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Expansion of the Geographic Range of *Decapterus kurroides*: A New Record From the Egyptian Red Sea

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ABSTRACT

The continuous updating of geographic range expansion for non-native species and their characteristics is essential for conserving marine biodiversity and ecosystems. Members of the family Carangidae (commonly known as Jacks and Pompanos), which are critically important components of the Egyptian Red Sea fisheries, are primarily exploited by purse-seine fisheries, although a portion of the catch comes from trawling and hook-and-line fishing. This family comprises 39 genera and 152 species, with approximately 38 of these species found in the Red Sea. The genus *Decapterus* is represented in the Egyptian Red Sea by three species: *D. macrosoma* Bleeker, 1851, *D. macarellus* (Cuvier, 1833) and *D. russelli* (Rüppell, 1830). In January and April 2022, a total of 111 specimens of *D. kurroides* were identified for the first time in the carangid catch at Hurghada landing site. These specimens represent a new addition to the *Decapterus* genus in the Egyptian Red Sea. The fish ranged in total length from 22.4 to 33.5cm and in weight from 122.9 to 462.31g. The otolith shape is elongated and oval. These new findings increase the number of *Decapterus* species in the Egyptian Red Sea waters to four.

INRODUCTION

As a result of global warming, a primary driver of changes in marine ecosystems with a significant impact on biodiversity is the spread of non-native marine species (**Bonanno & Orlando-Bonaca, 2019**). Monitoring and tracking the geographic range and recording the characteristics of non-native species are important tools for conserving marine ecosystems and biodiversity. The Red Sea is narrow and elongated, extending over approximately 2,230km from the Gulf of Suez in the north to the Bab al-Mandab in the south. The Egyptian Red Sea coast spans about 980km and features diverse coastal and nearshore habitats, including coral reefs, lagoons, seagrass and algae beds, sandy bottoms, and mangroves (**Samy-Kamal *et al.*, 2011**). The winter sea surface temperature of the northern Red Sea is lower than that of the Indian Ocean. This temperature's difference is an important environmental factor that may influence the species present in each region, as well as their behavior and habitat preferences. (**DiBattista *et al.*, 2016; Shaltout, 2019; El Saman, 2022; Mehanna *et al.*, 2022; Osman & Samy-kamal 2023**).

Furthermore, marine ecosystems are affected by various anthropogenic impacts, including climate change, invasive species, and direct stressors such as pollution, construction, acidification, and overexploitation (**Costello *et al.*, 2010; Halpern *et al.*, 2015; Mehanna, 2024**). The information extracted from otoliths and other calcified structures is increasingly valuable for informing sustainable fisheries management and conserving marine biodiversity (**Bostanci *et al.*, 2015; Tuset *et al.*, 2018; Yedier *et al.*, 2019; Kontaş *et al.*, 2020; Yedier *et al.*, 2021; Osman *et al.*, 2022; Yedier *et al.*, 2022; Yedier *et al.*, 2023**).

The jacks and pompanos of the family Carangidae are a group of moderate to large fish species inhabiting tropical and temperate oceans worldwide. The family includes 152 species across 39 genera (**Fricke *et al.*, 2022a**). The genus *Decapterus* (Bleeker 1851) is distinguished by a single finlet behind both the second dorsal and anal fins. It lacks scutes on its lateral line and has two small papillae on the shoulder girdle. Additionally, it possesses a prominent adipose eyelid (**Gushiken, 1983**). Comprising 11 valid species (**Fricke *et al.*, 2022b**), *Decapterus* is distributed globally in tropical and warm temperate oceans.

Decapterus kurroides was previously described by Bleeker (1855) from Ambon (Maluku, Indonesia), based on a unique holotype (RMNH.PISC 26977). Its range extends across the Indo-West Pacific, from East Africa, Madagascar, and Réunion to the Philippines, north to southern Japan, and south to Western Australia. The species was first recorded in the Red Sea at the Gulf of Aqaba by **Kimura *et al.* (2013)** and by **Mehanna (2023, unpublished data)**. This paper contributes to the current knowledge of Red Sea ichthyofauna by reporting new observations of *D. kurroides* in the Red Sea and, for the first time, on the Egyptian Red Sea coast at Hurghada.

MATERIALS AND METHODS

1. Study area and sample collection

A total of 111 individuals of *Decapterus kurroides* (22.4-33.5 cm TL) were collected from Hurghada landing site during January and April 2022 (Fig. 1). In January, 39 samples were found in the catch. Later in April, a second group of fish appeared, from which 72 samples were collected. The majority of these fish were caught using purse seine nets. The specimens were weighed to the nearest gram for total weight (TW, g) and were measured to the nearest centimeter for total length (TL, cm). The pairs of otoliths were removed, cleaned, and stored dry for later age determination.

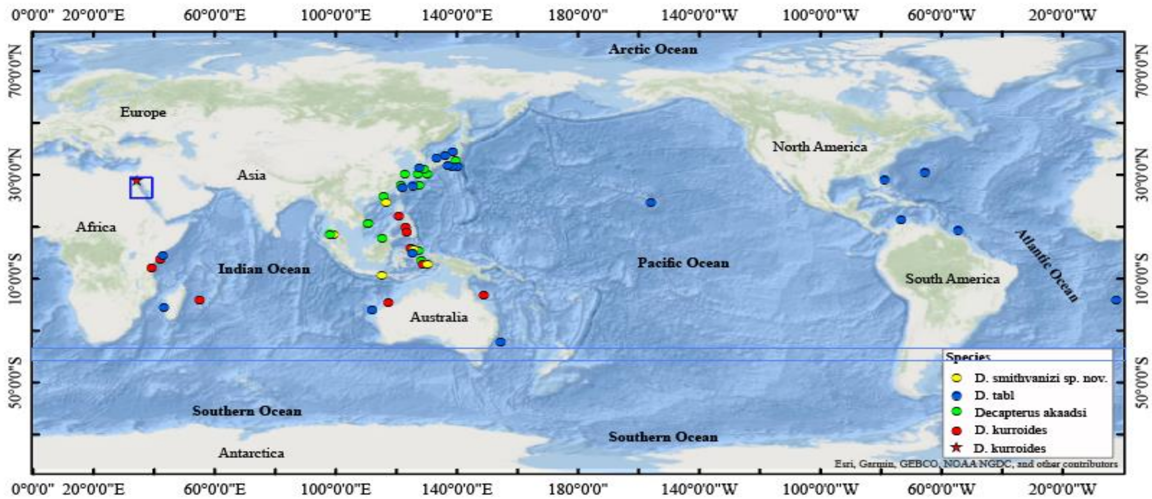

Fig. 1. Global and local distributional records of *D. kurroides* (red symbols). Stars specimens examined in Hurghada, and Circles bibliographic information

2. Morphological description

As it was not expected to find the species again, only the first group of 111 specimens that were collected were examined for morphological measurements and meristic counts; Morphological descriptive methods follow those of **Kimura *et al.* (2013)**. Fin-ray counts follow the method of **Fricke (1983)**. In this part, the standard length is abbreviated as SL mm. For morphological analysis, 20 commonly used taxonomic measurements (**Berinkey, 1966; Vlléger *et al.*, 2010; Petrtýl *et al.*, 2014**) were taken from the left side of each individual using a digital caliper; all data were recorded to the nearest 0.01 mm. The measured characteristics are provided in Table (1).

Table 1. Morphometric and meristic data and respective body proportions as a percentage of standard length (SL mm) of *Decapterus kurroides* caught off the Egyptian Red Sea coast

Meristic character	Number (count)
Dorsal-fin rays	VIII + I, 28–29
Anal-fin rays	II + I, 22–23
Pectoral-fin rays	20–22
Pelvic-fin rays	I, 5
Principal caudal-fin rays	18
lateral-line scales	54
Scales above the lateral line	11
Scales below the lateral line	17
Gill-rakers on the first arch	6+7
Gill-rakers on the upper arch	10-12
Gill-rakers on the lower arch	28- 31
Cycloid scales on the curved part of the lateral line	45- 51
Scutes on the posterior curved part of the lateral line	3- 4
Scutes on the straight part of the lateral line	31–33

Morphometric measurement	Min.- Max. (mm)	Average± SD (mm)	% of SL
Standard length	182.2-252.4	206.27±16.26	
Height of head	31.2-54.7	44.5±5.40	21.6
Pre-orbital distance	10.2-27.5	18.4±2.92	8.9
Post-orbital distance	15.7-32.1	23.5±3.01	11.4
Head length	46.0-80.0	61.3±6.85	29.7
Pre-pectoral length	50.1-87.7	68.0±7.20	33.0
Length of pectoral fin	29.5-72.0	52.9±8.21	25.7
Pre-pelvic distance	42.1-89.6	72.2±7.62	35.0
Length of pelvic fin	7.5-35.0	24.7±5.23	12.0
Pre-dorsal distance	65.1-97.8	79.8±7.42	38.7
Post-dorsal distance	22.0-147.1	121.4±45.85	58.9
Length of pre-dorsal fin	27.5-142.9	35.1±42.62	17.0
Length of post-dorsal fin	11.5-34.4	25.6±3.99	12.4
Pre-anal distance	110.1-167.9	141.4±11.33	68.6
Length of anal fin	12.8-27.8	20.6±3.27	10.0
Length of caudal Peduncle	4.0-22.9	15.9±6.01	7.7
Minimum body depth	4.8-11.0	8.9±1.15	4.3
Maximum body depth	46.4-67.9	56.2±4.72	27.2

SD, standard deviation; SL, standard length; Min, minimum; Max, maximum.

3. Length-weight relationship

All 111 samples (the 39 collected in January and the 72 collected in April) were used to analyze the length-weight relationship. The length (TL cm) - weight (W g) relationship was determined in the present study with power function and linear regression **(Le Cren, 1951; Froese, 2006)**:

$$W= aL^b$$

The parameters a and b were calculated by functional regression; the previous equation is transformed into a linear model by applying common logarithms to both sides and simplifying.

$$\text{Log } W = \log a + b*\text{Log } TL$$

Where:

W is the weight of fish in g, TL is the total length of fish in cm, a and b are constants. Fish total length (TL cm), fork length (FL cm), and standard length (SL cm) were investigated using linear regression analysis of TL = a + b * FL or SL (**Hossain, 2010**).

4. Otolith shape

The otolith shape of *D. kurroides* was imaged (20x, Stereomicroscopic 20V with camera Stereomicroscopic Erc5), where the otolith morphology includes (OL) otolith length (mm), (OH) otolith height (mm), (OSu) otolith sulcus (mm), (Oost) otolith ostium (mm), (OA) otolith area (mm^2), and (OP) otolith perimeter (mm). Otolith measurements were evaluated using ImageJ software. Paired t-tests were used to compare between the left and right otolith measurements.

RESULTS

1. Description

The body is slender, elongated, and compressed. The dorsal and ventral body profiles are slightly convex from the tip of the snout to the base of the caudal fin. The mouth is large and terminal; the posterior tip of the upper jaw is not hooked. The teeth in the jaws are minute; the upper jaw has two rows of teeth, while the lower jaw has a single row (Fig. 2). Scales are present on the head, except for the snout region, mandible, and antero-ventral part. The lateral line covers most of the body, starting below the second dorsal fin. It initially curves, then runs straight from below the second half of the dorsal fin to the base of the caudal fin. The straight part is shorter than the curved part. The lateral line is armed with ctenoid scales, and the posterior part contains scutes until the caudal fin.

The first dorsal fin is higher than the second. The two dorsal fins are widely separated; the first has 8 spines, and the second has 1 spine and 28 to 29 soft rays. A single finlet is present both dorsally and ventrally on the caudal peduncle. The pectoral fin has a pointed posterior tip, sometimes reaching beyond the origin of the second dorsal fin (Fig. 2). The caudal fin is forked and its base is covered with small scales (Fig. 2). Gill rakers are slender and covered with spinules on the inner surface. A small ctenoid is located above the anterior part of the lateral line (Fig. 2). Additionally, body scales of the specimens extend onto the head dorsally, forming a sideways "W-shaped" margin (Fig. 2).

The body color of *D. kurroides* is reddish, with a grey head and grey dorsal side, and a pale white to silvery ventrolateral side. However, fresh specimens were reddish with a black blotch located at the upper edge of the operculum. The distal margins of the dorsal, caudal, and pectoral fins, as well as the dorsal finlet are red with fine melanophores; the anal fin, pelvic fins, and ventral finlet are pinkish to white with fine melanophores (Fig. 2). The meristic data are illustrated in Table (1).

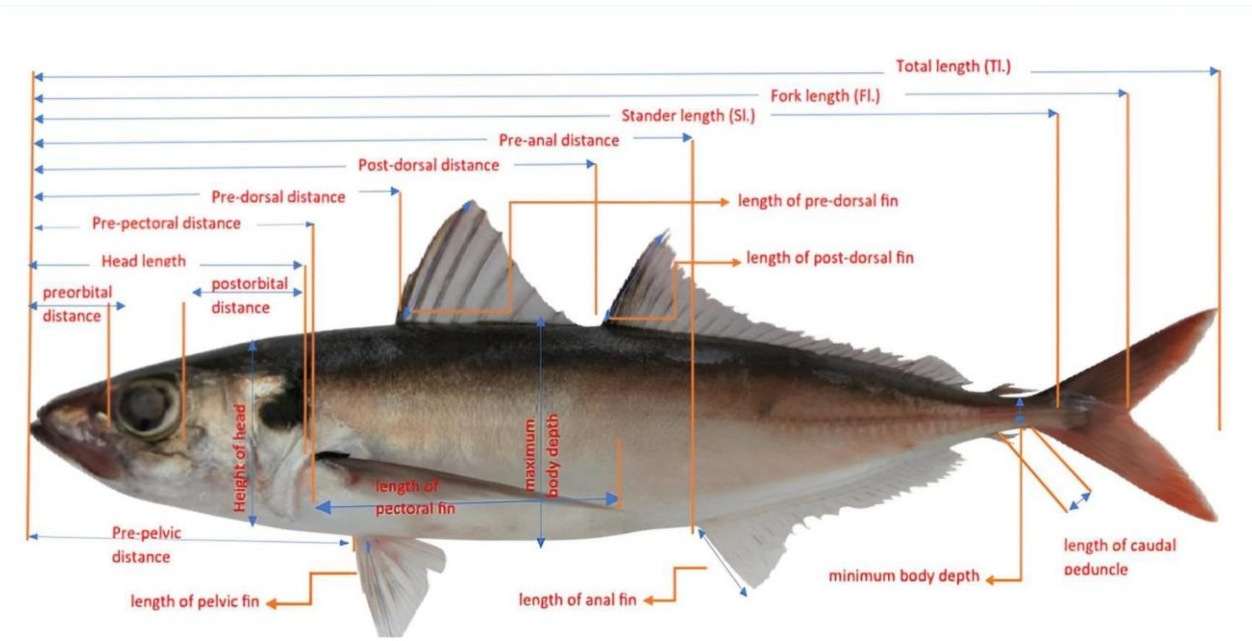

Fig. 2. *Decapterus kurroides* from the Egyptian Red Sea and fish morphological measurements

2. Length-weight relationship

The length-weight relationship parameters are given in Table (2). The fish weight ranged between 122.9 and 462.31g, with an average of 227.89 ± 91.22g (Table 2). The total length ranged from 22.4 to 33.5cm, with an average of 26.9 ± 3.3cm. The growth coefficient b value was 2.935 (95% CI: 2.860, 3.010), indicating an isometric growth type. For length-length relationships, the b values were 2.935 for log weight on log total length. The correlation between lengths was very strong and close to 1 (Table 2).

Table 2. Length-weight and length-length relationship of *D. kurroides* during the study period of 2022

Species	No.	Fish parameters measures			Regression parameters					
					a	b	P-value	95 % CI of a	95 % CI of b	R^2
D. kurroides	111	Min.- Max. Average± SD	122.9- 462.31 g 227.9± 91.22	$W=a*TL^b$	0.0107	2.935	---	0.005- 0.017	2.860- 3.010	0.98
		Min.- Max. Average± SD	20.6- 30.6 cm FL 24.6±2.9	TL=a+b*FL	-0.018	1.041	<0.05	-0.043- 0.008	1.022- 1.059	0.99
		Min.- Max. Average± SD	18.4- 28.3 cm SL 22.3±2.7	TL=a+b*SL	0.049	1.024	<0.05	0.002-0.094	0.991- 1.059	0.97
				FL=a+b*SL	0.061	0.986	<0.05	-0.028-0.094	0.961- 1.011	0.98

No, number; CI, Confidence intervals; Min, minimum; Max, maximum; SD, standard deviation

3. Otolith shape

Otolith shape was used only to identify the newly recorded species. The otolith was elongated and oval (Fig. 3); the dorsal margin was rounded, curved, and emarginate, while the ventral margin was lobed and tooth-like. The otolith sulcus area has an ostial shape. The ostium is elongated, and the cauda covers a large area of the otolith; the rostrum is very long and sharpened. Additionally, the box plot of the otolith measurements is shown in Fig. (4). A paired samples t-test was conducted to compare the left and right otolith morphology, revealing no significant differences between them (Table 3).

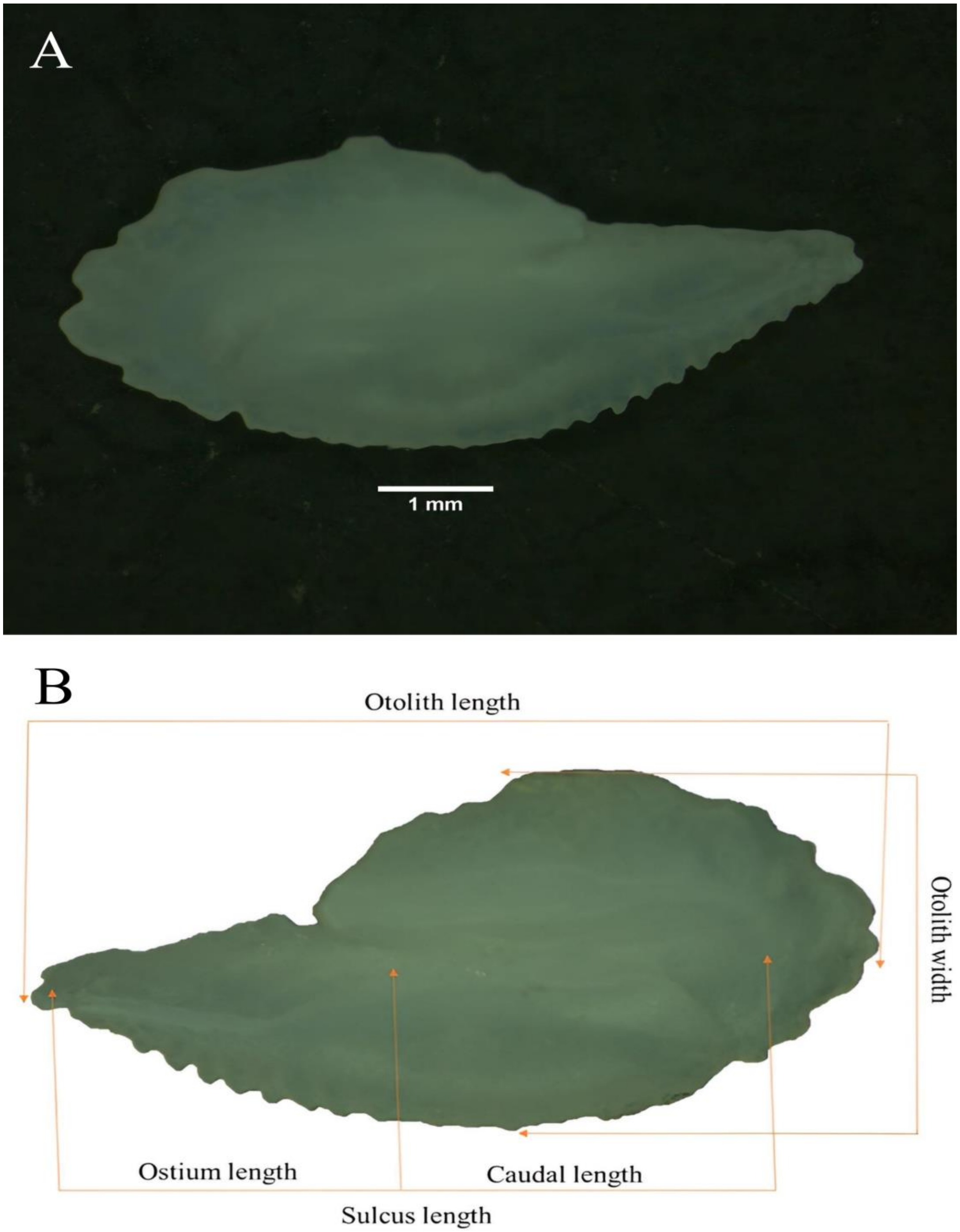

Fig. 3. Otolith view (A) and otolith morphological measurements (B) of *D. kurroides* from the Egyptian Red Sea

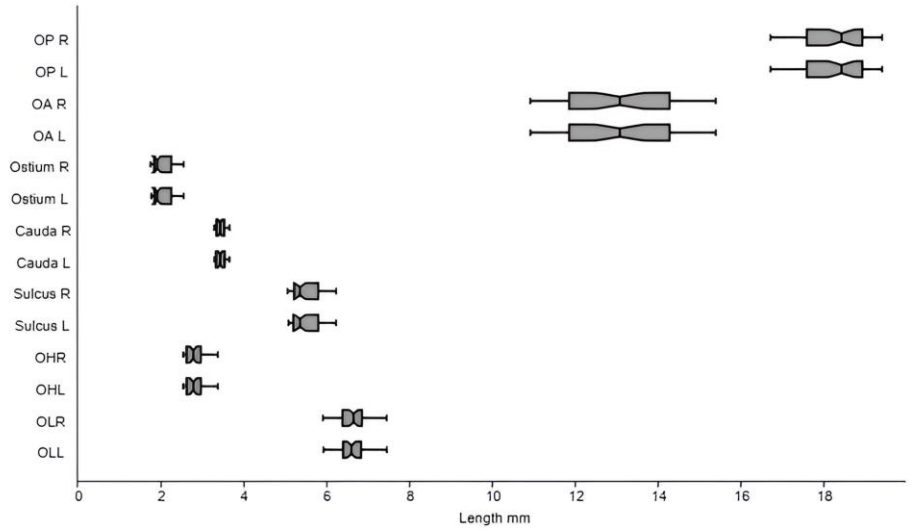

Fig. 4. Box plots of otolith measurements of *D. kurroides* from the Egyptian Red Sea

OLL, Otolith length left; OLR, Otolith length right; OHL, otolith high left; OHR, Otolith high right; Sulcus L, Otolith sulcus left; Sulcus R, Otolith sulcus right; Cauda L, Otolith cauda left; Cauda R, Otolith cauda right; Ostium L, Otolith ostium left; Ostium R, Otolith ostium right; OA L, Otolith area left; OA L, Otolith area right; OA L, Otolith perimeter left; OA L, Otolith perimeter right.

Table 3. Otolith measurements data and paired samples t-test of between left and right otolith of *D. kurroides*

Otolith parameter	Min.- Max. (mm)	Average± SD	Sig. (2-tailed)
OLL	5.950-7.474	6.660±0.448	0.652
OLR	5.937-7.47	6.663±0.452	
OHL	2.560-3.393	2.868±0.279	**0.041**
OHR	2.560-3.393	2.866±0.278	
Sulcus L	5.105-6.25	5.523±0.371	0.656
Sulcus R	5.082-6.251	5.524±0.37	
Cauda L	3.315-3.68	3.467±0.119	0.396
Cauda R	3.312-3.681	3.469±0.117	
Ostium L	1.790-2.57	2.056±0.254	0.523
Ostium R	1.770-2.57	2.055±0.256	
OA L	10.947-15.416	13.169±1.388	**0.032**
OA R	10.945-15.416	13.169±1.388	
OP L	16.740-19.433	18.295±0.77	0.306
OP R	16.739-19.433	18.285±0.765	

OLL, Otolith length left; OLR, Otolith length right; OHL, otolith high left; OHR, Otolith high right; Sulcus L, Otolith sulcus left; Sulcus R, Otolith sulcus right; Cauda L, Otolith cauda left; Cauda R, Otolith cauda right; Ostium L, Otolith ostium left; Ostium R, Otolith ostium right; OA L, Otolith area left; OA L, Otolith area right; OP L, Otolith perimeter left; OP L, Otolith perimeter right.

DISCUSSION

In the present study, specimens of *D. kurroides* were collected for the first time from the Egyptian Red Sea at the landing site of Hurghada. Most of the purse seine catches included sardines (Clupeidae) and jacks (Carangidae) **(Mehanna & El-Gammal, 2007; Mehanna, 2011; Osman *et al.*, 2021a, b)**.

The morphological characteristics of *Decapterus kurroides* distinguish it from other *Decapterus* species. Its caudal fin is red, and the first arch on the lower gill limb has 28-31 gill rakers. In comparison, the caudal fin of *D. russeli* is hyaline to dusky with a lower gill arch count of 32-39. The body color of *D. macrosoma* is bluish-green with a hyaline to dusky brown caudal fin. Additionally, the caudal fin of *D. macarellus* is yellow-green. Both *D. macrosoma* and *D. macarellus* are characterized by a lateral line with a straight part containing 14-36 scales (versus no scales). Moreover, the morphological measurements for *D. kurroides* differ from *Decapterus smithvanizi*, as the maximum length can reach 33 cm for *D. kurroides*, which is higher than *D. smithvanizi*. Furthermore, the body is deeper in *D. kurroides* than in *D. smithvanizi*.

Decapterus kurroides is widely distributed in different parts of the Indian Ocean. The preferred depth for the species is between 100 and 300 meters. Fish migration from the Indian Ocean to the Red Sea through Bab al-Mandab has increased in recent decades **(Collin *et al.*, 2022; Mehanna *et al.*, 2022)**. During the period from 2010 to 2019, the mean air temperature increased by 4.57 °C in Egypt, while the mean sea surface temperature increased by 2.21 °C (**Shaltout, 2019; El Saman, 2022**). Global warming and climate changes can affect multiple factors, including fish behavior such as migration to other areas or depths in search of suitable habitat (**Coll *et al.*, 2021; Corrales *et al.*, 2022; Arroyo *et al.*, 2022; Mehanna, 2025**).

In this study, the slope of LWR (*b*) for *D. kurroides* was estimated at 2.93, indicating a significant isometric growth pattern with equal growth of all body parts, also the b value for CI varied between 2.860- 3.010. These results differ from those recorded by previous studies (see Table 4**: Padilla *et al.*, 1991; Rumpet *et al.*, 1997; Wang *et al.*, 2011; Gumanao *et al.*, 2016; Palla *et al.*, 2018**). The observed differences might be attributed to seasonal, geographical, sample size, and environmental factors **(Froese, 2006; Tang *et al.*, 2018; Yedier *et al.*, 2020; Masoumi *et al.*, 2021; Bostancı *et al.*, 2022; Bouzidi *et al.*, 2022; Yedier, 2022; Yedier *et al.*, 2023)**.

Table 4. Length-weight relationship parameters of *D. kurroides* from different localities

Reference	Country	Locality	a	b	Length (cm)	r^2	n
Padilla et al. 1991	Philippines	Guimaras Strait, 1988-89	0.01000	3.110	---	---	---
Rumpet et al. 1997	Malaysia	Sarawak / 1997, 1998.	0.00670	3.194	TL	0.880	56
Wang et al. 2011	China	Beibu Gulf / 2006-2007	0.02500	2.850	13.3 - 35.8FL	0.984	150
Gumanao et al. 2016	Philippines	Davao Gulf / 2009-2012	0.01120	3.123	8.8 - 34.5SL	0.984	73
Palla et al. 2018	Philippines	Palawan / 1998-2014	0.05600	2.350	13.9 - 21.4TL	0.903	24
Present study	Egypt	Hurghada / 2022	0.0107	2.935	22.4- 33.5TL	0.98	111

The present study provides valuable information for fisheries management and conservation of this species. It also offers baseline data on length-weight and length-length relationships, which can support further biological research.

Otolith shape measurements are useful for studying variations within and between fish stocks and have been widely employed in recent species identification studies (**Libungan *et al.*, 2015; Yedier *et al.*, 2019; Osman *et al.*, 2020; Sadeghi *et al.*, 2020; Tuset *et al.*, 2020; Echreshavi *et al.*, 2021; Nazir & Khan, 2021; Tuset *et al.*, 2021; Yedier & Bostanci, 2021; Purrafee *et al.*, 2022**). The otolith morphology presented in this study aligns with findings from another previous research (**Manginsela *et al.*, 2020; Pranata *et al.*, 2022; Barnuevo *et al.*, 2023; Jawad *et al.*, 2023**).

D. kurroides has been recorded in various locations, including the South China Sea (**Kyushin *et al.*, 1982**), Taiwan (**Lin & Shao 1999**), Southern Korea (**Kim *et al.*, 2001**), Andaman Sea, Thailand (Kimura 2009), Madagascar (Frick et al. 2018), Southern Japan and Ryukyu Island **(Takahashi *et al*., 2018)**, Bangladesh (**Habib & Islam, 2020**), Makassar, Sulawesi, Indonesia (**Jimenez *et al.*, 2020**), and South Myanmar (**Psomadaskis *et al.*, 2020**). The current study extends its distribution to the Egyptian Red Sea waters (Fig. 1). *D. kurroides* is more widely distributed in the western Indian Ocean compared to *D. smithvanizi*, which is more prevalent in the Eastern Indian Ocean. This confirms the correct identification of the species in this study.

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