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► To cite this version:

Leandro Nolé, Michael Mincarone, Bárbara Teixeira Villarins, Thierry Frédou, Alex Lira, et al.. Length–weight relationships of eleven mesopelagic fishes from oceanic islands of the Southwestern Tropical Atlantic. *Journal of Applied Ichthyology*, Wiley, 2019, 35 (2), pp.605-607. 10.1111/jai.13840 . ird-02197003

HAL Id: ird-02197003

<https://hal.ird.fr/ird-02197003>

Submitted on 29 Jul 2019

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1 **Length–weight relationships of eleven mesopelagic fishes from oceanic**
2 **islands of the Southwestern Tropical Atlantic**

3 **DOI: 10.1111/jai.13840**

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17 **ABSTRACT**

18 This study provides the length-weight relationship for eleven deep-sea fishes from
19 oceanic islands of the Southwestern Tropical Atlantic: *Bonapartia pedaliota*, *Sigmops*
20 *elongatus* (Gonostomatidae), *Argyropelecus aculeatus*, *Argyropelecus affinis*,
21 *Argyropelecus sladeni*, *Sternoptyx diaphana*, *Sternoptyx pseudobscura*
22 (Sternoptychidae), *Malacosteus niger*, *Thysanactis dentex* (Stomiidae), *Melanonus*
23 *zugmayeri* (Melanonidae), and *Ectreposebastes imus* (Setarchidae). Data were collected
24 during a scientific survey (2017) around Rocas Atoll, Fernando de Noronha
25 Archipelago and adjacent seamounts, using a micronekton trawl (side length of body
26 mesh: 40 mm, side length of cod-end mesh: 10 mm) at 35 stations from 0 to 1113 m
27 depth. A new maximum standard length for *Bonapartia pedaliota* and *Ectreposebastes*
28 *imus* are also provided.

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32 **INTRODUCTION**

33 In the western Tropical Atlantic, the Fernando de Noronha Archipelago, Rocas
34 Atoll and adjacent seamounts host a remarkable biodiversity (Fiedler et al., 2016; Hazin
35 et al, 1998). For this reason, the marine ichthyofauna of this large biogeographic unit
36 categorized as Ecologically or Biologically Significant Marine Areas - EBSA (CBD,
37 2014) has been studied by many authors (Dominguez et al., 2016; Kikuchi &
38 Schobbenhaus, 2002; Oliveira et al., 2011). However, most efforts focused on fishes
39 living near to the surface (0-200 m) and few studies described the mesopelagic zone
40 (200-1000 m depth) of this region, which is considered as one of the most understudied
41 of the world ocean (St. John et al., 2016).

42 The mesopelagic community is a key resource for higher trophic levels,
43 maintaining part of the marine biodiversity and playing an important role in carbon
44 sequestration and thus on the biological carbon pump (Proud et al, 2017; St. John et al.,
45 2016). To better account for the role of this community in the ecosystem structure and
46 function, a prerequisite is to have the necessary biological information. One of such key
47 basic knowledge concerns the length-weight relationships (LWR) that are one of the
48 requisites for fisheries management and conservation (Froese, 2006; Froese et al.,
49 2011). Indeed, LWRs are used to estimate body weight by length measurements, assess
50 the condition factor or well-being of species of interest, as well as for the calculation of
51 production and biomass of a fish stock (Froese, 2006). Despite this, information on
52 LWRs are still lacking for many deep-sea fishes. Here, we provide new LWRs for
53 eleven mesopelagic fish species collected along the northeast Brazilian oceanic islands,
54 in order to increase the biological data and general knowledge of these species.

55 MATERIAL AND METHODS

56 The study area comprises the northeast Brazilian oceanic islands, including
57 Rocas Atoll (3°52'S, 33°49'W), Fernando de Noronha Archipelago (3°50'S, 32°25'W)
58 and adjacent seamounts. Data were collected during the scientific survey ABRACOS
59 (Acoustics along the BRAzilian COaSt) conducted on board the RV *Antea*, from 9th
60 April to 6th May 2017. Mesopelagic sampling was conducted using a micronekton trawl
61 (side length of body mesh: 40 mm, side length of cod-end mesh: 10 mm) at 35 stations
62 from 0 to 1113 m depth. After capture, the material was fixed in a 4% formalin solution
63 for one month and then preserved in a 70% alcohol solution for proximally six months
64 before processing for length and weight. At the laboratory, species were identified,

65 measured (nearest 0.1 cm of standard length, SL) and weighed (nearest 0.01 g of total
66 weight, TW). All specimens were deposited in the Fish Collection of the Núcleo em
67 Ecologia e Desenvolvimento Socioambiental de Macaé (NPM), Universidade Federal
68 do Rio de Janeiro (NUPEM/UFRJ).

69 The parameters of the LWR were estimated through the equation: $TW = a \times SL^b$,
70 where TW is the total weight (g), SL is the standard length (cm), a is a constant being
71 the initial growth index and b is the slope of the regression. Prior to the calculation of
72 LWRs, the relationship plots were executed for visual inspection and removal of
73 outliers (Froese & Binohlan, 2000). The significance of the regression was tested by
74 ANOVA and the degree of association between TW and SL was calculated by the
75 determination coefficient (r^2). We only included LWRs for species with $n > 30$, except
76 for three species for which a wide fish-length range was available.

77 RESULTS

78 A total of 11 species belonging to five families and three orders were analysed
79 (Table 1). All regressions were highly significant ($P < 0.01$), with the coefficient of
80 determination (r^2) ranging from 0.9511 to 0.9862. The value of b varied between 2.66
81 for *Sternoptyx pseudobscura* and 3.22 for *Sigmops elongatus*, while the parameter a
82 ranged between 0.0012 for *Thysanactis dentex* and 0.0250 for *Ectreposebastes imus*.

83 DISCUSSION

84 This work provides the first LWR for six species: *S. pseudobscura*, *B.*
85 *pedaliota*, *S. elongatus*, *T. dentex*, *M. zugmayeri*, and *E. imus*. LWR information has
86 been previously available for *A. aculeatus*, *A. affinis*, *A. sladeni*, *S. diaphana*, and *M.*
87 *niger*, but it was based on a small length range, small sample size (<5) and/or without
88 the descriptive statistics of the relationships (Alpoim et al., 2002; Davison et al., 2015).
89 All species presented here but *A. aculeatus* and *M. niger*, have no LWRs available in
90 FishBase. In addition, the highest standard-length values for *Bonapartia pedaliota* and
91 *Ectreposebastes imus* are reported herein.

92 As established by Froese (2006), the allometric coefficients for all LWRs were
93 within the expected range of 2.5–3.5. These values are reflection of intrinsic
94 characteristics and process of adaptations of each species, as ontogenetic reproductive
95 or environmental variations, mainly between sexes (Froese, 2006). In addition, fixation

96 in alcohol and formaldehyde can affect length and weight measurements through the
97 shrinking and dehydration of specimens. For that reason, we recommend consider the
98 LWRs presented here as being tentative.

99 Overall, this study increases the knowledge on mesopelagic fishes, providing
100 basic biological information useful for further studies in ecology, conservation, and
101 fisheries assessment.

102 **ACKNOWLEDGEMENTS**

103 We acknowledge the French oceanographic fleet for funding the at-sea survey
104 ABRACOS (<http://dx.doi.org/10.17600/17004100>) and the officers and crew of the RV
105 *Antea* for their contribution to the success of the operations. The present study could not
106 have been done without the work of all participants from the BIOIMPACT (UFRPE)
107 and LIZ (UFRJ) laboratories. We thank the CNPq (Brazilian National Council for
108 Scientific and Technological Development) for providing student scholarship to LNE
109 and ASL, and research grant for TF and FLF. This work is a contribution to the LMI
110 TAPIOCA, CAPES/COFECUB program (88881.142689/2017-01), and PADDLE
111 project (funding by the European Union's Horizon 2020 research and innovation
112 programme - grant agreement No. 73427).

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167 Table 1. Descriptive statistics and parameters of LWRs for 12 deep-sea fishes caught using a micronekton trawl at the northeast Brazilian oceanic
 168 islands and seamounts, from 9th April to 6th May 2017. **SL** = Standard Length, **TW** = Total Weight, **a** = initial growth index, **b** =slope of the
 169 regression and **r²** = determination coefficient.

170

Taxa	n	SL (cm)		TW (g)		Regression parameters		r ²
		Min	Max	Min	Max	a	b (95% CL)	
Stomiiformes								
Gonostomatidae								
<i>Bonapartia pedaliota</i> Goode & Bean, 1896	85	3.7	7.5	0.4	2.7	0.0074 (0.0058-0.0094)	2.94 (2.80-3.08)	0.9571
<i>Sigmops elongatus</i> (Günther, 1878)	35	4.9	25	0.2	28	0.0015 (0.0009-0.0023)	3.229 (3.07-3.39)	0.9814
Sternoptychidae								
<i>Argyropelecus aculeatus</i> Valenciennes, 1850	49	3	8.2	0.8	20.9	0.0350 (0.0245-0.0496)	2.996 (2.77-3.21)	0.9529
<i>Argyropelecus affinis</i> Garman, 1899	260	2.8	7.8	0.31	6.09	0.0218 (0.0183-0.0258)	2.807 (2.70-3.91)	0.9511
<i>Argyropelecus sladeni</i> Regan, 1908	26	2	6.6	1.15	7.2	0.0425 (0.0257-0.0705)	2.703 (2.39- 3.01)	0.9618
<i>Sternoptyx diaphana</i> Hermann, 1781	600	1.2	4.3	0.1	4.3	0.0570 (0.0370-0.0770)	2.89 (2.79-2.99)	0.9275
<i>Sternoptyx pseudobscura</i> Baird, 1971	51	1.3	5.6	0.24	6.6	0.0754 (0.0582-0.0970)	2.663 (2.45-2.88)	0.9655
Stomiidae								
<i>Malacosteus niger</i> Ayres, 1848	33	6.3	18.1	1.5	34.4	0.0057 (0.0009-0.0030)	2.956 (2.74-3.17)	0.9635
<i>Thysanactis dentex</i> Regan & Trewavas, 1930	35	4.3	14.5	0.1	10.6	0.0012 (0.0009-0.0012)	3.197 (3.07-3.33)	0.9868
Gadiformes								
Melanonidae								
<i>Melanonus zugmayeri</i> Norman, 1930	20	6.4	19.1	1.06	32.31	0.0036 (0.0018-0.0071)	2.973 (2.68-3.26)	0.9623
Scorpaeniformes								
Setarchidae								
<i>Ectreposebastes imus</i> Garman, 1899	25	5.2	23.4	3.43	290.3	0.0250 (0.0138-0.0482)	3.025 (2.81-3.24)	0.9728