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Length-weight relationships of 15 mesopelagic shrimp species caught during exploratory surveys off the Canary Islands (central eastern Atlantic)

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Summary: Length-weight relationships (LWRs) were estimated for 15 mesopelagic shrimp species off the Canary Islands (central eastern Atlantic). Total length, cephalothorax length and total weight were taken for individuals collected during three research campaigns using a commercial semi-pelagic trawl net. The most represented families among the collected species were Sergestidae and Oplophoridae, with eight and three species, respectively. Overall, 60% of the species showed isometric growth, 33.3% negative allometry and 6.7% positive allometry. These 15 LWRs are the first contribution on mesopelagic shrimp species from the northwest Africa region, contributing to knowledge on the relative growth of these crustaceans.

Keywords: relative growth; Oplophoroidea; Penaoidea; Sergestoidea; Atlantic Ocean.

Relaciones talla-peso de 15 especies de crustáceos mesopelágicos capturados durante campañas exploratorias frente a las Islas Canarias (Atlántico Centro Oriental)

Resumen: Se estimaron las relaciones talla-peso (LWR) para 15 especies de crustáceos mesopelágicos de las Islas Canarias (Atlántico Centro Oriental). Se tomaron la longitud total (TL), la longitud del cefalotórax (CL) y el peso total (W) de los individuos recolectados durante tres campañas de investigación utilizando una red de arrastre semipelágica comercial. Las familias más representadas entre las especies colectadas fueron Sergestidae y Oplophoridae con ocho y tres especies, respectivamente. En general, el 60% de las especies presentó crecimiento isométrico, el 33,3% alometría negativa y el 6,7% alometría positiva. Estas 15 LWR son la primera contribución para estas especies de crustáceos mesopelágicos de la región del noroeste de África, contribuyendo a aumentar el conocimiento sobre el crecimiento relativo de estos crustáceos.

Palabras clave: crecimiento relativo; Oplophoroidea; Penaoidea; Sergestoidea; océano Atlántico.

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INTRODUCTION

Mesopelagic shrimps live between the surface and 1000 m depth, and the most abundant families are Acanthephyridae, Benthesicymidae, Ciferidae, Oplophoridae, Pandalidae, Pasiphaeidae, Penaeidae and Sergestidae (Landeira and Fransen 2012, Vereshchaka et al. 2019). Many mesopelagic decapod crustaceans show diel vertical migrations (DVMs) associated with predation avoidance, ascending towards surface waters at night to feed and descending to depths during the day to hide from predators (Irigoien et al. 2004, Torres et al. 2018).

Over the years, the estimation of mesopelagic shrimp biomass from oceanographic campaigns has been influenced by a catchability problem of the fishing gears, since the sample size is usually not very large and the DVMs can significantly affect the estimated biomass in the water column (Vereshchaka et al. 2019). Biomass is normally estimated from acoustic data and primary production studies (Irigoien et al. 2014) because the information available on the ecology and biology of these species, and particularly on growth, is very scarce.

Frequently, the lack of biological data on crustacean species with low or without fishing interest at regional level is partially compensated by using standardized data available on global databases such as SeaLifeBase.org (Palomares and Pauly 2012), where it is possible to obtain the maximum length and weight reported for some species, the depth range and the geographical distribution. However, such data are only useful for a general approach, not for establishing any particular characteristic of the species at a more local or regional level. Unfortunately, in the particular case of mesopelagic shrimps, the biological information available is almost nil in the specialized literature, particularly for the central eastern Atlantic, with the exception of a few taxonomic monographies (Zariquiey-Alvarez 1968, De Grave and Fransen 2011), first records, faunal lists and latitudinal/vertical distributions of species (Quiles et al. 2001, Muñoz et al. 2012, Vereshchaka et al. 2019

Species life-cycle parameters are required for the proper management of fishing resources, but also for estimating biomass fluxes between trophic levels and assessing the role of each group within the marine ecosystem (Couce-Montero et al. 2021). Knowledge on the length-weight relationships (LWR) can be used to gather information of species growth patterns, estimate condition index and analyse growth variations on temporal or spatial scales between populations/stocks (González-Acosta et al. 2004, Gerritsen and McGrath 2007, Froese and Pauly 2015). In this study, 15 mesopelagic shrimp species caught around the Canary Islands (central eastern Atlantic) were analysed to estimate the LWRs and analyse their relative growth patterns.

MATERIAL AND METHODS

Fishing surveys

Individuals were collected during three research campaigns (Table 1) around the Canary Islands (Central eastern Atlantic) performed on board the R.V. *La Bocaina*. In a total of 70 biological sampling hauls, mesopelagic shrimps were caught between the sea surface and 1035 m depth. The fishing gear was a commercial semi-pelagic trawl net with 5 mm mesh size at the cod-end (for more details see Guerra-Marrero et al. 2020).

Biological sampling

Immediately after capture, shrimps were initially fixed in formaldehyde (4%) for 4 hours, and then preserved in 70% ethanol, prior to their identification to the lowest possible taxonomic level (Crosnier and Forest 1973, Zariquiey-Alvarez 1968, González-Perez 1995, Burukovskii 1992, among others). Subsequently, in the laboratory, the total length (TL) and cephalothorax length (CL) were measured to the nearest 0.01 mm using a digital calliper, and the total weight (TW) was recorded to the nearest 0.0001 g using a digital balance (Sartorious, Basic).

Length-weight relationships

The LWRs were fitted using the equation $TW= aTL^b$ (power function), where TW is the total weight, TL is the total length, *a* and *b* are the regression parameters (*a*, regression intercept or constant; *b*, regression slope or allometric coefficient) estimated by linear regression on the logarithmic-transformed data and adjusted through the least squares method. Student's t-test was used to verify the positive or negative allometry when the *b* value is significantly higher or lower than the isometric value (*b=3*). The standard error and 95% confidence interval were also estimated for the LWR parameters.

All statistical analyses were conducted using the R software (R Core Team 2023).

RESULTS

A total of 1210 specimens belonging to 15 species from 3 superfamilies (Oplophoroidea, Penaeoidea and Sergestoidea) were sampled and identified (Table 2). Five families were collected, Sergestidae being the most abundant in both number of species (eight) and individuals, following by Oplophoridae with three species.

The growth patterns of 15 species were described from the LWRs parameters (Tables 1 and 2). The mean values of the correlation coefficients were high, with a mean value of 0.944±0.0333. *Systellaspis pellucida* showed the worst correlation index, with a value of 0.874, while *Allosergestes nudus* showed the highest correlation index (R=0.994). In relation to growth, it was observed that 60% of the species analysed showed isometric growth (b=3; t-test, p>0.05), while 6.7% and 33.3% showed positive (b>3; t-test, p<0.05) or negative allometric growth (b<3; t.test, p<0.05). *Allosergestes sargassi and S. pellucida* showed the lowest values of the allometry coefficient range (*b*), while *Systellaspis debilis* showed the highest value.

Table 1. – Names and dates of research campaigns, number of trawls and depth intervals where the mesopelagic shrimps were collected.

Research campaigns	Dates	No. trawls	Depth intervals (m)
ECOS 04/99	8-30 April 1999	23	8 - 716
Pelagic 11/00	10-22 November 2000	20	17 - 1009
Bocaina 03/02	7-18 April 2002	27	13 - 1035

Table 2. – Length-weight relationships for mesopelagic shrimps from Canary Island waters. TL, total body length; CL, cephalothorax length; W, wet weight; CI, confidence interval; n, number of specimens analysed; ns, nonsignificant. *a*, *b* and R are the regression parameters calculated from the TL~W relationship.

Superfamily	Family	Species	n	TL range (mm)	CL range (mm)	W range (g)	*a*	*b*	95% CI of *b*	R	*p*-value	Relative growth
Oplophoroidea	Acanthephyridae	*Acanthephyra purpurea*	23	56.98-102.52	20.34-39.55	0.6370-4.3046	0.000007	2.866	2.433-3.298	0.900	ns	i
		Ephyrina hoskynii	59	56.02-123.87	13.15-31.42	0.9232-15.3201	0.000001	3.348	2.844-3.853	0.972	ns	i
	Oplophoridae	*Oplophorus spinosus*	288	31.41-67.47	15.02-32.89	0.1024-1.7358	0.000004	3.095	2.851-3.339	0.943	ns	i
		Systellaspis debilis	57	48.52-88.80	14.55-31.18	0.3641-3.9890	0.0000001	3.878	3.210-4.547	0.985	<0.001	a+
		Systellaspis pellucida	49	19.74-57.55	5.44-27.88	0.0592-0.3445	0.0002	1.752	1.250-2.254	0.874	<0.001	a-
Penaeoidea	Benthesicymidae	*Gennadas valens*	172	12.18-46.82	4.37-12.56	0.0668-0.8482	0.0002	2.154	1.985-2.323	0.905	<0.001	a-
	Penaeidae	*Funchalia villosa*	159	36.85-80.01	9.92-23.55	0.2354-2.592	0.000003	3.157	2.874-3.440	0.972	ns	i
Sergestoidea	Sergestidae	*Allosergestes nudus*	66	26.92-51.80	7.35-15.17	0.0975-0.8581	0.000002	3.342	2.976-3.709	0.994	ns	i
		Allosergestes sargassi	75	20.37-61.31	5.74-19.78	0.1116-1.1513	0.00007	2.347	1.440-3.254	0.928	ns	i
		Deosergestes corniculum	*21*	24.29-61.04	7.05-20.32	0.11187-1.3032	0.00005	2.477	2.071-2.883	0.955	<0.001	a-
		Deosergestes henseni	63	31.39-59.43	10.11-17.33	0.2313-1.0182	0.00008	2.311	1.648-2.973	0.959	<0.001	a-
		Parasergestes armatus	28	13.87-37.95	6.35-13.09	0.0196-0.4700	0.00001	2.829	2.577-3.081	0.954	ns	i
		Parasergestes diapontius	42	19.61-51.65	6.11-13.45	0.0603-0.7585	0.00003	2.576	2.123-3.030	0.941	ns	i
		Robustosergia robusta	40	21.70-75.07	7.57-20.65	0.1933-2.2974	0.0002	2.157	1.948-2.367	0.920	0.001	a-
		Sergestes atlanticus	68	30.51-78.9	8.04-25.18	0.0938-1.9709	0.000004	3.021	2.105-3.936	0.955	ns	i

DISCUSSION

This study provides the first estimation of the LWRs of 15 mesopelagic shrimp species caught in several exploratory surveys carried out in the Canary Islands area (central eastern Atlantic). This is the first study that gives growth information on these mesopelagic decapod crustaceans. Biological data on these crustaceans are scarce, probably because the fishing gears used in the exploratory campaigns of this mesopelagic community make the individuals suffer a significant deterioration of their structures, because their exoskeleton and appendages are very fragile. The deterioration of these structures of high taxonomic value reduces the number of samples, so in this study only individuals that allowed a reliable taxonomic identification were included.

It should be noted that although the LWRs of the 15 species are shown, only 53.3% had the necessary correlation values for reliable LWRs (greater than 0.95, the preferred significant level).

The sample conservation system is a subject under study because conservation dehydrates the tissues. In the case of crustaceans, Fazhan et al. (2021), describe reductions of around 5% for larvae of *Scylla olivacea* and *Macrobrachium rosenbergii*, although they state that this low percentage of contraction is a result of their rigid chitinous exoskeleton. In our study, we did not evaluate the effect of conservation on the dehydration of these individuals, and because previous studies are not known, it is recommended that the estimated parameters for the 15 species be used as preliminary. In conclusion, the information provided for these 15 species contributes to knowledge of these species and allows for more accurate biomass estimations of them, which is vital for the sustainable management and conservation of mesopelagic shrimp populations. The information will also be a reference for future comparisons between populations from other areas of the region, for identifying stocks in the same area, or for determining changes in the growth pattern according to variations in climate parameters (Gerritsen and McGrath 2007).

DECLARATION OF COMPETING INTEREST

The authors of this article declare that they have no financial, professional or personal conflicts of interest that could have inappropriately influenced this work.

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AUTHORSHIP CONTRIBUTION STATEMENT

Airam Guerra-Marrero: Conceptualization, Formal analysis, Writing – original draft. Catalina Caballero-Méndez: Investigation, Methodology, Formal analysis, Writing – review & editing. Ana Espino-Ruano: Formal analysis, Writing – review & editing. Lorena Couce-Montero: Formal analysis, Writing – review & editing. David Jiménez-Alvarado: Formal analysis, Writing – review & editing. José J. Castro: Conceptualization, Methodology, Funding acquisition, Investigation, Project administration, Writing – review & editing.

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