J. Indian Soc. Coastal Agric. Res. 43(1):1-8(2025) https://doi.org/10.54894/JISCAR.43.1.2025.162336

Review Article

Reproductive Biology of Carangids Occurring Along the Indian Coast: A Brief Review

M.B. SHETKAR*, V.H. NIRMALE, K.B. RATHOD and H.G. SHETYE

Department of Fisheries Biology, College of Fisheries, Dr. B.S. Konkan Krishi Vidyapeeth
Ratnagiri - 415 629, Maharashtra, India

Received: 12.12.2024 Accepted: 12.05.2025

The present article attempted to review the reproductive biology of fishes belonging to the Carangidae family from Indian waters. Carangids, commonly known as jacks, trevallies, scads, queen fishes, runners, amberjacks and pompanos, constitute one of the most commercially important food fishes in our country. The family is represented by 62 species and 21 genera. They are well distributed in tropical and subtropical regions of the Atlantic, Pacific and Indian oceans. Reports indicate that carangids from Indian waters reach maturity at 113-270 mm TL. Sexual maturation evidently occurs at a slightly smaller size in males than females. In some species females outnumbered males, while in some species males dominated the commercial catches. Carangids are moderately fecund. GSI and ova-diameter studies show that most of the carangids are multiple spawners, spawning at least twice or thrice in an extended spawning season. Peak spawning in most carangids occurs during March-May prior to the southwest monsoon along the West coast and September- November prior to the southeast monsoon along the East coast.

(***Key words:*** *Reproductive biology, Carangids, Indian coast)*

The family Carangidae encompasses a diverse group of marine fishes commonly known as jacks, trevallies, scads, queen fishes, runners, amberjacks, and pompanos. Carangids are well distributed in tropical and subtropical regions of the Atlantic, Pacific and Indian oceans (Poojary *et al.,* 2015; Sasidharan *et al.,* 2018; Rakhunde *et al.,* 2023). A total of 147 species belonging to 30 genera are described by Nelson (2016). The queen fish and jacks grow to a comparatively larger size (Reuben *et al.,* 1992; Devaraj *et al.,* 1997; Kasim, 2003; Nelson, 2016; Rakhunde *et al.,* 2023). Approximately 62 species are reported from the Indian coast including 14 major species of commercial importance (Sasidharan *et al.,* 2018). Carangids are found in good concentration up to a depth of 100 m along entire coastline of our country. They support lucrative fisheries throughout the year, particularly along the coasts of Andhra Pradesh, Tamil Nadu, Kerala, Gujarat, Maharashtra, and Karnataka (Nair and Radhakrishnan, 2000). Carangids are exploited by a multitude of gears including boat seines, shore seines, bottom trawls, hook and lines, gillnets, ring seines and purse seines (Reuben *et al.,* 1992; Nair and Radhakrishnan, 2000; Kasim, 2003; Sasidharan *et al.,* 2018). In recent years there has been a significant increase in the production of carangids due to increased exploitation using multitude of gears at different depths. Carangids contribute to about 6.7% of the total marine fish landings in India (Anon, 2022). They are having good demand in the domestic market and recently larger species are also exported in frozen form (Pillai *et al.,* 2007). *Alectis indicus, A. ciliaris, Alepes djedaba, A. para, Decapterus russellii, D. kurroides, D. dayi, Megalaspis cordyla, Scomberoides lysan, S. commersonianus, Trachinotus blochii, S. crumenophthalmus, Atropus atropos, Caranx sexfasciatus, C. carangus, C. ignobilis, C. kalla, C. para, Carangoides armatus, C. malabaricus, C. oblongus, Atule mate, Parastromateus niger, Seriolina nigrofasciata* and *Selaroides leptolepis* are the most common carangid species contributing to fishery in maritime states of India (Reuben *et al.,* 1992; Sivakami, 1996; Nair and Radhakrishnan, 2000; Kasim, 2003: CMFRI, 2015). Studies on reproductive biology of carangids from Indian coast are reported by different authors including Sivakami (1990), Reuben *et al.* (1992), Raje (1993), Sajana *et al.* (2019), Bandkar *et al.* (2022) for *A. djedaba*; Murty (1991), Reuben *et al.* (1992), Premalatha (1993), Manojkumar (2007), Poojary *et al.* (2010), for *D. russelli*; Sreenivasan (1978),

**Corresponding author:* E-mail: maheshshetkar2000@gmail.com

Bapat *et al.* (1982), Reuben *et al.* (1992), Premalatha (1993), Sivakami (1995), Jadhav and Mohite (2014), for *M. cordyla*; Prabhu (1956), Tandon (1960), Reuben *et al.* (1992), for *S. leptolepis*; Reuben *et al.* (1992), Raje (1994), Rakhunde *et al.* (2023), Kasim (1999), Rajesh *et al.* (2018) for *A. atropos*; Rajesh *et al.* (2019), for *S. nigrofasciata*; Ruben *et al.* (1992), Sasidharan *et al.* (2018) for *A. mate* and Sreenivasan (1981) for *D. dayi*. Studies on reproductive biology can potentially enhance our knowledge of important biological characteristics that will help us suggest appropriate management interventions resulting in sustainable exploitation of carangids in our country. Further, there is a scope for undertaking biological studies on other commercial species of carangids occurring in the Indian waters.

Size at first maturity

The sizes at first maturity have been reported in *C. kalla, M. cordyla, D. dayi, D. russelli, S. leptolepis, A. djedaba, C. carangus, A. mate* and *A. atropos* by different authors (Table 1). Kagwade (1968) reported the length at first maturity for *C. kalla* from Calicut coast to be 122 mm for females and 117 mm for males. The size at first maturity of this species noticed by Reuben *et al.* (1992) from southwest coast is slightly higher, *i.e.*, 129 mm than that observed by Kagwade (1968). In the case of *M. cordyla*, Sreenivasan (1978) observed that both the sexes attain maturity at a minimum length of 270 mm. Reuben *et al.* (1992) reported the size of first maturity to be 250 mm from east coast of India. The size at first maturity was reported to be 264 mm for both the sexes of *M. cordyla* by Jadhav and Mohite (2014) along Ratnagiri coast. According to Prabhu (1956), maturity is reached earlier in males of *S. leptolepis*. Murty (1991) reported the size at first maturity for *D. russelli* from Kakinada coast to be 150 mm, whereas Reuben *et al.* (1992) reported that the fish matures at the size of 137 mm along the east coast and the northwest coast. Tandon (1961) observed that in *S. leptolepis* the males mature relatively earlier than females. Reuben *et al.* (1992) reported that *S. leptolepis* matures at a size of 88-101 mm. The size at first maturity for females of *A. djedaba* from Ratnagiri coast was found to be 149 mm (Bandkar *et al.,* 2022). The size at first maturity in carangids varies from species to species and within a species from one region to another, as reported by different authors.

Sex ratio

Sex ratio provides basic information required for reproduction and stock size assessment (King, 1995). According to Sivakami (1990), the sex ratio of *A. djedaba* showed that males outnumbered females during all the months except during October, January, May and June. While the Sajana *et al.* (2019), reported an equal proportion of males and females of *A. djedaba* throughout the year except in April and November from Cochin coast. Raje (1993) reported that males of *A. djedaba* outnumbered females from Veraval coast of Gujarat. Jadhav and Mohite (2014) reported the sex-ratio of *M. cordyla* from Ratnagiri coast. The results showed that in most of the months, females dominated over males and the overall male: female ratio was 1:1.3. Sivakami (1995) reported the monthly ratio of male and female *M. cordyla* with Chi square values. It was observed that females were significantly dominant only during the months of January and February. Chi-square test revealed that the sex ratio did not significantly deviate from the ratio 1:1. The sex ratio in different size groups of *A. atropos* showed that males were dominant in the smaller size groups (10 - 12 cm), while females were dominant in the larger size groups (24-26 cm) (Rajesh *et al.,* 2018). Bandkar *et al.* (2022) estimated sex ratio for *A. djedaba* from Ratnagiri coast. The ratio was observed to be 1:0.85. The dominance of either sex might be possible due to selectivity of gear, vulnerability of either sex to capture and variation in size at first capture (Pawase *et al.,* 2020).

Fecundity

Several species of carangids have undergone fecundity studies (Table 2). The fecundity of *S. leptolepis* (Tandon, 1962), *C. kalla* (Kagwade, 1968), *M. cordyla* (Sreenivasan, 1978; Sivakami, 1995; Jadhav and Mohite, 2014), *D. dayi* (Sreenivasan, 1981), *A. djedaba* (Bandkar *et al.,* 2022; Raje, 1993; Sajana *et al.,* 2019) and *A. atropos* (Raje, 1994; Rakhunde *et al.,* 2023; Rajesh *et al.,* 2018) were studied and the results are tabulated in Table 3. The present review revealed that carangids are highly fecund fishes and the fecundity showed positive linear correlation with total length, body weight and gonad weight (Poojary *et al.,* 2015; Sreenivasan, 1981 and Manojkumar, 2005; Rajesh *et*

Table 1. *Size at first maturity in different carangid species*

Species	Locality	Lm (mm)	Author (s)
Megalaspis cordyla	Vizhinjam	270	Sreenivasan (1978)
	East coast	250	Reuben *et al.* (1992)
	Cochin	251-270	Sivakami (1995)
	Ratnagiri	264	Jadhav and Mohite (2014)
Decapterus dayi	Vizhinjam	130-139	Sreenivasan (1981)
Decapterus russelli	Kakinada	150	Murty (1991)
	Northwest coast	153	Poojary *et al.* (2015)
	East coast	137	Reuben *et al.* (1992)
Caranx kalla	Calicut	124	Kagwade (1968)
Atule mate	Kerala	172	Reuben *et al.* (1992)
Alepes kalla	South-west coast	129	Reuben *et al.* (1992)
Selaroides leptolepis	Mandapam	139	Prabhu (1956)
	Mandapam	101	Tandon (1962)
	Tamil Nadu	88-101	Reuben *et al.* (1992)
Atropus atropos	North-west coast	210	Reuben *et al.* (1992)
	Veraval	210	Raje (1994)
	Ratnagiri	171	Rakhunde *et al.* (2023)
	Mangalore	180-200	Rajesh *et al.* (2018)
Caranx carangus	Tamil Nadu	220	Reuben *et al.* (1992
Atule mate	Kerala	172	Reuben *et al.* (1992
Alepes djedaba	Cochin	180-189	Shivakami (1990)
	Kerala	189	Reuben *et al.* (1992)
	Ratnagiri	149	Bandkar *et al.* (2022)
	Cochin	174	Sajana *et al.* (2019)
S. nigrofasciata	South-west coast	270	Rajesh *et al.* (2019)

al., 2018; Sajana *et al.,* 2019). The fecundity varies from species to species and within the species from region to region in accordance to the reproductive potential of the stocks (Kende, 2016; Bandkar, 2022). Similarly different environmental factors particularly temperature, day length and food supply, are reported to directly influence the fecundity (Sajana *et al.,* 2019).

GSI and maturity studies

Based on GSI and maturity studies, several workers have reported the spawning of important carangid species along the coast of India (Table 3). Studies on maturation and spawning of *D. russelli* from east coast were carried out by Reuben *et al.* (1992). The spawning season was noted from December to August. Peak spawning was noted in January and September for *D. russelli* along Maharashtra coast (Poojary *et al.,* 2015). Sivakami (1990) studied maturity stages and spawning in *A. djedaba* from Cochin coast of Kerala. Based on the occurrence of individuals in advanced stages of maturity he concluded that *A. djedaba* has a prolonged spawning season from July to November and releases two batches of eggs during the period. Sajana *et al.* (2019) studied the GSI in males and females of A. djedaba from Cochin coast. The GSI studies indicated that the spawning season of *A. djedaba* is during August

Table 2. *Fecundity in respect of the carangids in the Indian coast*

Species	Locality	Fecundity	Author
M.cordyla	Vizhinjam	91854 to 324292	Sreenivasan (1978)
	Cochin	91854 to 324292	Sivakami (1995)
	Ratnagiri	92268 to 549900	Jadhav and Mohite (2014)
D. dayi	Vizhinjam	16388 to 107640	Sreenivasan (1981)
D. russelli	Northwest	29986 to 152123	Poojary *et al.* (2015)
C. kalla	Calicut	30000 to 75000	Kagwade (1968)
S. leptolepis	Mandapam	373750	Tandon (1962)
A. atropos	Veraval	31432 to 372344	Raje (1994)
	Ratnagiri	16458 to 138688	Rakhunde *et al.* (2023)
	Mangalore	33298 to 188675	Rajesh *et al.* (2018)
A. djedaba	Ratnagiri	15004 to 640800	Bandkar *et al.* (2022)
	Veraval	621600 to 806386	Raje (1993)
	Cochin	59744 to 330190	Sajana *et al.* (2019)

to December. Rajesh *et al.* (2018) observed that A. atropos is a protracted spawner and spawning occurs during September to December and March to May from Mangalore coast of Karnataka. Raje (1994) reported prolonged spawning season of *A. atropos* along the Veraval coast based on the occurrence of ripe individuals. Sreenivasan (1981) reported the occurrence of spawners of *M. Cordyla* during July to October from Vizhinjam waters indicating a protracted breeding season for the species. Monthly distribution of maturity stages showed that the spawning season of *M. cordyla* was May-January with peak spawning during May-October (Jadhav and Mohite, 2014). The spawning season of *M. cordyla* from the north west coast was described by Bapat *et al.* (1982). He observed that the species has a single peak spawning period during December to February based on maturity studies. The ova diameter study indicated that *A. djedaba* follows a protracted spawning season with the individual spawning twice in a spawning season along Ratnagiri coast (Bandkar *et al.* 2022). Sivakami (1995) studied GSI for *M. cordyla* from Cochin. The GSI values indicated spawning period for *M. cordyla* during May to September. Kagwade (1968) reported two spawning peaks for *C. kalla* along the Calicut coast during December to January and May to June respectively. Ruben *et al.* (1992) observed the peak spawning of *A. kalla* from Kerala during October and less pronounced spawning in July. Subrahmanyam (1966) recorded higher percentages of ripe females of *A. kalla* in July and August from Madras coast. Restricted spawning was noticed in *A. atropos* by Reuben *et al.* (1992) along south-west coast of India.

Ova diameter studies

Few studies on ova diameter for various carangid species have been carried out so far from Indian waters. These are discussed as given below. Subrahmanyam (1966) noted that the eggs of *A. kleinii* from the Madras coast are pelagic, spherical and transparent, measuring 0.58 to 0.61 mm in diameter. Based on occurrence of two modes in stage IV, Bandkar *et al.* (2022) concluded that *A. djedaba* spawns twice in a spawning season along the Ratnagiri coast. Rajesh *et al.* (2018) studied the ova diameter of *A. atropos* from Mangalore coast. The modal values for stage I, II and III were noted to be 0.116 mm,0.24 mm, 0.29 mm respectively. In stage IV, the mode progressed to 0.31 mm with a secondary mode at 0.225 mm. In stage V and stage VI, presence of two modal values was noted. Ova diameter study revealed that *A. atropos* spawned twice in a spawning season. Rakhunde *et al.* (2023) observed the appearance of two modes in Stage IV which shows the possibility of *A. atropos* spawning two times in a spawning season along the Ratnagiri coast. Murty (1991) studied the

Table 3. *Spawning season in carangids based on maturity and GSI studies*

Species	Locality	Spawning season	Authors
M. cordyla	Vizhinjam	Apr to Feb Peak: May to Aug	Sreenivasan (1978)
	North-west coast	Aug to May Peak: Dec to Feb	Bapat *et al.* (1982)
	East coast	March to May	Reuben *et al.* (1992)
	Northwest	July	Reuben *et al.* (1992)
	Southwest	Jan	Reuben *et al.* (1992)
	South-west coast	Apr to May & Oct to Nov	Premalatha (1993)
	Cochin	Apr.-Feb Peak: May to Aug	Sivakami (1995)
	Ratnagiri	May to Oct	Jadhav and Mohite (2014)
D. dayi	Vizhinjam	Feb to Nov Peak: Feb to April	Sreenivasan (1981)
D. russelli	Kakinada	Dec to Aug	Murty (1991)
	East coast	April to Aug	Reuben *et al.* (1992)
	Northwest	Dec to Aug	Reuben *et al.* (1992)
	Southwest	Dec to Sep	Reuben *et al.* (1992)
	Southwest	May	Reuben *et al.* (1992)
	Northwest	June to October and December to April	Premalatha (1993)
C. kalla	Calicut	Dec to Jan & May to June	Kagwade (1968)
A. mate	Kerala	Apr to May & Jun to Feb	Reuben *et al.* (1992)
A. kalla	South-west coast	Oct to Jul	Reuben *et al.* (1992)
S. leptolepis	Mandapam	July to Aug	Prabhu (1956)
	Mandapam	Jan to March & July to Oct	Tandon (1962)
	Tamil Nadu	Oct to Jul	Reuben *et al.* (1992)
A. atropos	North-west coast	Nov to Dec	Reuben *et al.* (1992)
	Veraval		Raje (1994)
	Ratnagiri	May to Dec	Rakhunde *et al.* (2022)
	Gujarat	May to Sep	Kasim (1999)
	Mangalore	Sep to Dec & Feb to May	Rajesh *et al.* (2018)
C. carangus	Tamil Nadu	Nov to April	Reuben *et al.* (1992
A. mate	Kerala	April to May & June to Feb	Reuben *et al.* (1992
A. djedaba	Cochin	Jun to Nov	Sivakami (1990)
	Kerala	Dec & Sep	Reuben *et al.* (1992
	Ratnagiri	August to December	Bandkar *et al.* (2022)
	Cochin	June to September Peak in July	Sajana *et al.* (2019)
S. nigrofasciata	South-west coast	March to May & October to December	Rajesh *et al.* (2019)

ova diameter of *D. russelli* from the Kakinada coast. He concluded that spawning takes place in two batches during spawning season.

In conclusion, reproductive studies on carangids indicated that size at first maturity, reproductive potential and spawning varied from species to species and from one region to another, as reported by different authors. Researchers found that carangids are moderately fecund fishes. Most of them have a prolonged spawning period along the coast of India, with individual fish species reportedly spawning twice in a spawning season.

Future directions and research gaps

Despite considerable research on carangid reproduction in Indian waters, key gaps remain. Most studies have primarily centered around a few commercially significant species such as *A. djedaba, D. russelli, A. atropos* and *M. cordyla* (Reuben *et al.,* 1992; Sivakami, 1995; Bandkar *et al.,* 2022), while other ecologically and economically important species like queenfishes (*Scomberoides* spp.) and lesser-known jacks remain underexplored. Much of the data is outdated, with limited recent updates (Prabhu, 1956; Kagwade, 1968; Reuben *et al.,* 1992), raising concerns about its current relevance given ongoing ecological changes. Additionally, inconsistencies in methodologies used for fecundity estimation, GSI analysis, and ova diameter measurements (Tandon, 1962; Jadhav and Mohite, 2014; Rajesh *et al.,* 2018) hinder accurate inter-species and regional comparisons. Furthermore, only a few studies have correlated reproductive patterns with environmental parameters such as temperature, photoperiod, and food availability and the impact of climate change especially shifting seasonal patterns and ocean temperatures on spawning phenology is yet to be addressed. Regional reproductive variations are noted (Murty, 1991; Poojary *et al.,* 2015), but comparative studies are scarce.

Although reproductive biology data exist, their application in formulating region-specific fishery regulations remains limited. Future research should thus focus on lesser-studied species, apply standardized reproductive assessment methods, integrate environmental data, and address climate change impacts, while also translating findings into adaptive fishery management strategies for sustainable exploitation.

CONFLICTS OF INTEREST

The authors declare that there is no conflict of interest.

ACKNOWLEDGEMENT

The authors thank the supporting institutions and colleagues for their valuable inputs. We also gratefully acknowledge the contributions of all researchers whose studies on the reproductive biology of various carangid species formed the foundation of this review.

REFERENCES

Anon. (2022). *Handbook on Fisheries Statistics*, Fisheries Division, Department of Agriculture and Co-operation, Ministry of Agriculture, GOI, New Delhi, India. 153 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 Journal of Fisheries* **69**(1): 37-44.

Devaraj, M.K., Kurup N., Pillai N.G.K., Balan K., Vivekanandan E. and Sathiadas R. (1997). Status, prospectus and management of small pelagic fisheries in India. In: *Proceedings of the APFIC Working Party on Marine Fisheries, First Session, Small Pelagic Resources and their Fisheries in Asia Pacific Region,* M. Devaraj and P. Martsusubroto (eds.), Bangkok, Thailand.

Kagwade, V.N. (1968). Maturation and spawning in horse mackerel, *Caranx kalla* (Cuv. & Val.). *Indian Journal of Fisheries* **15**: 207-220.

Kasim, M.H. (2003). Carangids. In: *Status of exploited marine fishery resources of India*, M. Joseph, and A.A. Jayaprakash (eds.), ICAR-Central Marine Fisheries Research Institute, Kochi, India, pp 166-175.

Kende, D.R. (2016). Biological studies on Moustached Thryssa, *Thryssa mystax* along the Ratnagiri coast of Maharashtra, *Unpublished M.F.Sc. Thesis*, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Maharashtra, India.

Murty, V.S.R. (1991). Observations on some aspects of biology and population dynamics of the scad, *Decapterus russelli* (Ruppell) (Carangidae), in

the trawling grounds off Kakinada. *Journal of the Marine Biological Association of India* **33** (1&2): 396-408.

Nair and Radhakrishnan, P.N. (2000). Carangid resources of India. In: *Marine Fisheries Research and Management*, V.N. Pillai and N.G. Menon (eds.), ICAR-Central Marine Fisheries Research Institute, Cochin, Kerala, India. pp 317-348.

CMFRI. (2015). *CMFRI Annual Report 2014-15*, ICAR-Central Marine Fisheries Research Institute, Kochi, India. pp. 317-348.

Nelson, J.S. (2016). *Fishes of the World*, Fifth edition, John Wiley and Sons Inc., Hoboken, New Jersey, USA. 332 p.

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 Journal of Geo-Marine Sciences* **49**(01): 87-94.

Pillai, N.G.K., Jayaprakash A.A. and Ganga U. (2007). Status and scope of research on pelagic fisheries of India. In: *Status and Perspectives in Marine Fisheries Research in India*, M.M. Modayil and N.G. Pillai (eds.), ICAR-CMFRI, Cochin, Kerala. pp 52-114.

Poojary, N., Tiwari, L.R. and Sundaram, S. (2015). Reproductive biology of the Indian scad, *Decapterus russelli* (Ruppell, 1830) from Maharashtra waters, north-west coast of India, *Journal of the Marine Biological Association of India* **57**(1): 71-77.

Prabhu, M.S. (1956). Maturation of the intra ovarian eggs and spawning periodicities in some fishes. *Indian Journal of Fisheries* **3**: 59-90.

Raje, S.G. (1993). Some aspects of biology of *Alepes djedaba* (Forsskal 1775) from Veraval, Gujarat. *Indian Journal of Fisheries* **40**(3):189-192.

Raje, S.G. (1994). Fishery and biology of *Atropus atropos* (Bloch and Schneider) from Veraval. *Journal of the Marine Biological Association of India* **36**(2): 181-187.

Rajesh, D.P., Anjanayappa, H.N. and Benakappa, S. (2018). Maturation and spawning frequencies of *Atropus atropos* from Mangalore coast, Karnataka, India. *Journal of Fisheries and Life Science* **3**: 46-53.

Rajesh, K.M., Rohit, P., Mini, K.G., Sathyavathi, T. and Abdul Hakeem, M.M. (2019). *Seriolina nigrofasciata* (Ruppel, 1829), its fishery and biological aspects off south-west coast of India. *Indian Journal of Fisheries* **66**(1): 9-16.

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 Journal of Fisheries* **70**(2):33-40.

Reuben, S., Mohamad Kasim, H., Sivakami, S., Nair, P.N., Kurup, K.N., Sivadas, M., Noble, A., Nair, K.V. and Raje, S.G. (1992). Fishery, biology and stock assessment of carangid resources from the Indian seas. *Indian Journal of Fisheries* **39**(3&4): 195-234.

Sajana, N., Bijoy Nandan, S. and Radhakrishnan, C.K. (2019). Feeding behaviour and reproductive biology of the shrimp scad *Alepes djedaba* (Forsskal, 1775) off Cochin coast, Kerala, south India. *Indian Journal of Fisheries* **66**(3):32-40.

Sasidharan, V., Prakash, H., Kumar, R.R. and Kumar, K. (2018). Biology of *Atule mate* (Cuvier, 1833) with a note on species composition of Carangid landings from South Andaman coast, India. *Journal of the Andaman Science Association* **23**(1):58-64.

Sivakami, S. (1990). Observation on some aspects of biology of *Alepes djedaba* (Forskal) from Cochin. *Journal of the Marine Biological Association of India* **32**:107-118.

Sivakami, S. (1995). Fishery and biology of the carangid fish *Megalaspis cordyla* (Linnaeus) off Cochin. *Journal of the Marine Biological Association of India* **37**(1&2): 237-248.

Sreenivasan, P. (1978). Observation on the fishery and biology of *Megalaspis cordyla* (Linnaeus) at Vizhinjam. *Indian Journal of Fisheries* **25**:122-140.

Sreenivasan, P.V. (1981). Maturity and spawning in *Decapterus dayi* Wakiya. *Journal of the Marine Biological Association of India* **23**: 19-28.

Subrahmanyam, C.B. (1966). Eggs and early development of two more carangids from Madras. *Journal of the Marine Biological Association of India* **8**(1): 188-192.

Tandon. K.K. (1960). Biology and fishery of *Selaroides leptolepis* (Cuvier and Valenciennes). *Indian Journal of Fisheries* **7**(1): 82-100.

Jadhav, T.D. and Mohite, S.A. (2014). Reproductive biology of Horse mackerel *Megalaspis cordyla* (Linnaeus, 1758) along Ratnagiri coast of Maharashtra, India. *Journal of the Marine Biological Association of India* **55**(2): 35-40.

Bapat, S.V., Deshmukh, V.M. Krishnamoorthi, B., Muthiah, C., Kagwade, P.V., Ramamirtham, C.P., Mathew, K.J., Pillai, S.K. and Mukundan, C. (1982). Fishery resources of the exclusive economic zone of the Northwest coast of India. *CMFRI Bulletin 33*, ICAR-CMFRI, Cochin, Kerala.86 p.

Kasim, M.H. (1999). Age growth mortality yield per recruit and stock assessment of *Atropus atropos* (Bloch and Schneider). Proceedings *The Fourth Indian Fisheries Forum*, Asian Fisheries Society Indian Branch, Mangaluru, Karnataka, India, pp 373-375.

King, M. (1995). *Fisheries Biology, Assessment and Management*, Fishing News Books Ltd., Oxford, UK. pp 158-160.

Premalatha P. (1993). Observations on the carangid resources of the southwest coast of india, *Journal of the Marine Biological Association of India* **35**(1&2): 157-166.

Manojkumar, P.P. (2005). Maturation and spawning of *Decapterus russelli* (Ruppell, 1830) along the Malabar Coast. *Indian Journal of Fisheries* **52**(2): 171-178.

Manojkumar, P.P. (2007). Stock assessment of Indian scad, *Decapterus russelli* (Ruppell, 1830) off Malabar. *Journal of the Marine Biological Association of India* **49**(1): 79-80.