which is suitable for feeding of different growth stages of fish, high reproduction rate, and permanent presence in aquatic ecosystems have caused this animal to be one of the most important species suitable for mass culture to rise in fish farming as a food. Finding some reproductive and biological characteristics will facilitate artificial propagation and raring of this genus.

MATERIALS AND METHODS

Komehr spring is located in a village with same name near Sepidan city, Fars province in south of IRAN

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(Figure l). Latitude and longitude were recorded by using GPS. Samples were collected seasonally started in autumn 2006 and finished in summer 2007.

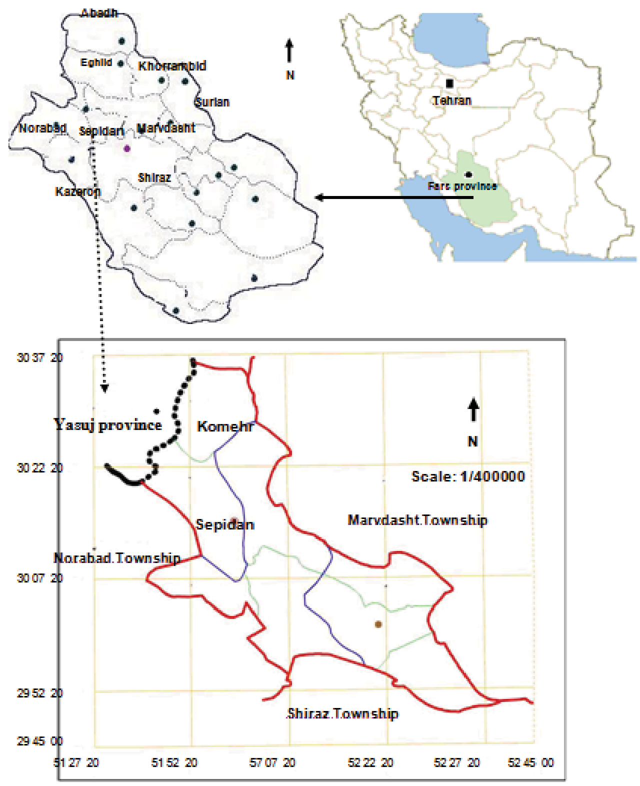

Fig. 1: Above, right Iran map and Fars province position, left fars province map and Sepidan township position, below, Sepidan township map and Komehr village

Specimens were collected using a net with 1 mm mesh size, were immediately fixed in formaldehyde (4%) in the field and transferred to 70% ethyl alcohol in laboratory. *G. pulex* specimens were sorted, identified, and counted under a stereomicroscope (Nikon ms2b). The total length was measured from the tip of the rostrum to the tip of the third uropod by using micrometer. other biological parameters including length and wet weight of males and females, number of female having eggs, number of eggs present in Marsopium sac, egg size, fecundity and reproductive effort and sex ratio were studied**,** also eggs length and width were measured with micrometer (Pockl, Sutcliffe, 1992).

Egg Volume was calculated as follows (Sutcliffe, 1992):

$EV= \pi$ a4 b4 2/6

Where: a4: longest egg's length, b4= widest egg's width

Wet body weight measured by using digital balance (Sartorius GM312, 0.001 gr.).

Fecundity index and reproductive effort were calculated by using following equations (Pockl, 1993; Sutcliffe, 1992):

FI= N eggs/ WWT

RE= EV×FI

Where:

FI= Fecundity, N= Number of eggs, WWT= female's wet weight, RE= reproductive effort, EV= Egg Volume.

Water temperature, Do (dissolved oxygen), PH, No2, No, PO4, TDS (total dissolved solid), EC, Ca, Mg, Total hardens and TDS were measured. SPSS 11 was used for statistical analysis.

RESULTS AND DISCUSSION

The highest mean wet weight for males was calculated in autumn, 0.02942 ± 0.0117 g. and after decrement in winter started to increase in summer in which was calculated 0.0208 ± 0.0141 g. Females had different trend and started to increase from 0.011 ± 0.0049 g in autumn to 0.022 ± 0.0063 g in summer (fig. 3).

Changes trend in mean length of both males and females were as same as male's wet weight (fig. 3).

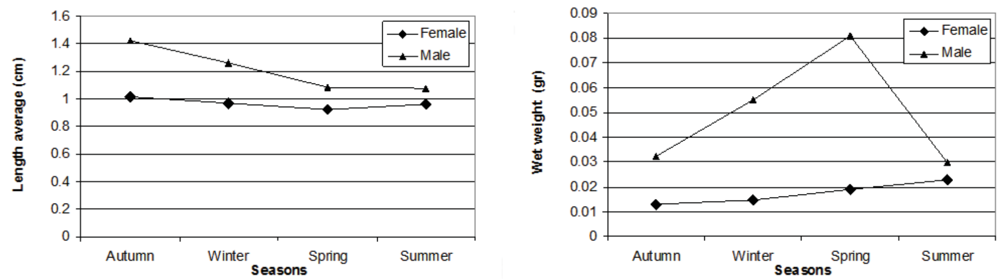

Fig. 3: Length average (left) and weight average (right) of male and female in different seasons.

The maximum average of eggs number in each female was counted in summer (18.57 ± 8.5) and the least eggs Volume was measured in spring and summer (0.0331 ± 0.018 cm^3 and 0.0337 ± 0.02 cm^3) respectively while minimum number of eggs was counted in winter and Autumn (8.38 ± 3.45 and 5.87 ± 2.8), with egg volume of 0.0383± 0.007 and 0.0351± 0.034 cm3 respectively (fig. 4).

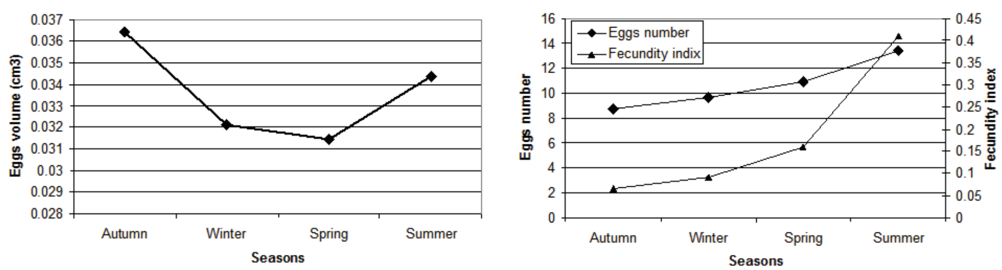

Fig. 4: Eggs volume (left) and eggs number (right) of female in different seasons.

The highest mean of reproductive coefficient and reproductive effort were calculated in summer (0.391± 0.254 and 0.0112± 0.0064 respectively) but these indices were lower in autumn and winter (fig. 4).

1: (Portable O_2 meter WTW OXY 320)
2: (Portable PH meter HANA HI 1281)
3: (Ec meter WTW LF 340)
4: (Spectrophotometer Hach, 2400)

The highest mean of fecundity index and reproductive effort were calculated in summer (0.391± 0.254 and 0.0112± 0.0064 respectively) but these indices were lower in autumn and winter (Fig. 5).

More than 50 percent of females of the population contained eggs and reproduction took place in whole seasons. 88.2 percent of females had eggs in autumn, decreased in winter to (59%) and increased in spring (96.4%) and summer (77.7%). 52.90 percent of mature specimens were male (tab. 1).

This ratio deceased in winter (42%) and in spring (43.5%) and increased again in summer up to 62.5 percent. Whole population specimens studied in 4 seasons were consist of 35% male, 37% female and 28% immature (tab. 1).

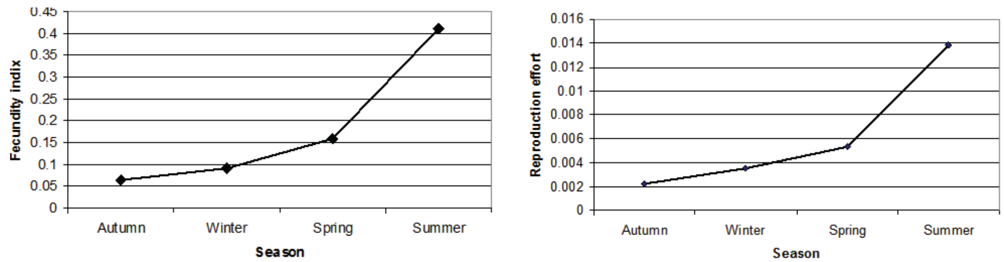

Fig. 5: Fecundity index (left) and reproductive effort of female (right) in different seasons.

Table 1: Percentage of males and females, sex ratio (left) and percentage of female with eggs and without eggs (right).

Seasons	Percent. Of Females	Percent. Of Males	Sex ratio Males/Females	Seasons	Percent.s of Fem With eggs	Percent.s of Fem Without eggs
Autumn	88.2	11.8	1.1	Autumn	88.2	11.8
Winter	59	41	0.7	Winter	59	41
Spring	96.4	3.6	0.7	Spring	96.4	3.6
Summer	77.7	22.3	1.6	Summer	77.7	22.3

TDS, TH, Ca, PO4, NO3, NO2 and pH were high in autumn and after a decrement in winter started to increase again in summer. Water temperature and Mg showed an increasing trend from autumn to summer and no significant difference in water temperature and EC between seasons were observed (table 2).

Table 2: Some of chemical and physical parameters in different seasons in Komehr spring

Parameters	Autumn	winter	Spring	Summer	Parameters	Autumn	winter	Spring	Summer
D.O	7.8	8	7.8	7.5	Mg	5.6	11.7	12.8	12.9
Water temp.	11	11	11.5	11.9	pH	7.1	7	7.6	7.4
TDS	134.2	122	127.6	136.8	Po4	0.12	0.08	0.11	0.12
EC	225.8	262.5	255.7	254.3	No3	1.2	1.2	0.9	1.2
Hardens	195	167.8	182	191.2	No2	0.005	0.002	0.006	0.005
Ca	68.94	47.9	50.5	52.71					

Discussion:

Length and weight of Gamarids depend on different factors. Temperature is one of the most important environmental factor of growth and distribution of Amphipods (Demarch, 1981, Pockl, 1993). Relative activity and swimming speed of amphipods are decreased with decrement in water temperature (Lindstrom and Fortelivs, 2001). Availability of foods has important effect on Gammarids weight so that in autumn and early winter that tree's leaves fall into aquatic ecosystems, females are fatter and larges (Glazier, 1999).

Male's wet weight increases in autumn probably due to dried leaves fallen into water and deceases in winter and spring because of temperature decrement and low availability of food sources, and again increases in summer probably with increase in water temperature (Demarch, 1981; poecki, 1993) (figure 1).

This trend is observable for males and females length (figures 3 and 4). These changes were significant ($p<0.01$).

Phosphorus increment can influence plant and animal populations (Delgado and et al, 1999). Phosphorus changes trend throughout the year are the same as male's wet weight and length in both sex and it means that decrease / increase in phosphorus amount decreases / increases these three parameters.

Changes trend of some chemical factors such as nitrate, pH, Ca, Mg, TDS and total hardness showed same results (table 3).

Increment in female's weight were observed from winter to summer that can be explained with increasing in reproduction activity and increasing in eggs number available in egg's sac in females. These trend also showed significant differences ($P<0.01$) (figure 2).

Different factors can affect number of eggs released in each spawning (Melyian, 1991). Temperature is an important effective factor on number of eggs in egg sac (Marsopium) in females so the increase in temperature resulted in increment in number of eggs in *Gammarus fossarum* and *G. roeseli* (pockl, 1993). Confirming to Pockl, 1993, in this stream there was low number of eggs in spring and winter with low temperature, and high number of eggs was observed in summer when with high temperature. These changes were found significant ($p<0/01$). Although volume of eggs reduced with increasing in number of them, this changes were not found to be significant.

Reproduction in Amphipods usually occurs in through out the year beside winter (Rowshan, 1991; Zielinsk, 1998; Demarch, 1981; Melyian, 1991). Low temperature extends maturation period (Demarch, 1981) and increases mating and fertilization time (Maranhao et al, 2001; Sutcliffe, 1992). In some species like *G. fossarum* and *G. lacustris* that with no reproduction in winter, reproduction cessation was not observed when temperature was controlled in laboratory condition (pockle, 1993; Demarch, 1998; Memon, 1966).

In the study area there was not any cessation in reproduction in winter because there were not wide range changes in water temperature comparing to other seasons, although lower temperature in winter caused 25 percent reduction in reproduction rate.

Number of female with eggs decreased in winter and revealed increment when temperature started to increase.

Sex ratio, male-female, differs from a species to another and even in same species in different climates, for example in *G. leopoliensis* females are more than males throughout the year (Zielinski, 1998). Temperature and photoperiods are the most important factors which can affect sex ratio, for example in *G. duebeni* number of males increases in long daylight while females are more frequent in shorter daylight periods (Bulnheim, 1972).

Confirming to zielinski, 1998 and Bulnheimm, 1977, in the studied population females were generally more frequent than males and in warm season males number increased and conversely in winter, when daylight is shorter and temperature in lower, females population started to increase and males' decrease.

Water temperature is an important factor influences fecundity and reproduction effort (Memon, 1966), and in these study this parameters increased twice in summer comparing to cold seasons (autumn and winter) and these differences were significant ($p<0/01$).

Dissolved oxygen is an important factor to amphipods survival but toleration range for different populations and species in different conditions is too much changeable (Borgamn, 1994). But in Gammarus, oxygen reduction itself is almost tolerable but when it coincidences to poisonous contamination and or eutrification, Amphipods toleration unexpectedly decreases (Sutcliff, 1992; Zamanpour, 1992)

ACKNOWLEDGEMENTS

We would like to thank all those people who assisted in the collection of samples, particularly Mr A. Alavi. We wish to thank Dr. V. yavari, Dr. P. kucheanian and Dr. Dezfullianzadeh, A. R. Dr G. H. Eskandari, Dr. AL-Hossini and Mr S. R. Said Mortezai and Miss S. Shoshtari for their advice on this paper and we expresse special thanks to Dr C. Sazima for paper he sent to us.

Financial support for this project was provided Fishery research inst. Of Iran and Islamic Azad university, Research and Sciences Unit -Ahwaz

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