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SHORT PAPER

Length–Weight Relationships of Kitefin Shark Dalatias Licha, and Little Sleeper Shark *Somniosus rostratus* from the Western Mediterranean Sea, and Long Snouted Lancetfish *Alepisaurus ferox* from the Eastern North Atlantic Ocean

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Abstract

This paper provides length-weight relationships (LWR) for three species: long snouted lancetfish *Alepisaurus ferox*, kitefin shark *Dalatias licha* and little sleeper shark *Somniosus rostratus*. Samples were collected occasionally from 2009 to 2013. A total of 49 *D. licha* and 24 *S. rostratus* samples from the western Mediterranean Sea, and 211 samples of *A. ferox* from the eastern North Atlantic Ocean were recorded for LWR. For each species, regression coefficients and parameters "a" and "b" were calculated with 95% confidence interval. The LWR parameter b for all species ranged from 2.889 to 3.5048, with R^2 ranging from 0.717 to 0.823**.**

Keywords: Biometry, bycatch, fisheries, fish biology, longline.

Introduction

Long snouted lancetfish *Alepisaurus ferox* Lowe, 1833 is a primarily nocturnal habits large bathypelagic circumglobal species. Despite being taken as bycatch by the tuna longline fisheries, it is not targeted directly by any fishery (Paxton, 2010). Kitefin shark *Dalatias licha* (Bonnaterre, 1788) and little sleeper shark *Somniosus rostratus* (Risso, 1827) are two demersal Elasmobranchii species, both presenting a broad distribution in the eastern North Atlantic Ocean and western Mediterranean Sea (Yano, Stevens, & Compagno, 2004). *A. ferox* is a very important predator species (Potier, Ménard, Cherel, Lorrain, Sabatié, & Marsac, 2007). Likewise, Navarro, López, Coll, Barría, and Sáez Liante (2014) showed a high trophic position of *D. licha* within the food web of the western Mediterranean Sea. In opposition, *S. rostratus* (Squaliformes) is a specialist predator that feeds mostly on cephalopods, especially squids (Golani, 1986; Barría, Coll, & Navarro, 2015).

They are caught as accessory species in the Spanish longline fishery targeting tunas (*Thunnus spp.*) and swordfish *Xiphias gladius* in the Western Mediterranean Sea (*S. rostratus* and *D. licha*) and the Atlantic Ocean (*A. ferox*). This fishery operates off the western Spanish coast and seasonally (i.e., October - March), part of the fishing fleet moves to the Atlantic Ocean (mainly Macaronesian Islands and south Portugal area) (García-Barcelona, Báez, Ortiz de Urbina, Gómez-Vives, & Macías, 2013).

The relationship between body length and weight of fish is of great importance in fisheries biology and population dynamics where many stock assessment models require the use of length-weight parameters (Froese, 2006). Length–weight relationships (LWRs) of fishes are also useful to implement fish stock and population assessments (Froese, 2006). The growth-in-weight equations are useful to assess the fitness, health status, and life history parameters like reproduction in fishes. LWR data allow the conversion of growth-in-length to growth-in-weight (Froese, 2006).

In the present study, LWRs of three fish species (i.e., *A. ferox*, *D. licha* and *S. rostratus*) were analyzed. Given the lack of data in the FishBase database (Froese & Pauly, 2016) for the two species in the Mediterranean Sea (i.e., *D. licha* and *S. rostratus*) (Froese & Pauly, 2016), the aim of the study is to provide LWR formulas for these species , and improving the fitting of the LWR parameters for *A. ferox* from the Atlantic Ocean.

Materials and Methods

Since 1999, the Spanish Institute of Oceanography (IEO) has conducted a scientific onboard observer program on commercial longline

vessels targeting highly migratory species in the Mediterranean Sea, aiming to obtain direct information on catches and discards of target and bycatch species (e.g. catch and bycatch species, number of individuals, size and other biological and fishery parameters). In the present study, data were collected within the aforementioned observers program. The mean number of vessels of the Spanish longline fleet targeting tuna and swordfish through the years was 80 vessels. These vessels have a length ranging between 12 m to 27 m length overall (LOA). The fishing grounds cover a large area of the western Mediterranean basin, between 36° and 44°N and 02°W and 05°E, and of the Atlantic Ocean around the Macaronesian Islands and South of Portugal area.

Onboard fresh fish samples were collected occasionally over a 4-year period from 2009 to 2013 as bycatch of the commercial pelagic longline fishery targeting tuna and swordfish in the western Mediterranean Sea and eastern North Atlantic Ocean (Canary Islands area). A total of 49 *D. licha* and 24 *S. rostratus* samples from the Mediterranean Sea, and 211 *A. ferox* samples from the eastern North Atlantic Ocean were recorded for length–weight analyses. Each fork length measurement was made to the nearest 1 cm using a vernier caliper. *D. licha* and *S. rostratus* were weighted in the port to the nearest 50 g, whereas *A. ferox* was weighted onboard to the nearest 25 g.

Length and weight data were plotted for each species and obvious outliers were removed, such as is suggested in Keller and Kerstetter (2012) (figures 1a, 1b, 1c). Length-weight relationships were determined by fitting the pairs of data obtained in commercial fishing operations, to a potential relationship based on the exponential equation (Froese, 2006): W= a*L^b; where, W is the total weight (expressed in g), L is the fork length (expressed in cm), "a" and "b" are the power regression coefficients (i.e, "a" is a coefficient related to body form and "b" is an exponent indicating isometric growth when equal to 3 and indicating allometric growth when significantly different from 3) (Froese, 2006).

Furthermore, log-transformed fork length and log-transformed weight were used to estimate the 95% confidence interval (CI) for parameters "a" and "b". Results and figures were generated using IBM-SPSS statistical software version 19.

Results

A total of 49 pairs of data (weight/length) of the species *S. rostratus* and 24 pairs of data (weight/length) of the species *D. licha* from the western Mediterranean Sea were recorded between 2000 and 2015; and 211 pairs of data (weight/length) of the species *A. ferox* from the Atlantic Ocean were recorded in the same period.

Table 1 shows the sample size (N), fork length (L) and weight (W) ranges, LWR parameters with 95% CI for parameters "a" and "b", for each of the three fish species analyzed. The determination coefficient (R^2) ranged from 0.717 for *A. ferox* to 0.823 for *D. licha*.

Discussion

Keller and Kerstetter (2012) reported b= 3.358 (2.949-3.767, 95% CI) for *A. ferox*, whereas Fishbase reported b= 3. These values differ with the "b" reported in the present study (b= 2.889). Differences in "b" values can result from multiple factors, e.g., the number and length range of the sampled specimens, seasonality, habitat, gonad ripeness, stomach fullness, and growth phase (Sharma, Singh, Gupta, Pandey, Tiwari, Singh, & Akhtar, 2016), and the lack of precision in measuring the weight onboard.

No previous LWR estimates were available for *S. rostratus* and *D. licha* in the Fishbase database. In the case of *Somniosus* genus, from five species described in the genus, there is only available LWRs information for *S. microcephalus* and *S. pacificus*. For these species "b" ranges between 2.77 and 3.57, thus the observed value of "b" in the present study (b= 3.12) is within the range. However, due to the high variability observed in 95% of the confidence interval for both parameters (a, b), we believe that the present formula for *S. rostratus* should be treated with caution. *D. licha* is the only species in its genus; for

Table 1. Descriptive statistics and estimated parameters of LWRs for three bycatch marine fish species of the Spanish longline fisheries targeting tuna and swordfish in the eastern North Atlantic Ocean (*Alepisaurus ferox*) and the western Mediterranean Sea (*Somniosus rostratus* and *Dalatias licha*). Length-weight relationship parameters are showed with 95% confidence interval (CI). All regression were significant to P<0.001.

		Fork length (cm)		Total body weight (gr)		Regression parameters			IC 95%	
Species	N	Min	Max	Min	Max	a	b	R^2	a	b
Alepisaurus ferox	211	66	157	400	10500	0.00573	2.889	0.717	0.00184 0.01786	2.567 3.047
Somniosus rostratus	24	74	103	2600	7500	0.00396	3.12	0.745	0.001059 0.149	2.314 3.927
Dalatias licha	49	56	119	600	22000	0.00091	3.5048	0.823	0.00114 0.00719	3.027 3.982

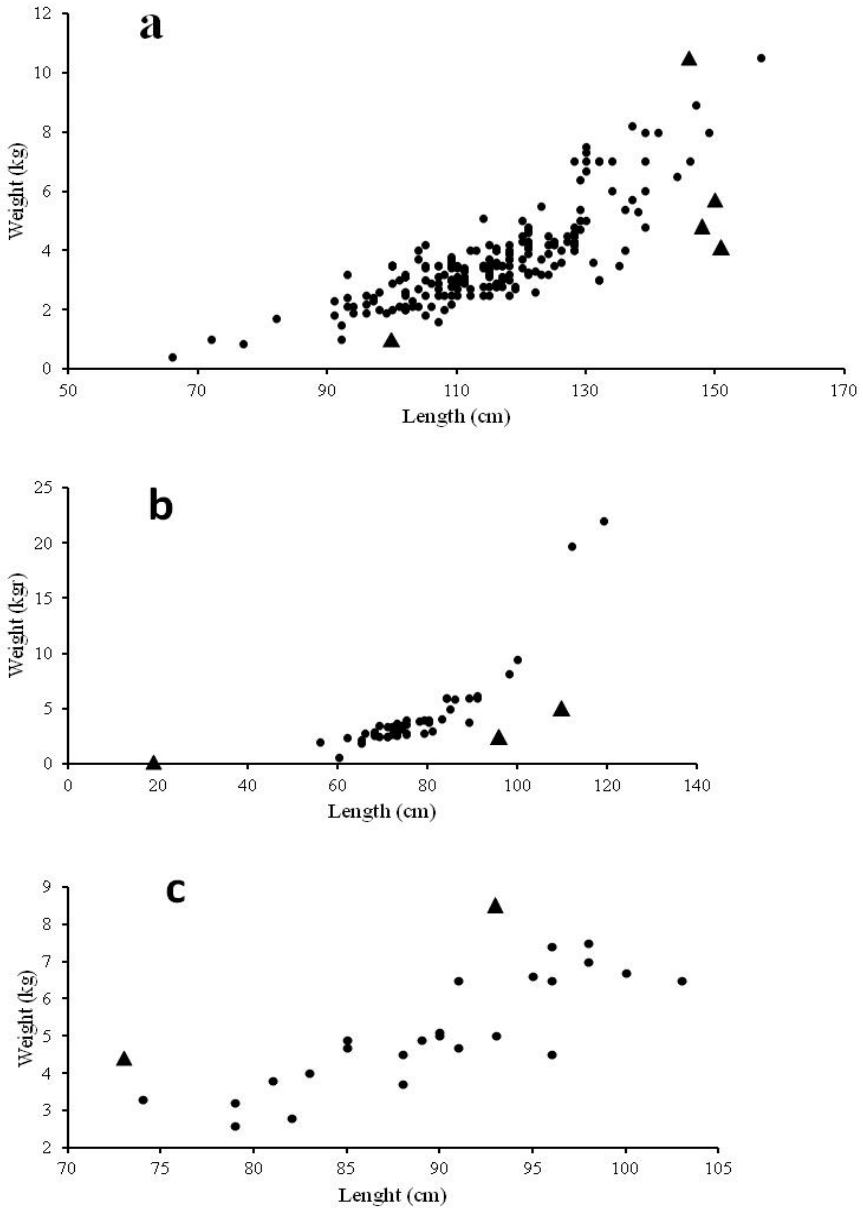

Figure 1. Fork length and weight plotted for: Alepisaurus ferox samples from the eastern North Atlantic Ocean (a); Dalatias licha (b) and Somniosus rostratus (c) samples from the western Mediterranean Sea. Obvious outliers were removed (triangle).

this reason, there is no possible comparison with the current results.

The results obtained herein can be used as basis for new studies, giving the presence of these species as bycatch in longliners. Furthermore these results can be used for comparisons with results obtained in future studies and for providing valuable information for the online FishBase database as well as contribute to fishery research, management and conservation.

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