A Preliminary Study on Reproductive Biology of *Palaemon elegans* Rathke, 1837 Along the South-eastern Black Sea Coast

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Abstract

Some biometric parameters (total, abdomen and carapace lengths, and live weight), egg production, and embryonic and larval development of *Palaemon elegans* were studied. Total length and body weight mean 44.77±0.029 mm and 0.962±0.0021 g. Females produce around (306-1,704) egg/individual and the incubation period lasted 9-11 days at 19-27°C. Larvae reached post larval stage after 22 days of hatching.

Key Words: The Black Sea, biometrics, egg production, larval development, *Palaemon elegans*, prawn

Introduction

There are plenty of Palaemonid species all over the world and many of them have been or are going to be exploited in the near future. Prawns are widely distributed in Mediterranean as well as Eastern Atlantic coasts, while *Palaemon elegans* occurs all over the Mediterranean Sea, Aegean Sea, Sea of Marmara and the Black Sea. It inhabits in rocky and planted habitats in the sub littoral zone. Total annual prawn production was estimated as 890 tons (DİE, 2001). Distribution of the production by species is unknown due to the unclassified data collection system of State Statistical Institute (DIE) and Ministry of Agriculture and Rural Affairs (MARA). Major fishing grounds are the Mediterranean Sea (259 tons), Sea of Marmara (342 tons) and Aegean Sea (284 tons) (Figure 1). The Black Sea has the lowest catch share with only 5 tons (3 tons from western and 2 tons from eastern part). Prawns are basically caught by trawls, followed by dredges, beam trawl, gill-nets and pots. They are marketed as fresh in Italy, France, Morocco, Spain, Egypt, former Yugoslavia and Russia. Furthermore they have significant place in benthic and demersal food chains (Kocatas *et al*., 1991).

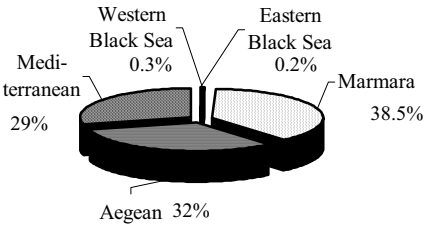


Figure 1. Distribution of prawn production of Turkey by regions in 1999 (DİE, 2001).

There is very limited data on *P. elegans* from Turkish waters. Kocatas *et al*. (1991) presented some general data on the species. Since the distribution and catches of *P. elegans* in the Black Sea is very limited, studies on the species are also lacking. The present study aimed to investigate basic biometric and reproductive characteristics of the *P. elegans* from the South-eastern Black Sea coast.

Materials and Methods

The study was carried out in summer 1998 and 1999. Samples were collected by wire meshed screens on rocky shores of Sürmene, 50 km east from Trabzon. Egg bared 68 prawns were carried to the laboratory in buckets and placed into 1 ton tank for acclimatization. After anaesthetizing with MS 222, total length, carapace and abdomen lengths were measured with a calliper to the nearest 0.01 mm, live weight (before and after removing eggs) and dry body weight (105°C over 24 h) were taken by a precision balance with a precision of 0.001 g. Egg production was assessed after removing egg mass from broods by a needle, washing the abdomen and counting the whole eggs by spreading the whole mass onto the petri plate (Brown and Patlan, 1974; Demirhindi, 1990, 1991; Alpbaz and Hoşsucu, 1991). Weight of eggs were calculated from the difference between the live weights with and without eggs. Egg size were determined by measuring the two axis (since the shape of eggs is oval) under binocular microscope using milimetric oculars (Bayhan, 1984; Campbell, 1988; Demirhindi, 1990; Alpbaz and Hoşsucu, 1991). The two axis were measured.

Twenty four egg bearing specimens were put into the 30x20x25 cm aquarium individually to observe the gonadal egg development (Demirhindi, 1990). Sea water was supplied such water exchange

of twice a day until hatching and a continuous aeration was provided. After the hatching, broods were removed, water inflow closed and water was partially renewed in three days intervals. Embryonic development, larval stages and metamorphosis were followed daily under the stereo microscope (Moore, 1983; Spinder *et al*., 1987; Granvil and Yates, 1988). Embryonic development in the abdomen was examined by taking the eggs from the ovary with a needle to separate individual eggs from the egg mass. Egg samples were observed by binocular microscope. Gonads are also inspected by the naked eye in order to follow the colour variations in adult females kept in the aquariums. After hatching, larval development was also observed and sketched daily under the microscope.

Results and Discussion

Biometric parameters taken during the study are presented in Table 1. Mean total length and live weight (including eggs) are 44.77±0.029 and 0.962±0.0021 g, respectively (Table 1). Fecundity and mass of eggs varied from 306 to 1,704 eggs per females (860±2) and 0.04 to 0.43 g (0.173±0.0006), respectively.

Embryonic development followed by daily observation of the eggs removed from the ovary and the stages were drawn in an appropriate order (Figures 2 and 3). Samples were kept in the aquarium at 19-27°C and incubation period completed in 9-11 days. All the eggs were fertilized and during the first stage shape of eggs was oval with short axis (width) of 0.4-0.6 mm and long axis (length) of 0.5-0.6 mm. They were full and ovarian colour was uniform dark green. There was no hearth beats (Table 2). In the second stage divisions of the cells completed in 5 days. After 7 days eyes appeared and hearth beating started. The colour of the ovary changed to light green. After 8 days, the colour turned pale green, eyes became round and black, body was translucent (IV. stage). Nauplius stage completed in 8-10 days resulting pale green-brownish ovarian colour, egg was rather oval, larvae was still in egg membrane. In the last stage, egg diameter has reached to 1.1-2.7 mm (axis variations has lost), body was translucent, larvae hatched in curl shape. This stage was characterised by unclear 4 segments, two big eyes, 4 pereiopods, telson, uropod in fan shape (Figure 2). During the development of eggs in the ovary, shape (thus the size) of the eggs changed from oval to spherical.

Daily development of larvae was monitored for 26 days and metamorphosis was summarised in details in Table 3. As a conclusion, it can be said that nauplius stage completed in 1-3 days, zoea in 4-15 days (I. Zoea in 4-5 days, II. Zoea in 5-8 days, III. Zoea in 8-15 days, IV. Zoea in 6-13 days, V. Zoea in 13-15 days), Mysis in 16-21 days and after 22 days post larvae was formed.

Table 1. Some biometric and reproductive features of the *Palaemon elegans* (n=68)

Parameter	TL (mm)	CL (mm)	AL (mm)	LW (+ eggs) (g)	LW (- eggs) (g)	DW (mg)	Egg number	Egg mass (g)
Mean	44.77	18.52	18.29	0.962	0.787	203.29	860	0.173
S.E	0.029	0.014	0.013	0.0021	0.0016	0.489	2.3	0.0006
Min.	37.00	14.80	14.30	0.430	0.380	28.80	306	0.040
Max.	58.40	23.80	22.90	1.80	1.430	398.10	1,704	0.430

TL: total length, CL: carapace length, AL: abdomen length, LW: live weight, DW: dry weight.

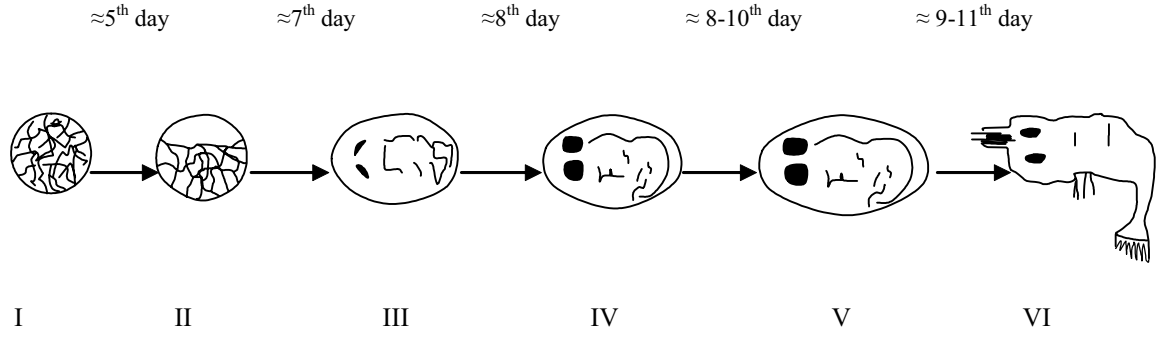


Figure 2. Embryonic development stages of *P. elegans* at 19-27°C.

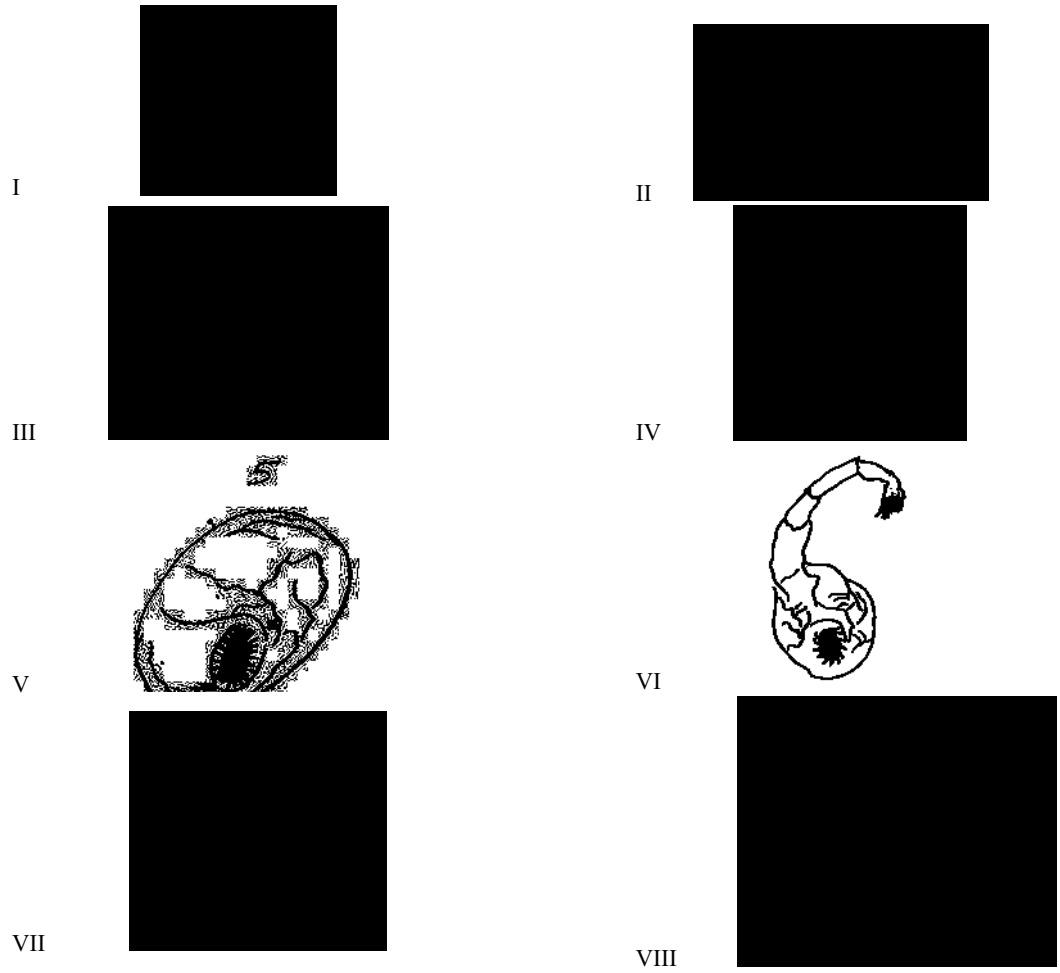


Figure 3. Embriyonal development stages (I: fertilised eggs, II: completed cell division, III-V: nauplius in egg membrane, VI-VIII: nauplius)

Table 2. Some observation on the embryonic stages of *P. elegans* (n=247 eggs).

Stages (Figure 3)	Egg width (mm)	Egg length (mm)	Ovarian Colour	Development
I (Fertilized egg)	0.4 – 0.6	0.5 – 0.6	Eggs are full with uniform dark-green	No heart beating, in egg is inactive, egg shape is light oval
II (Cell divisions)	0.5 – 0.6	0.5 – 0.7	Dark green-green	Increasing precipitation in egg, veins are become clear
III (Nauplius in egg membrane	0.4 –0.7	0.6 – 0.7	Light green	Appearance of the nauplius eye, heart beating is available
IV (Nauplius in egg membrane	0.4 – 0.6	0.5 – 0.8	Pale green	Eyes are round and black colour, translucent body
V (Nauplius in egg membrane)	0.4 – 0.6	0.5 – 0.8	Pale green- brownish	Egg is rather well oval, green colour get lost, translucent colour is available, larva is in egg membrane
VI (I. Zoea Nauplius)	-	1.1 – 2.7	Translucent body	Larva come out from egg curl shape, rostrum place is light dark object available, bronchia thorn, a pair antenna, indeterminate 4 segment, two huge eyes, 4 pereiopod, telson and uropod completed fan shape.

Table 3. Larval development details of *P. elegans.*

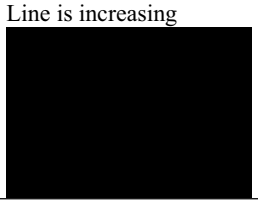
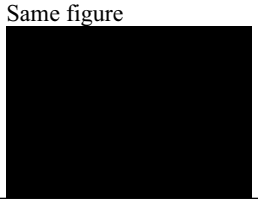
Day	TL (mm)	Carapace Length (mm)	Number of Larva	Developments in Carapace and Abdomen	Development of Tail	Feed	T (°C)
1	2.54 2.54 2.61	0.61 0.62 0.62	3	4 unclear segments, translucent body, quite active 4 pair of pereiopods, bronchia thorn, a pair of antenna	telson and uropod completed fan shape and, 11 beam are available 	-	26
2	2.46 2.69 2.54	0.61 0.62 0.54	3	External shell more thick and clear, Rostrum determinated	Same figure	-	26
3	2.69 2.38 2.69	0.38 0.54 0.61	3	Carapaces has teeth, external shell quite translucent	Same figure	*Artemia*	26
4	2.69 2.30 2.61	0.69 0.38 0.69	3	Determinated eyes are justified, 5 pair of preiopods	Tail consist of line 	*Artemia*	26
5	2.69 2.53	0.69 0.62	2	Between eyes opening, pereiopods become feather Carapace is huge, appearance of pleiopods like bud.	Line is continue	*Artemia*	24
6	2.46 2.69 2.77	0.62 0.77 0.69	3	Determinated segments	Line is increasing 	*Artemia*	24.5
7	2.69 2.92	0.61 0.63	2	Same figure	Same figure 	*Artemia*	24.5
8	3.08 2.69 2.92	0.85 0.77 0.77	3	Same figure	Telson and uropod begin to separate	*Artemia*	24
9	3.08	0.77	1	Pereiopods are quite developed, rostrum has no teeth, shell quite thick	Telson and uropod separated 	*Artemia*	24

Table 3 (Continued). Larval development details of *P. elegans.*

Day	TL (mm)	Carapace Length (mm)	Number of Larva	Developments in Carapace and Abdomen	Development of Tail	Feed	T (°C)
10	2.99 3.23 3.08	0.85 0.85 0.77	3	Carapace is huge, 5 pair of pereiopods quite developed and thickened. Pleiopods hasn't yet appearance.	Same figure	*Artemia*	25
11	-	-	-	-	-	-	-
12	3.15	0.85	1	Same	Tail has 5 piece	*Artemia*	25
13	3.15	0.85	1	Same	Tail has 5 piece	*Artemia*	25.5
14	3.31	0.99	1	Same	Tail has 5 piece	*Artemia*	26.5
15	3.46 3.08 3.08	0.92 0.85 0.85	3	Appearance of pleiopods like bud	Tail has 5 piece	*Artemia*	25
16	4.38 3.46	0.99 0.85	2	Abdomen has 5 pair of leg	Tail has 5 piece	*Artemia*	25
17	3.69 4.54	1.04 1.23	2	Abdomen has 5 pair of leg	Tail has 5 piece	*Artemia*	25.5
18	3.15	0.92	1	3 thorn is on the, rostrum, carapace with 4 teeth, appearance of pleiopods	Tail has 5 piece	*Artemia*	26
19	4.92	1.23	1	Same figure	-	*Artemia*	27
20	5.92 6.46	1.38 1.61	2	Appearance of pleiopod with two piece and thin. Teeth of rostrum are quite determinated.	-	*Artemia*	27
21	-	-	-	-	-	-	-
22	6.15	1.53	1	Larva look like adult	-	*Artemia*	27
23	615 6.22	1.61 1.61	2	Larva look like adult	-	*Artemia*	27
24	6.22	1.61	1	Larva look like adult	-	*Artemia*	26
25	6.22 5.84 6.46	1.53 1.53 1.53	3	Larva look like adult	-	*Artemia*	24
26	6.23 6.54	1.34 1.34	2	Larva look like adult	-	*Artemia*	22.5

Some regressions were derived using data gathered during the study. In case of length to the total weight (with eggs), there is rather a high correlation ($W_T = 0.00001\ L_T^{2.9153}$, r = 0.88). On the other hand there is weaker relationship between the total length and dry weight (r = 0.61) (Figure 4).

Regression between the total length to carapace length and abdomen length exhibited a high correlation ($L_C = 0.4568\ L_T - 1.9316$; $r_{C\text{-}T} = 0.93$; $L_A = 0.4111\ L_T - 0.1114$, $r_{A\text{-}T} = 0.91$). A similar tendency can be seen between the abdomen length and total weight (with eggs) ($W = 0.0004\ L_A^{2.6615}$, r = 0.90). A moderate link between the size of the brood and the fecundity (number of eggs) was also found ($F = 0.0089\ L_T^{3.0057}$, r = 0.70). Other evaluated relationships were carapace length versus total weight (with eggs) ($W_T = 0.002\ L_C^{2.0971}$, r = 0.76) and abdomen length versus total weight (without eggs) ($W_T = 0.0006\ L_A^{2.4368}$, r = 0.89). Abdominal length - fecundity ($F = 0.8995\ L_A^{2.3416}$, r = 0.61) and fecundity-eggs mass ($W_E = 0.008\ F^{0.7834}$, r = 0.56) were not well correlated (Figures 4, 5, 6; Table 4).

There are limited numbers of published works on this species. Demirhindi (1990) studied the larval development and reported the egg production from only one brood as 914. In the present study, mean fecundity has been estimated as 860±2 eggs/brood varied between 306 and 1704 in 68 specimens. Egg bearing females keep contracting their abdomens steadily. Move towards the corners and hold themselves in these areas and increase the contracting actions as the hatching time closes. The reason for this behaviour is to aerate the egg mass and prevent fungal infection. All the females moulted 12 hrs after

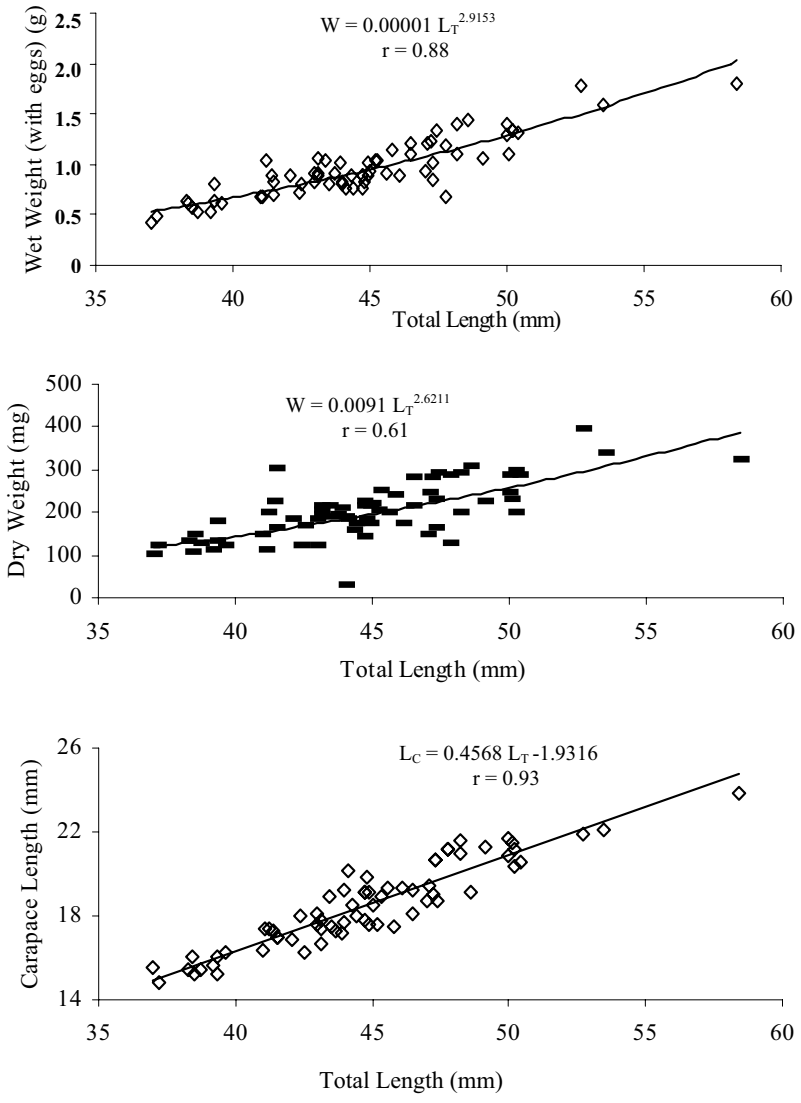


Figure 4. Relationship between total length to wet weight, dry weight and carapace length.

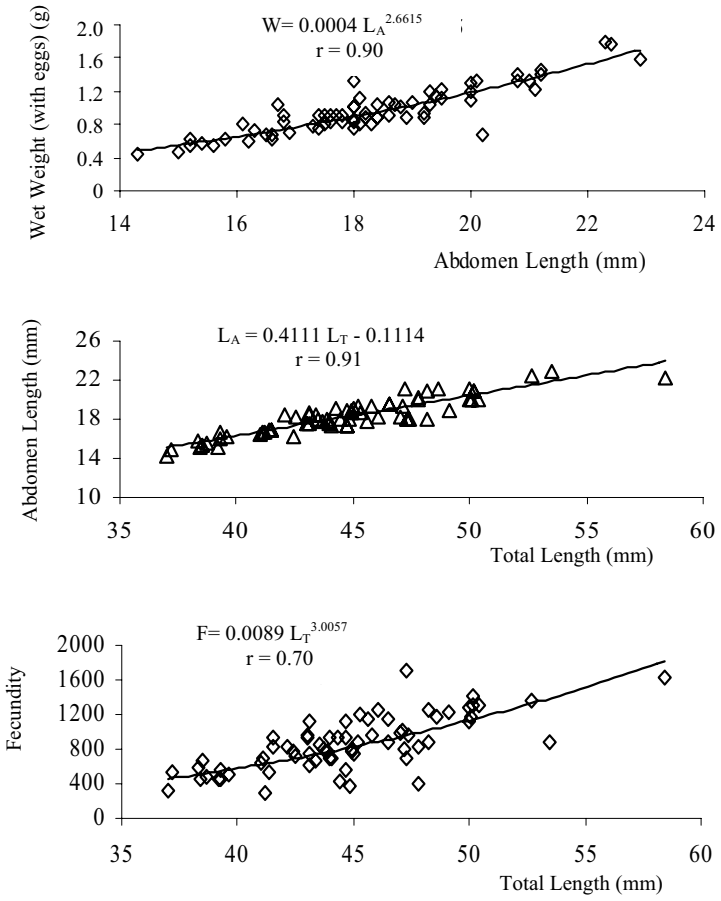


Figure 5. Relationship between total length-abdomen length, abdomen length-wet weight and total length-fecundity.

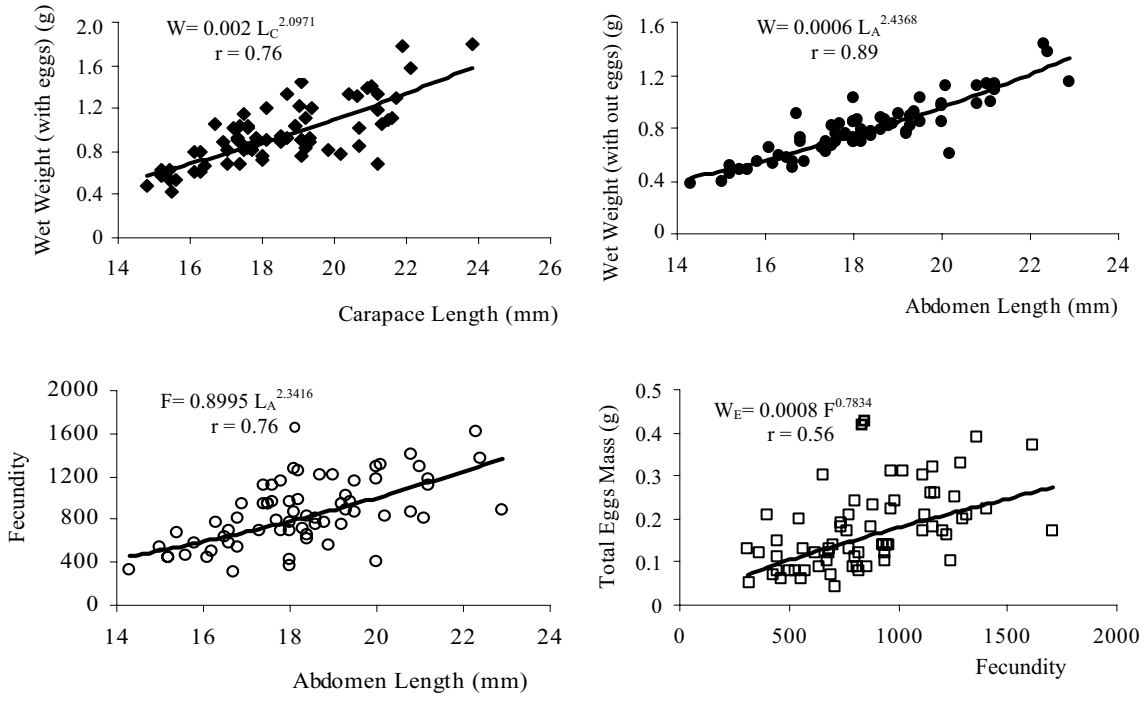


Figure 6. Relationship between carapace length-wet weight, abdomen length-wet weight, abdomen length-fecundity and egg number -total egg mass

Table 4. Average of some biometrical parameters (±SE) of *P. elegans* by size groups.

		Size Group				
		35-40	41-44	45-50	51-54	55-60
N		10	23	32	2	1
Length (mm)	total	38.55±0.042	42.84±0.024	47.14±0.030	53.10±0.100	58.40
	abdomen	15.54±0.032	17.61±0.016	19.24±0.018	22.65±0.062	22.30
	carapace	15.56±0.022	17.64±0.019	19.68±0.020	22.00±0.025	23.80
Weight (g)	with eggs	0.586±0.0048	0.855±0.0024	1087±0.0032	1675±0.0238	1800
	without eggs	0.494±0.0036	0.725±0.0021	0.876±0.0023	1265±0.0288	1430
Dry weight (mg)		129.71±1060	178.10±1088	229.55±0.766	369.75±7087	324.60
Egg mass (g)		0.092±0.0015	0.129±0.0011	0.210±0.0012	0.410±0.0050	0.370
Number of eggs		499±5	756±4	1008±5	1122±59	1615

SE: standart error.

egg lying. Larval stages have been separated by following the procedures described by Demirhindi (1991) as VII zoea stages. Moore (1983) and Granvil and Yates (1988) reported that the larvae has 6 nauplius, 3 zoea, 3 mysis and a post larvae stage. The colour of the ovary varied from dark olive to light green during the time of the capture showing the gonadal development stages of III and IV (Tomiyama, 1988; Igakura, 1989). The time needed for the incubation of larvae from dark green coloured ovary stage to hatching was around 9-11 days at 19-27°C. Eggs in the ovary completed the cell division in 5th, eyed stage in 6^{th}-7^{th} and hatching in 9-10^{th} days. The larvae of *P. elegans* reached the post larval stage nearly in 22 days. This period has been reported as 18-45 days by Demirhindi (1991).

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