Indian J. Fish., 72 (3): 58-67, 2025
doi:10.21077/ijf.2025.72.3.165769-06
Available online at: epubs.icar.org.in/index.php/IJF

Feeding dynamics and reproductive biology of deep-bodied mojarra *Gerres erythrourus* (Bloch, 1791) along the Ratnagiri Coast, Maharashtra, India

Mahesh Shetkar*, Vivek Nirmale, Ravindra Pawar, Santosh Metar and Bhaskar Bhosale
College of Fisheries, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth,,Shirgaon, Ratnagiri - 415 629, Maharshtra, India

Abstract

Biology of the deep-bodied mojarra *Gerres erythrourus* landed along the Ratnagiri coast, Maharashtra was studied from 678 individuals sampled during September 2023 to July 2024. Total length (TL) ranged between 6.8 to 25.3 cm. The length-weight relationship showed positive allometric growth in males and females. All morphometric measurements showed a high degree of correlation with total length. Mean length at sexual maturity for females was estimated at 17 cm total length (TL). The study indicated that *G. erythrourus* spawned twice during an extended spawning season and had a moderate fecundity ranging from 64579 to 297040 eggs. Gut content analysis revealed *G. erythrourus* to be an omnivorus fish, feeding mainly on polychaetes, amphipods, gastropods, bivalves, shrimp juveniles and mysids. The index of relative importance (IRI) values indicated that bivalves are the major diet components. This is the first comprehensive biological study of *G. erythrourus* along the Indian coast.

*Correspondence e-mail:
maheshshetkar2000@gmail.com

Keywords:
Diet, Fecundity, Feeding intensity, Gerreidae, Spawning

Received : 08.03.2025
Accepted : 12.09.2025

Introduction

Family Gerreidae (Order: Perciformes) comprises of eight genera (*Deckertichthys, Diapterus, Eucinostomus, Eugerres, Gerres, Parequula, Pentaprion* and *Ulaema*) and approximately 54 species commonly known as mojarras, silver biddies or purse mouths (Gopi and Mishra, 2015; Nelson, 2016). Gerreids are extensively distributed in the Atlantic, Pacific, and Indian oceans (Cyrus and Blaber, 1982; Sarre *et al.*, 1997; Araujo *et al.*, 1999; Mishra *et al.*, 2018). Almost 16 species reportedly occur in the Western Indian Ocean (Fischer and Bianchi, 1984). Their distribution is mostly confined to shallow waters up to a depth of 40 m (Fischer and Bianchi, 1984; Woodland, 2001). Most species are known to inhabit sandy shallow tidal creeks, lagoons and coral reefs, while some are known to enter freshwaters (Cyrus and Blaber, 1982).

Members of the family Gerreidae are characterised by a highly protrusible mouth that can be extended as a tube into the substrate during feeding, and a sheath of scales along the bases of their median fins (Narasimhaiah *et al.*, 2020). Gerreids are exploited by beach seines, bottom trawls, long lines, cast nets, gillnets and traps (Cyrus and Blaber, 1984; Badrudeen and Pillai 1996; Sivshanthini *et al.,* 2008) by employing traditional crafts such as catamarans, plank-built boats and dugout canoes (Sivshanthini, 2008). They are consumed locally in fresh and dried forms (Kuganathan, 2006).

The deep bodied mojarra, *Gerres erythrourus* (Bloch, 1791) is distributed widely in the Indo-Pacific region and support fisheries significantly in many countries such as Bahrain, Fiji Islands, India, Kiribati, Malaysia, Mexico, Philippines, Qatar, Saudi Arabia, Sri Lanka, United Arab Emirates and United States of America (Beevi, 1998; Froese and Pauly, 2000). About nine species of gerreids belonging to two genera., *Gerres* and *Pentaprion* have been reported along the Indian coast - *G. erythrourus, G. filamentosus, G. oyena, G. acinaces, G. lucidus, G. oblongus; G. poieti, G. rappi* and *P. longimanus* (Varsha *et al.*, 2017). *G. erythrourus* occurs along both the east and west coasts of India (Day, 1878; Munro, 1982; Talwar and Kacker, 1984; Varsha *et al.*, 2017). It is listed in the IUCN Red List as Least Concern (IUCN, 2023). The important species of gerreids found along the Ratnagiri coast are *G. filamentosus, G. macracanthus* and *G. erythrourus*.

Biological studies on different species of *Gerres* have been reported by several authors including Chacko (1949), Rao (1968), Kurup and Samuel (1987), Beevi (1998), Sivashanthini (2008), Abu El-Nasr (2016), Narasimhaiah *et al.* (2020) for *G. filamentosus*; Chacko (1949), Sivashanthini (2008) and Sivashanthini *et. al.* (2008) for *G. abbreviates*; Chacko (1949), Rao (1968), Lamtane *et al.* (2007), Kanak and Tachihara (2008a,b) and Putri *et al.* (2022) for *G. oyena*, Badrudeen and Pillai (1996) for *G. macracanthus*, Hosny and Al-Jaber (2017) for *G. longirostris* and Rao (1968) for *G. limbatus*. Very few studies on *G. erythrourus* including biological studies have been carried out around the world. No work on the biology of *G. erythrourus* in India has been reported so far. Information on biological parameters would help in sustainable exploitation of the species in the region, more so in the context of increasing importance and demand for this family due to a plethora of uses.

Materials and methods

A total of 678 individuals of *G. erythrourus* in a size-range of 6.8 to 25.3 cm TL were collected from three locations *viz*. Mirkarwada (16^{0}59'42" N; 73^{0}16'14"E), Shirgaon (17^{0}01'45"N; 73^{0}17'06"E) and Bhatye (16^{0}58'183"N; 73^{0}18'376"E) along the Ratnagiri coast (Fig. 1) from September 2023 to July 2024. The collected specimens were immediately placed in insulated ice boxes and transported to the laboratory for further analysis. The total length and body weight of all the fish were measured to the nearest 1 cm and 0.1 g, respectively. Length-weight relationship (LWR) was calculated as $W = aL^b$ (Le Cren, 1951) for both sexes. A t-test was employed to check whether estimated 'b' values differed significantly from the isometric value of 3 (Zar, 2005). Relative condition factor "Kn" was calculated as per Le Cren (1951).

The fish were dissected to identify the sex and classify the maturity stage. Month-wise homogeneity of sex ratio (1:1) was tested using χ^2 test. Gonads were carefully removed and weighed using an analytical balance to the nearest 1 mg and preserved in 5% neutral formalin for further study. Stomach content was analysed by occurrence, point (volumetric) and numerical methods (Hynes, 1950), and the food items were graded using the Index of Preponderance, IP (Natarajan and Jhingran, 1961) and the Index of Relative Importance, IRI (Pinkas *et al.*, 1971). The gastrosomatic index (GaSI) was determined for both sexes from the gonad weight and total weight of the fish using the equation: GaSI = (SW/BW) × 100, where SW and SW represent stomach weight and body weight, respectively (Biswas, 1993). Gonadosomatic index (GSI) was estimated as per Bal and Rao (1984) using gonad weight and stomach weight. A six-stage maturity scale (immature, early maturing, maturing, matured, ripe and spent) was used to classify the gonads of females (Brown-Peterson *et al.*, 2011). The mean length at sexual maturity (Lm_{50}) was estimated as per King (1995). Absolute fecundity was estimated using the gravimetric method as described by Sinha (1995), based on a random selection of 43 ovaries. The development of ova was studied using ocular micrometer and frequency polygons of ova diameter in different stages of maturity were drawn.

Results

Length-weight relationship, condition factor and morphometrics

Length-weight relationship (LWR) of four groups *viz*, indeterminants, males, females and pooled individuals were calculated separately. Estimated parameters of the LWR including total length (TL) and body weight (BW), number of specimens (N), values of parameters 'a' and 'b' and the coefficient of determination (r^2) are given in Table 1. The estimated 'b' value indicated positive allometric growth in males, females, indeterminants and pooled individuals ($p<0.05$). The relative condition factor for pooled individuals showed an increasing trend from September to January (Fig. 2). The correlation coefficient (r) of total length against twenty other morphometric characters of *G. erythrourus* ranged from 0.807-0.994, showing a strong linear correlation between morphometric lengths and total length (Fig. 3; Table 2).

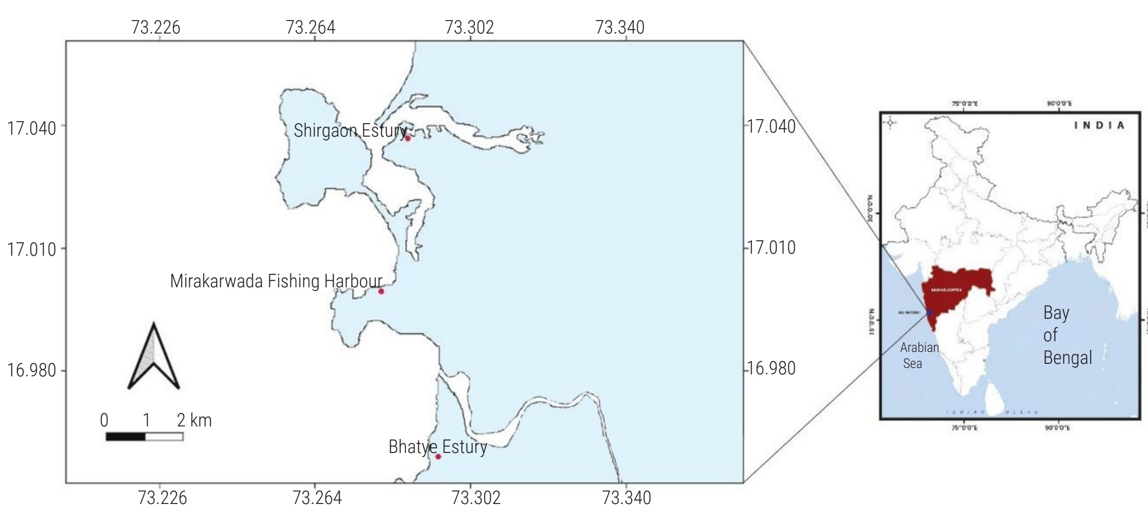

Fig. 1. Map depicting sampling locations of deep-bodied mojarra, *G. erythrourus* along the Ratnagiri Coast (Arabian Sea; central west coast) of India

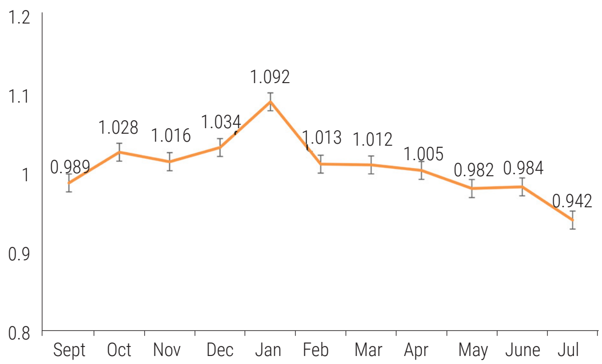

Fig. 2. Monthly variation in relative condition factor of *G. erythrourus*

Food and feeding biology

Analysis of stomach contents by the frequency of occurrence and the points (volumetric) methods and the Index of Preponderance indicated that gastropods, bivalves, polychaetes, amphipods, *Lingula* spp., mysids, and shrimp juveniles were the preferred food items of *G. eythrourus*; semi-digested matter was also notably present. The numerical method and the Index of Relative Importance identified the same items, with bivalves being the dominant group (Table 3).

Feeding intensity

Among the samples analysed, 28.91% had full stomachs, 43.44% had partially full stomachs and 27.66% had empty stomachs. The dynamics of stomach vacuity and fullness and gastro-somatic index (GaSI), based on seasons is depicted in Table 4. Maximum individuals of *G. erythrourus* with empty stomachs were recorded during post-monsoon season. Individuals with full stomachs were mostly observed during monsoon. Feeding intensity was higher in maturing and spent individuals, whereas lower feeding intensity was observed in spawners. The GaSI was recorded to be highest during February to July (post-spawning). Polychaetes, amphipods, gastropods, *Lingula* spp. and bivalves were noted in all size groups of fish. There was a notable shift in the consumption of shrimp juveniles and mysids. Adults consumed a higher percentage of shrimp juveniles (1.26%) compared to juveniles (0.25%), while the reverse was observed for mysids (Table 5).

Reproductive biology

In the present study, sex ratio (M:F) was found to be 1:0.87 ($\chi2$ = 0.433, p>0.05). The mean GSI values of both males and females reached their peak in February and gradually decreased in subsequent

Table 1. Length weight relationship of females, males, indeterminants and pooled individuals of *G. erythrourus* during September 2023 to July 2024

Group	N	TL range (cm)	BW range (g)	Regression parameters		
				a	b	r^2
Females	337	9.2 - 25.3	11.27 - 267.75	-1.8397	3.0655	0.978
Males	288	8.73 - 23.9	8.89 - 138.9	-1.837	3.0656	0.971
Indeterminants	53	6.8 - 15.9	5 - 62.92	-1.9841	3.1812	0.988
Pooled	678	6.8 -25.3	5 – 267.75	-1.8848	3.1043	0.967

*N: Number of specimens, a: Intercept, b: Slope, r^2: Coefficient of determination

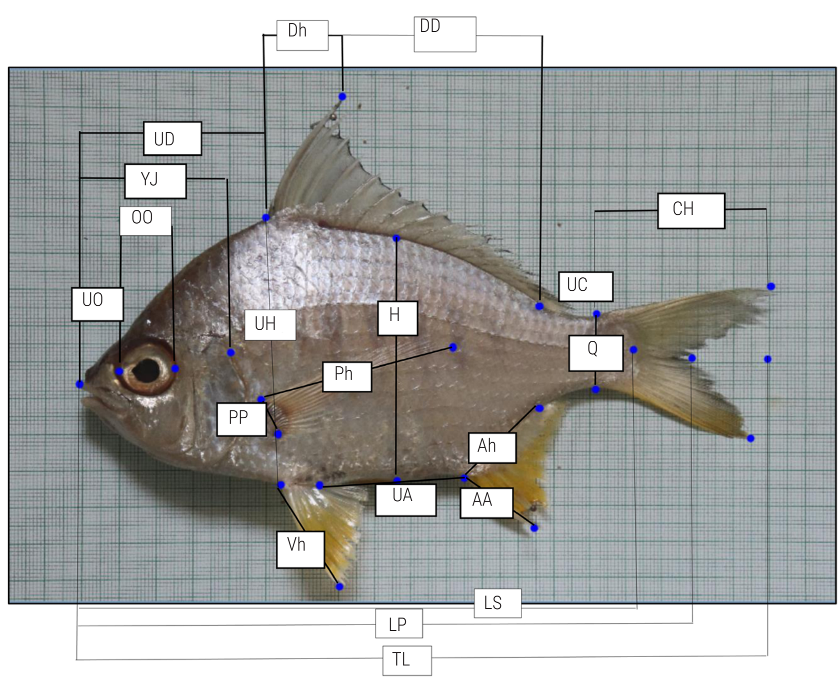

Fig. 3. Morphometric characters of *G. erythrourus*

Table 2. Regression values for various morphometric characteristics as function of TL

Sr. No.	Parameter	Times in TL	a	b	r
1	Fork length	1.143	0.422	0.845	0.994
2	Standard length	1.319	0.449	0.734	0.973
3	Head length	4.151	-7.258	0.730	0.985
4	Snout length	14.062	-0.065	0.077	0.807
5	Eye diameter	7.407	0.811	0.078	0.834
6	Body depth	3.198	-0.694	0.370	0.938
7	Dorsal base-Pelvic base	2.804	-0.509	0.396	0.959
8	Pre-dorsal length	2.984	-0.156	0.353	0.913
9	Pre-caudal length	6.346	-2.428	0.347	0.938
10	Pre-anal length	5.632	0.278	0.160	0.846
11	Pre- pelvic length	2.548	0.574	0.357	0.908
12	Dorsal height	5.742	-0.177	0.189	0.926
13	Dorsal base length	2.447	-0.623	0.449	0.980
14	Anal height	12.526	-1.029	0.164	0.941
15	Anal base length	6.823	-0.233	0.165	0.941
16	Pelvic height	6.261	-0.122	0.170	0.923
17	Pectoral height	3.607	-0.751	0.338	0.944
18	Pectoral base length	5.474	-1.997	0.334	0.940
19	Caudal height	4.029	1.167	0.166	0.926
20	Caudal peduncle	10.056	-0.005	0.101	0.963

*TL: Total length, a: Intercept, b: Slope, r: Correlation coefficient

months, whereas the lowest mean values were noticed in June (Table 6). Maturity stage I (immature) was noticed mostly during the months of October, December and June. Individuals in maturity stage II (early maturing) were noted during December to January. Individuals in maturity stage III (maturing) were observed during September to January while stage IV (matured) was more evident in September, October, March and April. Stage V (ripe) individuals were noted from September to February and stage VI (spent) from April to July (Fig. 4). The length at first maturity for females was estimated to be 17 cm TL (Fig. 5). Absolute fecundity ranged from 64579 to 297041 eggs per female. Ova diameter recorded at different stages of oocyte development are given in Table 7. In all maturity stages, the ova diameters progressed in a unimodal fashion barring the Stage V ovaries, which displayed two modes with modal values of 0.35 and 0.55 mm (Fig. 6).

Table 3. Food composition and dominance in *G. erythrourus*

Food items	% FO	% V	% N	%IP	%IRI
Shrimp juveniles	5.60	1.97	0.93	0.30	0.21
Mysids	8.31	4.05	3.12	0.91	0.78
Gastropods	47.46	23.43	26.14	30.16	30.93
Polychaetes	36.31	19.50	16.51	19.21	17.19
Amphipods	35.71	17.49	16.17	16.95	15.80
Lingula spp.	11.94	5.87	4.75	1.90	1.67
Bivalves	45.57	23.08	30.27	28.53	31.97
Semi digested matter	16.31	4.62	2.11	2.04	1.44

*FO: Frequency of occurrence, N: Numerical percentage, V: Points (volumetric) IP: Index of preponderance, IRI: Index of relative importance

Table 4. Seasonal and size-wise dynamics in feeding intensity of *G. erythrourus*

Month/ Seasons	N	Stomach vacuity and fullness			Gastro-somatic index	
		Empty-trace (%)	Part full (%)	Full (%)	Male	Female
Monsoon						
September	50	26.00	44.00	30.00	1.89	1.91
Post-monsoon						
October	61	36.07	52.46	11.48	1.81	1.98
November	64	32.81	46.88	20.31	1.93	2.03
December	100	40.00	33.00	27.00	1.49	2.08
January	78	35.90	47.44	16.00	1.40	2.11
Pre-monsoon						
February	69	35.71	35.71	28.57	1.41	1.35
March	61	29.51	55.74	14.75	1.39	1.92
April	67	32.84	44.78	22.39	1.68	2.27
May	52	28.85	42.31	28.85	1.78	2.39
Monsoon						
June	49	24.49	46.94	28.57	2.86	3.47
July	28	14.29	28.57	57.14	1.78	2.85
Juveniles	392	31.28	21.91	46.81	-	-
Adults	287	41.59	36.92	21.50	-	-

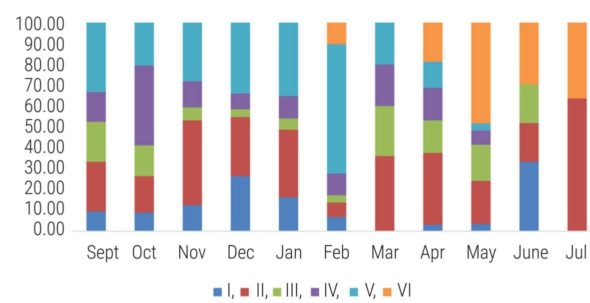

Fig. 4. Maturity studies of female *G. erythrourus*

Table 5. Size-wise percentage composition of food items of *G. erythrourus*

Food items	Size groups in TL (cm)	
	Juveniles (7- 17 cm)	Adults (< 17 cm)
Shrimp juveniles	0.25	1.26
Mysids	2.53	0.75
Gastropods	18.71	27.20
Polychaetes	16.31	18.26
Amphipods	16.12	20.06
Lingula spp.	4.50	5.05
Bivalves	28.80	31.42
Semi digested matter	3.28	5.50

Discussion

Length-weight relationship, condition factor and morphometrics

The length-weight relationship of *G. erythrourus* along Ratnagiri coast was determined to be $W = -1.8848L^{3.1043}$. The t-test was

Table 6. Seasonal dynamics of reproductive parameters in *G. erythrourus*

Month	Sex ratio				GSI		Spawning seasonality
	Male	Female	M: F	χ^2	Male	Female	Mature and ripe female (%)
September	13	21	0.62	0.941	2.33	2.16	47.62
October	24	33	0.73	0.711	1.43	2.03	58.82
November	26	33	0.79	0.415	1.82	1.71	40.63
December	42	53	0.79	0.637	1.02	2.04	41.51
January	38	37	1.03	0.007	1.92	2.08	45.95
February	32	37	0.86	0.181	3.34	3.11	72.41
March	29	25	1.16	0.148	1.51	2.28	40.00
April	32	33	0.97	0.008	0.96	1.56	28.13
May	21	29	0.72	0.640	0.92	1.16	10.34
June	18	27	0.67	0.900	0.55	0.67	0.00
July	14	11	1.27	0.180	0.75	0.8	0.00

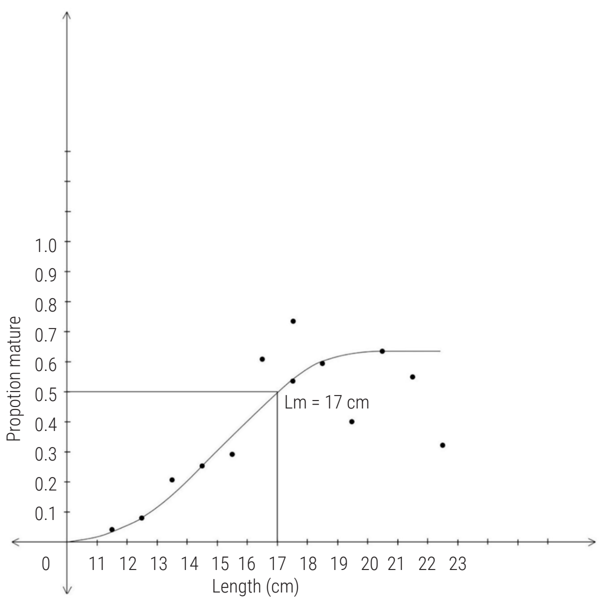

Fig. 5. Length at sexual maturity of *G. erythrourus* along the Ratnagiri coast

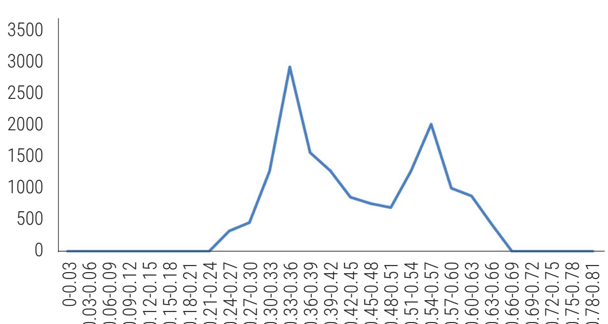

Fig. 6. Ova diameter trend in stage V (Ripe) of *G. erythrourus*

employed to test the deviation from isometric growth within the groups. According to Froese (2006), 'b' values for fish typically range between 2.5 and 3.5. In the present study, the estimated 'b' values were more than 3, indicating positive allometric growth in males, females, indeterminants, and pooled individuals ($p<0.05$). Most of the earlier studies on length-weight relationship in *Gerres* spp. have indicated negative allometric growth (Kurup and Samuel, 1987; Hussain *et al.*, 2010; Kamikawa *et al.*, 2015; Martin *et al.*, 2016; Abu El-Nasr, 2017; Narasimhaiah *et al.*, 2020) except Golikatte (2002); Renuka and Bhat (2011b) and Krishna *et al.* (2015) who reported isometric growth, similar to the findings reported by Sivashanthini (2008), Isa *et al.* (2012); Hashemi *et al.* (2012); Aziz *et al.* (2013) from Parangipettai waters (south-east coast of India), Peninsular Malaysia, Oman Sea and Kerala respectively (Table 8). Differences in 'b' values can result from geographic, ecological, physiological, environmental and biological factors (Wootton, 1998; Froese, 2006; Rakhunde *et al.*, 2023).

Morphometric traits of fish are crucial for taxonomic and evolutionary studies (Dwivedi and Menezes, 1974; King, 1995). In the present study, a strong correlation between various morphometric characteristics and total length was observed, agreeing with the findings of Abu El-Nasr (2016) for G. *filamentosus* from Hurghada Sea, Egypt. Morphometrics are commonly used in stock differentiation studies, as morphological variability among geographical populations is often linked to genetic differences and varying environmental conditions, with animals sharing similar morphometric measurements and typically considered part of the same stock (Mamuris *et al.*, 1998; Natarajan *et al.*, 2011). The present study found that the relative condition factor 'Kn' increased from September to February during spawning season and then declined. Narasimhaiah *et al*. (2020) studied 'Kn' for *G. filamentosus* from the Mangalore coast, and noted highest values in December and lowest in September. Comparatively higher values of condition factor (K) in females of *G. filamentosus* from Parangipettai waters and Azhikode Estuary were reported by Sivashanthini (2008) and Aziz *et al.*, (2013) respectively; higher values coincided with spawning season in both cases. Kurup and Samuel (1987) recorded peak 'K' values for *G. filamentosus* during August to October indicating spawning. Higher 'Kn' values observed in the present study too aligned with the spawning season. Condition factor is influenced by environment, feeding intensity, food type, fat or muscle development, breeding cycle, age, sex, and gonad development stage (Weatherly, 1979; Abowei, 2010; Pawase *et al.*, 2020).

Feeding biology

The present study revealed that *G. erythrourus* is an omnivorous fish feeding mostly on gastropods, bivalves polychaetes,

Table 7. Observations on ova diameter in *G. erythrourus*

Maturity stages	Avg. % of females in different stages	Ova diameter (mm)	No. of modes	Modal value (mm)
Stage I (Immature)	10.93	0.03-0.13	One	0.07
Stage II (Early maturing)	29.36	0.7-0.21	One	0.13
Stage III (Maturing)	11.64	0.15-0.34	One	0.23
Stage IV (Matured)	12.39	0.19-0.59	One	0.25
Stage V (Ripe)	22.65	0.27-0.64	Two	0.35, 0.55
Stage VI (Spent)	13.03	0.08-0.56	one	0.19

Table 8. Length-weight relationship of gerreids reported from different locations

Species	Sex	a	b	Region/Locality	Reference
G. filamentosus	Female	-1.2874	2.8381	Cochin coast, Kerala	Kurup and Samuel (1987)
	Male	-l.32244	2.8740		
	Indeterminates	-0.8167	2.2558		
	Female	-4.8405	3.0017	Sharavati Estuary, Karnataka	Golikatte (2002)
	Male	-5.1929	3.1657		
	Indeterminants	-4.5945	2.8220		
	Female	0.007	3.247	Parangipettai, South-east coast, India	Sivashanthini (2008)
	Male	0.007	3.264		
	Unsexed	0.008	3.203		
	Pooled	0.006	3.285		
	Unsexed	1.849	2.989	Pakistan, Arabian Sea	Hussain *et al.* (2010)
	Female	-1.728	2.883		
	Female	0.000069	3.0017	Central west coast of India	Renuka and Bhat (2011b)
	Male	0.000001	3.1657		
	Indeterminants	0.000039	2.8220		
	Unsexed	0.0086	3.2441	Peninsular Malaysia	Isa *et al.* (2012)
	Unsexed	0.0088	3.21	Iran, Oman Sea	Hashemi *et al.* (2012)
	Female	0.0341	3.7227	Azhikode Estuary, Kerala	Aziz *et al.* (2013)
	Male	0.0478	2.5868		
	Pooled	0.0330	2.7316		
	Unsexed	0.0050	3.130	Visakhapatnam, India.	Krishna *et al.* (2015)
	Unsexed	0.001	2.14	Bay of Bengal, India	Martin *et al.* (2016)
	Female	0.0146	2.9543	Egypt, Hurghada Sea	Abu El-Nasr (2017)
	Male	0.0143	2.9564		
	Pooled	0.0144	2.9597		
	Female	0.0146	2.9543		
	Female	-1.7716	2.9511	Mangalore coast, Karnataka	Narasimhaiah *et al.* (2020)
	Male	-1.7526	2.9364		
	Indeterminants	-1.8343	2.9720		
	Pooled	-1.8521	3.0165		
G. abbreviatus	Female	0.010	3.119	Parangipettai, South-east coast, India	Sivashanthini (2008)
	Male	0.011	3.095		
	Unsexed	0.012	3.037		
	Pooled	0.009	3.178		
G. oblongus	Female	0.015319	3.126119	Sri Lanka, Palk Bay	Sivashanthini and Adeyrami (2003)
	Male	0.01127	2.958295		
	Pooled	0.01135	3.095936		
G. acinaces	Unsexed	0.0826	2.59	Guam, Philippine Sea	Kamikawa *et al.* (2015)
G. erythrourus	Female	-1.8397	3.0655	Ratnagiri coast, Maharashtra	Present study
	Male	-1.837	3.0656		
	Indeterminants	-1.9841	3.1812		
	Pooled	-1.8848	3.1043		

amphipods, *Lingula* spp. and to some extent on shrimp juveniles and mysids. The IP and IRI indicated gastropods and bivalves as the dominant prey items. The results of feeding biology studied in different gerreid species by other workers are given in Table 9. The dietary composition of fishes is influenced by factors such as prey availability, habitat, ontogeny, prey energy content, size selection and seasonal shifts in prey composition (Cyrus and Blaber, 1983; Shalloof and Khalifa, 2009; Manon and Hossain, 2011; Hadj Taieb *et al.*, 2013).

Mysids were observed in juveniles of *G. erythrourus*, while adults were observed to have consumed shrimp juveniles. Polychaetes, amphipods, gastropods, bivalves, *Lingula* spp. and semi-digested matter were observed in both juveniles and adults throughout the study. Early-stage gerreids feed on planktonic copepods and diatoms, transitioning to bivalves, polychaetes and amphipods in later stages (Rao, 1968; Cyrus and Blaber, 1983). Food preference varies with prey size, availability, mouth size and life history traits (Garcia *et al.*, 2018; Batool and Siddiqui, 2020). The gastro-somatic index (GaSI) peaked from February to July, aligning with post-spawning recovery, with an inverse relationship observed between GaSI and GSI (Sarman *et al.*, 2018; Babu *et al.*, 2024). Higher feeding intensity has been recported in juveniles (7-17 cm) compared to adults (>17 cm), likely due to ontogenic changes (Chacko, 1949; Garrido *et al.*, 2008; Babu *et al.*, 2024).

Reproductive biology

The overall sex ratio (M: F) was 1:0.87, which indicated dominance of males agreeing with previous findings for *G. filamentous* (Kurup and Samuel, 1991) from the Kerala coast and *G. abbreviates* from Parangipettai waters (Sivshanthini, 2008). Dominance of females was reported in *G. filamentous* from Kerala coast (Beevi, 1998), *G. longirostris* along western Arabian Gulf (Hosny and Al-Jaber, 2017) and *G. oyena* (Lamtane *et al.*, 2007) along Bagamoyo coast, Tanzania. The variation in sex ratio could be due to the segregation or aggregation of sexes for feeding, breeding and pre-spawning migration of males (De Sylva, 1973).

The length at sexual maturity (L_{m50}) was determined to be 17 cm TL in the present study. The L_{m50} reported for *G. filamentous* ranged from 7.0-13.7 cm (Cyrus and Blaber, 1984; Kurup and Samuel, 1991; Beevi, 1998; Sivshanthini, 2008). The size at first maturity of *G. equulus* from Kyushu, Japan was reported to be 14.1 cm (Iqbal *et al.*, 2006) and the L_{m50} for males and females of *G. oyena* was found to be 13.5 and 14.1 cm respectively from the Gulf of Suez, Red Sea, Egypt (Osman *et al.*, 2020). Kanak and Tachihara (2008a) reported the L_{m50} for females and males of *G. oyena* from Okinawa Island of southern Japan to be 104 mm and 92 mm SL respectively. The differences in length at sexual maturity within and between species may be possibly due to the presence of distinct stocks, variation in growth rate, maximum size reached by different species under the influence of varying environmental conditions and food availability (Bandkar *et al.*, 2022; Pawase *et al.*, 2022).

The fecundity of *G. erythrourus* was noted to be higher than that reported for *G. setifer* and *G. filamentous* (Patnaik, 1971; Renuka and Bhat, 2011a) and lower than *G. oyena* (Kanak and Tachihara, 2008b). Fecundity varies from species to species and within species from one region to other in accordance to the reproductive potential of the stocks (Rakhunde *et al.*, 2023).

Based on maturity studies and GSI, *G. erythrourus* was found to have a prolonged spawning season extending from September to February along Ratnagiri coast. Sivashanthini (2008) recorded high GSI during October to July indicating the breeding period of *G. filamentosus* along the south-east coast of India. Two spawning seasons for *G. oyena* from March to May and July to September have been reported from Gulf of Suez, Egypt (Osman *et al.*, 2020). The spawning season of *G. filamentosus* from the Kerala coast was reported to be from October to February (Kurup and Samuel, 1991). Hosny and Al-Jaber (2017) noted that the spawning season of *G. longirostris* extends from May to June. Iqbal *et al.* (2006) reported

Table 9. Food and feeding habits of different gerreid species reported by other workers

Species	Food and feeding habits	Area of study	Author (s)
G. macracanthus	Polychaetes, prawns, amphipods, copepods, bivalves, diatoms	Palk Bay	Badrudeen and Pillai (1996)
G. oyena	Bivalves, amphipods, gastropods, polychaetes and organic detritus	Pulicat Lake	Rao (1968)
G. filamentosus	Amphipods, polychaetes, bivalves' detritus and decapod crustacea	Pulicat Lake	Rao (1968)
G. limbatus	Polychaetes, amphipods, bivalves	Pulicat Lake	Rao (1968)
G. oyena	Seaweeds (*Halimeda, Gelidium*)	Gulf of Mannar	Chacko (1949)
G. filamentosus	Molluscs (fragments of bivalve shell), worms (*Perinereius Polydora, Marphysa*) and seaweeds (*Sargassum, Halimeda*)	Gulf of Mannar	Chacko (1949)
G. abbreviatus	Molluscs (fragments of bivalve shell), worms (*Perinereius, Marphysa*) and seaweeds (*Halimeda*)	Gulf of Mannar	Chacko (1949)
G. oyena	Phytoplankton, zooplankton, zoobenthos, crustaceans	Karang Congkak Island	Putri (2022)
G. abbreviatus	Crustaceans, copepods, *Acetes* spp., amphipods and Polychaete worms	Madras Coast	Basheeruddin and Nayar (1962)
G. setifer	*Acetes* indicus, amphipods, copepods and other crustaceans	Madras Coast	Basheeruddin and Nayar (1962)
G. setifer	Crustaceans, molluscs, algae, detritus	Chilka Lake	Jhingran and Natarajan (1966)
G. filamentosus	Sponges, coelenterates, polychaetes, bivalves, gastropods, plant material and sand particles	Sharavati Estuary	Golikatte and Bhat (2011)
G. filamentosus	Digested matter, shrimp larvae, Polychaetes, mud and detritus crab instar, plankton and clam shells	Cochin, Kerala	Babu *et al.* (2024)
G. erythrourus	Polychaetes, bivalves, gastropods, amphipods, *Lingula* spp., shrimp juveniles and mysids	Ratnagiri coast, Maharashtra	Present study

that *G. equulus* from western Kyushu, Japan had a spawning season from June to September. The spawning season coinciding with higher GSI values noted in the present study agrees with the findings of Sivashanthini (2008), Kanak and Tachihara (2008b), Lamtane *et al.* (2007). The temporal difference in spawning season of *G. erythrourus* reported by different authors may be attributed to the spatial, environmental and stock level differences (Bandkar *et al.*, 2022). Size of the ova diameter ranged from 0.03 mm to 0.64 mm. Appearance of two modes in Stage V shows the possibility of *G. erythrourus* spawning two times in a spawning season along the Ratnagiri coast. The spawning of *G. filamentosus* was reported to be continuous or protracted in the Parangipettai waters (Sivshanthini, 2008). Kurup and Samuel (1991) noted multiple spawning of *G. filamentosus* in a season on the Kerala coast.

G. erythrourus is a moderately fecund species with a protracted spawning season. The reproductive biological data obtained in this study particularly on size at maturity, spawning seasonality, and fecundity provides important insights for the sustainable management of this species along the Ratnagiri. Size at first maturity can inform the establishment of minimum legal size to prevent the harvest of immature individuals. Knowledge of peak spawning periods supports the implementation of seasonal closures or spatial protections to safeguard the spawning stock of *G. erythrourus*. Additionally, fecundity estimates contribute to more robust stock assessment models, facilitating science-based harvest limits and long-term population monitoring. However, many crucial life-history traits (age and growth, lifespan and mortality) are still unknown and need investigation. Also, gonadal histology, which could not be performed in the present study, should be attempted in future for strongly supporting the macroscopic descriptions.

Acknowledgements

The authors extend their gratitude to the authorities of the College of Fisheries, Ratnagiri for providing the necessary facilities.

References

Abowei, J. F. N. 2010. The condition factor, length-weight relationship and abundance of *Ilisha africana* (Block, 1795) from Nigeria. *Adv. J. Food Sci. Technol*., 2(1): 6-11.

Abu El-Nasr, T. M. 2016. Morphological observations, length-weight relationships, and condition factors of the whipfin fish, *Gerres filamentosus* (Cuvier, 1829) in the Hurghada Red Sea, Egypt. *J. Biosci. Appl. Res*., 2(7): 458-469. https://doi.org/10.21608/jbaar.2016.108734.

Araujo, F. G., Santos, A. C. and De, A. 1999. Distribution and recruitment of mojarras in the continental margin of Sepetiba Bay, *Brazil. Bull. Mar. Sci*., 65 (2): 431-439.

Aziz, M., Ambily, V., and Bijoy Nandan, S. 2013. Age and growth of *Gerres filamentosus* (Cuvier, 1829) from Kodungallur, Azhikode estuary, Kerala. *Afr. J. Agric. Res.*, 8: 4007-4014.

Babu, G. S., Sajeevan, M. K., Suryawanshi, U., Anjanayappa, H. N., Somashekara, S. R., Naik, A. K., Nayana, P., and Pathan, J. G. K. 2024. Food and feeding habits of *Gerres filamentosus* in the Cochin backwaters. *J. Adv. Biol. Biotech.*. 27(6): 498-515. https://doi.org/10.9734/jabb/2024/v27i6910.

Badrudeen, M. and Pillai, P. K. 1996. Food and feeding habits of the big-eyed mojarra, *Gerres macracanthus* (Bleeker, 1854) of the Palk Bay and the Gulf of Mannar. *J. Mar. Biol. Ass. India*. 38(1&2): 58-62.

Bagenal, T. B. and Braum, E. 1978. Eggs and early life history. In: Bagenal, T. (Ed.), *Methods of assessment of fish production in Fresh waters*. *IBP Handbook*, pp. 165-201.

Bal, D. V. and Rao, K. V. 1984. *Marine fisheries*. Tata Mc Graw Hill Publishing Ltd., 233 p.

Bandkar D., Nirmale, V. H., Gurjar, U. R., Metar, S. Y., Pawar, R. A. and Chogale, N. D. 2022 Reproductive biology and feeding dynamics of the shrimp scad *Alepes djedaba* (Forsskal, 1775) from Ratnagiri, central west coast of India. *Indian J. Fish*.. 69(1): 37- 44. https://doi.org/10.21077/ijf.2022.69.1.109595-04.

Batool, T. and Siddiqui, G. 2020. The seasonal variation in diet composition and feeding strategyof *Grammoplites suppositus* (Troschel, 1840) (Family: Platycephalidae) in relation to its sex and size. *Indian J. Mar. Sci*., 49(12): 1848-1855.

Beevi, A. R. 1998. *Some aspects of reproductive biology of Gerres filamentosus (Cuvier,1829).* Ph.D. Thesis, ICAR-Central Institute of Fisheries Education, Mumbai, India

Biswas, S. P. 1993. *Manual of methods in fish biology*. South Asian Publishers. pp. 65-91.

Brown-Peterson, N. J., Wyanski, D. M., Saborido-Rey, F., Macewicz, B. J. and Lowerre-Barbieri, S. K. 2011. A standardized terminology for describing reproductive development in fishes. *Mar. Coast. Fish*.. 3: 52-70.

Chacko, P. I. 1949. Food and feeding habits of the fishes of the Gulf of Mannar. *Proc. Indian Acd. Sci*.. 29(3): 83-97.

Cyrus, D. P. and Blaber, S. J. M. 1982. Species identification, distribution and abundance of Gerreidae (Teleostei, Bleeker, 1859) in the estuaries of Natal. *South Afr. J. Zool.*, 17: 105-116. https://doi.org/10.1080/02541858.1982.11447789.

Cyrus, D. P. and Blaber, S. J. M. 1983. Diet of *Gerres* fry in the Kosi system. *South Afr. J Zool.,* 8: 403- 406.

Cyrus, D. P. and Blaber, S. J. M., 1984. The reproductive biology of *Gerres* spp. in Natal estuaries. *J. Fish Biol*., 24: 491-504.

Dwivedi, S. N. and Menezes, M. R. 1974. A note on the morphometry and ecology of *Brachirus orientalis* (Bloch and Schneider) in the estuaries of Goa. *Geobios*, 1: 80-83.

Fisher, W. and Bianchi G. 1984. *FAO species identification sheets for fishery purposes. Western Indian Ocean; (Fishing Area 51)*. Food and Agricultural Organisation of the United Nations, Rome, Italy.

Froese, R. 2006. Cube law, condition factor and weight length relationships: History, meta-analysis and recommendations. *J. Appl. Ichthyol.*, 22: 241-253. https://doi.org/10.1111/j.1439-0426.2006.00805.x.

Froese, R., and Pauly, D. 2023. *FishBase*. World Wide Web electronic publication. http://www.fishbase.org. (Accessed 22 December 2024).

Garcia, D. A. Z., Vidotto-Magnoni, A. P. and Orsi, M. L. 2018. Diet and feeding ecology of nonnative fishes in lentic and lotic freshwater habitats. *Aquatic Invasions*, 13: 565-573.

Garrido, S., Murta, A. G., Moreira, A., Ferreira, M. J. and Angelicon, M. M. 2008. Horse mackerel (*Trachurus trachurus*) stomach fullness off Portugal: index calibration and spatiotemporal variations in feeding intensity. *ICES J. Mar. Sci*., 65(9): 1662-166. https://doi.org/10.1093/icesjms/fsn169.

Golikatte, R. G. 2002. *Some biological aspects and fishery of the whipfin silverbiddy Gerres filamentosus (Cuvier, 1829) from Sharavati estuary, central west coast of India.* Ph. D. thesis, Karnataka University, Karwar, India.

Golikatte, R. G. and Bhat, U. G. 2011. Food and feeding habits of the whipfin silverbiddy *Gerres filamentosus* from Sharavati estuary, central west coast of India. *World J. Sci. Technol*., 1(2): 26-28.

Gopi, K. C. and Mishra, S. S. 2015. Diversity of marine fish of India. In: Venkataraman, K. and Sivaperuman, C. (Eds.), *Marine faunal diversity in India: Taxonomy, ecology and conservation*. Academic Press, Elsevier Inc., USA: pp. 171-193. https://doi.org/10.1016/B978-0-12-801948-1.00012-4.

Hadj Taieb, A., Sley, A., Ghorbel, M. and Jarboui, O. 2013. Feeding habits of *Sparusaurata* spp. (Sparidae) from the Gulf of Gabes (central Mediterranean). *Cah. Biol. Mar.*, 54: 263-270.

Hashemi, S. H., Salarpouri, A., Kiamrani, E., and Danehkar, A. 2012. Growth parameters and mortality rates of whipfin silverbiddy (*Gerres filamentosus*) and longtail silver-biddy (*Gerres longirostris*) from creeks of Hara protected area in Jask, Iran. *Iran. J. Fish. Sci*., 20: 139-150.

Hosny, C. F. H. and Al-Jaber, A. M. 2017. Reproductive biology of *Gerres longirostris*, Lacepede, 1801 (Perciformes: Gerreidae) in the western Arabian Gulf. *Indian J. Fish*., 64(2): 10-16.

Hussain, S. M., Paperno, R., Khatoon, Z. 2010. Length–weight relationships of fishes collected from the Korangi-Phitti Creek area (Indus delta, northern Arabian Sea). *J. Appl. Ichthyol*., 26: 477-480.https://doi.org/10.1111/j.1439-0426.2009.01374.x.

Hynes, H. B. N. 1950. The food of fresh-water sticklebacks (*Gasterosteus aculeatus* and *Pygosteus pungitius*), with a review of methods used in studies of the food of fishes. *J. Anim. Ecol*., 19(1): 36-58. https://doi.org/10.2307/1570.

Iqbal, K. M., Masuda, Y., Suzuki, H. and Shinomiya, A., 2006. Age and growth of the Japanese silver-biddy, *Gerres equulus*, in western Kyushu, Japan. *Fish. Res*., 77: 45-52. https://doi.org/10.1016/j.fishres.2005.10.001.

Isa, M. M., Abdul Basri, M. N., Mohd Zawawi, M. Z., Yahya, K. and Md Nor, S. A. 2012. Length-weight relationships of some important estuarine fish species from Merbok estuary, Kedah. *J. Nat. Sci. Res*., 2: 8-17.

IUCN 2023. *The IUCN Red List of Threatened Species*, Version 2023-2.

Jhingran, V. G. and Natarajan, A. V. 1966. Final report on the fisheries of the Chilka Lake (1957-65). *Bull. Cent. Inland Fish. Res. Inst.*, 8: 1-39.

Kamikawa, K. T., Cruz, E., Essington, T. E., Hospital, J., Brodziak, J. K. T. and Branch, T. A. 2015. Length weight relationships for 85 fish species from Guam. *J. Appl. Ichthyol*., 31: 1171-1174.

Kanak, M. K. and Tachihara, K. 2008a. Age and growth of *Gerres oyena* (Perciformes: Gerreidae) in Okinawa Island of Southern Japan. *Fish. Sci*., 72: 932-938.

Kanak, K. and Tachihara, K. 2008b. Reproductive biology of common silver biddy *Gerres oyena* in Okinawa Island of southern Japan. *Fish. Sci., 74*: 265-275.

King, M. 1995 *Fisheries biology: Assessment and management*. Fishing News Books Publ., Oxford, UK, 341 pp.

Krishna, N. M., Govindarao, V. and Venu, D. 2015. Length-weight relationships for some rock pool fishes off Visakhapatnam, east coast of India. *Int. J. Fish. Aquat. Stud*., 2: 139-140.

Kuganathan, S. 2006. Population dynamics of *Gerres abbreviatus* (Bleeker, 1850) from the Parangipettai waters, southeast coast of India. Sri Lanka. *J. Aquat. Sci*., 11: 1-19.

Kurup, B. M. and Samuel, C. T. 1987. Length-weight relationship and relative condition factor in *Daysciaena albida* and *Gerres filamentosus*. *Fish. Technol.*, 24: 88-92.

Kurup, B. M. and C. T. Samuel, 1991. Spawning biology of *Gerres filamentosus* Cuvier in the Cochin Estuary. *Fish. Technol.,* 28: 19-24.

Lamtane, H. A., Pratap, H. B. and Ndaro, S. M. G. 2007. Reproductive biology of *Gerres oyena* (Pisces: Gerreidae) along the Bagamoyo coast, Tanzania. *J. Mar. Sci*., 6(1): 29-35.

Le Cren, E. D. 1951. The length-weight relationship and seasonal cycle in gonad weight and condition in the perch (*Perca fluviatilis*). *J. Anim. Ecol*., 20(2): 201-219.

Mamuris, Z., Apostolidis, P., Panagiotaki, P., Theodorou, A. J. and Triantaphyllidisdir, C. 1998. Morphological variation between red mullet populations in Greece. *J. Fish. Biol*., 52(1): 107-117. https://doi.org/10.1111/j.1095-8649.1998.tb01556.x.

Manon, M. R., and Hossain, M. D. 2011. Food and feeding habit of *Cyprinus carpio var. specularis*. *J. Sci. Found*., 9(1&2): 163-181.

Martin, P., Kuppan, A. and Kalaichelvi, N. 2016. Length-weight relationship of pelagic marine fishes in east coastal region, Chennai, Tamil Nadu. India. *Int. J. Curr. Res. Biol. Med.,* 1: 1-7.

Mishra, S. S., Saren, S. C. and Sengupta, A. 2018. First record of *Gerres infasciatus* (Iwatsuki and Kimura 1998) (Perciformes: Gerreidae) from north-eastern coast of India. *Rec. Zool. Surv. India*, 118(2): 202-205.

Narasimhaiah, N., Rajashekar, K. P., Shivaprakash, S. M. and Tenjing, S. Y. 2020. Allometry and condition factor of whip fin silverbiddy, *Gerres filamentosus* from Mangalore coast, Karnataka, India. *Indian J. Anim. Res*., 55(3): 324-32. https://doi.org/10.18805/IJAR.B-3983.

Natarajan, A. V. and Jhingran, A. G. 1961. Index of preponderance - A method of grading the food elements in the stomach analysis of fishes. *Indian J. Fish.,* 8(1): 54-59.

Natarajan, S., Subrahmanyan, S., Santhanam, R. and Thangavel, B. 2011. Morphometric studies on wild caught and cultured shrimp *Penaeus monodon* (Fabricius, 1798) from Parangipettai, *Indian J. Adv. Appl. Scient. Res.,* 2: 490-507.

Nelson, J. S. 2016. *Fishes of the world,* 5th edn, John Wiley & Sons, Inc., New York, USA, 752 p.

Osman, M. A. A., El Ganainy, A. A. A., Khouriba, H. H. M., and Aly, M. M. 2020. Some reproductive aspects of the common silverbiddy *Gerres oyena* (Forsskal, 1775) from the Gulf of Suez, Red Sea, Egypt. *Egypt. J. Aquat. Biol. Fish*., 29(5): 1090-1096.

Patnaik, S. 1971. Observations on the fishery and biology of Chilka Jagili, *Gerres setifer* (Hamilton, 1822). *J. Inland Fish. Soc. India*, 3: 25-43.

Pawase, S. V., Nirmale, V. H., Bhosale, B. P., Pawar, R. A., Sawant, M. S. and Kende, D. R. 2020. Study on biology of *Thryssa dussumieri* (Valenciennes, 1848) from the coast of Ratnagiri, Maharashtra, India. *Indian J. Geo-Mar. Sci*., 49(01): 87-94.

Pinkas, L. M., Oliphant, S. and Iverson, I. L. K. 1971. *Food habits of albacore, bluefin tuna and bonito in California waters*. California Department of Fish and Game, *Fish Bull*., 152: 105.

Putri, A. K., Nazal, M. F. and Simanjuntak, C. P. H. 2022. Diet and feeding strategy of the common silver-biddy, *Gerres oyena* (Forsskal, 1775) in the seagrass beds of Karang Congkak Island, Kepulauan Seribu National Park. *IOP Conference Series: Earth and Environmental Science Publishing,* 1036(1): 012021. https://doi.org/10.1088/1755-1315/1036/1/012021.

Rakhunde, A. V., Nirmale, V. H., Pawar, R. A., Metar, S. Y. and Bhosale, B. P. 2023. Biology of the cleft belly trevally *Atropus atropos* (Bloch and Schneider, 1801) from Ratnagiri coast of India. *Indian J. Fish*., 70(2): 33-40. https://doi.org/10.21077/ijf.2023.70.2.131346-04.

Rao, A. V. 1968. Observations on the food and feeding habits of *Gerres oyena* (Forskal, 1775) and *Gerres filamentosus* (Cuvier, 1829) from the Pulicat Lake with notes on the food of allied species. *J. Mar. Biol. Ass. India*., 10(2): 332-346.

Renuka, G. and Bhat, U. G. 2011a. Fecundity of whipfin silverbiddy *Gerres filamentosus* (Cuvier) from Sharavati estuary, central west coast of India. *Recent Research in Science and Technology*. 3(4): 71-74.

Renuka, G. and Bhat, U. G. 2011b. Length-weight relationship of whip fin silver biddy *Gerres filamentosus* (Cuvier, 1829) from Sharavathi estuary, central west coast of India. *Recent Research in Science and Technology*., 3: 75-79.

Sarman, V., Hitesh, K., Vinaykumar, V., Mahendra, P. and Piyush, V. 2018. Biological aspects of threadfin bream *Nemipterus japonicus* (Bloch, 1791) along coast of Saurashtra, Gujarat. *J. Fish. Life Sci.*, 3(1): 34-38.

Sarre, G. A., Hyndes, G. A. and Potter, I. C. 1997. Habitat, reproductive biology and size composition of *Parequula melbournensis*, a gerreid with a temperate distribution. *J. Fish Biol*., 50: 341-357. https://doi.org/10.1006/jfbi.1996.0305.

Shalloof, K. A. S. and Khalifa, N. 2009. Stomach contents and feeding habits of *Oreochromis niloticus* (Linnaeus, 1758) from Egypt. *World Appl. Sci. J*., 6: 1- 05.

Sinha, R. K. 1995. *Some aspects of biology of freshwater catfish Clarius batrachus (Linnaeus, 1758) of the Bombay region,* M. F. Sc. Thesis. Central Institute of Fisheries Education, Mumbai, India, 74 p.

Sivashanthini, K. 2008. Length-weight relationships and condition of gerreids (Pisces: Gerreidae) from the Parangipettai waters (SE coast of India). *Asian Fish. Sci*., 21(4): 405-419. https://doi.org/10.33997/j.afs.2008.21.4.005.

Sivashanthini, K., Charles, G. A. and Shutharshan, S. 2008. Fecundity studies of *Gerres abbreviatus* (Bleeker, 1850) from the Jaffna lagoon, Sri Lanka. *J. Fish. Aquat. Sci*., 3(5): 320-327. https://doi.org/10.3923/jfas.2008.320.327.

Talwar, P. K. and Kacker, R. K. 1984. *Commercial sea fishes of India*. Zoological Survey of India, Calcutta, India, 997 p.

Weatherly, A. H. 1979. *Growth and ecology of fish population*. Academic press Inc. Ltd, London, UK, 75 p.

Woodland, D. J. 2001. Gerreidae, Mojarras (silverbiddies). In: Carpenter, K. E. and Niem, V. H. (Eds.), *FAO species identification guide for fishery purposes. The living marine resources of the Western Central Pacific*. 5(3): 2946-2960.

Wootton, R. 1990. *Ecology of teleost fishes*. Chapman and Hall. London, UK, 404 p.

Zar, J. H., 2005. *Biostatistical analysis*, 4th edn. Person Education (Singapore) Pvt. Ltd., New Delhi, India, 633 p.