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SEXUAL DIMORPHISM IN *RISSOIDES PALLIDUS* (GIESBRECHT) (CRUSTACEA, STOMATOPODA)

SUMMARY

Thirteen morphometric characters of *Rissoides pallidus* (Giesbrecht), a small stomatopod crustacean, were measured from 34 males and 32 females. The specimens were collected by means of bottom trawlers on the upper continental slope of the North Tyrrhenian Sea (mid-western Mediterranean Sea). Comparisons of the slopes between sexes indicated no significant difference in all studied dependent parameters (Y) with carapace length (X), except antennular length and scaphocerite width which were significantly longer and larger in females than in males, respectively. The hierarchical cluster analysis was also performed to identify similarity or dissimilarity among the morphometric characters measured. The biometric relationships considered in this work may prove useful during studies of feeding habits, and to reconstruct the size and biomass of the individuals of this small mantis shrimp from the remains of its exoskeleton.

RIASSUNTO

Tredici caratteri morfometrici sono stati misurati in 34 maschi e 32 femmine di *Rissoides pallidus* (Giesbrecht), un piccolo crostaceo stomatopode. Gli esemplari sono stati raccolti per mezzo di motopescherecci che operano sulla scarpata continentale superiore del Mar Tirreno settentrionale (Mediterraneo occidentale). La comparazione del parametro b delle regressioni nei due sessi non ha mostrato alcuna differenza significativa tra tutti i parametri indagati, ad esclusione della lunghezza delle antennule e della larghezza dello scafocerite che rispettivamente sono risultati significativamente più lunghe e più larghe nelle femmine che nei maschi. È stata eseguita anche un'analisi di agglomerazione al fine di identificare similarità o dissimilarità tra i caratteri morfometrici utilizzati. Le relazioni biometriche considerate in questo lavoro possono risultare utili negli studi di alimentazione poiché dai resti degli individui di questo piccolo stomatopode è possibile risalire alla loro taglia e relativa biomassa.

INTRODUCTION

Sexual differences in morphometric characters occur commonly in the animal kingdom and there is most certainly a myriad of natural and sexual selection pressures responsible for its evolution (Greenwood, 1987). Sexual dimorphism in chelipeds, abdomen, pleopods and other characters have been intensely studied in decapod crustaceans because the rigid exoskeleton of this group of animals allows accurate measurements (Teissier, 1960; Hartnoll, 1982; Sardà *et al*., 1995). Few records have been made concerning morphometric analyses or sexual dimorphism of stomatopod crustaceans (Massi *et al*., 1993; Mori *et al*., 1998; Mclaughlin, 1980). We therefore decided to analyse thirteen morphometric characters to the aim to verify the existence of a possible sexual dimorphism in the little stomatopod crustacean *Rissoides pallidus* (Giesbrecht, 1910) occurring on the upper continental slope of the North Tyrrhenian Sea.

MATERIALS AND METHODS

From January 1994 to December 1995 a total of 66 specimens of *Rissoides pallidus* (34 males and 32 females) were obtained from the by-catches of bottom trawlers operating in the southern Tuscany Archipelago at depths of 250 to 550 m (Tyrrhenian Sea, mid-western Mediterranean Sea). Individuals exhibiting pathological conditions or having chelae that appeared to be regenerating were not included in the morphometric analysis. The measurements taken with an ocular micrometer by the same person, with accuracy of ± 0.01 mm, were: CL, carapace length; RPL, rostrum (rostral plate) length; TCL, carapace length plus rostrum length; CoW, cornea width; EL, eye length; AL, length of 2nd to 3rd antennular article; SCL, scaphocerite (antennal scale) length; SCW, scaphocerite width; PRL, length of propodus of raptorial claw; PRW, width of propodus of raptorial claw (thoracopod 2); TW, telson width (Fig 1). The total length (TL), from the tip of the rostrum to the end of the telson including submedian teeth (Fig. 1), was measured with a vernier calliper with accuracy of ±1 mm. From September to December

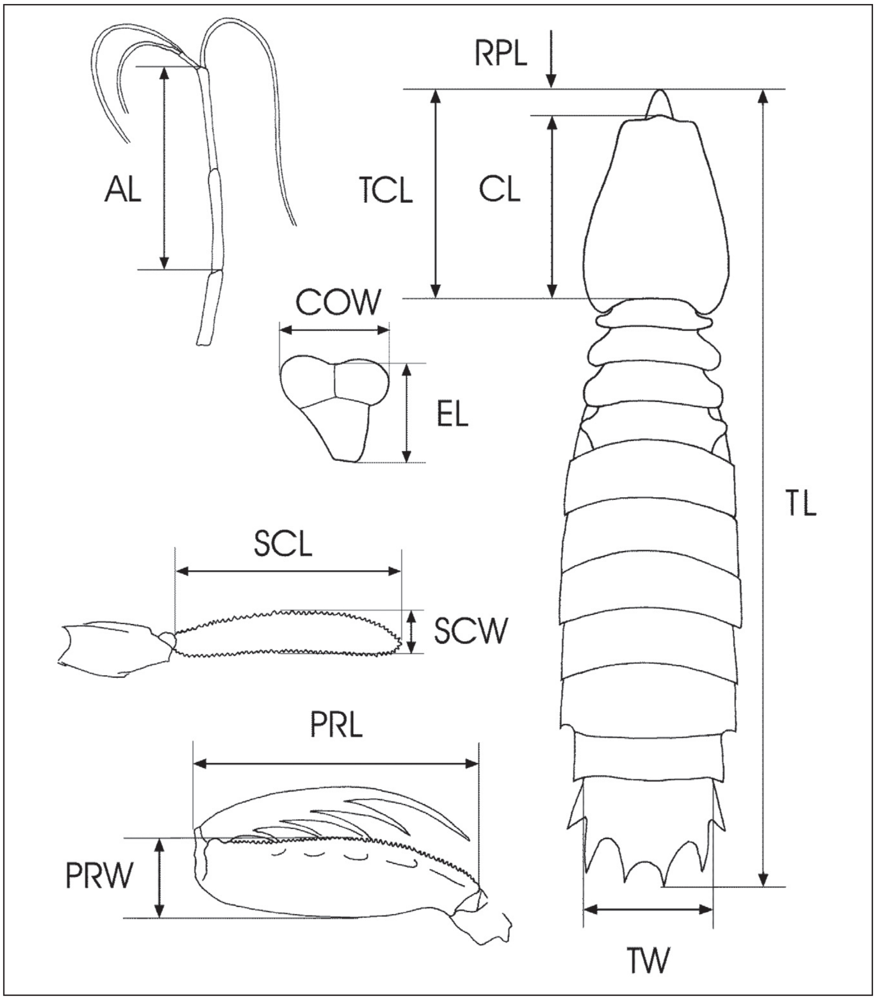

Fig. 1 - *Rissoides pallidus*. Position of the morphometric variables measured. CL, carapace length; RPL, rostral plate length; TCL, carapace length plus rostral plate length; CoW, cornea width; EL, eye length; AL, antennular length; SL, scaphocerite length; SCW, scaphocerite width; PRL, propodus length; PRW, propodus width; TW, telson width, TL, total length.

1996 additional specimens (41 males and 52 females) were collected to estimate the carapace length-weight relationships. The wet weight of the whole body, after externally blotting the animals, was determined with an electronic balance (Mettler PM 460) with a precision of 0.01 mg.

The morphometric data were analysed using the potential model $Y = aX^b$ in its logarithmic transformation, $\text{Log}Y = \text{Log } a + b \text{ Log}X$, to reduce heteroscedasticity (Sokal and Rohlf, 1984). Carapace length (CL) was chosen as the main reference dimension. The Least-Squares (Model I) method was applied to calculate the relative parameters of the regressions. However, the use of such method must comply with some conditions including the correlation coefficients being between 0.950 and 0.999 (Finney and Abele, 1991). Many correlation coefficients of the regressions calculated in this paper were <0.950, so the parameters were also estimated by Reduced Major Axis (Model II) method (Ricker, 1973). The correlation coefficient (r) is the same for both Models (Weisberg, 1980). Confidence intervals of slopes were used to compare pairs of regressions between males and females estimated by means Model II method (Lowett and Felder, 1989); the slopes estimated using the Model I method were instead compared by means Student's t-test (Scossiroli and Palenzona, 1978). Hierarchical cluster analysis were made for twelve variables for each sex, using Bray-Curtis Cluster Analysis (Single Link) (Fowler and Coehn, 1993). All statistical analyses were performed with PAST ver.1.91 (Hammer *et al*., 2001).

RESULTS AND DISCUSSION

Table 1 represents summary statistics of measured morphometric variables for males and females separately, whereas results of regression analysis are showed in Table 2. Excluding the TCL/Cl and TL/CL relationships, the most calculated correlation coefficient were low, thus justifying also the application of the Reduced Major Axis (Model II) method to estimate the parameters of the regressions (Tab. 2). The comparison of the pairs of regressions performed by means of the confidence intervals of slopes yielded that all body measurements are similar in both sexes, excluding antennular length (AL) and scaphocerite width (SCW) that are significatively longer and larger in females than in males, respectively (Tab. 2). Similar results were obtained comparing the slopes, estimated using the Model I method, by means Student's t-test (Tab. 2). The body measurements that did not differed between the two sexes were cumulated and the relative equations were re-calculated (Tab. 2, M+F).

Similarly, the regressions of wet weight/carapace length, did not significantly differed between sexes (P > 0.05), hence the male and female data was pooled (Tab. 3). The present study suggests, as described for some squillids (Mclaughlin, 1980), the role of antennular length and scaphocerite width in determining sexual dimorphism in *Rissoides pallidus*. As in many squillids (Manning, 1967; 1969; 1995), male *Rissoides pallidus* also exhibits a sexual dimorphism in having inflated telson carinae and tubercles (Mori *et al*., submitted): however, the present study indicates that the growth of the telson width (TW) is similar in both sexes.

Tab. 1 - Summary statistics of measured morphometric variables for males and females. All the variables are represented in millimetres. Abbreviations as in Fig. 1.

	Males					Females				
Variables	**N°**	**Min**	**Max**	**Mean**	**±SD**	**N°**	**Min**	**Max**	**Mean**	**±SD**
CL	34	8.5	16.68	14.36	1.79	32	8.5	15.45	13.25	1.38
RPL	34	1.4	2.48	2.08	0.25	32	1.3	2.21	1.87	0.17
TCL	34	9.9	19.13	16.44	2.00	32	9.8	17.66	15.12	1.54
CoW	34	2.0	2.99	2.74	0.22	32	2.1	2.78	2.57	0.16
EL	34	2.1	2.88	2.61	0.20	32	1.9	2.59	2.41	0.15
AL	34	7.6	13.77	12.09	1.29	32	7.5	14.54	11.92	1.42
SCL	34	4.3	8.90	7.47	1.02	32	4.3	8.50	7.02	0.85
SCW	34	1.1	1.78	1.52	0.17	32	0.8	1.73	1.45	0.17
PRL	34	8.4	15.76	13.78	1.56	32	9.1	15.30	13.50	1.29
PRW	34	2.4	4.11	3.64	0.40	32	2.4	3.92	3.47	0.31
TW	34	6.1	11.30	9.58	1.13	32	6.0	10.30	9.06	0.85
TL	34	36.0	68.00	59.99	6.12	32	35.4	66.00	58.51	5.56

The hierarchical cluster analysis revealed for both sexes a clear dissimilarity between total length (TL) and other body measurements (Fig. 2, group 1). In male and female individuals data could suggest other two similar clusters. A first cluster (Fig. 2, group 2a) could be composed by carapace length (CL), length of propodus of raptorial claw (PRL), carapace length plus rostral plate length (TCL), length of 2nd to 3rd antennular articles (AL), telson width (TW) and scaphocerite length (SCL). A second cluster (Fig. 2, group 2b) was composed by rostral plate length (RPL), cornea width (CoW), eye length (EL), scaphocerite width (SCW) and width of propodus of raptorial claw (PRW). In both sexes carapace length should reflect with PRL, AL, TCL, TW and SCL, as suggested by Fernández-Vergaz *et al.* (2000) for an other crustacean species, standard growth, whereas a secondary role in individuals development seems to be played by RPL, CoW, EL, PRW and SCW.

The biometric relationships among the different body part of *Rissoides pallidus* may result useful in the trophic ecology since their exoskeleton made up by a matrix of chitin and calcareous salts (carbonates and phosphates), impedes the rapid decomposition of the structures by digestive enzymes, thus facilitating the identification of preys and size measurements for crustaceans (Rodríguez-Marín, 1993). According to Sartor (1995), *Rissoides pallidus* is food for Gadidae fish inhabiting the Tyrrhenian Sea as *Merluccius merluccius* (L.), *Trisopterus minutus capelanus* (Lacépède) and *Phycis blennoides* (Brünnich).

Tab. 2 - Parameters and statistics for power regressions with log-transformed data estimated both by reduced major axis (Model II) and by Least-Squares (Model I) methods of morphometric measurements (Y) on carapace length (X) for males and females of *Rissoides pallidus* (Giesbrecht). M = males; F = females; N = sample size; *r* = coefficient of correlation; 95% CI = confidence interval of slope; *t*= value of Student's t-test; ns= not significant; **= *P*<0.01. Abbreviations as in Fig. 1.

			Model II				**Model I**		
Y/CL	Sex	N	intercept (log a)	slope (b)	95%CI (b)	*r*	intercept (log a')	slope (b')	*t* (b')
RPL	M	34	-0.730	0.906	±0.101	0.943	-0.674	0.858	0.73
	F	32	-0.672	0.842	±0.101	0.947	-0.618	0.784	ns
	M+F	66	-0.761	0.927	±0.075	0.943	-0.701	0.874	
TCL	M	34	0.098	0.966	±0.023	0.998	0.101	0.964	0.27
	F	32	0.087	0.974	±0.020	0.998	0.089	0.972	ns
	M+F	66	0.087	0.975	±0.015	0.998	0.089	0.973	
CoW	M	34	-0.265	0.608	±0.082	0.920	-0.209	0.559	0.57
	F	32	-0.217	0.559	±0.079	0.919	-0.166	0.514	ns
	M+F	66	-0.270	0.609	±0.057	0.924	-0.217	0.563	
EL	M	34	-0.248	0.573	±0.072	0.931	-0.200	0.534	0.01
	F	32	-0.261	0.573	±0.078	0.925	-0.213	0.530	ns
	M+F	66	-0.311	0.624	±0.060	0.920	-0.2541	0.574	
AL	M	34	0.095	0.854	±0.103	0.907	0.157	0.800	8.83
	F	32	-0.184	1.122	±0.135	0.942	-0.110	1.057	**
SCL	M	34	-0.389	1.091	±0.138	0.931	-0.303	1.016	0.87
	F	32	-0.447	1.152	±0.116	0.960	-0.396	1.106	ns
	M+F	66	-0.383	1.090	±0.090	0.942	-0.311	1.027	
SCW	M	34	-0.819	0.866	±0.115	0.923	-0.742	0.799	6.66
	F	32	-1.127	1.147	±0.160	0.921	-1.025	1.056	**
PRL	M	34	0.082	0.914	±0.099	0.950	0.134	0.869	0.02
	F	32	0.118	0.902	±0.073	0.924	0.145	0.878	ns
	M+F	66	0.140	0.872	±0.074	0.937	0.202	0.818	
PRW	M	34	-0.420	0.848	±0.082	0.940	-0.381	0.814	0.17
	F	32	-0.118	0.902	±0.073	0.974	-0.145	0.878	ns
	M+F	66	-0.393	0.828	±0.051	0.968	-0.363	0.802	
TW	M	34	-0.091	0.927	±0.085	0.996	-0.052	0.893	0.24
	F	32	-0.049	0.897	±0.088	0.961	-0.010	0.862	ns
	M+F	66	-0.054	0.898	±0.059	0.963	-0.016	0.865	
TL	M	34	0.818	0.829	±0.098	0.940	0.876	0.780	1.22
	F	32	0.693	0.956	±0.133	0.921	0.777	0.882	ns
	M+F	66	0.807	0.847	±0.083	0.915	0.888	0.775	

Also in other regions the stomatopods have been recognized as important food items in the trophic web of demersal communities. According to MACPHERSON (1983a, b) *Pterygosquilla armata capensis* Manning is a frequent item in diet of many demersal fish off the coast of Namibia. So, new regression analyses were estimated considering the carapace length as variable y and morphometric measurements as variable x (Tab. 3). Then, the appearance of hard portions of this small mantis shrimp in the stomach contents will permit a reliable estimate of the length of the specimens eaten. Similarly, a reliable estimate of the biomass ingested can be obtained by utilizing the body part size/weight size relationship (Tab. 3).

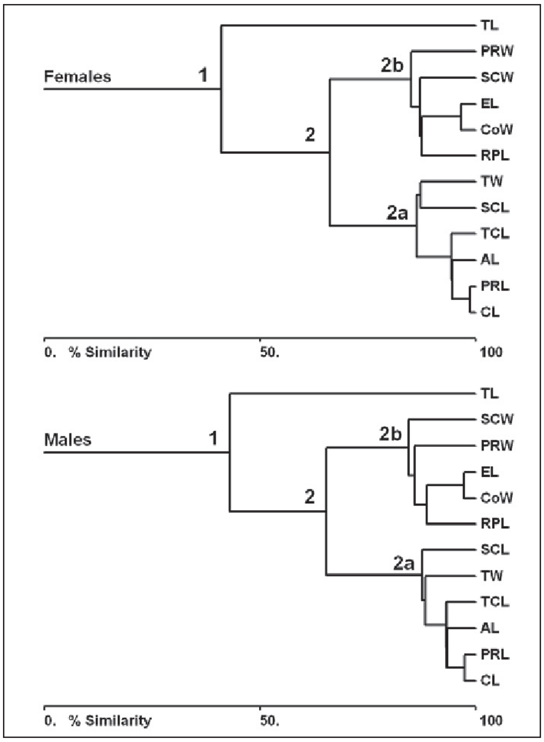

Fig. 2 - *Rissoides pallidus*. Dendrogram using hierarchical classification analysis for the female and male variables. Abbreviations as in Fig. 1.

Tab. 3 - Regression analyses (calculated by reduced major axis, with log-transformed data) of the carapace length based on morphometric measurements as the main reference dimensions of *Rissoides pallidus* (Giesbrecht). The relationship between wet weight (WW)/CL for both sexes is also given. Abbreviations as in Fig. 1.

M+F	$CL = 6.612\ RPL^{1.079}$	M+F	$CL = 2.246\ SCL^{0.918}$
M+F	$CL = 0.815\ TCL^{1.026}$	Males	$CL = 8.830\ SCW^{1.156}$
M+F	$CL = 2.774\ CoW^{1.641}$	Females	$CL = 9.600\ SCW^{0.870}$
M+F	$CL = 3.150\ EL^{1.602}$	M+F	$CL = 0.691\ PRL^{1.146}$
Males	$CL = 0.774\ AL^{1.171}$	M+F	$CL = 2.984\ PRW^{1.207}$
Females	$CL = 1.457\ AL^{0.891}$	M+F	$CL = 1.149\ TW^{1.114}$
M+F	$CL = 0.111\ TL^{1.180}$	M+F	$WW = 0.0052\ CL^{2.378}$

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