



Research Article

Addressing knowledge gaps in the biology of the Bengal corvina (*Daysciaena albida* Cuvier, 1830) from the Northeastern Arabian Sea

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Bengal corvina, *Daysciaena albida*, a commercially important species, has not been studied much from the Northeastern Arabian Sea. To address the knowledge gaps in the biology of this species, studies were conducted from April 2022 to December 2023. To estimate the biological parameters, 121 fish samples in the length range of 10.9 – 40.0 cm were analysed collected from landings by fishermen operating valloms. The results obtained showed that the fish showed negative isometric growth patterns with the growth exponents, 'b' values, of the female, male, and pooled data as 2.89, 2.87, and 2.90, respectively, which were also close to the optimum value of 3. Relative condition factor K_n fluctuated between 0.95 and 1.1, which suggest a state of wellbeing for the species. The GSI values among months were significantly different ($P < 0.01$), but between the sexes, there was no difference over the months. This study will help to fill the gaps in the biology of the Bengal corvina *Daysciaena albida* and will contribute to the management and conservation of the species.

[**Keywords:** *Daysciaena albida*, GSI, Kerala coast, Length weight relationship, Relative condition factor]

Introduction

The family Sciaenidae, also referred to as croakers, are extensively found in the coastal and estuarine seas of India, and are vital to the nation's marine fishing industry. With over 299 species in 69 genera, the Sciaenidae family is one of the largest families in the order Perciformes and is found all over the world¹. Few species are able to adapt to a wide variety of salinities and are primarily found in tropical and subtropical coastal waters as well as estuarine areas of the Atlantic, Indian, and Pacific Oceans. A considerable portion of the marine fish landings in India is contributed by sciaenids. They are the essential contributors to the fishermen's livelihood and are a significant source of revenue for coastal towns. In India, the Blackspotted croaker *Protonibea diacanthus*, silver croaker *Pennahia aneus*, and croaker species in the genus *Johnius* are the commercially important species. The western and eastern shores of India are home to the majority of these species, especially the states of Gujarat, Maharashtra, Andhra Pradesh, and Tamil Nadu.

The goal of fisheries management is to adopt a plan that satisfies society's need for food without depleting fish stocks. This involves addressing various issues,

including biological, social, and economic issues that affect fish stocks². Biometric studies that provide data on fish species for an estimated assessment of their biomass are crucial tools for research and management³. In biometric research, it is essential to ascertain the growth traits associated with fish weight and length⁴, as well as the impact of various biological and environmental variables on species. Understanding fish reproductive biology is also very crucial for improving commercial aquaculture production as well as managing fish populations^{5,6}. Reproduction of teleostean fishes is a seasonal phenomenon with a limited duration^{7,8}. Many studies have been conducted on the reproductive biology of sciaenids from the Indian coast⁹⁻²⁴. However, only a few reports are available on *Daysciaena albida*²⁴⁻²⁵ from Indian waters.

Fish weight (W) at a given length (L) can be estimated using the Length-Weight Relationships (LWRs), which is a formula that can be applied to studies on gonadal development, feeding rate, and maturity conditions²⁹. The importance of establishing fish LWRs has been emphasised in numerous studies³⁰⁻³². Biometric parameters such as Total Length (TL), Body Weight (BW), Hepatosomatic

Index (HSI), relative condition factor (K_n), and Gonadosomatic Index (GSI) are also essential to evaluate how the species uses its habitat. The morphological traits and life histories of population residing in different places can also be compared using this method; however, this relationship may vary with seasons³². The significance of the relative condition factor (K_n), which assesses an organism's deviation from the sample mean weight to ascertain if a certain environment is conducive to fish growth³³ was noted by Yılmaz *et al.*³⁴. Several studies have evaluated the importance of relative condition factor (K_n), Hepatosomatic Index (HSI) and Gonadosomatic Index (GSI) on several species³⁵.

Bengal corvina or two-beard croaker, *Daysciaena albida* (Cuvier, 1830), is an amphidromous benthopelagic fish that primarily inhabits brackish water bodies along the coasts of India, Sri Lanka, and Pakistan²⁵. This species can be found at depths between 10 and 75 meters²⁶. Seasonal migration has been observed in this species by the local fishermen in Chilika lake²⁷. *Daysciaena albida* is commercially important^{28,29} and is harvested for consumption using hand lines, gill nets, and bottom trawls²⁹. The fishery is not very large, but it is a highly valued commodity in the local market. Fishermen use gill nets operated *valloms* to regularly catch the fish off the coast of Cochin. *Daysciaena albida* accounted for a mere 54 t of the estimated 3231 t of croaker landings that were landed in Kerala in 2023 (CMFRI-NMFDC, 2024). The landings were highest during the premonsoon season. The length-weight relationship and feeding

behaviour of *D. albida* is investigated earlier from the Vembanad Lake²⁷ and Chilika Lake²⁸, Odisha. However, very little information is available on other aspects of this resource such as GSI, vaucity index. By generating knowledge on the biology and fishery of *D. albida*, a species located along India's southwest coast, this study seeks to address these knowledge gaps.

Materials and Methods

Sample collection

Fish samples were collected every week from Kalamukku fisheries harbour (09°59'924" N, 76°14'564" E) and Munambam fisheries harbour (10°10'965" N, 76°10'258" E) (Fig. 1) on the southwest coast of India, representing various length groups. The centres were chosen because the landings by *valloms* operating gill nets were more common in these areas. Once the fishes were collected, their body weight (g) and total length (cm) were measured.

Biological indices

Biometric indices used in the study were Total Length (TL), Body Weight (BW), Hepatosomatic Index (HSI), Gonadosomatic Index (GSI), and relative condition factor (K_n). These parameters also show the physiological state of the specimens based on fat accumulation^{28-33,41-46}, gonadal development, overall health, and environmental adaption.

Length-Weight Relationship (LWR)

Once the specimen was brought to the laboratory, the total length was measured as the distance from the

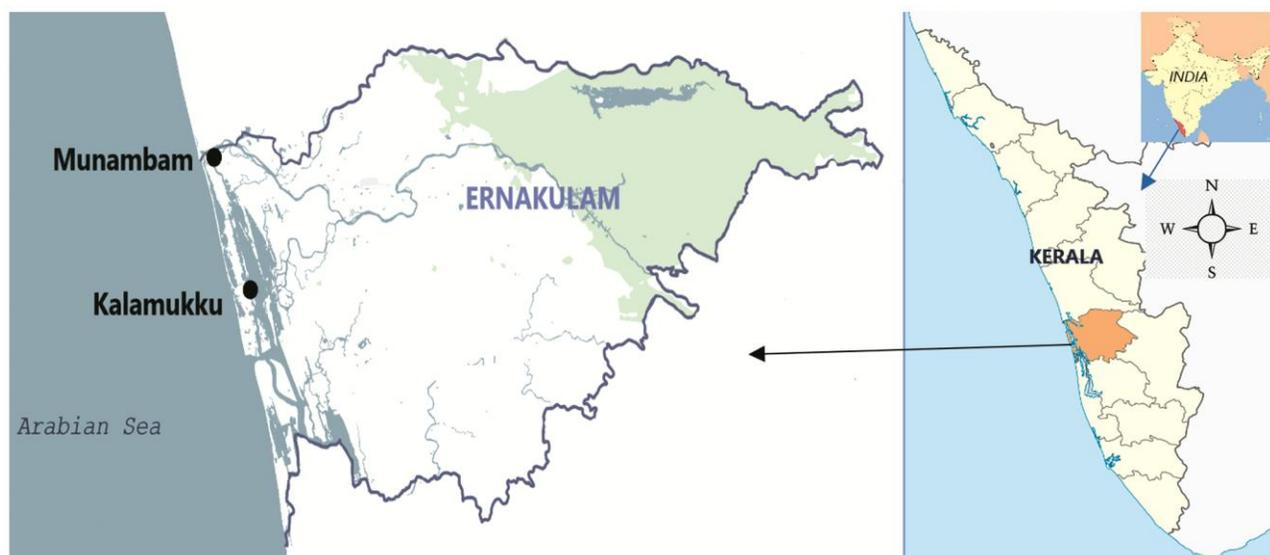


Fig. 1 — Map of the study area along the north eastern Arabian Sea (India)

tip of the snout to the distal end of the caudal fin (nearest cm) using a digital Vernier calliper, and total body weight was measured to the nearest gram using a digital weighing balance. The LWRs were estimated from the allometric formula $W = a L^{b(\text{refs. } 34,47-49)}$, where, 'W' is the total body weight (g), 'L' is the total length (cm), and 'a' and 'b' are the coefficients of the functional regression between W and L^(refs. 47,48).

The values of constants 'a' and 'b' were estimated by least-square linear regression from the log-transformed values of length and weight *i.e.* $\log W = \log a + b \log L$, with 'a' being the intercept on the length axis, and 'b' the slope or regression coefficient⁴⁹, which usually ranges from 2 to 4. Regression was performed using Excel software, and all calculations were performed for both sexes and combined.

Eq. (1) is log-transformed to obtain a linear relationship^{34,35}:

$$\text{Log}W = \text{Log}a + b\text{Log}L$$

The power of the relationship was calculated as the coefficient of determination (r^2). Differences in the slopes of the length-weight relationship between sexes were assessed using analysis of covariance (ANCOVA) at a 5 % significance level. Using Student's *t*-test at the 5 % level of significance, the slope value 'b' was compared to the isometric value of 3^(ref. 50). When the average log length is plotted against the log weight, a straight line is observed.

Relative condition factor (K_n)

The relative condition factor (K_n) is an index used to assess the well-being of a fish relative to the expected weight for its length. It is calculated by comparing the observed weight of a fish to the expected weight derived from a standard length-weight relationship. A K_n value of 1 indicates that the fish is in average condition, while values above or below 1 suggest better or poorer condition, respectively. It helps evaluate environmental influences, health, and nutritional status. This factor is commonly used in fisheries biology to monitor population health and habitat suitability. The formula used is

$$K_n = \frac{W}{aL^b}$$

Where, K_n = Relative condition factor, W is the observed weight of the fish, L is length of the fish and a , b are constants from the length-weight relationship

($W = aL^b$). A K_n value of 1 indicates the normal condition, > 1 indicates a better condition, and < 1 indicates a poorer condition. It is useful for evaluating fish health, feeding status, and environmental conditions.

Gonadosomatic Index (GSI)

Since the GSI is a reliable predictor of reproductive activity in fish, the frequency distribution of the gonadal maturity stages and the GSI are used to determine the spawning season. To compute the GSI (100 GW/BW), the Gonadal Weight (GW) was determined. The GSI is a measure of gonadal maturation, which increases during the ripe stage and then falls, particularly in females, following spawning. Fish with a single spawning episode typically have a higher GSI than those with multiple spawning; although during the late ripening stage, the GSI varies depending on the species' reproductive strategy.

Another index used to plot the spawning period was the Dobriyal index. It was calculated by the equation:

$DI = \sqrt[3]{GW}$, where, GW is gonadal weight¹¹. A plot of DI and the Modified Gonadosomatic Index (MGSI) was used to confirm the spawning period of the fish. In total, 121 individuals of *D. albida* were examined for the calculation.

Hepatosomatic Index (HSI)

Liver weight of the fish expressed as a percentage of its total body weight is called the hepatosomatic index. It can be used to determine the fish's overall health status and assess how a species uses the resources in its environment.

The HSI was calculated by using the following equation:

$$HSI = LW/BWT \times 100$$

Where, LW is the weight of the liver in grams, and BWT is the fish body weight in grams⁵⁰⁻⁵². In fish, the HSI can indicate metabolic health and energy reserves, which are important for subsistence fisheries.

Gut content analysis

Using a stereomicroscope, the contents of each fish's stomach were identified down to the lowest taxonomic level and counted^{53,54}. Two groups of stomachs *i.e.* the one with food (referred to as "full") and the other without food (referred to as "empty"), were used for feeding intensity studies. The stomach's

level of fullness or emptiness was assessed visually. The percentage of empty stomachs compared to stomachs containing prey items was used to measure the feeding intensity using the Vacuity Index (VI)⁵⁵.

Vacuity Index (VI) is estimated using the following equation:

$$VI = \text{Number of empty stomachs} / \text{Number of examined stomachs} \times 100$$

Fish were classified into five categories based on VI, which included $0 \leq VI \leq 20$ for edacious fish, $20 \leq VI \leq 40$ for somewhat edacious fish, $40 \leq VI \leq 60$ for moderate feeding, $60 \leq VI \leq 80$ for comparatively abstemious fish, and $80 \leq VI \leq 100$ for abstemious fish⁵⁶. The food items that were removed from the stomach and intestine were cleaned, identified, and placed into eight distinct taxonomic groupings. The Frequency of Occurrence (FO) numbers were utilised to verify that the preferences for every prey items were established. FO was calculated using following formulae⁵³:

$$FO = \text{Number of stomachs containing specific prey} / \text{Total number of full stomachs analysed} \times 100$$

If FO is < 10, then the prey is considered randomly ingested and not a preferred food item; if $10 < FO < 50$ then the food is considered second preferred item; and if $FO > 50$, then the prey item is considered a main preferred food of fish⁵⁶. Recording the presence or absence of each food item across all individuals is the simplest way to reveal the relative importance of different food items and to judge the dietary composition of a fish population.

Classification of maturity stages

Maturity stages were described in accordance with the classification offered by the International Council for the Exploration of the Sea⁵⁷. The following external characteristics were taken into consideration while classifying the gonads macroscopically *i.e.*, size, shape, colour, presence of blood vessels, and amount of space occupied in the body cavity. The gonadal phases were categorised as Stage I – Immature; Stage II – Early

developing; Stage III – Late developing; Stage IV – Maturing; Stage V – Mature; Stage VI – Ripe (Running), and Stage VII – Spent. The number of males and females in the different stages of gonadal development were counted and recorded. Using the stage-wise classification, spawning activity was noted.

Results and Discussion

Length-Weight Relationship (LWR)

A total of 120 individuals (67 females and 53 males) of *D. albida* (Fig. 2) in the length range 10.9 – 40.0 cm (mean 27.6 ± 5.84), and body weight in the range from 70 to 189 g (mean 246.6 ± 137.05) were used for this study. Table 1 lists the sample size (n), weight range, total length range, regression parameters *a* and *b*, and coefficient of determination (*r*²). Male total length varied from 13.0 to 38.4 cm (mean 26.63 ± 5.6), and body weight ranged from 22 to 506 g (mean 218.55 ± 115.5 g); while the female total length ranged from 10.9 to 40 cm (mean 28.47 ± 5.9), and body weight ranged from 13 to 698 g (mean 268.8 ± 149.1).

The LWR was determined separately for both sexes and pooled data with the indeterminate stages.

Males: $Log W = Log -10.69619 + 2.86 Log L$

Female: $Log W = Log -10.84862 + 2.89 Log L$

Pooled: $Log W = Log -10.84862 + 2.88 Log L$

The estimated *r*² values for the female, male, and pooled groups were 0.93, 0.94, and 0.92, respectively. These values are noteworthy since they are close to 1.



Fig. 2 — *Daysciaena albida*

Table 1 — Descriptive statistics on the total length (mm) and body weight (g) measurements of *Daysciaena albida* (Cuvier, 1830) in the north eastern Arabian Sea (India)

Sex	Length range		Weight range		<i>a</i>	<i>b</i>	<i>R</i> ²	Sample size
	Min	Max	Min	Max				
Males	130	384	22	506	2.2631E-05	2.860087	0.9444	53
Females	109	400	13	698	1.9431E-05	2.889716	0.933313	67
Pooled	109	400	13	698	2.0278E-05	2.881123	0.938699	121

The slopes, or *b* values, of the female, male, and pooled data were 2.90, 2.86, and 2.90, respectively, which were also close to the optimum value of 3^(refs. 58,59). A slope or *b* value less than or greater than 3 indicates allometric growth⁶⁰. Since the *b* values for this species were below 3.0, the growth of these fishes is said to be negatively allometric (Fig. 3). Studies on *D. albida* from Chilika lake, Kakinada^{28,61} (Table 2), have also shown negative allometry. Physiological factors, such as spawning and maturity, as well as hereditary body form, influence LWR variation among fish species³¹. The value of *b* can vary over

time signify the gonadal phases, general appetite, and stomach fullness. Diverse biotic variables might also cause variations in the growth process of the same species^{50,56} residing in disparate settings. The *b* value of the fish species vary from their typical range as a result of ecological changes⁶². When the exponent value of a species is 3, it means that the fish is growing isometrically and that the surrounding conditions are favourable for its maximum development. Growth of Bengal corvina, being amphidromous, is fluctuating due to the varying conditions in its habitat.

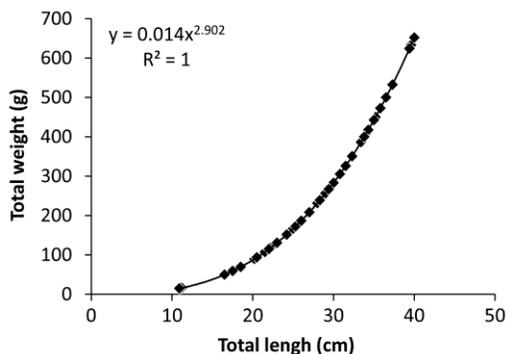
Table 2 — Comparative analysis of work done on sciaenids from India

Species	Study location	LWR	Reproductive biology	Other biological observations	References
<i>Otolithes cuvieri</i>	Mumbai coast	W = 0.000014L ^{3.12} (males), W = 0.000012L ^{3.15} (females)	Spawning season: April–June; Maturity size ~300 mm TL	Carnivorous; feeds on small fish and crustaceans; important in trawl fishery	Raje & Joshi (2002)
<i>Otolithes cuvieri</i>	Veraval coast (Gujarat)	<i>b</i> = 3.10; Allometric growth observed	Peak spawning during May–July; multiple spawner	Inhabits coastal shelf; migratory behaviour noted	Zynudheen <i>et al.</i> (2004)
<i>Otolithes cuvieri</i>	Kakinada coast (Andhra Pradesh)	W = 0.000013L ^{3.11} (combined sexes)	Spawning observed in pre-monsoon; GSI peak in May	Bottom-dwelling predator; abundant in muddy habitats	Murty (1980)
<i>Otolithes cuvieri</i>	Cochin coast (Kerala)	<i>b</i> = 3.09 (combined sexes); <i>r</i> ² = 0.97	Breeding peak during May–August; Maturity ~295 mm TL	Common in estuarine and marine catches; euryhaline species	Bineesh <i>et al.</i> (2011)
<i>Otolithes cuvieri</i>	Chennai coast (Tamil Nadu)	W = 0.000015L ^{3.08} (combined sexes)	Reproductive activity seen from April to July	Demersal carnivore; occupies shallow coastal waters	Radhakrishnan <i>et al.</i> (2009)
<i>Otolithes ruber</i>	Mumbai coast	W = 0.000007 L ^{3.14} (females), W = 0.000006 L ^{3.08} (males)	Spawning: March–June; maturity ~285 mm TL	Feeds on small fishes, prawns, crabs; nearshore species	Raje & Joshi (2002)
<i>Otolithes ruber</i>	Visakhapatnam coast (AP)	<i>b</i> = 3.17 (combined sexes); positive allometric growth	Spawning: August–October; high fecundity	Demersal fish, common in trawl catches	Murty (1980)
<i>Otolithes ruber</i>	Veraval coast (Gujarat)	W = 0.000009 L ^{3.05} (combined sexes)	Spawning: April–July; batch spawner	Hook-and-line dominant catch; benthic predator	Zynudheen <i>et al.</i> (2004)
<i>Otolithes ruber</i>	Chennai coast (TN)	<i>b</i> = 3.11 (combined sexes); <i>r</i> ² = 0.98	Spawning: April–July; peak GSI in June	Males mature earlier; coastal and estuarine habitats	Radhakrishnan <i>et al.</i> (2009)
<i>Otolithes ruber</i>	Cochin coast (Kerala)	W = 0.000008 L ^{3.12} (females), W = 0.000007 L ^{3.06} (males)	Maturity: 280–290 mm; breeding May–August	Important in estuarine fishery; euryhaline species	Bineesh <i>et al.</i> (2011)
<i>Otolithes ruber</i>	Cochin (Kerala)	Log W = -5.19+ 3.09 Log L (<i>r</i> ² = 0.986)	Length at first maturity was found to be 215 mm in females and 255 mm in males	Important in estuarine fishery	Sangeetha & Nair (2023)
<i>Pennahia macrophthalmus</i>	Hooghly-Matla estuarine system	<i>b</i> = 3.04 (combined sexes); W = aL ^b format	Spawning peak in monsoon (July–August); maturity ~130 mm	Bottom-dwelling; tolerates low salinity; important in estuarine fisheries	Das & Saha (1975)

(Contd.)

Table 2 — Comparative analysis of work done on sciaenids from India (Contd.)

Species	Study location	LWR	Reproductive biology	Other biological observations	References
<i>Pennahia macrophthalmus</i>	Kakinada coast (Andhra Pradesh)	$b = 3.02$ (combined sexes); $r^2 = 0.96$	Reproductive activity highest during May–August	Feeds on small benthic invertebrates and detritus	Murty (1980)
<i>Pennahia macrophthalmus</i>	Palk Bay and Gulf of Mannar	$b = 3.08$ (females), 3.00 (males); positive allometry	Spawning during June–September; maturity ~125 mm TL	Occurs in shallow muddy zones; commercial bycatch species	CMFRI Annual Report (2005–2006)
<i>Pennahia macrophthalmus</i>	Veraval coast (Gujarat)	$b = 3.01$; isometric growth	Gonad development indicates spawning in pre-monsoon	Low-value catch; locally consumed and dried	Zynudheen <i>et al.</i> (2004)
<i>Johnius dussumieri</i>	Mumbai coast (Maharashtra)	$W = 0.000011 L^{3.08}$ (combined sexes); $r^2 > 0.98$	Peak spawning: May–August; maturity size ~150 mm TL	Demersal feeder; diet includes benthic invertebrates and crustaceans	Raje & Joshi (2002)
<i>Johnius dussumieri</i>	Kakinada coast (AP)	$b = 3.05$ (combined sexes); near-isometric growth	GSI high during June–August; maturity at ~145 mm TL	Found in muddy coastal waters; shows seasonal migration	Murty (1980)
<i>Johnius dussumieri</i>	Veraval coast (Gujarat)	$W = 0.000010 L^{3.02}$ (combined sexes)	Spawning April–July; evidence of batch spawning	Part of mixed sciaenid trawl fishery; marketed fresh and dried	Zynudheen <i>et al.</i> (2004)
<i>Johnius dussumieri</i>	Cochin coast (Kerala)	$b = 3.07$ (females), 3.00 (males); slightly allometric growth	Reproductive peak in pre-monsoon (March–May)	Abundant in estuarine-marine interface zones	Bineesh <i>et al.</i> (2011)
<i>Protonibea diacanthus</i>	Gujarat coast (Veraval)	$b = 3.03$; allometric growth pattern	Peak spawning in May–July; multiple spawner	High-value species; lives near reefs and muddy bottoms	Zynudheen <i>et al.</i> (2004)
<i>Nibea maculata</i>	Cochin waters	$b = 3.11$; LWR indicates positive allometric growth	Maturity size ~200 mm; peak spawning July–Sept	Found in estuarine-marine interface zones	Bineesh <i>et al.</i> (2011)
<i>Johnius carutta</i>	Chennai coast	$b = 3.14$ (combined sexes); strong positive allometric growth	Spawning during April–June and Sept–Oct	High fecundity; demersal egg layer	Radhakrishnan <i>et al.</i> (2009)
<i>Johnius dussumieri</i>	Mumbai waters	$W = 0.000011 L^{3.08}$	Breeds during pre- and post-monsoon; maturity at ~150 mm TL	Bottom-dwelling, common in muddy substrates	Raje & Joshi (2002)
<i>Daysciaena albida</i>	Vembanad lake	*	High during April and June -September	Microphagous carnivore	Kurup & Samuel (1988)
<i>Daysciaena albida</i>	Vembanad lake	*	Spawning July -November	feeding intensity high	Kurup & Samuel (2011)
<i>Daysciaena albida</i>	Chilika lake	$b = 2.5$ to 3.5	Spawning: Pre monsoon	-	Karna & Panda (2014)
<i>Daysciaena albida</i>	Cochin backwaters, Kerala	$b = 2.8 - 2.9$	Spawning: July and August	Carnivorous	Present study (2025)

Fig. 3 — Length weight relationship of *D. Albida*

Relative condition factor (K_n)

During the period from June 2022 to June 2023, the relative condition factor varied between 1.02 and 1.12; however, the values were nearly 0.9 throughout the study period. A good growth condition of the fish is deduced when $K_n \geq 1$, while the organism is in poor growth condition compared to an average individual with the same length when $K_n < 1$. Monthly K_n values in the current study fluctuated between 0.95 and 1.1 as shown in Figure 4. These values suggest a state of well-being for the species. The present results match well with the observations of Murty¹⁵ for the *Johnius*

dussumieri and *Johnius carutta*, wherein low K_n values were associated with peak spawning periods. Lowest relative condition factor (K) values often occur during advanced gonadal development⁶³, suggesting a shift of energy reserves toward spawning. The values of condition factor also vary seasonally and are influenced by environmental conditions. Comparing the relative condition factor among populations in specific feeding areas can provide insights into factors such as food availability, population density, and climate. It also helps identify periods of gonadal maturation and monitor feeding activity to assess how effectively a species is utilising its food resources⁶⁴. The K -value reflects the physiological condition and overall well-being of the fish. From a nutritional perspective, it indicates fat accumulation and gonadal growth³⁵, while from a reproductive standpoint, some species exhibit peak K -values during specific stages of reproduction.

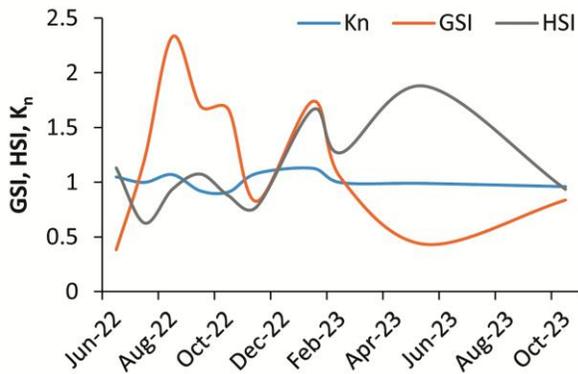


Fig. 4 — Monthly variations in GSI, HSI and condition factor of *D. Albida*

Gonadosomatic Index (GSI)

The maturity index, also known as the gonadosomatic index or relative weight of the gonad to fish weight, is a statistic that can be used to indirectly estimate a species' spawning season⁶⁵. The gonadosomatic indices of the fish are plotted sex-wise (Fig. 4). The GSI values among months were significantly different ($P < 0.01$), but between the sexes, there was no difference over the months. GSI values of *D. albida* fluctuated between a highest value of 2.33 in August 2022 and a lower value of 0.38 in June 2023. GSI values against the total length in male fishes are shown in Figure 5. GSI value of 2.15 was noted for male fish with a total length of 347 mm in October 2023. Mature male fish with ripe gonads were observed in October thus the peak GSI coincided with the mature stages. The male fishes with a total length greater than 280 mm showed higher GSI values. Plot of the GSI values against the total length in female fishes is shown in Figure 6. The highest GSI values for female fishes were recorded in July and August, tallying with the occurrence of mature specimens. The GSI values of female fishes were between 205 – 230 during the months of August – October 2022. The fishes with a total length of 280 mm or greater had GSI values of 3 or greater. The method of plotting GSI for calculating the spawning period is as per earlier works^{23,66}. A value of 1 indicates that the population is in a healthy condition. These results are similar to those from similar studies on *Otolithes ruber* from Dakshina Kannada⁶⁷; wherein GSI values were relatively high in both sexes during the spawning period. The condition factor of *P. heterolepis* was almost constant during the pre-

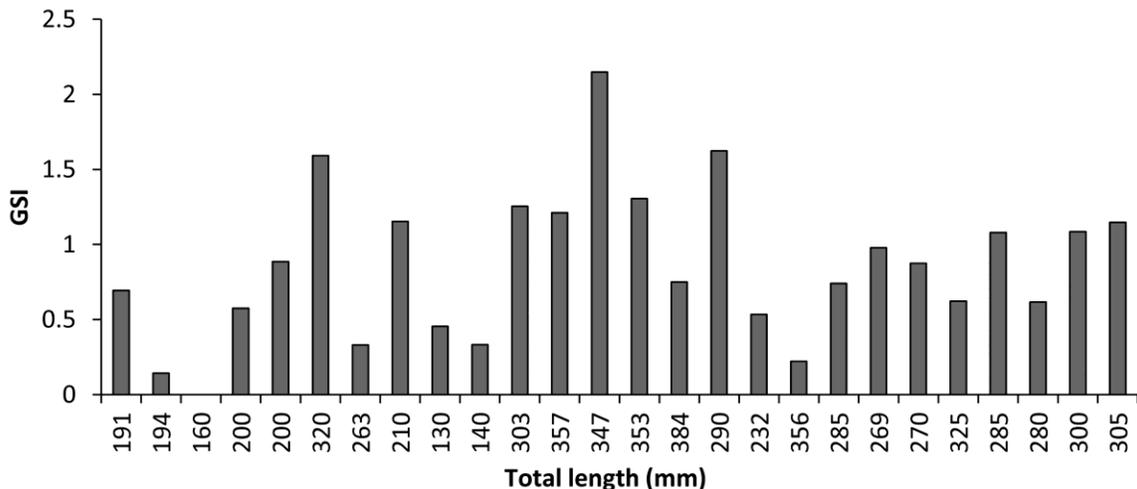


Fig. 5 — Plot of GSI v/s total length of male *D. albida* (2022 – 2023)

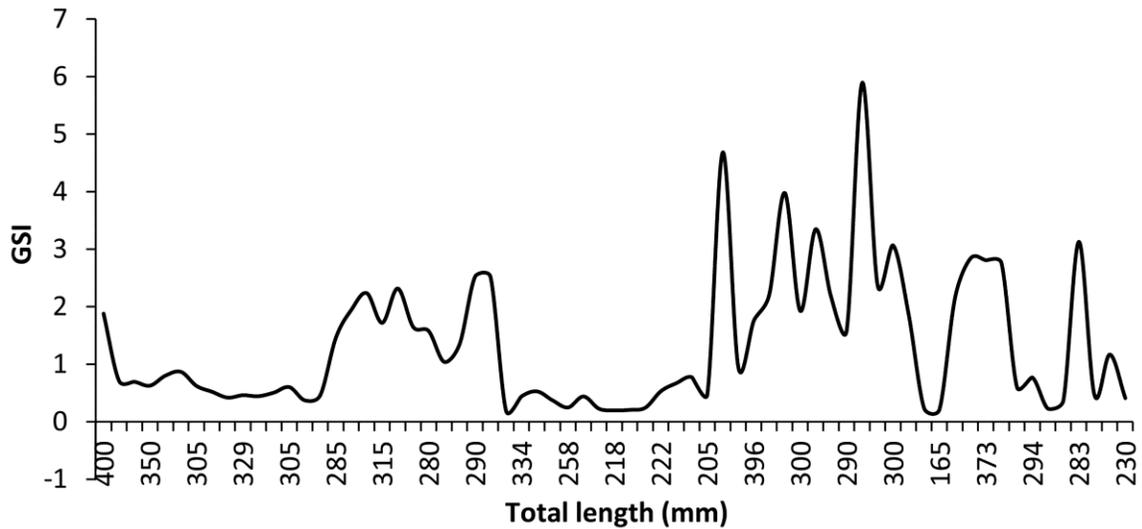


Fig. 6 — Plot of GSI v/s total length of female *D. albida* (2022 – 2023)

spawning period⁶⁸, it decreased during spawning, and was lowest during the peak-spawning period. When determining the days and seasons of spawning, the GSI is useful because, in gravid females, the ovaries enlarge rapidly just before the spawning, after gonadal maturity, and the GSI rises during the ripe stages before falling *i.e.* after spawning or spermiation, especially in females. Fish that spawn completely have higher GSIs than those that spawn numerous times, and the GSI in the late ripening stage varies depending on the species. The spawning season was determined by examining the relationship between the two metrics, as the gonadal maturity stage and GSI are both trustworthy markers of fish reproductive activity (Fig. 4). Due to the ease of computation, the GSI has been extensively utilised to assess reproductive time⁶⁹⁻⁷³ as simple and affordable methods for characterising fish maturity status in areas with limited access to histological observation facilities.

Hepatosomatic Index (HSI)

Hepatosomatic Index (HSI) of *D. albida* during 2022 – 2023 is shown in Figure 4. HSI values were high during the pre-spawning phase and low during the spawning phase (Fig. 4). The highest value of 1.88 was measured in May and June, which were the months with the lowest GSI values. This variation is due to the preparedness of the fish for spawning. Similarly, the lowest values of the HSI tallied with the highest values of the GSI, which represented the spawning months of the fish. Present observations are in concurrence to studies on greyfin croaker *Pennahia*

aneus in the northern South China Sea³⁶ which showed a high hepatic activity during November (preparatory period), while low hepatic activity was reported during the spawning season of March – April.

Dobriyal Index (DI)

Dobriyal Index and the mean GSI values was plotted to decipher the sexual maturity and to confirm the spawning period of the fish. The peak spawning period was found to be July – November. This period also coincided with the presence of ripe gonads in the fish samples collected (Fig. 7). Similar studies *Barilius barna* from the Garhwal Himalaya region⁷⁴ used analysis of GSI and DI to conclude the spawning season pointing the effectiveness of this index in marking the spawning season.

Gut content analysis

A stereomicroscope was used to identify the stomach contents of each fish to the lowest taxon possible. The quantity of identified prey that were found and the wet weight of the prey (which could be measured to within 0.1 g of accuracy) were used to quantify the contents of the stomach. The partially digested remnants of prey, which included fish heads, crab claws, and telson, were accounted as per methodology given by Mahesh *et al.*⁵³ and Pais⁵⁴. Gut contents when sorted number wise, occurrence wise and weight wise showed that prawn and crab were the most preferred items in the diet; and *Cynoglossus* sp., *Trypauchen vagina*, *Acetes* sp. and *Stolephorus* sp. were the randomly ingested food. These findings also agreed

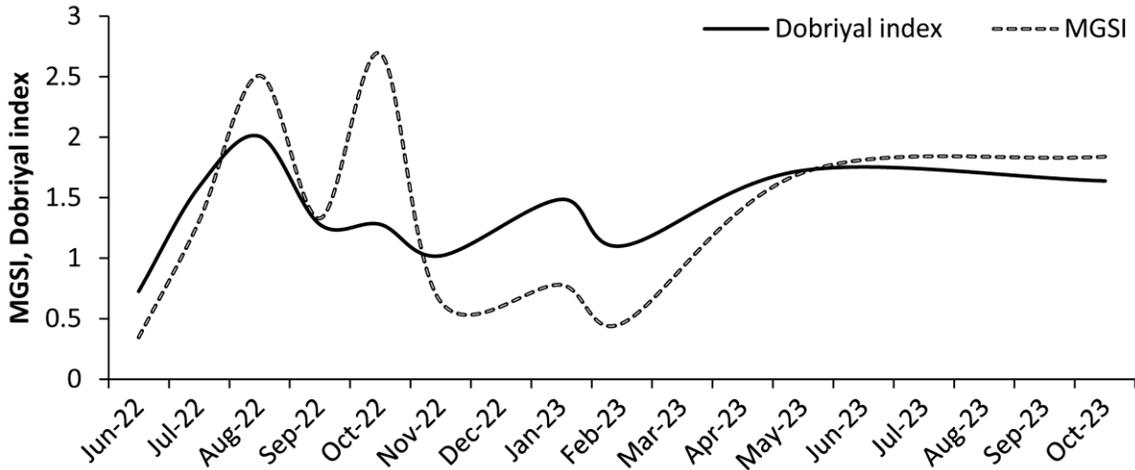


Fig. 7 — Variations in MGSi and Dobriyal index of *D. Albida*

with the observations by Kurup & Samuel⁷⁵ on *D. albida* from Vembanad waters. The feeding status was characterised through Vacuity Index (VI). According to the vacuity index plot, July to October had the highest number of empty stomachs, with a peak in July, indicating that turbid waters during the monsoon and river runoffs could have lead to decrease in prey items in the water column⁷⁶. Out of the 120 fish that were examined for gut content analysis, 87 fish had partially or semi-digested food in their intestines (Fig. 8).

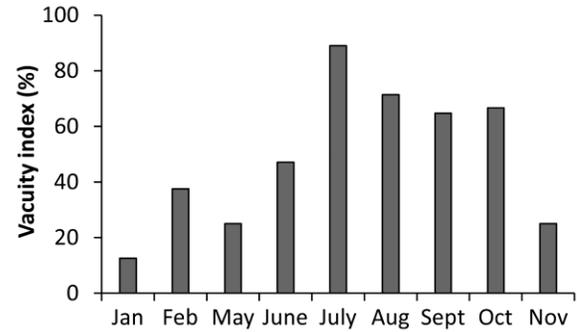


Fig. 8 — Monthly variations in vacuity index of *D. Albida*

Gonadal stages

The following maturity phases are distinguishable based on the size, form, and colour of the reproductive organs (ovary and testis).

Stage I - Immature: Ovaries are tiny, transparent, thread-like, delicate, milky white in hue. The ovaries only make up a tiny portion of the body cavity. The flagellate, slender testis occupies hardly one fourth of the body cavity.

Stage II - Early maturing phase: Ovaries are thicker, opaque, pale yellowish in colour, and significantly larger, taking up to 3/4 of the body cavity. In this stage, the ovary weighed more than it did in Stage I. The testes were rather translucent, slender, string-like, and grey in colour.

Stage III - Developing phase: The eggs are just barely visible, and the ovaries are enlarged and have a bright golden colour and take up 2/3 to 3/4 of the body cavity. There is an additional rise in their weight and volume. The testis are smooth, white, and enlarged at this stage. The blood capillaries become more noticeable as the vascular supply expands.

Stage IV - Mature or pre-spawning phase: The ovaries are more enlarged, occupying almost the entire body cavity. They are turgid, deep orangish yellow in colour, and a large number of spherical ova are visible to the naked eye through the thin ovarian wall and extend up to nearly the top of the body cavity. The blood supply increases considerably. Both translucent and opaque ova are present, and the ovaries reach their maximum weight. The fish becomes gravid due to ripe ova tucking inside, and the abdomen becomes bulged. The ova are not discharged until the environmental conditions become favourable. Histologically, a large number of ova were in stage VII, and ripe eggs were observed in the ovaries. The testis is enlarged, whitish, and smooth and extends to nearly the top of the body cavity.

Stage V - Spawning phase: The ovaries are very enlarged, occupying the entire body cavity. They are turgid and orangish red in colour with a large number of translucent eggs. The ovarian wall is very thin and almost transparent. At the beginning of this phase, the ova are extruded by applying gentle pressure on the

abdomen. The testis occupies most of the body cavity. It is milky white, slimy, smooth and highly fragile.

Stage VI - Spent phase: The ovaries are flaccid, shrunk, and reduced in volume and have a dull reddish orange colour. The blood vessels are prominent on the ovaries. Some unspawned large ova and a large number of small ova are present when grossly examined. The testis is shrunken, thin, slackened, and greyish in nature.

Conclusion

The current study on Bengal corvina (*Daysciaena albida*) from the northeastern Arabian Sea significantly contributes to filling existing knowledge gaps in its biology especially new insights into its morphometric relationships, reproductive biology, relative condition factors, vaucity index, dobriyal index and seasonal variations. This work lays a foundation for science based management of this commercially important species from the west coast of India. Understanding these biological parameters is essential not only for assessing the stock health and growth patterns of *D. albida* but also for establishing sustainable harvest strategies. The findings support informed decision making for regulating fishing pressure during critical reproductive periods, enhancing stock resilience. Ultimately, this research serves as a valuable reference for fisheries managers and conservation planners aiming to ensure the long-term sustainability and ecological security of Bengal corvina populations in Indian waters.

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Conflict of Interest

The authors have no competing interests. All authors of this manuscript agree for publication in *Indian Journal of Geo-Marine Sciences (IJMS)*.

Ethical Statement

No animals were killed for the work as sampling was done from commercial landings from the harbours.

Author Contributions

RJN: Design of the experiment, data collection, analysis and manuscript preparation, review and editing; ATS: Sampling, data analysis and methodology; KMV: Data analysis and methodology; SP & KTSS: Sampling, laboratory work; and EMA: Logistics. All authors significantly contributed to bring out this manuscript. All authors read and approved the final manuscript.

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