MORPHOLOGICAL STUDY OF *Parapenaeus longirostris* (Penaidae), IN THE EASTERN MEDITERRANEAN SEA

Chatzispyrou A.*, Lampri P-N., Fytilakos I., Mytilineou Ch., Kapiris K.

Hellenic Centre for Marine Research, Institute of Marine Biological Resources and Inland Waters, 46.7 km Athens Sounio ave., P.O. Box 712, Anavyssos, 19013, Attiki, Greece

Abstract

Relative growth of several characteristics in the rose shrimp *Parapenaeus longirostris* were studied for the first time in the Eastern Mediterranean Sea. According to the median values, the morphometric characters of female and male individuals caught in the Aegean Sea were greater than those from the Ionian Sea. A negative allometry of swimming morphological characters (uropod, scaphocerite, telson) and of abdomen (related to the rapid locomotion, reproduction) was found in both sexes and areas. In contrast to this, the growth of the third pereiopod (involved in walking ability) in females from the Aegean Sea was positively allometric. Both sexes showed positive allometry of rostrum length with size in both areas.

Key words: *rose shrimp, relative growth, allometry, cephalothorax*

*Corresponding author: Chatzispyrou Archontia (a.chatzispyrou@hcmr.gr)

1. Introduction

Parapenaeus longirostris is actually the target species of an important fishery of trawlers in the Mediterranean. The deep-water rose shrimp, *Parapenaeus longirostris*, is one of the most important species of crustacean landings in Greece (Kapiris *et al.* 2007; Sobrino *et al.* 2005). The higher mean annual landings of *P. longirostris* were in the period 1990-2011 landed in the ports of Peiraias and Thessaloniki, followed by the ports of Kavala, Alexandroupolis and Patra (ETANAL data), while, according to EL.STAT. (Hellenic Statistical Authority) data the most important fishing areas in Greece for *P. longirostris* are mainly in the Aegean Sea: 13 (Thermaikos Gulf), 14 (N. Aegean Sea) and 18 (Kriti) (Mytilineou *et al.* 2001) An evaluation of the exploitation state of this species in the Greek waters indicates a general over- or full-exploitation (Kapiris *et al.* 2007). In the Mediterranean basin, the bathymetric distribution of the deep water rose shrimp ranges between 20 and 750 m, but the species is more common and abundant on sandy-muddy bottoms between 100 and 400 m (Politou *et al.* 2005). The knowledge on the exploitation state, spatial distribution and biology of this important species in the Greek seas is incomplete and is an outcome of the experimental surveys mainly carried out by the Hellenic Centre for Marine Research (Kapiris *et al.* 2002, 2012, 2013; Kapiris 2004; Politou *et al.* 2008) in the frame of European projects. Is worth noting that very few studies on the morphometric characters of the species have been published.

The aim of this study is to present the intraspecific variation of the morphometric profile of both sexes of *P.longirostris*, from the Ionian and Aegean Sea, and compare specimens of both areas to investigate differences in the relative growth. Comparison to other shrimp species is not included, since there is no available data for deep water rose shrimp characteristics from other areas. The current study is a preliminary attempt of further investigation of the morphometric structure of the deep sea rose shrimp, in relation to its swimming and feeding behavior.

2. Material and Methods

All specimens of *Parapenaeus longirostris* were collected during different trawl surveys in the Greek Ionian Sea and the Central Aegean Sea, between December 2013 and May 2014 in the frame of the National Fishery Data Collection Project (EPSAD) under the Reg. 199/2008. A total of 345 individuals (167 males and 178 females) caught in the Ionian Sea and 210 specimens from the Aegean Sea (105 males and 105 females) was measured with digital caliper to the nearest 0.1mm, and weighed to the nearest 0.01g. Seven morphometric characteristics were measured on each specimen (Fig.1): carapace length (CL), abdominal length (ABD), third pereiopod length (P), rostral length (R), scaphocerite length (S), telson length (T) and the uropodal exopodite length (U) (Figure 1). According το Sardà *et al.* (1995) these appendages are related to distinct functional aspects, such as swimming, walking-cropping, balance or orientation ability.

The carapace length was considered as the independent variable for all relationships performed. The relationship between all measurements versus CL was investigated for each area and

sex separately using the simple linear model: $Y=a*X^b$, where Y and X corresponded to the morphological dimensions and a, b the regression constants. The relationships obtained were log transformed to the form $\log_{10}Y=\log_{10}a+b\log_{10}X$. The log transformation is preferred in order to better satisfy the assumptions of regression analysis (Sokal & Rohlf, 1981). The pattern of allometry for each parameter was established by testing the slope (b) of the obtained regression equations against isometry applying the Student's t-test. (Ho:b=1 or 3 for length-weight).The Mann–Whitney test was applied as a nonparametric test to compare independent samples. The comparison of the appendages' slopes b and carapace length between sexes was carried out by ANCOVA (Zar, 1984).

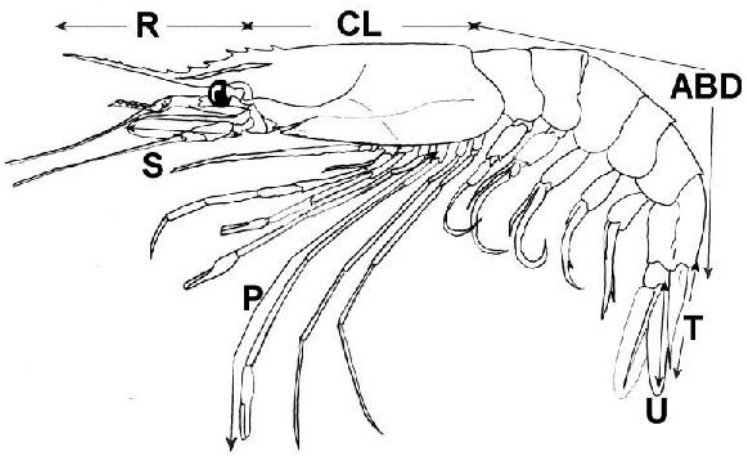

Figure 1. Morphometric measurements taken on *Parapenaeus longirostris*. CL, carapace length; T, telson; U, uropodal exopodite; S, scaphocerite; P, third pereiopod; R, rostrum; ABD, abdomen.

3. Results

Carapace length (CL) ranged between 13 and 27 mm in males and 10 and 33 mm in females individuals caught in the Aegean Sea. On the other point, carapace length of males and females caught in the Ionian Sea were from 12 to 29 mm and from 10 to 31mm, respectively.

The median values of all the morphological characters of the specimens showed a difference between the sexes (Mann-Whitney test, $P>0.05$ in all cases). Mean sizes of all females' appendages were greater than those of males in both areas (Table 1). Both males and females specimens caught in the Aegean Sea showed greater median values compared those of the Ionian Sea (Mann-Whitney test, $P>0.05$).

The equation parameters representing the relative growth of each parameter in relation to carapace length, after logarithmic transformation, for each sex in the Aegean and the Ionian Sea are presented in Table 2. For all the variables regressions were statistically significant (ANOVA, $P<0.01$).Correlation coefficient (r) and the type of allometry are also included, as a comparison of the slopes of the regression lines. Females in the Ionian Sea showed higher correlation coefficients (r) than those of males; In the Aegean Sea male and female shrimps had almost similar (r) values. For all variables, except the telson, regressions were statistically significant (ANCOVA, $P=0.005$).

The allometry showed the same pattern for *P.longirostris* in both areas; the length of the rostrum for both sexes was positively allometric and the length of the third pereiopod in females in the Aegean Sea, while all other measurements indicated a significant negative allometry ($b<1$ or $b<3$ in carapace length-weight relationship) in both sexes.

Table 1. Mean sizes (mm) of *Parapenaeus longirostris* measurements of male (M) and female (F) specimens from the two study areas

Measure	Sex	Area			
		Aegean		Ionian	
		Mean	n	Mean	n
ABD	M	48,52	105	43,06	167
	F	50,56	104	47,20	178
CL	M	20,86	105	18,08	167
	F	24,04	105	20,78	178
P	M	34,53	80	28,41	147
	F	41,62	89	34,27	153
R	M	14,39	80	12,01	140
	F	18,42	82	14,83	144
S	M	22,35	103	19,48	157
	F	24,25	103	21,39	169
T	M	13,66	74	12,32	125
	F	16,02	69	13,74	132
U	M	19,81	100	17,94	160
	F	21,63	102	19,33	165
W	M	4,39	105	3,4	167
	F	6,84	104	5,19	178

Table 2. Allometry of the seven measured appendages in *P. longirostris* in the Aegean and Ionian Sea

Dimension Measured/CL	Sex	n	a	b	r	t-test	Allometry
	AEGEAN						
ABD	M	104	0.63	0.79	0.97	-236	Negative
	F	103	0.64	0.78	0.97	-934	Negative
P	M	79	0.23	0.98	0.96	-179	Negative
	F	88	0.20	1.01	0.94	236	Positive
R	M	79	-0.29	1.1	0.95	298	Positive
	F	81	-0.23	1.07	0.92	109	Positive
S	M	102	0.2	0.86	0.89	-430	Negative
	F	102	0.35	0.75	0.94	-776	Negative
T	M	73	-0.02	0.88	0.91	-221	Negative
	F	68	0.12	0.78	0.93	-406	Negative
U	M	99	0.15	0.87	0.92	-285	Negative
	F	101	0.16	0.85	0.96	-558	Negative
W	M	104	0.001	2.71	0.96	-302	Negative
	F	103	0.001	2.57	0.98	-298	Negative
IONIAN							
ABD	M	166	0.67	0.76	0.98	-3101	Negative
	F	176	0.66	0.77	0.98	-3193	Negative
P	M	125	0.39	0.84	0.81	-598	Negative

	F	133	0.33	0.9	0.97	-1157	Negative
R	M	108	-0.51	1.26	0.92	675	Positive
	F	123	-0.46	1.24	0.96	890	Positive
S	M	143	0.27	0.8	0.91	-1200	Negative
	F	160	0.27	0.8	0.94	-1268	Negative
T	M	91	0.06	0.81	0.89	-607	Negative
	F	108	-0.04	0.9	0.97	-571	Negative
U	M	143	0.15	0.87	0.94	-780	Negative
	F	151	0.23	0.8	0.96	-1822	Negative
W	M	166	0.001	2.55	0.98	-287	Negative
	F	177	0.001	2.64	0.98	-308	Negative

4. Discussion

The present work provides for the first time important information relating to certain morphometric characters of the deep water rose shrimp in the Greek seas (Aegean and Ionian Seas). The current study shows no extensive variation in morphometric aspects exist in the populations of *P. longirostris* in Aegean and Ionian Seas.

A clear sexual dimorphism size appears to exist for *P. longirostris* females, which reach larger dimensions than males, in both areas. Females weighted also more than males at the same cephalothorax sizes. This has also been reported by Sobrino *et al*. (2005). The parameters of the CL-W relationship estimated in this study are similar to those calculated by other authors in other Mediterranean areas (Sobrino *et al*. 2005).

The relative growth between the sexes differs only slightly as indicated by morphometric relationships from both areas. All the above observed morphological variations between sexes could be attributed to the differences in growth pattern of males (much lower maximum carapace length and lower Von Bertalanffy values) compared with females (Sobrino *et al*., 2005) and/or the life span aspects of this species.

A negative allometry of all the swimming appendages (scaphocerite, uropod, telson) observed in both sexes and regions, reflects the decreasing growth rate of these morphological characters in relation to CL. The slightly higher slopes (b) of the regression lines for the morphological swimming characters of the females would imply greater swimming ability compared to the ability exhibited by males. Similarly, a negative allometry in the length of the abdomen (directly related to overall metabolic process, primarily reproduction, rapid locomotion) was observed in both sexes and areas. The reduction of the ability for rapid locomotion with increasing size is in agreement with the above reduction of swimming ability.

The positive allometry in the third pereiopod length (directly related to walking ability and cropping behavior when searching for food in the substratum, Sardà et al. 1995) in females caught in the Aegean Sea was expected, since the swimming ability decreases, walking ability should increase. Since the allometric growth pattern of the rostrum (an organ possibly related to mating and swimming behavior, sexual segregation and feeding) was found similar between sexes and areas, a faster rostrum growth rate than the carapace growth rate is indicated.

The present study improves the few existed data and fills knowledge gaps on deep water rose shrimp biology and ecology in the Greek and international bibliography. In general, this study suggests that there is no morphological variability of *P. longirostris* amongst both Greek Seas (Aegean and Ionian Sea). Regardless of the more intense fishing pressure exercised in the Aegean Sea variations in morphometric variables are not extensive between the studied populations in both studied areas.

Studies of the population structure, including biology, growth rate of the total or body's appendages, spawning season, of commercially important marine organisms as deep sea rose shrimp are of great interest to evolutionary biologists and to fishery managers, and thus provide an initial incentive for further investigation of this decapod in the whole Mediterranean.

References

References in Articles:

Kapiris K., Markovic O., Klaoudatos D., Djurovic M., (2013). Contribution to the biology and fishery characteristics of *Parapenaeus longirostris* (Lucas, 1846) in the South Ionian and South Adriatic Sea. Turkish Journal of Fisheries and Aquatic Sciences 13(4), 647-656.

Kapiris K. (2004). Feeding ecology of *Parapenaeus longirostris* (Lucas, 1846) (Decapoda: Penaeidae) from the Ionian Sea (Central and Eastern Mediterranean Sea). Scientia Marina 68(2), 247-256.

Politou C-Y., Maiorano P., D'Onghia G. and Mytilineou Ch. (2005). Deep-water decapods crustacean fauna of the Eastern Ionian Sea. Belgian Journal of Zoology 135, 235-241.

Politou C-Y., Tserpes G., Dokos J. (2008). Identification of deep-water pink shrimp abundance distribution patterns and nursery grounds in the eastern Mediterranean by means of generalized additive modeling. Hydrobiologia 612, 99-107.

Sardà F., Bas C., Lleonart J. (1995). Functional morphometry of Aristeus antennatus (Risso1816) (Decapoda, Aristeidae). Crustaceana 68, 461–471

Sobrino I., Silva C., Sbrana M, Kapiris K. (2005). Biology and Fisheries of Deep Water Rose Shrimp (Parapenaeus longirostris) in European Atlantic and Mediterranean waters. Crustaceana 78 (10): 1153-1184.

Conference Proceedings:

Kapiris K., Kavadas S., Maina I., Tserpes G., Kallianiotis A., Peristeraki P., Politou C-Y. (2012). Spatial distribution of deep-water rose shrimp juveniles (*Parapaenaeus longirostris*) in the Aegean and Ionian Sea using predictive habitat modeling. 12th International Congress on the Zoogeography, Ecology and Evolution of Southeastern Europe and the Eastern Mediterranean, Athens, 18-22/6/2012, Book of Abstracts, 74 p.

Kapiris K., Mytilineou Ch., Maiorano P., Kavadas S., Capezzuto F. (2002). Abundance and bathymetrical distribution of *Parapenaeus longirostris* in the South Ionian Sea. Fourth European Crustacean Conference, 22-26 July, Poland.

Mytilineou Ch., Politou C-Y., Kavadas S., Fourtouni A., Kapiris K., Dokos J. (2001). Crustacean fishery in Hellas. Life histories, assessment and management of Crustacean fisheries. A Coruna, Galicia, Spain. Book of abstracts 54.

Book Chapter:

Kapiris K., Mytilineou Ch., Politou C-Y., Kavadas S., Conides A. (2007). Research on shrimps' resources and fishery in Hellenic waters. In: C. Papaconstantinou, A. Zenetos, V. Vassilopoulou, G. Tserpes (Eds.), HCMR Publications, Athens: 421-432.

Sokal RR., Rohlf F.J. (1981). Biometria, (Madrid: H. Blume Ediciones), 832 pp.

Zar JH (1984) Biostatistical analysis, 2nd ed. Prentice-Hall, Englewood Cliffs, pp 662.