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Length–weight relationship for the data-poor deepwater fish, *Hoplostethus marisrubri* Kotlyar, 1986 from the Red Sea

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Abstract
Length–weight relationship (LWR) for the Red Sea roughy, *Hoplostethus marisrubri* Kotlyar, 1986 [Trachichthyiformes: Trachichthyidae], collected with a commercial shrimp trawler ($n = 136$) off Yanbu in the Red Sea at depths ranging between 662 and 667 m, is presented herein. *Hoplostethus marisrubri* can be distinguished by a combination of characters: dorsal-fin rays V–VI, 13; pectoral-fin rays 14–15; anal-fin rays II–III, 9; predorsal scales 19–20; distinctly enlarged lateral-line scales; and the dorsal fin without a black outer edge. In our study, a new maximum standard length of 130 mm was recorded. We estimated the length–weight relationship (LWR) parameters *a* and *b* for *H. marisrubi* as 0.033 and 3.17, respectively, which are new additions to FishBase. Based on the b value of the LWR, *H. marisrub*i has a positive allometric growth.

Keywords Fishbase · *Hoplostethus* · LWR · Range-restricted species · Red Sea roughy · Slimeheads · Trachichthyidae

1 Introduction

Fishes belonging to the Trachichthyiform family Trachichthyidae Bleeker, 1856, commonly called slimeheads or roughies, are distributed in the Atlantic, Indian, and Pacific Oceans [1]. These deep-bodied, medium-sized fishes are mostly mesobenthopelagic as adults [2], occurring near the bottom at depths ranging from 100 to 1000 m [3]. Globally, Trachichthyidae comprises 52 species in eight genera viz., *Aulotrachichthys* Fowler, 1938, *Gephyroberyx* Boulenger, 1902, *Hoplostethus* Cuvier, 1829, *Optivus* Whitley, 1947, *Paratrachichthys* Waite, 1899, *Parinoberyx* Kotlyar, 1984, *Sorosichthys* Whitley, 1945 and *Trachichthys* Shaw, 1799 [2]. In the Red Sea, Trachichthyidae is represented by a single species, the Red Sea roughy, *Hoplostethus marisrubri* Kotlyar, 1986. Originally described from the Red Sea, *H. marisrubri* is a range-restricted, data-poor deepwater fish, known only from the type locality (the Red Sea) and the Gulf of Aden [4–9].

The length–weight relationship (LWR) is a valuable tool in fish stock assessments, biomass estimates [10–12], the computation of condition indices, and the comparison of species growth trajectories across different populations and habitats [12].

Although LWRs have been calculated for various fish species [13], many other estimates still remain unavailable for many fish species, mainly deepwater fishes [12]. This technical contribution provides LWR for *H. marisrubri* based on 136 specimens from the Red Sea. The LWRs in fishes are affected by numerous factors, including sex, season, habitat, maturity, and locality [11, 14]. The sampled fish were not sexed and analyses were conducted without accounting

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for these factors. This work was aimed at calculating the LWR for non-sexed *H. marisrubri* and it is the first report of LWR from the Red Sea.

2 Materials and methods

On December 11, 2023, a deep-sea trawling survey (two hauls) was conducted with a commercial shrimp trawler off Yanbu, in the Red Sea. The first haul took place between 23°53.947′ N, 38°00.725′ E and 23°49.699′ N, 38°02.556′ E; and the second haul was between 23°52.018′ N, 38°01.616′ E and 23°54.535′ N, 37°59.575′ E, at depths ranging between 662 and 667 m (Fig. 1). *Hoplostethus marisrubri* was recorded in both hauls and was the most abundant species among the bycatches.

Species identification, terminology and methodology were based on Kotlyar [4], with genus and species classifications following Fricke et al. [15]. Voucher specimens were preserved in 10% formaldehyde and deposited in the zoological collections of Beacon Development-King Abdullah University of Science and Technology (BD-KAUST), Saudi Arabia.

Due to the species' slender and delicate caudal-fin structure, caudal-fin rays were partially or completely damaged during trawling, limiting size measurements primarily to standard length (*SL*). The standard length (distance from the tip of the snout to the base of the caudal fin) of each fish was measured to the nearest mm, and its total body weight (*W*) was recorded in g with an accuracy of 0.01 g. The LWR was calculated based on the linear regression analysis after Log transformation based on the formula [10, 16]:

$$W = a \times SL^{b}$$

In this non-linear relationship, *a* is the coefficient for the ratio between *W* and *SL*, and *b* is the exponent related to body form, indicating the rate at which a fish's body mass (*W*) increases as its size grows (*SL*). For easier comparison of the estimated value for parameter *a* with reported values for congeneric species in the literature, *SL* measurements were converted to cm prior to log transformation for linear regression analysis. Deviations from isometric growth—specifically, whether the estimated exponent *b* differed significantly from its hypothesized value of 3—were assessed by checking if the 95% confidence intervals for *b* included the value 3 [10, 17]. Isometric growth, where the exponent *b* equals 3, indicates that the fish's body weight increases proportionally to the cubic power of its length, meaning the fish maintains a constant body shape as it grows. A *b* value significantly different from 3 suggests allometric growth, where body weight increases disproportionately relative to length, or other changes in body form [11, 17].

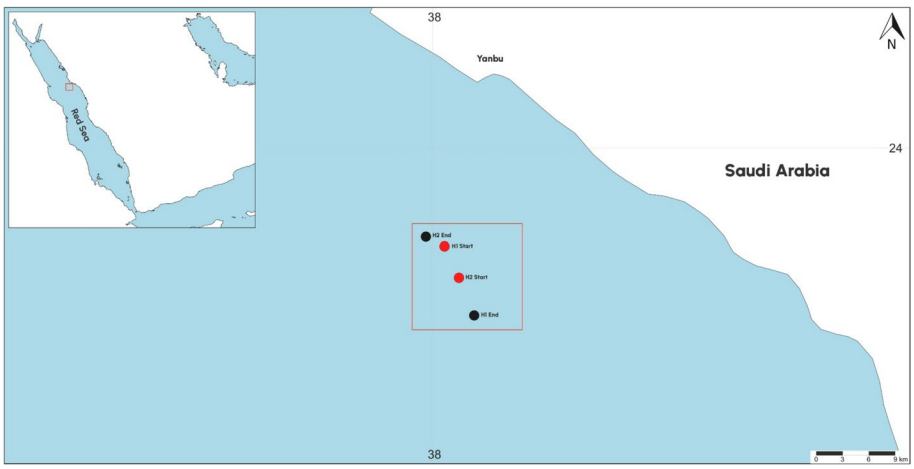


Fig. 1 Geographic location of the experimental survey hauls ($n = 2$) off Yanbu coast in the Red Sea, Saudi Arabia

3 Results

3.1 Taxonomic treatment

Trachichthyidae Bleeker, 1856
Hoplostethus Cuvier, 1829
***Hoplostethus marisrubri* Kotlyar, 1986**
(Fig. 2A–B)
Hoplostethus marisrubri Kotlyar, 1986: 123, Table 7, Fig. 11 [Red Sea].

3.2 Brief description

Body oblong, longer than deep, maximum body depth 44.4–47.8% of *SL*; head length 39.2–40.4% of *SL*; horizontal diameter of eye 11.5–12.1% of *SL*; dorsal-fin rays V–VI,13; pectoral-fin rays 14–15; anal-fin rays II–III,9; predorsal scales 19–20; pelvic fins reach anal-fin origin; pectoral fins extending to above middle of anal fin; abdominal scutes 10; lateral-line scales distinctly larger than adjacent body scales, 27–28; lower jaw slightly projecting; palatines with bands of cardiform teeth, vomer usually without teeth; light organs absent.

Colour of freshly collected specimens reddish dorsally; silvery with reddish tinge on side of body, silvery blue ventrally (Fig. 2A); jaws pinkish; head region and pectoral fins pinkish basally and translucent distally; dorsal fin without black border along the outer edge, spinous portion pale orange-red, soft portion translucent; caudal fin orange-tan; inner side of opercle and peritoneum black. Preserved specimens are yellowish brown; all fins are paler than body colour (Fig. 2B).

3.3 Taxonomic remarks

The circumglobal roughy fish genus *Hoplostethus* is the most diverse group within the family Trachichthyidae [18]. Among the congeners, *H. marisrubri* closely resembles *H. japonicus* Hilgendorf, 1879, *H. crassispinus* Kotlyar, 1980 and *H. gigas* McCulloch, 1914 in number of scales in the ventral keel [4, 19], and it resembles *H. melanopeza* Roberts and Gomon,

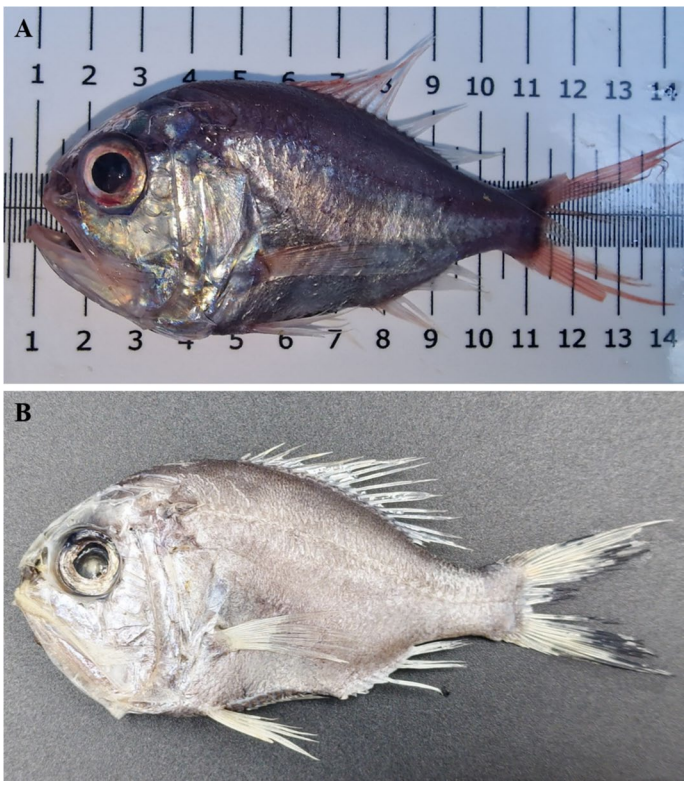


Fig. 2 *Hoplostethus marisrubri* Kotlyar, 1986 caught off Yanbu coast, Red Sea, Saudi Arabia. **A** freshly collected specimen, uncatalogued; **B** BD/KAUST-1223–006; 93 mm *SL*

Table 1 Summary statistics of standard length and total weight measurements for *Hoplostethus marisrubri* Kotlyar, 1986 from the Red Sea, along with length–weight relationship parameters (*a* and *b*)

n	Standard length (mm)					Total weight (g)					Length–weight relationship parameters		
	min	max	mean	SD	med	min	max	mean	SD	med	*a* (95% CI)	*b* (95% CI)	r^2
136	32	130	73.71	13.86	73.5	1.03	72.74	14.08	9.78	11.94	0.022 (0.018–0.027)	3.17 (3.08–3.29)	0.97

n: sample size, min: minimum, max: maximum, SD: standard deviation, med: median, CI: confidence intervals, r^2: coefficient of determination

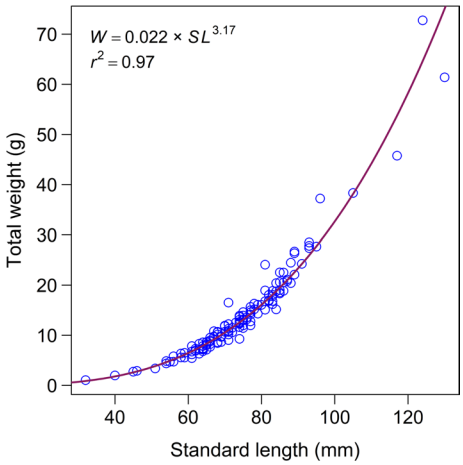


Fig. 3 Length–weight relationship for *Hoplostethus marisrubri* Kotlyar, 1986 from the Red Sea, Saudi Arabia

2012 and *H. mikhailini* Kotlyar, 1986 in pectoral-fin ray numbers [20]. The material examined in our study exhibited all characteristic features of *H. marisrubri* considered diagnostic by Kotlyar [4].

3.4 Length–weight relationship

The *H. marisrubri* specimens examined ($n = 136$) ranged from 32 to 130 mm *SL* and 1.03 to 72.74 g in *W*. The estimated *b* value of the LWR was 3.17, indicating positive allometric growth. The coefficient of determination (r^2) was 0.97, which suggests the LWR model is a good fit for the data (Table 1; Fig. 3).

4 Discussion

Hoplostethus marisrubri is known only from the type series ($n = 5$) collected from the Red Sea main basin and from a single specimen collected from the Gulf of Aqaba so far [4, 5]. Our study contributes to the knowledge of regional distributions of *H. marisrubri* in the Red Sea, and it includes additional specimens and data ranges.

Our study reports a new maximum *SL* (130 mm), surpassing the previously recorded 122 mm *SL* of the type specimens. This new slight increase in the maximum *SL* might represent geographical variations among conspecific populations. However, further research is required to draw any definite conclusions about the eco-phenotypic variations of *H. marisrubri* populations in the Red Sea.

Of the approximately 36 recognized species in the genus *Hoplostethus*, LWR estimates are available for only two so far: the Orange roughy, *H. atlanticus* Collett, 1889 ($a = 0.02239$; $b = 3.08$) and the Mediterranean slimehead, *H. mediterraneus* Cuvier, 1829 ($a = 0.01122$; $b = 3.14$) [13, 21]. Our study provided LWR parameters for *H. marisrubi* contributing to the limited data. In general, the LWRs for these three speces indicate the genus exhibit a positive allometric growth.

The LWR estimates reported in this study for this data-poor deepwater species are new additions to the FishBase. Although small fish are generally numerically dominant, their biomass is often overlooked when assessing assemblage indices [22]. The LWR estimates provided in our study will serve as baseline information for understanding the growth of *H. marisrubri* and for estimating their biomass.

5 Data and/or code availability

The authors confirm that the data supporting the findings of this study are available within the article.

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Authors' contribution G-B: methodology, investigation, data curation, formal analysis, writing-original draft; RGS: conceptualization, investigation; TKS: methodology, investigation; EMT: data validation, writing-review and editing; MD: funding acquisition, supervision and project administration. The manuscript has been read and approved by all named authors.

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Data availability The authors confirm that the data supporting the findings of this study are available within the article.

Declarations

Ethics approval and consent to participate Permission was obtained from the Ministry of Environment, Water and Agriculture, Saudi Arabia for conducting on-board observations. All *H. marisrubri* specimens were already dead when collected. *Hoplostethus marisrubri* is currently not listed as threatened according to the IUCN Red List of Threatened Species.

Not applicable.

Consent for publication Not applicable.

Competing interests All authors certify that they have no affiliations with or involvement in any organization or entity with any financial interest or non-financial interest in the subject matter or materials discussed in this manuscript.The authors declare no competing interests.

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