Indian Journal of Geo Marine Sciences
Vol. 50 (02), February 2021, pp. 141-147

Population growth and maturity characteristics of Commerson's anchovy (*Stolephorus commersonnii* Lacepède, 1803) along the southwest coast of India

P G Nair*[a,b], S Joseph[a], V Kripa[a] & V N Pillai[a]

[a]Central Marine Fisheries Research Institute, Kochi – 682 018, India
[b]Department of Marine Biology, Microbiology and Biochemistry, Cochin University, Kochi – 682 022, India

*[E-mail: preethagnair@yahoo.in]

Received 29 October 2018; revised 05 November 2020

Population and maturity characteristics of Commerson's anchovy (*Stolephorus commersonnii*) from the south-west coast of India have been presented here to elaborate upon the fishery of the species in the region. The present study on Commerson's anchovy formed the first of its kind from the Indian waters and showed that the lifespan of the species is 3.06 years. The results also revealed that Commerson's anchovy attains the length of 10.2, 13.5 and 14.7 cm at the end of 1st, 2nd and 3rd year of its life. The recruitment pattern of Commerson's anchovy has two peaks - a minor one from February to March and a major one from June to July. The length-frequency analysis for the probability of capturing the species showed that the length at the first capture was 8.2 cm, indicating that the fish mostly being commercially exploited after they reach the first maturity *i.e.* the length of 7.1 cm. Total mortality, natural mortality and fishing mortality of the species were calculated as 2.78, 2.18 and 0.64 Y^{-1}, respectively. Virtual population analysis (VPA) indicated that the number of natural mortality of the species is much larger than the commercial utilization, indicating the low exploitation of the species from the southwest coast of India.

[**Keywords**: Commerson's anchovy, Growth, Maturity, Morality, Virtual Population Analysis]

Introduction

Anchovies are small pelagic fishes belonging to family Engraulidae, which constitute one of the most significant pelagic resources along the southwest coast of India[1]. The anchovies present in Indian waters is commonly called as whitebaits[1,2]. Even though 10 species of whitebaits are present in Indian waters, only five species namely *Encrasicholina devisi*, *E. punctifer*, *Stolephorus waitei*, *S. commersonii* and *S. indicus* are contributing to a commercial scale[1]. They are characterised by a small pig-like snout projecting beyond the tip of the lower jaw and comprise of fishes belonging to the genera *Stolephorus*, *Coilia*, *Setipinna*, *Thryssa* and *Thryssina*. All around the world, anchovies comprise of some of the well-known fishes like Peruvian anchoveta, Californian anchovies, Chilean anchovies and Japanese anchovies. In India, anchovies contribute significantly to the artisanal fisheries and form a major source of income for the traditional fishers[3].

The dominant anchovies along the Indian coast belong to the genera *Encrasicholina* and *Stolephorus* with the species *Encrasicholina devisi*, *Stolephorus bataviensis*, *E. punctifer*, *S. commersonnii*, *S. indicus*, *S. baganensis* and *S. macrops*[3]. Among these anchovies inhabiting the Indian coastline, *Stolephorus commersonnii* (Commerson's anchovy; Fig. 1) has the second position (27 %) in landing with a size range 7.5-15.5 cm[1,3]. Anchovy fishery along the Kerala coast is mainly contributed by the genus *Stolephorus* and they usually have a discontinuous availability/ fish landing pattern[2,3]. Anchovies are a preferred food item of several carnivorous fishes and therefore the movement of anchovy shoals into the inshore regions usually coincides with the stock of larger sized carnivorous and piscivorous fishes such as carangids, ribbon fishes, tunas, seer fishes, barracudas, sciaenids, sharks, wolf herrings etc.[2,3]. Anchovies have very strong schooling behaviour[2,3] and they usually do northward schooling movement along the southwest coast of India during the southwest monsoon[4].

Growth and maturity are two chief variables used to study the dynamics of fish stocks[5]. The growth parameters are important for the management of the fish stocks, and the maximum length of fish is a robust forecaster for several growth parameters. It is important to study the growth to determine the total recruitment of the fish in a water body with time[6]. The

best way of virtual population analysis is Length Cohort Analysis, and this estimate could, in turn, be used to predict indices from survey data; therefore, it is practicable to verify whether a given stock estimate is in agreement with a time series of CPUE data[7]. The estimation of sex and the stage of maturity provide valuable basic information on the procreative biology of a fish stocks[8,9]. The information derived from such studies is indispensable for estimating the spawning potential and recruitment prediction of a fish stock[5]. It is also known that the life history traits of fishes determine the productivity of the fishery resources, which could be combined with the scientific forecasts for fisheries management as well as with the size/age at first maturity, sex ratio, fecundity, spawning periods and spawning behavior[8,9].

A concise account of the past research works on various aspects of anchovies as a group has been discussed below. The spawning habits of *Stolephorus indicus* and *Anchoviella heteroloba* were reported earlier based on ova diameter[10,11]. Several researchers have studied the breeding habits of *Encrasicholina devisi*, *Stolephorus waitei*, and *S. insulars*[2,12-15]. Some others have studied the eggs of *Stolephorus* spp. collected from the plankton samples from inshore waters[16-22]. The Commerson's anchovy is a zooplankton feeder predominantly feeding on copepods, fish eggs, ostracods, tintinids, etc[3]. The absence of diatoms in the diet composition was a striking feature, indicating the carnivorous diet of the fish[3]. Even if some evidence is available on the growth and maturity parameters of most of the anchovies species[23-27], practically no data is accessible on growth and maturity of Commerson's anchovy, which forms a major part of small pelagics along the Kerala coast. Therefore, in the present study, emphasis is given to understand the population growth and maturity characteristics of Commerson's anchovy, a major small pelagic fish resource available along the west coast of India. The objectives of the present study also include prediction on the current stock levels of Commerson's anchovy using Virtual Population Analysis (VPA) method to reveal the status of their fishery along the region.

Fig. 1 — Different size classes of Commerson's anchovy

Materials and Methods

Data used in this study was collected from Kalamukku and Munambam fish landing centres of Kochi, Kerala during the year 2010 and 2011. Total 1180 *Stolephorus commersonnii* samples caught using ring and purse seines were considered for the present study. Fish samples were collected during every fortnightly visit in the fish landing centres. The total length of the specimen was measured from the tip of the snout to the tip of the caudal fin using a measuring scale and the weight of the specimens were measured using a standard weighing balance. The samples were segregated into male and female and assigned the maturity stages based on the stage of gonads. Individual samples with I and II stages of gonad maturation were considered as juveniles while those with gonad stage III to VI were considered as mature.

Growth

Growth parameters like L Infinity (L_∞), Growth coefficient (k), Length at 0-year class (t_0), lifespan, length at age (L_t), recruitment pattern, and the probability of capture were estimated from length-frequency data and were grouped into 1 cm class intervals using ELEFAN I module in FiSAT software[28]. Data of various size classes were used to decide the stock structure and growth. Length at 0 years is defined as the hypothetical age (in years)

the fish would have had at zero length and was calculated from Pauly's empirical equation[29].

$$t_0 = - (EXP ((-0.392-0.275*LN (L_\infty)-1.038*K) \quad \ldots (1)$$

Lifespan is the approximate maximum age (t_{max}) of fish of a given population would reach[30]. It was calculated using the parameters of the von Bertalanffy growth function:

$$t_{max} = 3 / K \quad \ldots (2)$$

The length of fish at age t was determined using the Bertalanffy growth equation[31] as:

$$L_t = L_\infty (1-exp-(k) [t-(t_0)]) \quad \ldots (3)$$

The probability of capture by length is used to estimate length at first capture (Lc), which was calculated by the ratio between the points of the extrapolated descending arm of the length-converted catch curve using the FiSAT software[32]. The length at which 50 % of fish are retained is known as length at first capture. The total mortality was estimated by using length converted catch curve method[33] and natural mortality using empirical formula[30] by taking 28 °C as the temperature of the habitat. The fishing mortality was calculated from the equation F = Z-M and exploitation ratio was calculated from the equation E = F/Z. Length structured Virtual Population Analysis (VPA) was carried out using the growth and mortality parameters as input in FiSAT.

Maturity

Size/length at first maturity is a significant parameter to understand the population size structure and distribution of any fish species of interest. To estimate the size/length at first maturity (L_m), male and female fishes of Commerson's anchovy were categorised discretely into 5 mm size class interval, and the fishes with gonad maturation stage III and above were considered for estimating the length at first maturity[35].

Results

Growth

The growth variables of Commerson's anchovy achieved from von Bertalanffy growth equation showed that Length at infinity (L_∞) = 15.4 cm, K = 0.98 yr^{-1} and t_0 = -0.1152 (Fig. 2). The present data showed that Commerson's anchovy from the Kerala coast attains a length of 10.2 cm in the first year, 13.5 cm in the second year and 14.7 cm in the third year, with a maximum lifespan of 3.06 years (Fig. 3). The recruitment pattern showed two peaks: a small one during February - March and the second one during June – July (Fig. 4). The values of probability of capture were L_{25} = 7.22 cm, L_{50} = 8.2 cm and L_{75} = 9.61 cm (Fig. 5). The length frequency histogram for the probability of capture showed the length at first capture of Commerson's anchovy as 8.2 cm, indicating that the fish undergo maximum utilization after they attain the first maturity (7.1 cm; Fig. 5). The natural mortality (M) obtained from Pauly's empirical calculation was 2.12 y^{-1}. Total mortality (Z) obtained was 2.78 y^{-1} by taking annual habitat temperature as 28 °C, and fishing mortality (F), were estimated by subtracting M from Z and

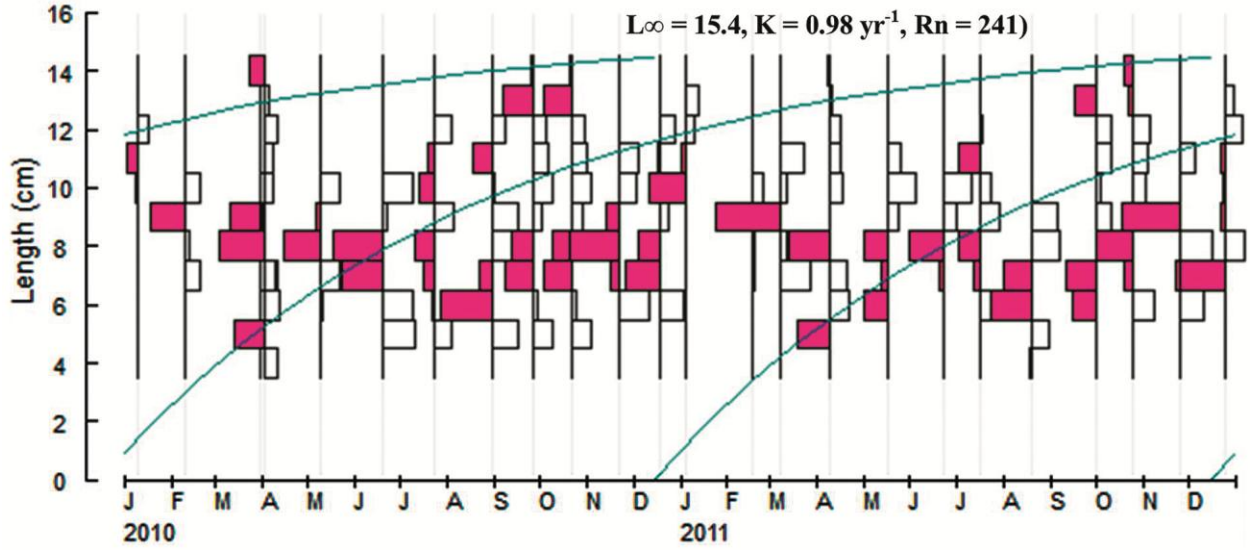

Fig. 2 — Length frequency curve of Commerson's anchovy (pooled data) using ELEFAN I

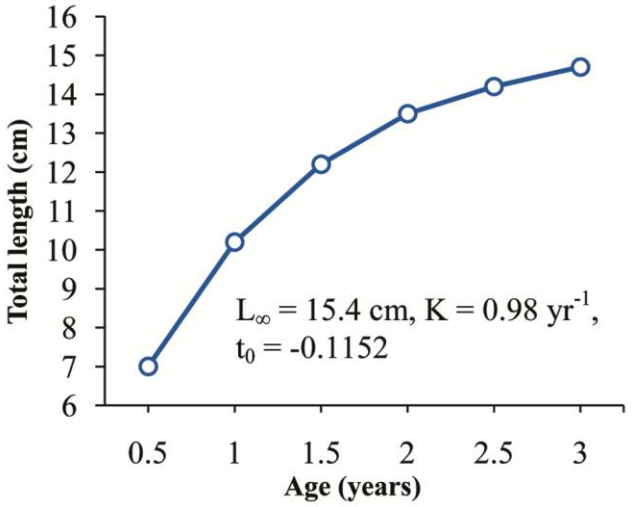

Fig. 3 — Average length attained by Commerson's anchovy at different ages

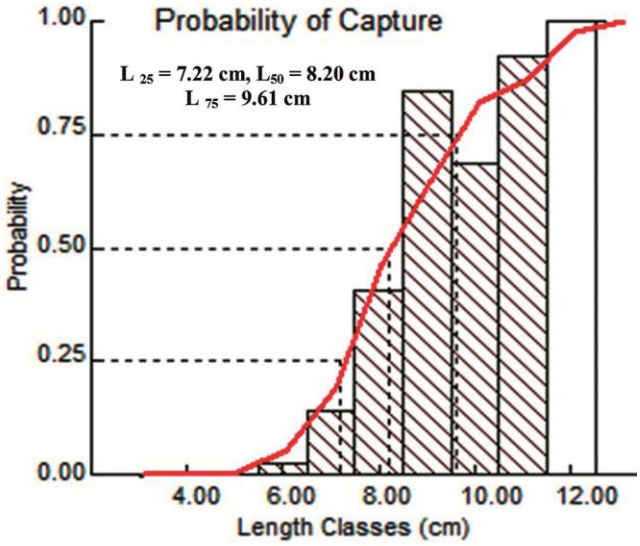

Fig. 5 — Probability of capture of Commerson's anchovy for Lc 50

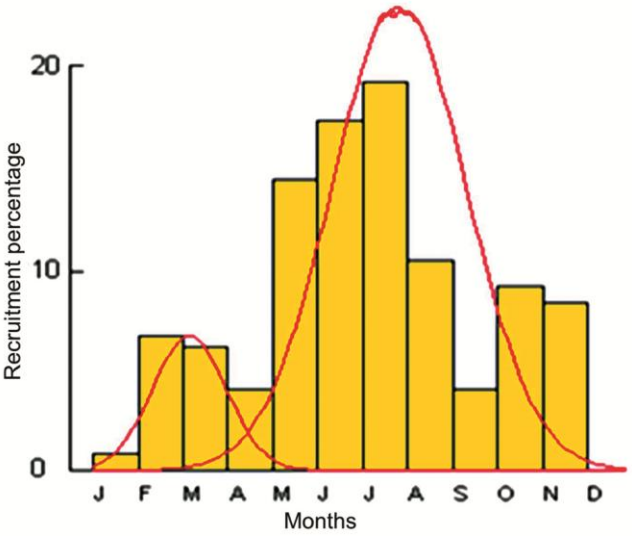

Fig. 4 — Annual recruitment pattern of Commerson's anchovy

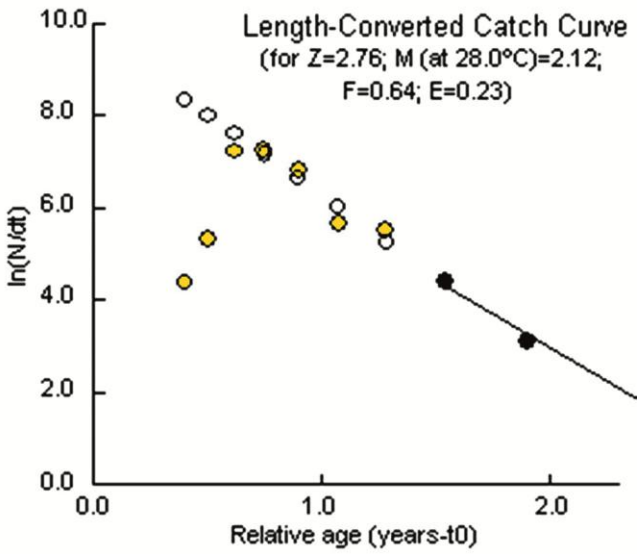

Fig. 6 — Length converted catch curve for mortality rates

estimated as 0.64 Y^{-1}. The exploitation rate of 0.23 indicated that the species has not undergone high fishing pressure (Fig. 6) along the study area.

Maturity

The length at first maturity of Commerson's anchovy presented values of 7.1 and 7.2 cm for male and female, respectively. This showed that male Commerson's anchovy attains its first maturity at the length of 7.1 cm and the female at 7.2 cm (Figs. 7a & b). Virtual population analysis (VPA) results showed that the maximum number of Commerson's anchovy were caught between 6.5 to 10.5 cm (Fig. 6) and consequently, the number of natural deaths was much larger than catches. The major loss in the fish stock up to 6.5 cm size was due to natural mortality (Fig. 8). The maximum fishing mortality was observed in fishes that attained maturity. Natural mortality was found to be maximum at the juvenile stage.

Discussion

The littoral waters of Kerala have high primary production due to large quantities of nutrients being brought to the surface waters through large land/river input and coastal upwelling[35]. Most of the small pelagic fishes in this situation live for only about two years and are being utilized by less than one year before they get a chance to reproduce even once[36].

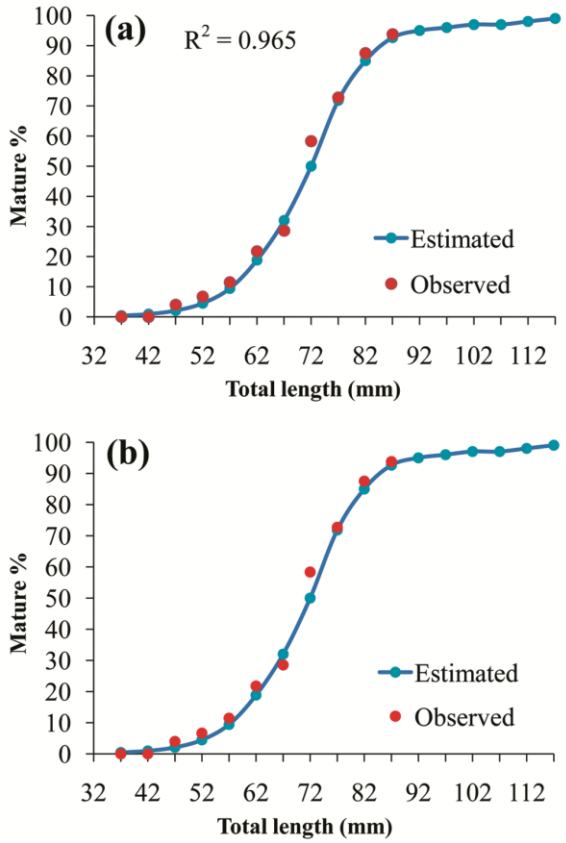

Fig. 7 — Length at first maturity of Commerson's anchovy: (a) male, and (b) female

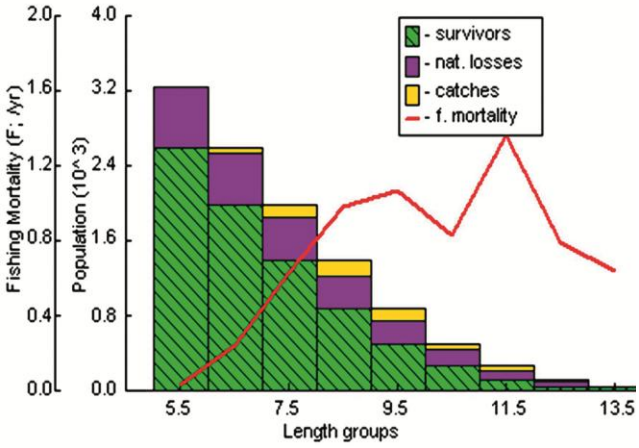

Fig. 8 — Length structured VPA indicating number of survivors, natural deaths and number of individuals being caught

The recruitment of juveniles to the stock is governed by the annual variations in the intensity and duration of upwelling and plankton bloom in the coastal waters[36]. It was shown in the past that recruitment even in tropical fishes oscillates seasonally and is often distributed normally with one or two peaks per year[37]. This condition influences the obtainability of diverse varieties of fish for exploitation throughout the year. The success of the commercial fishery during each season is decided by the number of juveniles recruited at the start of the season, which, in turn, is influenced by several environmental factors such as coastal upwelling and plankton abundance[36].

The growth and maturity variables of Commerson's anchovy inhabiting Indian waters are not available so far. The L_∞ of Commerson's anchovy found in this study was 15.4 cm, which is similar to the value (15.5 cm) reported in the past from North Queen Island[38]. The growth and maturity studies of other anchovies available from the Indian coast, for instance, L_∞ of *E. devisi*, was found to be 11.3 cm[12], while L_∞ of *E. devisi* and *S. waitei* were 10.25 cm and 13.46 cm, respectively[15]. In the present study, based on von Bertalanffy growth equation, it was observed that Commerson's anchovy attains a length of 10.2 cm in the first year; subsequently, growth slows down and it reaches 13.5 cm and 14.7 cm in the second and third years, respectively. In the present study, the lifespan of Commerson's anchovy was found to be 3.06 years, which was similar to the lifespan (3 years) reported for another anchovy *Engraulis encrasicolus* from Turkish waters[39]. The probability of capture of Commerson's anchovy was found to be 8.5 cm, indicating that the species is utilised commercially after attaining sexual maturity at 7.1 cm size.

The recruitment pattern of Commerson's anchovy found in the present study advocates two peak recruitment periods: the major peak from June to July and a minor peak in Februry to March. Similar two recruitment peaks were reported earlier for the anchovy group along the west coast[15,22]. An earlier study on the spawning of anchovies as a group showed that they spawn throughout the year[40]. Later, supporting evidence for the above was given by another study, by showing that larvae of *Stolephorus* sp. occur in all the months, peaks in March to July period with a secondary dominance around November[41]. Similarly, it was noticed earlier that Peruvian anchovy spawns throughout the year with major peak recruitment in June to July and a minor one in February to March[42]. The present study corroborated the above observations and showed that the recruitment of Commerson's anchovy along the southwest coast of India also occurs throughout the year with two seasonal peaks.

In the present study on Commerson's anchovy along the southwest coast of India, higher natural mortality (2.12) compared to the fishing mortality (0.64) was observed, and the former contributed the majority of the total mortality (2.78). This could be due to the short lifespan of the species; also, it may be functioning as the major prey item of carnivorous fishes. The high natural mortality of this species could be the reason for the poor representation of large-sized individuals in the fishery. The high rate of natural mortality for anchovy was also noticed in earlier studies[15,22,43]. In the case of Peruvian anchovy, the natural mortality is found to be very high, and a significant portion of their population is consumed by large predators[42]. The length at which 50 % of the fishes are matured is considered as the length at first maturity[44], and the knowledge about this parameter helps to predict the harvestable size of the fish. The size at first maturity of fishes varies because of the climatic conditions, food availability, fishing removals and changes in growth rates[45,46]. The length/size at first maturity of Commerson's anchovy in the present study was found to be 7.1 cm for male and 7.2 cm for female. As sufficient past data on Commerson's anchovy is not available, the present data were compared with other closely related species of anchovies. Based on studies elsewhere[47], following are the length at first maturity values observed for different species; *Anchoviella tri* (9.0 cm), *A. baganensis* (7.0 cm), *A. indica* (4.0 cm), *A. commersonii* (10.0 cm), *A. heteroloba* (6.5 cm), *A. zollingeri* (70 cm) and *A. bataviensis* (7.0 cm). Considering *Anchoviella commersonii* equivalent to *Stolephorous commersonnii* (Commerson's anchovy)[47] can be ambiguous in this case as a noticeable decrease was observed in the length at first maturity of Commerson's anchovy. The result of this comparison probably involve sample ambiguity as both these studies are from temporally and spatially well-separated geographical areas and, therefore, deserve more concerted efforts and careful evaluation of the taxonomic details. Absence of historical data on length at first maturity of Commerson's anchovy from the Indian coast made it impossible to attempt a long term comparison considering the Indian coastline.

Acknowledgements

Authors thank the Director, ICAR - Central Marine Fisheries Research Institute, India for facilities and encouragement. The authors thank the Director, ESSO-INCOIS, Hyderabad, India for the financial support under the PFZ mission programme. This paper is a part of the PhD work of the lead author. The lead author thanks The Kerala State Council for Science, Technology and Environment (KSCSTE) for the women scientist fellowship which enabled her to publish this research work.

Conflict of Interest

The authors declares no conflict of interests that could influence the work reported in this paper.

Author Contributions

PGN & SJ have contributed the conception and design of the study, acquisition of data, analysis and interpretation of data, drafting the article or revising it critically for important intellectual content and final approval of the version to be submitted. VK & VNP have contributed to acquisition of data, overall guidance to execute the work and also provided important intellectual content to the manuscript submitted.

References

1 CMFRI, *CMFRI Annual Report: 2012-2013*, (Central marine Fisheries Research Institute, Cochin, India), 2013, pp. 200.

2 Luther G, Anchovy fishery of southwest coast of India with notes on characteristics of the resources, *Indian J Fish*, 26 (1979) 23-36.

3 Nair P G, *Studies on major small pelagic fishes along the Kerala Coast with respect to the Potential Fishery Zone (PFZ) advisories*, Ph.D thesis, Mangalore University, India, 2015, pp. 172. http://eprints.cmfri.org.in/10763/

4 Reghunathan A, Mathew K J, Rao D S, Gopinathan C P, Kurup N S, *et al.*, Fish and fisheries of the Mudbanks, *CMFRI Bull*, 31 (1984) 60–71.

5 Carvalho G R & Nigmatullin M, Stock structure analysis and species identification. Squid Recruitment Dynamics, In: *The genus Illex as a model, the commercial Illex species and influence on variability*, edited by P Rodhouse, E G Dawe & R K O'Dor, (FAO Fisheries Technical paper, Rome), 1998, pp. 190-232.

6 Katsukawa T, Points of view introduction of spawning potential: improvement in the threshold management theory, *Rev Fish Bio Fish*, 7 (1997) 285-289.

7 Morgan M J, Integrating reproductive biology into scientific advice for fisheries management, *J Northwest Atl Fish Sci*, 41 (2008) 37-51.

8 Qasim S Z, An appraisal of the studies on maturation and spawning in marine teleosts from the Indian waters, *Indian J Fish*, 20 (1973) 166-181.

9 Pope J G, An investigation of the accuracy of virtual population analysis using cohort analysis, *ICNAF Res Bull*, 9 & 10 (1972) 65-74.

10 Prabhu M S, Maturation of intra-ovarian eggs and spawning periodicities in some fishes, *Indian J Fish*, 3 (1956) 59-90.

11 Dharmamba M, Studies on the maturation and spawning habits of some common clupeoids of Lawson's Bay, Waltair, *Indian J Fish*, 6 (1959) 374-388.

12 Rao G S, Biology of *Stolephorus devisi* (Whitley) from Mangalore area 4, Dakshina Kannada, *Mar Biol Assoc India*, 30 (1988) 28-36.

13 Rao G S, Some aspects of biology of *Stolephorus bataviensis* Hardenberg, from Mangalore area, Dakshina Kannada, *Mar Biol Assoc India*, 30 (1988) 107-113.

14 Puthran P, Fishery and certain biological aspects of *Stolephorus devisi* (Whitley) at cochin, West coast of India, In: *The Second Indian Fisheries Forum, Mangalore (India), 27-31 May 1990*, (The Asian Fisheries Society, Indian Branch), 1993.

15 Luther G, Rao K, Narayana V, Rao G S, Muthiah C, *et al.*, *Present status of exploitation of fish and shellfish resources: Whitebaits*, *CMFRI Bull*, 45 (1992) 111-120.

16 Gopinath K, Notes on the larval and post larval stages of fishes found along the Trivandrum coast, *Proc Nat Inst Sci India*, 12 (1946) 7-2.

17 Devanasen & Varadarajan, On the hatching of fish eggs in 1940-41 in the laboratory of west hill biological station, Calicut, *Proceeding of 29th Indian Science Congress*, 3 (1942) 157-158.

18 John M A, Pelagic fish eggs and larvae of the Madras coast, *J Zool Soc India*, 3 (1951) 41-69.

19 Varadarajan A, Note on the distribution of *Anchoviella Zollingeri* (Bleeker) in Indian Seas, *J Bombay Nat Hist Soc*, 51 (1953) 946-948.

20 Nair R V, Studies on some fish eggs and larvae of the Madras plankton, *Proc Ind Acad of Sci*, 35 (1952) 181-208.

21 Vijayaraghavan V, Food of the Indian herrings, *J Madras Univ*, 22 (1953) 239-247.

22 Luther G, Rao K, Narayana G, Muthiah G, Gopakumar G, *et al.*, Resource characteristics and stock assessment of whitebaits, *Indian J Fish*, 39 (1992) 152-168.

23 Venkataraman G, Studies on some aspects of the biology of the common anchovy, *Thrisso clesmystax* (Bloch & Schneider), *Indian J Fish*, 3 (1956) 311-333.

24 Marichamy R, Maturity and spawning of the anchovy, *Thrissina baelama* (Forskal) from the Andaman Sea, *Indian J Fish*, 17 (1970) 179-187.

25 Marichamy R, Food and feeding habits of the short-jaw anchovy, *Thrissina baelama* (Forskal), of the Andaman Sea, *Indian J Fish*, 19 (1972) 54-59.

26 Rohit P, Fishery and certain biological aspects of *Stolephorus devisi* (Whitley) at Cochin, west coast of India, In: *Second Indian Fisheries Forum*, (May 1990, Mangalore, India), 1993, pp. 27-31.

27 Gopakumar G & Pillai N G K, Whitebaits, In: *Marine Fisheries Research and Management*, edited by V N Pillai & N G Menon, (CMFRI, Kochi, India), 2000, pp. 296-309.

28 Gayanilo Jr & Pauly D, The FAO-ICLARM Stock Assessment Tools (FiSAT) Reference Manual, (FAO Computerized Information Series (Fisheries), FAO, Rome), 8 (1997), pp. 262.

29 Pauly D, Gill size and temperature as governing factors in fish growth: a generalization of von Bertalanffy's growth formula, (Ber. Inst. Meereskd. Christian-Albrechts Univ. Kiel) 63 (1979), pp. 156.

30 Pauly D, Length converted catch curves, A powerful tool for fisheries research in the tropics (part 1), *ICLARM Fish Byte*, 1 (1983) p. 325.

31 Bertalanffy V L, Untersuchungenfiber die Gesetzlichkeit des Wachstums. I. Allgemeine Grundlagen der Theorie mathematische und physiologische Gesetzlichkeiten des Wachstumsbei Wassertieren, *Roux Arch Entwicklungsmech*, 131 (1934) 613-652.

32 Pauly D, Fish population dynamics in tropical waters: a manual for use with programmable calculators, *ICLARM Stud Rev*, 8 (1984) p. 325.

33 Pauly D, A selection of simple methods for the assessment of tropical fish stocks, *FAO Fisheries Circulars*, 729 (1980) 54.

34 King M, Fishery biology, *Assessment and management*, 2nd edn, Fishing News Books, (Blackwell Science Limited), 2 (2007), pp. 352.

35 Madhupratap M, Gopalakrishnan T C, Haridas P, Nair K K C, Aravindakshan P N, *et al.*, Lack of seasonal and geographical variation in mesozooplankton biomass in the Arabian Sea and its structure in the mixed layer, *Curr Sci*, 71 (1996) 863-868.

36 ICAR, *Handbook of fisheries and aquaculture*, (Indian Council of Agricultural Research, New Delhi), 2011, pp. 1116.

37 Pauly D, Studying single-species dynamics in a tropical multi-species context, In: Theory *and management of tropical fisheries*, edited by D Pauly & G I Murphy, *ICLARM Conf Proc*, 9 (1982) 33-70.

38 Hoedt E F, A comparative study on the habitats, growth and reproduction of eight species of tropical anchovy from Cleve and Bowling Green Bays, North Queensland, PhD thesis, James Cook University, 1994, pp. 183.

39 Aka Z, Torcu Koc H & Turan C, A study of the growth of anchovy *Engraulis encrasicolus* Linaeus (1758) in Turkish Seas, *Pak J Biol Sci*, 7 (2004) 1121–1126.

40 Nair S K V, Studies on the fishery, biology and population dynamics of Anchovies of the Kerala Coast, Ph.D thesis, M. G. University, Kerala, 1999.

41 George K C, Results of ichthyoplankton surveys along the southwest coast of India with special reference to pelagic fish resources, *Mar Biol Assoc India*, 31 (1989) 172-189.

42 Khan M Z, Kasim H M, Rohit P & Thiagarajan R, *Trends in world anchovy fisheries and India's status, Ocean Life Food and Medicine Expo*, 2004, pp. 1-12.

43 Tiroba G, Rawnson N J P, Nichols P V & Leqata J L, Length frequency analysis of major bait fish in the Indo-Pacific Region, edited by S J M Blaber & J W Cpol, (Proceedings of a workshop, Horiara Solomon Islands), *ACIAR Proc*, 30 (1990) 114-133.

44 Hood P B & Johnson A K, Age, growth, mortality, and reproduction of red porgy, *Pagrus pagrus*, from the eastern Gulf of Mexico, *Fish Bull*, 98 (2000) 723–735.

45 Kagwade P V, Food and feeding habits of the Indian oil sardine, *Sardinella longiceps* Valenciennes, *Indian J Fish*, 11 (1964) 345-370.

46 Potts J C & Manooch C S, Differences in the age and growth of white grunt from North Carolina and South Carolina versus southern Florida, *Bull Mar Sci*, 68 (2001) 1-12.

47 Hardenberg J D F, Some remarks on the genus *Stolephorus* Lacepede in the Indo-Australian Archipelago, *Treubia*, 14 (1934) 313 -375.