



Original article

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Study of the growth, reproductive biology and abundance for invasive shrimps *Palaemon elegans* Rathke from Garmat Ali river Basrah, Southern Iraq

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ABSTRACT

Objective: To describe the growth, reproductive biology and abundance of the population of invasive shrimps *Palaemon elegans* (*P. elegans*) in one of the branches of Garmat Ali river at Basrah, Southern Iraq.

Methods: Monthly samples of the prawn *P. elegans* were collected with a bottom hand net (40 cm, 0.5 mm mesh) hauled over a distance of 10 m. A simple random sampling was conducted monthly between December 2012 and November 2013.

Results: Seasonal changes were observed in the composition of the population of the species during the study year with the highest abundance in 2013 and the lowest abundance for the males was reported in January and for the females occurred in June. Salinity showed a significant correlation with the abundance of shrimps at the sampling site. The largest female measured 67.90 mm while the corresponding value for males was 61.31 mm. The proportion of ovigerous adults rose during spring season to peak on about July and ovigerous prawns were taken in all months of the year. The sex ratio indicated a preponderance of females over males in all months in the study period. Each females produced around 36–1324 eggs and the incubation period lasted for 11–14 days at 17–29 °C.

Conclusions: The results of the present study indicate that this species has a wide distribution range, high density, and great reproduction potential. This study reveals the lack of researches on this species in environments of Shatt Al-Arab river and its branches. Thus, *P. elegans* has most likely formed a permanent population in all the brackish waters in Basrah area.

1. Introduction

Palaemonid prawns *Palaemon elegans* Rathke (*P. elegans*) is common in European estuaries and elsewhere[1,2]. Shrimps live in a wide range of environments from freshwater estuaries to oceans. It is essentially a shore species and may also occur in shallow water regions. *P. elegans* is omnivorous, feeding on algae, small crustacean and foraminiferans and it is an important part of the food chain as food for fishes, birds and other predators[2]. *P. elegans* is a species of freshwater prawns of the Palaemonidae family. Particularly, freshwater palaemonid shrimps have commercial value as fishing bait and food. *P. elegans* hides under or between stones and aquatic

plants during the day and comes out at night searching for food.

P. elegans is characterized by open habitats[3], usually in the tidal zones, on sandy bottoms covered with macroalgae, bare sandy sea beds, the brown algae belt and stony bottoms[4-7].

The Caridean prawns *P. elegans* are introduced to the lake Abu Dibic, Southern Iraq. Because of the high salinity (over 4‰), these shrimps were taken in the area of Al-Fao city on the Iraq coast of the Arabian Gulf[8]. The Caridean prawns *Exopalaemon styliferus* (H. Milne Edward, 1840) are common in the Iraqi coastal waters of the Arabian Gulf and the inland waters of Iraq. It has appeared in Iraq in mid 1983[9]. After 2002, a massive invasion of the palaemonid prawns *Macrobrachium nipponense* (De Haan, 1849) was reported in the area but apparently it sharply declined in numbers in these days. So, *Exopalaemon styliferus* returns back to its previous state.

On this occasion, the present investigation was carried out to study some biological aspects such as the growth, sex ratio, size frequency, length/weight relationship, maturity and ovigerous prawn of *P. elegans* inhibited in one of the branches of the Garmat Ali river in Basrah University, north of Basrah.

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2. Materials and methods

Monthly samples of the prawns *P. elegans* were collected from one of the branches of the Garmat Ali river in Basrah University, north of Basrah (Figure 1). The animals were captured with a bottom hand net (40 cm, 0.5 mm mesh) hauled over a distance of 10 m. To monitor changes in abundance of shrimp population at these sites, a simple random sampling was conducted monthly between December 2012 and November 2013. All the specimens obtained were identified, stored in appropriately labeled plastic containers, and preserved in 70% ethanol.

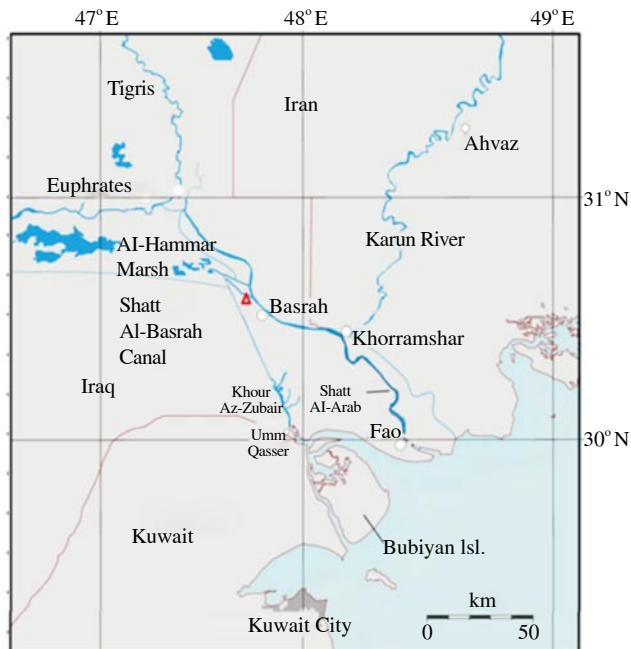


Figure 1. Map of the study area.

In the laboratory, several morphometric dimensions were measured by the use of a stereomicroscope with a calibrated ocular micrometer and by a vernier caliper to the nearest 0.01 mm. The total length (TL) of the shrimp was measured from the tip of the rostrum to the end of the telson (Figure 2).



Figure 2. Specimen of *P. elegans*.

To determine the presence of an appendix masculina, the second pleopod was dissected off and inspected under a dissecting microscope. This procedure allowed the identification of the minimum body size at which individuals could be sexed.

The sex of the shrimp was determined according to the presence, in the males, of an appendix masculina on the endopoda of the second pleopoda. Moreover, adult females possessed wider pleural plates on

abdominal segments than adult males[10].

Length frequency distribution of each sample was plotted by sex at 5 mm intervals.

The water temperature was recorded monthly with a hand thermometer, the salinity was measured by salinometer in order to test the correlation of the abundance of individuals and the median values (point measurements) of these physical factors (Spearman correlation, $P < 0.05$).

For fecundity analyses, the eggs were carefully removed from the pleopods and counted under a stereomicroscope by means of a manual counter[11].

The relationship of fecundity/total length (TL) was expressed by a potential equation.

$$F = aTL^b$$

where F stood for the number of eggs per female and a and b were constants.

The length/weight relationship were determined separately for the males and females by the general formula:

$$W = aL^b$$

where W was the weight in grams, L was the length in centimeters and a and b are the constants to be calculated.

Non-seasonal von Bertalanffy growth parameters were estimated from the length frequency distribution analysis for *P. elegans* males and females. The von Bertalanffy growth (VBG) equation $L_t = L_\infty [1 - e^{-K(t-t_0)}]$ predicted length as a function of age and was used when growth has a non-seasonal pattern.

where, L_t was the length at age t, L_∞ was the asymptotic length to which the shrimps grow, K referred to the growth rate parameter, t_0 was the nominal age at which the length is zero, t_1 was the age at which the length in months[12].

Thirty two of ovigerous females were put into the 30 x 30 x 15 cm aquarium individually to observe the eggs development[4], brackishwater was supplied and the water was exchanged twice a day until hatching[13].

Experimental data were analysed using One-way ANOVA pair with *t*-test, regression equations and Kruskal-Wallis, and significant differences were determined at a 0.05 probability level using Minitab statistical software 18.2.

3. Results

A total of 3026 specimens of *P. elegans*, 841 males and 2185 females, were sampled between December 2012 and November 2013. The total lengths of males ranged between 21.50 and 53.40 mm with the mean length of (32.16 ± 0.027) mm and the total lengths of females ranged between 22.00 and 59.50 mm with the mean length of (39.48 ± 0.031) mm. Some of other morphological and reproductive features taken during the study were presented as follows. The mean wet weight for the males are (1.0627 ± 0.0019) g and (1.2580 ± 0.0027) g for females. Fecundity and mass of eggs varied from 36 to 1324 eggs per females (662 ± 8.32) and 0.0570 g to 0.6210 g (0.2210 ± 0.0018) , respectively.

Size frequencies between the seasons showed a pronounced seasonal variation of each season from December 2012 to November 2013. Size classes showed a regular shift in dominant size class at certain times of the years as the new summer cohort might be seen in May or June to grow in body length through the autumn months

to January. Low numbers found in winter, followed by a general increase as seasonal fluctuation of population density indicated summer and autumn (Table 1, Figure 3).

Table 1

Shrimps abundance, numbers of females and males, salinity and temperature means in the study area between December 2012 and November 2013.

Months	Salinity (ppt)	Temperature (°C)	Females	Males
Dec	6	18	150	60
Jan	4	14	140	32
Feb	4	16	280	51
Mar	5	20	313	66
Apr	10	22	240	79
May	10	26	110	60
Jun	12	28	97	54
Jul	20	30	124	75
Aug	14	32	167	103
Sep	13	28	175	122
Oct	10	22	183	72
Nov	7	20	206	67

Table 1 shows the shrimps abundance during the months of the study year, the percentage occurrence of males and females in each monthly sample. Maximum numbers of females (313 individual in 10 meter distance) and of males (122 individual in 10 meter distance) were recorded on March and September, 2013 respectively, whereas minimum numbers were found in June 2013 of females (97 individual in 10 meter distance) and males (32 individual in 10 meter

distance) in January.

There was a correlation between temperature and the species abundance in the area. However, salinity did shows a significant correlation (Spearman correlation, $P < 0.05$). The median salinity and temperature in each month is presented in Table 2 as well as the shrimps abundance during the year by months.

Some of the prominent peaks of size-frequency distribution histograms of both sexes were followed by observing the successive sampling period (Figure 3).

one of the peaks of females (cohort A) in December 2012 was at 30 mm TL and reached 45 mm by April 2013 with the growth rate of 0.10 mm/day. Whereas the males cohort A were at 35 mm TL in January 2013 and reached 45 mm in April 2013 with the growth rate of 0.0833 mm/day.

Individuals of cohort B, on the other hand, were at 25 mm (both sexes) on June 2013 and became at 45 mm in September 2013 (females 0.133 mm/day) and 40 mm in males (0.100 mm/day). Therefore, the life span of the different cohorts of males and females varies from 6(+) to 8(+) months. The linear equations of the growth in length for the females and males were as follow:

Females: $L_{t+1} = 23.0 + 0.827L_t$

Males: $L_{t+1} = 24.0 + 0.792L_t$

These equations were obtained from the successive average monthly growth rates of cohorts A and B of males and females. The von Bertalanffy growth parameters obtained of each sex and analyses showed that females had higher L_{∞} (67.9 mm TL) than

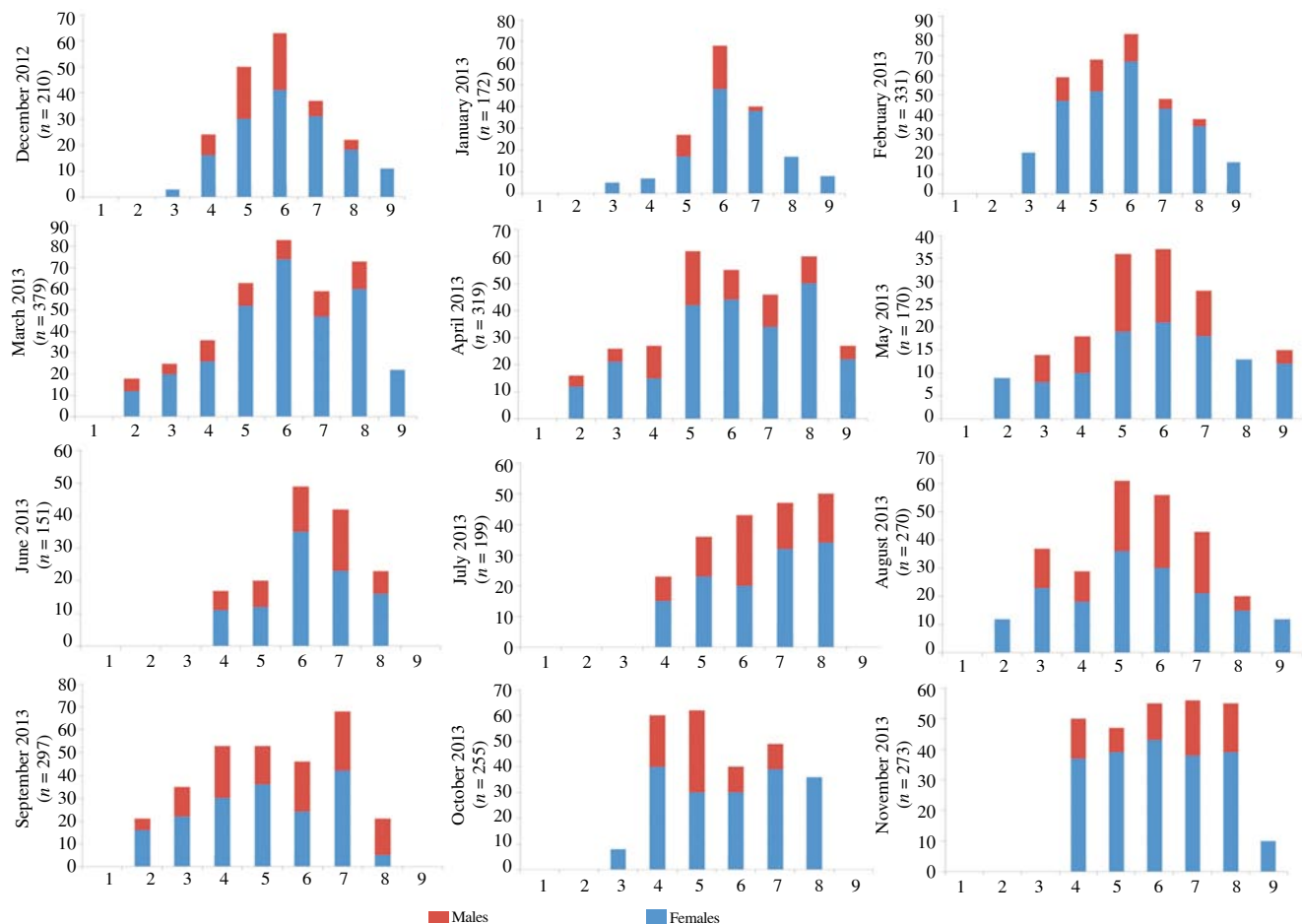


Figure 3. Size-frequency distributions of females and males of the pooled samples of 12 months for *P. elegans*.

X axis refers to body length (mm) (1: 10–14; 2: 15–19; 3: 20–24; 4: 25–29; 5: 30–34; 6: 35–39; 7: 40–44; 8: 45–49; 9: 50–54).

males (61.31 mm TL), whereas the growth coefficient value was higher in males. The K value for the females was 1.57 and for males was 1.75, therefore the mathematical model for the female was $L_t = 67.9[1 - e^{-1.57(t1 - t0)}]$ and for the males was $L_t = 61.31[1 - e^{-1.75(t1 - t0)}]$.

Furthermore, sexual differences in *P. elegans* related to total length and wet weight were noted. Wet weight of the shrimps increased in parallel with their body dimensions (Figure 4). The length/weight relationships for each sex $W = 0.00310246TL^{2.78561}$ for each female $W = 0.0030347TL^{2.62735}$ for male were calculated.

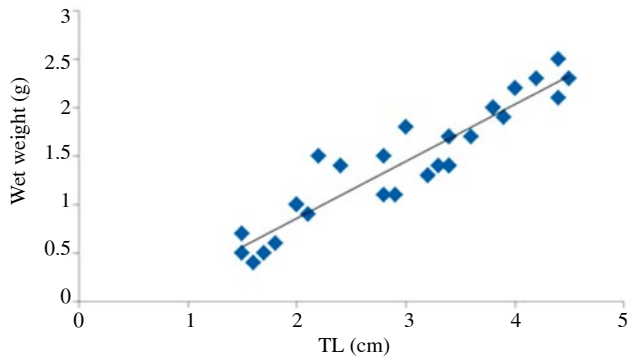


Figure 4. Relationship between TL and wet weight in *P. elegans*.

The sex ratio of the 3026 specimens was collected from December 2012 to November 2013. Out of these, females were 2185 (72%) and males were 841 (28%). Male to female ratio in the sampling area ranged from 1:1.434–1:5.490 on September and February 2013, respectively with more females than males in all months of the study period (Table 2).

Table 2

Sex ratio of *P. elegans* from December 2012 to November 2013.

Month	Male: Female
Dec	1:2.500000
Jan	1:4.375000
Feb	1:5.490196
Mar	1:4.742424
Apr	1:3.037975
May	1:1.833333
Jun	1:1.796296
Jul	1:1.653333
Aug	1:1.621359
Sep	1:1.434426
Oct	1:2.541667
Nov	1:3.074627

Figure 5 shows a positive linear correlation between total length and number of eggs ($F = 0.18351TL^{4.85682}$, $r^2 = 0.94$, $P < 0.05$). The proportion of males by size classes is shown in Figure 6. Figure 7 shows the higher number of ovigerous females in April 2013 and lower number of ovigerous females in January 2013.

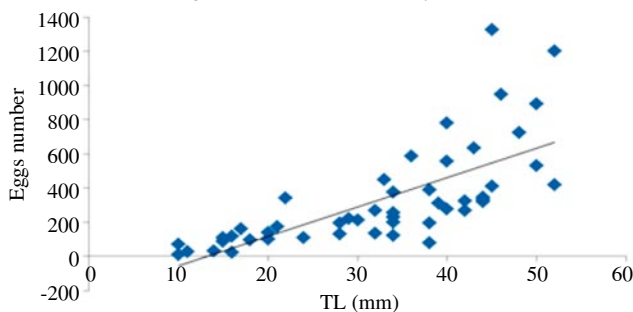


Figure 5. Relationship between fecundity (number of eggs) and size (TL) for *P. elegans*.

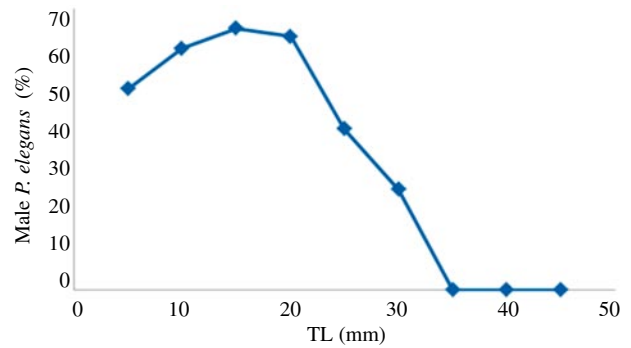


Figure 6. Percentage of male *P. elegans* in each size class (TL, in mm).

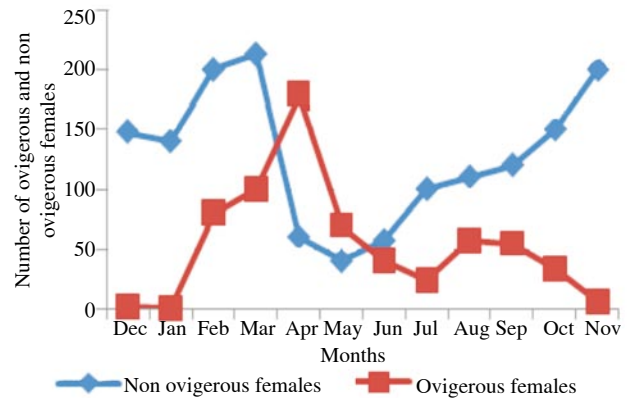


Figure 7. Numbers of ovigerous females and non-ovigerous for *P. elegans* during months of study.

4. Discussion

There are limited numbers of published works on this species. In this paper, both the growth and reproduction of a population of *P. elegans* are studied for the first time. The only previously available data were on other species in the Palaemonidae family [14-16].

Other species of *Palaemon* showed a clear sexual dimorphism in growth. The growth rate of males was much low than that of females, which reduced male energy investment in growth and possibly decreased their risk of predation [10]. The growth rates are different in various habitats. At different seasons in the same habitat, depending on temperature, food availability, density of the population and other attributes, many species of Palaemonidae exhibit different growth rates in different sexes. For instance, it is found that the female *Palaemon adspersus* after their first year have higher growth rates than those of males [10].

In the present study, the percentage of large specimens is the highest (body length = 37–45 mm) in early spring and summer. In autumn and winter, the proportion of smaller individuals increases (30–35 mm in length). The increase in density is due to the liberation of larvae into the environment, whereas the decrease in number is probably due to natural mortality or to migration from the site of sampling into deeper waters [14,16].

Juvenile shrimps were only detected at certain periods in the year indicating that the reproduction may be confined to certain times of the year, but the data of the embryonic development have shown that the reproduction is continuous and this may be caused by the selectivity of the sampling net. This perfectly agrees with the conclusion of Salman *et al.* [16] and may be applied for other caridean shrimps from different areas such as *Crangon septemspinosa* [11]

and *Palaemon adspersus*[17]. However, Guerao and Ribera[18] found the population of *Palaemon serratus* is formed mainly of juveniles (less than a year in age) in summer with the presence of 2 or 3 main types of population size structure, together with a rapid increase of medium-sized individuals during the times from late summer to the end of autumn. Başçınar *et al.*[13] studied the larval development and reported the egg production from only one brood as 914. In the present study, the mean fecundity has been estimated as (860 ± 2) eggs/brood varied between 36 and 1327 in 76 specimens.

Sexual dimorphism in size is pronounced in *P. elegans* with females reaching larger sizes than males. The same pattern in other species of the genus *Palaemon* was observed[12,19,20]. Females reach a greater total length than males as a function of differences between the sexes in growth rates and patterns of population structure. According to Bilgin *et al.*[21], the differences in the growth rates between males and females of *P. elegans* are related to the gonad development, by which females reaches a higher stage of development than in males. There is a reduction in energy investment for growth of males, which may decrease predation risks[13]. It may not be adaptive to diminish female body size beyond a certain limit, since the egg number in each brood depends on cephalothorax size[13]. However, in Palaemonidae, the opposite (males reaching higher sizes than females) has also been observed in some species of *Macrobrachium*[19,22-24].

Conflict of interest statement

We declare that we have no conflict of interest.

Acknowledgment

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