

LENGTH-WEIGHT RELATIONSHIPS OF 17 DEMERSAL FISH SPECIES IN THE CANARY ISLANDS (SPAIN, CE ATLANTIC)

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Jurado-Ruzafa, A. & P. Martín-Sosa (2025). Relaciones longitud-peso de 17 especies de peces demersales en las Islas Canarias (España, Atlántico Sur). *Vieraea* 48: <https://doi.org/10.31939/vieraea.2025.48.01>

SUMARY: Ten scientific surveys were carried out at ‘Isla de La Palma’ and ‘La Graciosa e Islotes al Norte de Lanzarote’ Marine Protected Areas (MPAs) between 2003 and 2010. Length-Weight Relationships (LWR) were estimated for 17 fish species using individual fish records collected by fish pots (half an inch mesh size), bottom horizontal longlines (hook size 3/0) and set gillnets (80 mm mesh size). Fish was measured fresh for the total length (to the lower 0.1 or 0.5 cm, depending on the scientific surveys design) and weighted for the total weight (TW, to the 0.1 g). Except

for the Myliobatiformes species (with b-values lower than 2.0), the b-value varied between 2.63 and 3.72. All LWRs were obtained from well adjusted linear regressions with $R^2 \geq 0.74$. In addition, two new maximum lengths were recorded. Data presented herein expand the knowledge base for these species in the Archipelago, where any status assessment of the species affected by the operating fisheries has been possible so far, and remain as data-poor stocks.

KEYWORDS: Length-weight relationships / demersal fish / the Canary Islands / Eastern Atlantic

RESUMEN: Entre 2003 y 2010, se llevaron a cabo diez campañas científicas en las Áreas Marinas Protegidas (AMP) de la Isla de La Palma y La Graciosa e Islotes al Norte de Lanzarote. Se han estimado las relaciones talla-Peso (LWR) para 17 especies de peces utilizando los datos de peces capturados con nasas (malla de media pulgada), palangres horizontales de fondo (anzuelos de tamaño 3/0) y redes de enmalle fijas (malla de 80 mm). Se midió la longitud total (TL, redondeando al 0,1 o 0,5 cm inferior, dependiendo del diseño de las campañas científicas) y se registró el peso total (TW, hasta

los 0,1 g) de todos los ejemplares en fresco. A excepción de las especies de Myliobatiformes (con valores b inferiores a 2,0), el valor b varió entre 2,63 y 3,72. Todas las LWR se obtuvieron a partir de regresiones lineales con elevados ajustes con $R^2 \geq 0,74$. Además, se registraron nuevas longitudes máximas para dos especies. Los datos presentados en este documento amplían la base de conocimientos de estas especies en el archipiélago, donde hasta ahora no ha sido posible evaluar el estado de las especies afectadas por las pesquerías, y siguen siendo stocks pobres en datos.

PALABRAS CLAVE: relaciones talla-peso / peces demersales / Islas Canarias / Atlántico oriental

INTRODUCTION

Three Marine Protected Areas (MPAs) with fishery interest are defined in The Canary Islands (CE Atlantic) in La Palma, El Hierro and La Graciosa. From 2003 to 2010, ten experimental fishing surveys were designed and coordinated by The Canary Islands Oceanographic Centre (Spanish Institute of Oceanography - IEO, CSIC), eight in waters of La Palma MPA and two in La Graciosa surroundings MPA, comprising the longitudinal distribution of the Archipelago (**Fig. 1, Table I**). The general goals of the surveys included the biological analysis of the total fish caught and the estimation of the Length-Weight Relationships (LWRs) for the species with a significant representation. The monitoring programmes of the artisanal fisheries in the Archipelago (RCG, 2021) based on length samplings performed on shore and on board (therefore, including both retained and discarded species), may take advantage of the useful information obtained. Moreover, we present useful information for species with local relevance both on fishery and conservation issues.

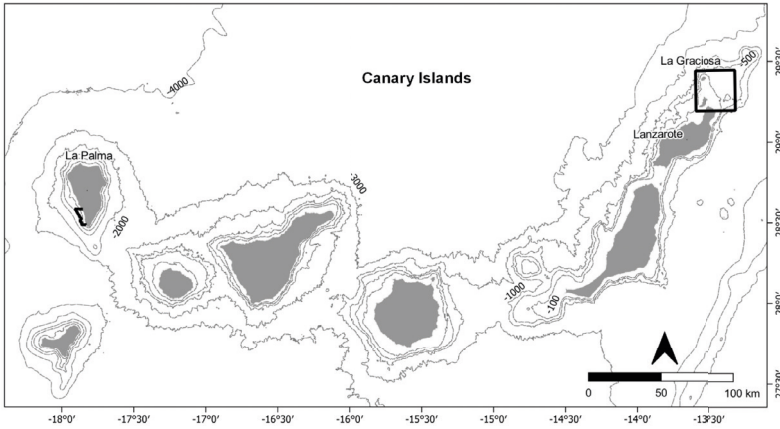


Figure 1. Location of the two Marine Protected Areas (MPAs, black areas) in the Canary Islands where fishes were caught and considered for the present study.

	Jun 2003	Jun 2004	Jun 2005	Oct-Nov 2005	May-Jun 2006	Sep 2006	Oct-Nov 2006	May-Jun 2008	May-Jun 2009	May-Jun 2010
La Palma	GN, BL, P	GN, BL	GN, BL		GN, BL		GN, BL	GN, BL	GN, BL	GN, BL
La Graciosa				GN, BL		GN, BL				

Table I. Time periods and fishing gears used in the scientific surveys. GN: gillnets, BL: Bottom longlines, P: Pots.

MATERIALS AND METHODS

During these scientific studies, fishing operations were performed by local professional fishers based on the scientific design. Different fishing gears were used, including fish pots, bottom horizontal longlines and set gillnets (**Table I**). After the taxonomical identification, all the specimens caught were measured for the total length (TL, to the lower 0.1 or 0.5 cm, depending on the different scientific surveys design) and weighted for the total weight (TW, to the 0.1 g). When possible, individuals were sexed.

LWRs were estimated whether data included at least 30 individuals, using the log-transformation ($TW = \log(a) + b \log(TL)$) of the power formula: $TW = a \times TL^b$, where a is the condition factor (related to body shape) and b is the allometry coefficient (related to the growth pattern). The 95% confidence interval and the standard error were also estimated for the LWR coefficients. Growth pattern (allometry) was tested ($H^0: b = 3$) using the t-Student's test, as modified by Pauly (1984).

RESULTS

The 17 species selected (with at least 30 measured individuals, also when considering sexes), have no LWRs for The Canary Islands or no references for the CE Atlantic, based on the FishBase database (Froese and Pauly, 2021). Results for the LWRs are presented in **Table II**. Linear regressions provided suitable adjustments ($R^2 \geq 0.74$), except for males of *Dasyatis pastinaca* (Linnaeus, 1758) ($R^2 = 0.42$). The b-value varied between 2.63 (*Balistes caprisus* Gmelin, 1789) and 3.72 (*Muraena helena* Linnaeus, 1758), excluding again *D. pastinaca* with a b-value of 1.93. Five out of the 17 fish species studied showed isometric growth ($b \approx 3$): *Beryx*

splendens Lowe, 1834, *Pseudocaranx dentex* (Bloch & Schneider, 1801), *Pagellus erythrinus* (Linnaeus, 1758), *Sarpa salpa* (Linnaeus, 1758) and *Stephanolepis hispidus* (Linnaeus, 1766); four species showed negative allometric growth ($b < 3$): *B. capriscus*, *D. pastinaca*, *Diplodus vulgaris* (Geoffroy Saint-Hilaire, 1817) and *Pagrus pagrus* (Linnaeus, 1758); and the rest of the species showed positive allometric growth ($b > 3$): *Conger conger* (Linnaeus, 1758), *Diplodus sargus* (Linnaeus, 1758), *Gymnothorax polygonius* Poey, 1875, *Helicolenus dactylopterus* (Delaroche, 1809), *Muraena helena*, *Pontinus kuhlii* (Bowdich, 1825), *Serranus atricauda* Günther, 1874 and *Squalus megalops* (Macleay, 1881).

Class	Order	Family	Species name	N	TL range Mean±sd	TW range Mean±sd	a	a CI SE	b	b CI SE	R ²	t p-sig	GP
Actinopterygii													
Anguilliformes													
		Congridae	<i>Conger conger</i> †	60	55.5-145.5† 90.4±23.1	229.5-6627.8 1845.8±1613.1	0.0003	0.0001-0.0006 0.356	3.434	3.275-3.593 0.079	0.970	1.830 <0.01	A+
		Muraenidae	<i>Gymnothorax polygonius</i> †	419	36.5-78.0 56.7±8.0	54.5-785.5 286.2±143.6	0.0002	0.0002-0.0003 0.1712	3.465	3.381-3.548 0.042	0.941	0.127 <0.01	A+
			Females	193	43.5-78.0 57.9±6.3	100.0-774.5 289.7±109.4	0.0008	0.0004-0.0015 0.3297	3.149	2.988-3.309 0.081	0.887	5.309 n.s.	A+
			Males	105	46.5-74.6 62.3±6.2	137.0-785.5 403.7±156.4	0.0001	0.0000-0.0002 0.4842	3.706	3.473-3.938 0.117	0.907	3.031 <0.01	A+
			<i>Muraena helena</i> †	34	65.5-112.5 94.3±11.1	472.5-5394.0 2060.9±1010.1	0.0001	0.0000-0.0008 1.0855	3.724	3.237-4.211 0.239	0.883	0.138 <0.01	A+
Beryciformes													
		Berycidae	<i>Beryx splendens</i> †	277	26.6-44.7 37.2±3.3	221.3-1133.0 643.2±167.7	0.0154	0.0111-0.0214 0.1675	2.935	2.844-3.027 0.046	0.936	2.626 n.s.	I
			Females	169	29.4-44.7 37.6±3.1	367.5-1133.0 664.5±166.0	0.0190	0.0119-0.0303 0.2369	2.880	2.751-3.009 0.065	0.921	6.774 n.s.	A-
			Males	100	28.9-43.5 36.8±3.2	311.0-1037.7 615.4±160.5	0.0150	0.0088-0.0256 0.2691	2.939	2.791-3.087 0.075	0.940	4.780 n.s.	I
Carangiformes													
		Carangidae	<i>Pseudocaranx dentex</i> †	101	25.5-66.0 38.6±11.7	176.9-3602.4 874.2±901.4	0.0118	0.0103-0.0135 0.0684	2.997	2.960-3.035 0.019	0.996	6.846 n.s.	I
Perciformes													
		Scorpaenidae	<i>Pontinus kuhlii</i> †	147	15.2-38.0 26.1±4.8	51.3-815.1 285.3±165.1	0.0110	0.0084-0.0143 0.1342	3.083	3.001-3.164 0.041	0.975	0.413 <0.05	A+
			Females	36	17.3-35 23.8±4.9	75.5-610.4 215.1±135.8	0.0202	0.011-0.0373 0.3015	2.888	2.694-3.082 0.095	0.964	2.292 n.s.	I
			Males	61	21.0-38.0 29.3±3.9	128.1-815.1 395.2±167.6	0.0079	0.0048-0.0131 0.2519	3.185	3.035-3.33 0.075	0.968	0.448 <0.05	A+
			<i>Helicolenus dactylopterus</i> †	96	18.5-41.3 29.5±5.3	102.7-1151.5 468.3±252.6	0.0121	0.0089-0.0165 0.1549	3.091	2.999-3.182 0.046	0.980	10.345 n.s.	A+
			Males	46	21.0-40.5 30.3±4.6	146.5-1120.5 505.2±245.5	0.0149	0.008-0.0276 0.3071	3.037	2.855-3.219 0.090	0.963	3.980 n.s.	I
		Serranidae	<i>Serranus atricauda</i> †	695	10.1-37.0 24.5±4.7	10.5-660.0 198.0±111.1	0.0066	0.0059-0.0074 0.0569	3.185	3.150-3.220 0.018	0.979	3.552 <0.01	A+
			Females	453	13.3-37.0 25.4±3.9	27.0-660.0 214.0±98.5	0.0081	0.0067-0.0098 0.0988	3.122	3.062-3.182 0.031	0.958	3.160 <0.01	A+
			Males	78	12.7-33.0 23.5±4.1	20.8-458.2 167.4±90.4	0.0058	0.0041-0.0082 0.1705	3.220	3.112-3.328 0.054	0.979	0.124 <0.01	A+
		Sparidae	<i>Diplodus sargus</i> †	45	20.0-35.0 24.9±3.7	131.2-762.7 289.2±168.3	0.0070	0.0042-0.0116 0.2515	3.278	3.120-3.436 0.078	0.976	3.486 <0.01	A+
			<i>Diplodus vulgaris</i> †	88	19.0-32.5 24.2±3.1	139.3-605.8 254.7±103.5	0.036	0.0226-0.0572 0.2334	2.768	2.622-2.914 0.073	0.943	2.750 <0.01	A-
			<i>Pagellus erythrinus</i> †	45	17.5-34.5 28.1±3.3	61.2-523.3 298.5±93.7	0.0124	0.0066-0.0233 0.3137	3.012	2.822-3.202 0.094	0.960	0.523 n.s.	I
			<i>Pagrus pagrus</i> †	907	16.3-65.0 39.7±9.9	70.6-4387.0 1144.1±817.4	0.0180	0.0165-0.0197 0.0454	2.956	2.932-2.981 0.012	0.984	2.475 <0.01	A-
			Females	329	20.0-60.9 40.1±9.2	144.0-3686.3 1145.3±736.2	0.0218	0.0179-0.0265 0.0995	2.906	2.852-2.959 0.027	0.972	1.405 <0.01	A-
			Males	180	22.5-65.0 42.9±11.8	173.6-4387.0 1480.3±1061.4	0.0201	0.0167-0.0244 0.0964	2.929	2.878-2.980 0.026	0.986	1.409 <0.01	A-
			<i>Sarpa salpa</i> †	52	27.0-39.0 31.4±2.7	280.1-917.9 453.9±131.1	0.0187	0.0066-0.0534 0.5218	2.921	2.616-3.225 0.151	0.881	0.907 n.s.	I
Tetraodontiformes													
		Ballistidae	<i>Balistes capriscus</i> †	37	28.0-47.0 39.1±4.5	376.0-1934.0 998.8±327.3	0.0631	0.0139-0.286 0.7441	2.627	2.214-3.039 0.203	0.827	12.300 n.s.	A-
		Monacanthidae	<i>Stephanolepis hispidus</i> †	31	16.1-23.0 19.7±1.9	64.6-237.0 136.2±42.7	0.0129	0.0041-0.0406 0.5592	3.094	2.710-3.478 0.188	0.904	4.954 n.s.	I

Class	Order	Family	Species name	N	TL range Meantsd	TW range Meantsd	<i>a</i>	<i>a</i> CI SE	<i>b</i>	<i>b</i> CI SE	R ²	<i>t</i> p-sig	GP
Elasmobranchii													
Myliobatiformes													
		Dasyatidae	<i>Dasyatis pastinaca</i>	170	38.0-155.0 69.9±18.4	321.2-14000.0 2913.9±2041.7	0.7207	0.3499-1.4845 0.366	1.935	1.763-2.106 0.087	0.748	6.016 <0.01	A-
			Males	93	38.0-125.0 66.1±8.7	321.2-14000.0 2421.5±1314.7	0.9419	0.1391-6.3764 0.9628	1.861	1.404-2.317 0.230	0.418	7.520 <0.01	A-
Squaliformes													
		Squalidae	<i>Squalus megalops</i> †	34	28.0-84.0† 54.6±14.2	140.2-5561.5 1523.8±1380.5	0.0024	0.0015-0.004 0.2463	3.276	3.150-3.402 0.062	0.989	0.127 <0.01	A+

Table II. Length-weight relationships for 17 fish species from The Canary Islands (CE Atlantic). N: sample size; TL: total length (cm); sd: standard deviation; TW: Total Weight (g); *a* and *b*, relationship parameters; CI: 95% confidence interval; SE: standard error; R²: determination coefficient; *t*: t-Student statistic value (modified by Pauly (1984)); p-sig: p-value for t-tests testing deviations from isometric growth (*b*=3) (n.s., not significant); GP: growth pattern (A: allometric; I: isometric). † Maximum TL reported; ‡ Species with commercial interest.

DISCUSSION

Based on the information available in FishBase (Froele and Pauly, 2024), new maximum lengths were recorded for Conger conger and *Squalus megalops*. The present study provides LWRs information for 17 common species in The Canary Islands area, including shallow-water to deep-water species. The LWRs here presented represent useful information for future status assessment of the fishing exploited species in the Canary Archipelago, where any status assessment of the species affected by the operating fisheries has been possible so far (FAO, 2018), and remain as data-poor stocks.

Regarding the growth pattern, among the species in which LWRs were also obtained for each sex, differences between them were only obtained for *B. splendens* and *P. kuhlii*. It is well known that the energy investment for the somatic growth is strongly related to the sex and reproduction cycles (gonad maturity), very dependent on the seasonality (Wootton, 1998). Indeed, in addition to the sex and maturity variability, other factors as health or condition of the fish, geographic or seasonal variations in the environmental conditions and differences in the size ranges of the considered specimens strongly influence the LWRs parameters (Casselman, 1987; Froese, 2006; Jurado-Ruzafa et al., 2016). These factors could not be analyzed in the present study. Therefore, growth patterns obtained from punctual samplings (as the ones here presented) should be considered with caution.

Regarding LWRs estimated previously, authors are aware that some information is not included in the FishBase database (Froese and Pauly, 2024), but published in scientific journals or included in academic and technical documents. A summary of this kind of information is presented in **Table III**. Comparison between results

could be noisy when all the above-mentioned factors promote variability in the LWRs' parameters. To implement standardized methodologies agreed among the institutions involved in fishery research in the region would be crucial to be able to monitor variations in ecological features of these species and their temporal variability, both seasonal and in the long term (Bolger and Conolly, 1989), especially critical in the current Climate Change scenario.

Species name	Length considered	N	Length range	a	b	R ²	GP	Reference
<i>Balistes capriscus</i>	TL	19	26.0-50.2	0.0344	2.759	0.951	na	Santana et al. (2002)
<i>Beryx splendens</i>	FL	643	18.2-38.9	0.0158	3.120	0.940	A+	Rico et al. (2001)
<i>Conger conger</i>	TL	140	12.5-187.5	0.0030	2.950	0.974*	na	González et al. (1988)
<i>Diplodus vulgaris</i>	TL	190	13.8-25.5	0.0168	2.994	0.966	na	Santana et al. (2002)
<i>Gymnothorax polygonius</i>	TL	476	39.5-110.0	0.0005	3.272	0.963*	A+	Jiménez (1997)
<i>Helicolenus dactylopterus</i>	TL	30	17.0-41.0	0.4882	2.680	0.895*	A-	González et al. (1988)
<i>Muraena helena</i>	TL	749	41.9-134.0	0.0005	3.314	0.942*	A+	Jiménez (1997)
<i>Pagellus erythrinus</i>	TL	280	57.5-132.5	0.0012	3.100	0.884*	na	González et al. (1988)
	TL	957	7.5-37.1	0.0128	3.013	0.990	I	Pajuelo and Lorenzo (1998) (males A+)
	TL	87	6.7-10.1	0.0117	3.061	0.932	I	Espino et al. (2016)
	TL	254	16.5-29.5	0.0162	2.886	0.957	na	Santana et al. (2002)
<i>Pagrus pagrus</i>	TL	114	13.2-33.8	0.0224	2.846	0.974	na	Santana et al. (2002)
	TL	1858	4.7-57.2	0.0179	2.958	0.990	na	Pajuelo and Lorenzo (1996)
	TL	na	na	0.0092	3.152	na	na	González et al. (1998)
<i>Pontinus kuhlii</i>	TL	142	20.5-31.5	0.0173	2.896	0.918	na	Santana et al. (2002)
<i>Sarpa salpa</i>	TL	1125	11.9-45.2	0.0137	3.011	0.099	I	Méndez-Villamil (2002)
<i>Serranus atricauda</i>	TL	512	16.2-43.2	0.0056	3.247	0.986	A+	Tuset (2000)
<i>Stephanolepis hispidus</i>	TL	362	11.4-21.7	0.0157	2.991	0.953	na	Santana et al. (2002)

Table III. LWRs published for coincident fish species from The Canary Islands. N: sample size; a and b: relationship parameters; R²: determination coefficient; GP: growth pattern (A: allometric; I: isometric); TL: total length (cm) ; FL: fork length (cm). na: not available. *correlation coefficient (r).

ACKNOWLEDGEMENTS

The present study was performed in the framework of Specific Collaboration Agreements between the IEO and Spain's Fishery Office from 2003 to 2010 with the aid of European Maritime and Fisheries Funds (EMFF).

The authors wanted to thank the crews involved in the surveys, the scientific observers on board, the MPAs Coordination and Surveillance Services, the Fishers' Guilds of La Graciosa, San Ginés, Tazacorte and Santa Cruz de La Palma, the national and regional governments staff, and the Canary Oceanographic Centre who helped to a greater or lesser extent in the process of the field work. The authors also appreciate Laura Martín-García's help with the map edition.

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