
**ISSN: 2347-5129**
(ICV-Poland) Impact Value: 5.62
(GIF) Impact Factor: 0.549
IJFAS 2016; 4(5): 183-188

www.fisheriesjournal.com
Received: 26-07-2016
Accepted: 27-08-2016

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# Age, growth and mortality of *Lutjanus vitta* (Quoy & Gaimard, 1824) off madras coast along south–east coast of India

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**Abstract**
Length measurements of 790 specimens (145–335mm TL) of *Lutjanus vitta* landed by the trawler MFV Samudrika and from Royapuram fish landing centre off Madras coast were taken from January 2007 to June 2009 between the area Lat.12°30' N to 13° 32' N and Long. 80° 12'E to 80°30'E. Age and growth parameters were estimated using length–based methods. The von Bertalanffy growth parameters estimated were, $L\infty$ = 351.8mm and annual K= 0.34. The recruitment pattern of the species was unimodal and the period was from January to July and peak during February to April. The length at first recruitment was found to be 145mm and the length at first capture ($L_{50}$) was 304.3 mm. The longevity was calculated as 9 years. Mortality estimates, M= 0.44, Z= 1.27 and F= 0.83 with the exploitation ratio E= 0.66. The VPA analysis reveals that natural mortality was up to 230 mm and later fishing mortality started at 235 mm.

**Keywords:** Age, growth, mortality, longevity, recruitment, brown stripe red snapper

## 1. Introduction
The family Lutjanidae (Snappers) comes under the order Perciformes and class Actinopterygii. They inhabit inshore waters within the boundary of the continental shelf in tropical waters around the globe and are often associated with reef habitats [1]. The snappers are important targets for fisheries in several regions worldwide. They are large apex predators and highly esteemed for their flavour and command high prices in virtually every society where they are found. These small to medium sized fishes are of high commercial value throughout the world and are regularly taken in artisanal, recreational and commercial fisheries. Due to their high fisheries demand, concerns are being raised about the level of harvest and sustainability of fishing lutjanid populations. Their aggregative behavior and reef based distribution make snappers particularly vulnerable to exploitation. Tamil Nadu state is one of the major contributor of perch (snappers, groupers and emperors) landings in India. Snappers formed 0.6% of the total landings in Tamil Nadu (6.6 lakh tonnes) and was mainly landed by trawlers (64%) [2]. There is no separate statistics available for individual species of snappers.
Determination of age and growth of commercially important fish is significant as it contributes in understanding the age class structure of the stock and role played by various year classes in the fluctuations of the fishery. Mortality estimates like total mortality, natural mortality and fishing mortality are highly required in the exploited fish stocks for better understanding on the optimum levels of exploitation.
Newman *et al.* [3, 4] studied the age, growth and mortality of the tropical red snappers (*L. adetii, L. quinquelineatus*, *L. erythropterus, L. malabaricus* and *L. sebae* from central Great Barrier Reef; *L. fulviflamma* in the southern Arabian Gulf was studied by Grandcourt *et al.* [5]. Growth rates of Lutjanidae from gulf of Aden was studied by Druzhinin and Filatova [6]. Population dynamics of *L. lineolatus* from gulf of Suez, Egypt was studied by Mehanna [7] and from Bitter Lakes, Suez Canal, Egypt by Amin [8]. Growth and Mortality of *L. vitta* from the northwest shelf of Australia was studied by Davis and West [9]. In Indian waters, publications are mainly on commercial fishery [10-12]. The biological aspects like food and feeding of *L. lineolatus* of Madras coast was studied by Job [13]. Length–weight relationship of *L. rivulatus* off Tutucorin, Gulf of Mannar was studied by Ameer Hamsa *et al.* [14]. Ramachandran *et al.* [15] studied the age and growth of *L. vitta* from the south-west coast of India (Arabian Sea).

In this present study, attempt has been made to study the age, growth, mortality, recruitment, $L_r$, $L_{50}$, $L_{75}$ and VPA of the Brown stripe red snapper, *Lutjanus vitta* from Madras coast along south-east coast of India based on length frequency data.

## 2. Materials and Methods

The monthly samples of the Brownstripe red snapper, *Lutjanus vitta* (Quoy & Gaimard,1824) were collected from January 2007 to June 2009 from the Madras coast along the south-east coast of India, Fig.1(Lat.12°30' N to 13° 32' N and Long. 80° 12'E to 80°30'E) in the depth range of 20 to 100 m during the exploratory surveys of the stern trawler, *M.F.V. Samudrika* (OAL: 28.8 m, GRT: 151T, BHP: 650) of Fishery Survey of India, Chennai using fish trawl net (27.5 m; coded mesh size:30 mm). The samples were also collected from Royapuram fish landing centre and the fishing gears employed by the local fishermen for harvesting these resources are mainly bottom trawl and hook & line. In the present study the length–frequency based methods was preferred because in tropical waters the growth rings which are formed in hard parts of the fish's body may not necessarily be annual, as various external factors like seasons and other environmental factors affect the formation of growth rings. A total of 790 specimens of *L. vitta* between the length range of 145-335 mm were taken for studies. Length frequency data collected were grouped into 10mm class intervals were used for the estimation of growth parameters and was analysed using FiSAT II(FAO-ICLARM Stock Assessment Tools). The von Bertalanffy [16] growth parameters, L∞ and annual growth coefficient K were computed by ELEFAN I (Electronic Length Frequency Analysis) method [17-18]. The age at nil ($t_0$) known as "the initial condition parameter" is the age of the fish when it's length is zero. But the growth begins after hatching as the larva already has a certain length, which may be called L (0) and hence $t_0$ was taken as 0. In addition to this the L∞, K and Z/K were also estimated by Shepherd's [19] and Powell –Wetherall method [20, 21] (this method was developed by Powell and later improved by Wetherall). The length at first recruitment ($L_r$) was taken as the smallest length in the length frequency distribution. The length at first capture $L_{50}$ (the length at which 50% of the fishes are vulnerable to capture) was estimated as a component of the length converted catch curve analysis. This was carried out by the probability of capture method of FiSAT software. Longevity was calculated by the formula tmax = 3/K+ $t_0$ [22]. Natural mortality (M) was calculated from Pauly's [22] empirical formula (ln (M) = -0.0152 - 0.279 ln (L∞) + 0.6543 ln (K) + 0.463 ln (T)) and the total mortality (Z) from length converted catch curve by taking the mean habitat temperature as 27 °C [23]. The fishing mortality was calculated as F= Z-M. The exploitation rate E was obtained by dividing F by Z. The length structured Virtual Population analysis (VPA) was carried out to ascertain the loss due to natural causes, the fishing pressure at different length class, catches as well as the survivors.

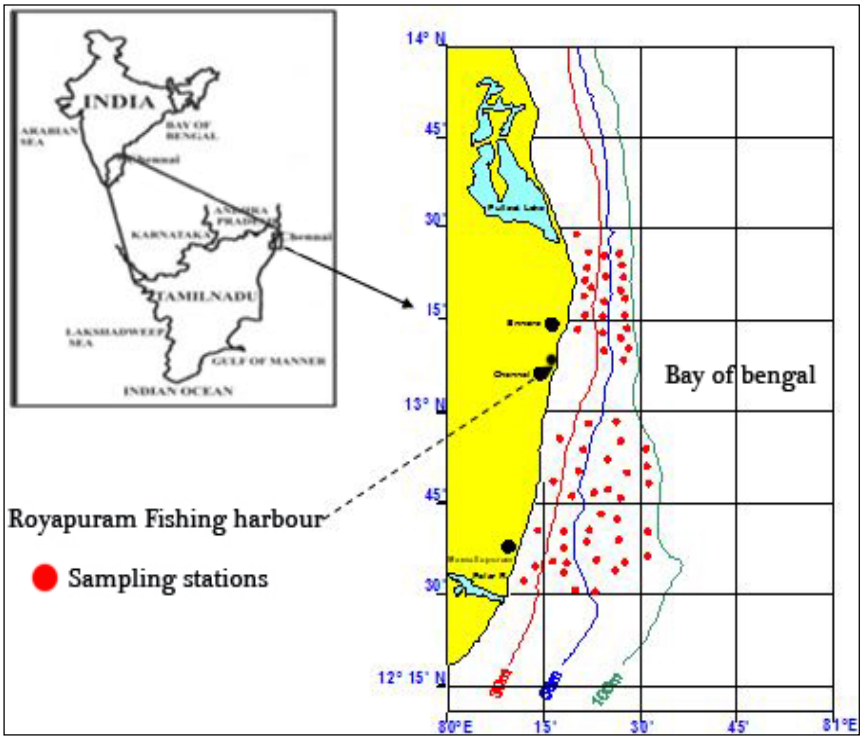


**Fig.1:** Sampling stations

## 3. Results

### 3.1. Growth parameters.

The growth parameters estimated for *Lutjanus vitta* by using the length frequency data in ELEFAN I programme gave the best fit for L∞= 351.8 mm and K = 0.34/year. Keeping the same L∞ value the growth constant 'K' obtained by the Shepherd's method was 0.12/year. The same length frequency data of *L. vitta* was analyzed by Powell–Wetherall method [20, 21] of FiSAT programme and the values of L∞ and Z/K obtained were 343.7 mm and 2.4/year and hence the Z value 0.83/year which is very low. By seeing both the parameters i.e L∞, K and considering the maximum length observed in the sample (335mm) values obtained by ELEFAN I appears to be the best. Hence, the values obtained by this method were taken as input in further analysis of the growth parameters. The growth curve generated by ELEFAN I employing FiSAT programme for *L. vitta* is shown in Fig.2.

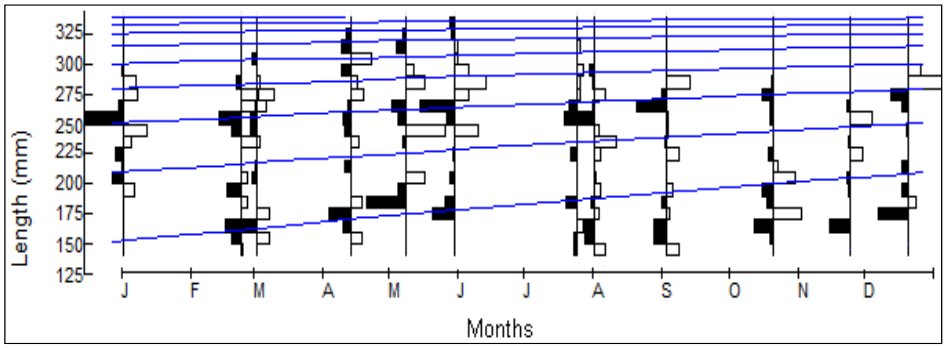


**Fig. 2:** ELEFAN I growth curve of *Lutjanis vitta* in Madras waters.

### 3.2. Recruitment Patterns.

The recruitment pattern of the species *L. vitta* was unimodal (Fig.3). The recruitment to the population or fishery was from January to July and peak during February to April. The percentage of recruitment to the fishery is maximum during March (22.8%) followed by April (16.8%) and February (14.9%) months.

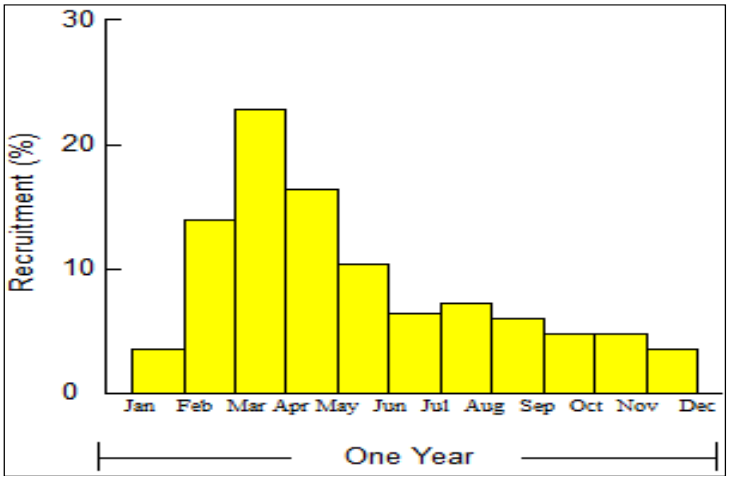


**Fig.3:** Recruitment pattern of *Lutjanus vitta* in Madras waters

### 3.3. Length at first capture ($L_c$) and length at recruitment ($L_r$).

The length at first recruitment ($L_r$) was taken as the smallest length in the length frequency distribution and the length at first capture ($L_c$) was obtained by probability of capture analysis (the length at which 50% of the fish are vulnerable to capture). The length at first recruitment was found to be 145 mm and the length at first capture ($L_{50}$) was 304.3 mm. Similarly, the length at which 75% of the fish are retained in the gear was estimated as 314.8 mm.

### 3.4. Longevity.

Taking $t_0$ as 0 the longevity of *L. vitta* was calculated as 9 yrs. The von Bertalanffy [16] growth curve after 1st, 2nd, 3rd, 4th, 5th, 6th,7th, 8th and 9thyear the length attained by individual of the species *L. vitta* was 101.4, 173.6, 225, 261.5, 287.5, 306.1, 319.2, 328. 6 and 335.3 mm (Fig.4) respectively. The growth rates of 8.5 and 6 mm/month registered during the first and second year. The growth pattern showed a decreasing trend in the subsequent months.

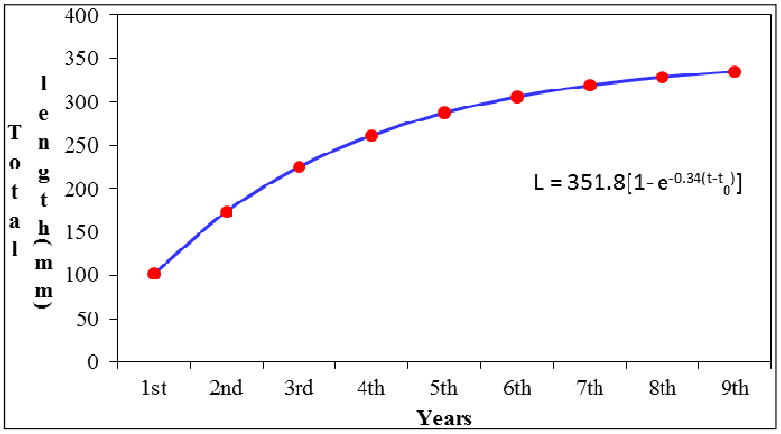


**Fig. 4:** von Bertalanffy's growth curve of *Lutjanus vitta* in Madras waters.

### 3.5. Mortality

The natural mortality (M / year) as per Pauly's empirical formula keeping the habitat temperature as 27 °C was found to be 0.44 for the species *L. vitta* (Fig.5). The total mortality (Z) was 1.27 and the fishing mortality was 0.83. Exploitation ratio (E) was 0.66.

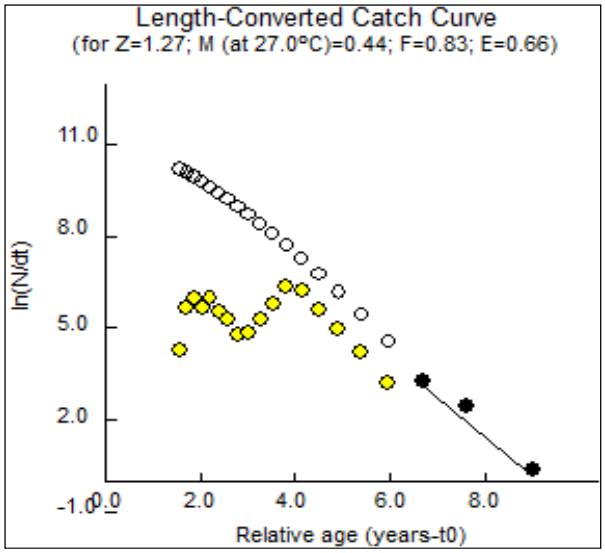


**Fig. 5:** Length converted catch curve, estimated annual total mortality rate of *Lutjanus vitta* from the Madras waters along the south-east coast of India (Z= 1.27).

### 3.6. Virtual Population Analysis (VPA)

The VPA or cohort analysis is one of the standard methods used to analyse length-frequency data, especially in the trawl fishery. It helps us to assess the state of a fish stock. With the help of the mortality parameters the status of the stock of a particular species of a particular area can be analysed. From the VPA graph, the role of the natural mortality, fishing pressure and fishing mortality on the status of the stock is understood.

In the present study, the mortality in the population due to natural causes alone was up to 230 mm, thereafter the fishing mortality started at 235 mm mid-length i.e. from 231 – 240 mm and it continued to increase registering maximum from 245 up to 275 mm length and later shown a decreasing trend from 276 to 285mm mid-length group(Fig.6).

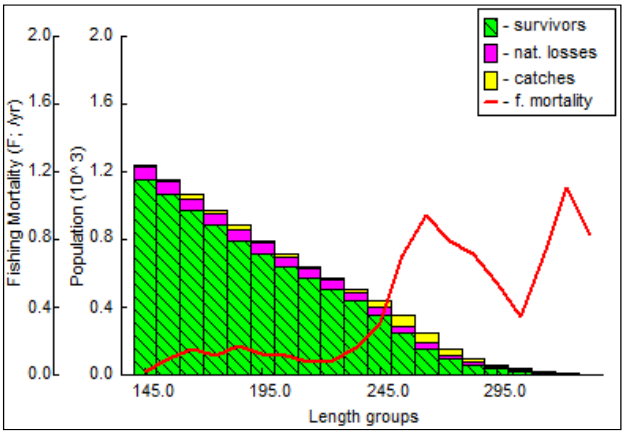


**Fig. 6:** Virtual Population Analysis (VPA) of *Lutjanus vitta* in Madras waters.

### 4. Discussion

In peninsular India lot of work has been done on the growth and population parameters of *Nemipterus japonicus* [24, 25]. *Priacanthus hamrur* [26]. However the work done on the growth and population parameter of the family Lutjanidae are limited to few species. The earlier works include mainly the catch records carried out in the Indian waters by Chacko and Rajendran [10], Alagaraja *et al.* [11] and James *et al.* [12]. The Length–Weight relation of *L. rivualtus* from Gulf of Mannar was studied by Hamsa *et al.* [14]. Age, growth and maturity of *L. vitta* from south-west coast of India was studied by Ramachandran *et al.* [15] and some notable observations were made on the biology of the species. The biology of *L. vitta* was studied by Davis and West [9] and Newman *et al.* [4] from Great Barrier reef, Australia. Most of the studies indicated a slower growth rate for the species.

In tropical waters the determination of growth parameters of a particular fish is estimated by the length–frequency methods as the estimation of growth parameters by other methods such as formation of growth rings in Otoliths has its limitations due to the absence of wide variations in environmental condition like that in the temperate waters. From the length–frequency method the asymptotic length, growth constant are obtained and by taking these as the primary inputs other parameters such as mortality, recruitment pattern and the status of stock are ascertained. The results of the studies carried out by taking into consideration the length – frequency data from various locations are given in table. 1.

**Table 1:** Age and growth parameters analysed based on length–frequency data of *L. vitta* from various locations.

| Sl. No. | Parameters | Present study | Ramachandran *et al.*, 2014 | Ambak *et al.*, 1985 | Corpz *et al.*,1985 |
|---|---|---|---|---|---|
| Location | | Madras coast | South-west coast of India | Malaysia | Philippines |
| I | Growth | | | | |
| | L∞(mm) | 351.8 | 335 | 425 | 398 |
| | K(Year$^{-1}$) | 0.34 | 0.45 | 0.256 | 0.7 |
| II | Recruitment | Jan-July | - | - | - |
| | Peak season | March | March | - | - |
| III | Length at recruitment($L_r$) | 145mm | - | - | - |
| | Length at first capture ($L_c$) | 304.3mm | 226 | - | |
| III | Longevity($t_{max}$) | 9years | - | 12 years | 4years |
| IV | Mortality/year | | | | |
| a. | Natural Mortality(M) | 0.44 | 1.33 | 0.37 | 0.92 |
| b. | Fishing Mortality(F) | 0.83 | 0.13 | - | - |
| c. | Total Mortality(Z) | 1.27 | 1.46 | - | - |
| d | Exploitation ratio(E) | 0.66 | 0.09 | - | - |

From table 1, it is understood that *L. vitta* recorded from the south–east coast of India are larger than the species recorded from the south–west coast of India. The parameters obtained by the length–frequency method comes close with more accurate methods like otolith measurements. The present 'K' value is 0.34 suggesting a slower growth of the *L. vitta*. In the first year the growth rate was 8.5 and 6 mm /month in the second year later it showed a decreasing trend i.e. in the 9th year it was only 0.6mm/month. Except the studies by Corpz *et al*. [28], all other studies indicate that this species has slow growth (K value 0.25-0.45). Studies from the north–west shelf of Australia (by growth ring method) [9] revealed that *L. vitta* is slow growing (K= 0.22- 0.37). The 'K' value obtained by Newman *et al.* [4] (by otolith methods) in the Great Barrier Reef, Australia was 0.34/year. All these studies have supported the present findings that the species has slow growth.

Ramachandran *et al.* [15] reported the peak recruitment period of species as March in the south–west coast of India. The present study agrees well with the above findings and the species has a protracted spawning period and the peak recruitment of the species to the fishery was during March–April. However, Ramachandran *et al.* [15] obtained higher values of mortality than the present study from the south–west coast of India showing exploitation level below the optimum level. In the east coast, scenario is something different and exploitation level is more than the optimum level. Length converted catch curve indicated that the fishing pressure is increasing on the species in the Madras coast. (M is not nearly equal to 2K, as suggested by Ralston [29] is suggestive of the fact that the population is more exploited. The prime cause of mortality up to 230 mm length was natural causes. The fishing pressure increased on the species in the length group 235 mm and above and it was more than the natural mortality up to 285 mm mid-length i.e 281–290mm. In Philippines waters this species has a fast growth rate (K = 0.7) and the age was recorded up to four years. The longevity of the species studied by other researchers indicates that the age of the species is up to 12 years. The present study agrees well with these. The K value is in between (0.25–0.45) which implies that this species has slow growth and longevity of 9 years is justified. The VPA analysis reveals that natural mortality was up to 230 mm later fishing mortality started at 235 mm and continued to increase from 245 up to 275 mm and later shown a decreasing trend from 276 to 285mm mid-length group.

These observations alone cannot give a clear picture on the status of *L. vitta* fishery along Madras coast as many other factors such as biomass, MSY and total landings all needs to be taken into consideration. Also lot more works on the complicated growth parameters, particularly taking into consideration the sexual diamorphic nature of the snappers needs to be done. The growth of the male as well as female *L. vitta* needs to be studied separately and the growth rate for both the sexes need to be established. Growth studies by otolith measurements need to be undertaken to revalidate the results obtained by the length–frequency method in the Madras coast. Further, periodic reassessment of the *L. vitta* stocks is required with adequate inputs from exploratory surveys as well as commercial landings to prevent any unsustainable trends in the development of *L. vitta* fishery along Madras coast. The same studies also needs to be done for other snappers species occurring along the Madras coast, hence contributing towards the sustainable management of snapper fishery along Madras coast.

## 5. Acknowledgement

The author is grateful to Late Dr. V.S. Somvanshi, Ex. Director General, Fishery Survey of India, Mumbai for suggesting this research topic, encouragement and guidance throughout the study period. I express sincere thanks to the present Director General, FSI for his encouragement during the study period. Further, I am very much thankful to Dr. A.B. Kar, Scientist, FSI, Vizag; Scientists of Chennai Zonal Base of FSI; Skipper & staff of *MFV Samudrika* for their support during the studies.

## 6. References

1 Allen GR. FAO Species Catalogue, Snappers of the world. An annotated and illustrated catalogue of Lutjanid species known to date. FAO, Rome, FAO Fisheries Synopsis. 1985; 125(6):208.
2 CMFRI. Annual Report of Central Marine Fisheries Research Institute. 2014, 279.
3 Newman SJ, McB Williams D, Russ GR. Age validation, growth and mortality rates of the tropical snappers (Pisces: Lutjanidae) *Lutjanus adetii* (Castelnau, 1873) and *L. quinquelineatus* (Bloch, 1790) from the central Great Barrier Reef, Australia, Marine and Freshwater Research. 1996; 47:575-584.
4 Newman SJ, Cappo M, McB Williams D. Age, growth and mortality of the stripey, *Lutjanus carponotatus* (Richardson) and the brown-stripe snapper, *L. vitta* (Quoy and Gaimard) from the central great Barrier Reef, Australia, Fisheries Research. 2000; 48:263-275.
5 Grandcourt EM, Al Abdessalaam TZ, Francis F. Age, growth, mortality and reproduction of the blackspot snapper, *Lutjanus fulviflamma* (Forsskal, 1775) in the southern Arabian Gulf. Fisheries Research. 2006; 78:203-210.
6 Druzhinin AD, Filatova NA. Some data on *Lutjanidae* from the Gulf of Aden Area, Journal of Ichthyology. 1980; 20:8-14.
7 Mehanna SF. Population dynamics of the bigye snapper *Lutjanus lineolatus*, ruppell, 1829 (Family: *lutjanidae*) from the Gulf of Suez, Egypt, Egyptian Journal of Aquatic Biology and Fisheries. 2003; 7(3):71-85.
8 Amin Amal MM. Population Dynamics of *Lutjanus lineolatus* (Family: *Lutjanidae*) from the Bitter Lakes, Suez Canal, Egypt, Egypt Journal of Aquatic Biology and Fisheries. 2006; 10(2):79- 92.
9 Davis TLO, West GJ. Growth and mortality of *Lutjanus vitta* (Quoy and Gaimard) from the North West Shelf of Australia, Fishery Bulletin, US. 1992; 90:395-404.
10 Chacko JF, Rajendran ADI. A Survey of the fishery industry of Tuticorin, Gulf of Mannar, Madras Fisheries Year book. 1955; 8:175-193.
11 Alagaraja K, Joseph Andrews, Pavithran PP. Perch fisheries in India. A critical analysis. In: Rengarajan K, Sam Bennet P. (Eds.), Bulletin of Central Marine Fisheries Institute. 1994; 47:10-25.
12 James PSBR, Lazarus S, Armugam G. Present status of major perch fisheries in India, In: Rengarajan K, Sam Bennet P (Eds), Bulletin of Central Marine Fisheries Institute. 1994; 47:1-9.
13 Job TJ. Nutrition of Madras Perches. Records of Indian Museum. 1940; 42:286-364.
14 Ameer Hamsa KM, Mohamad Kasim SH, Rajapackiam S. Length-weight relationship of *Lutjanus rivulatus* off Tuticorin, Gulf of Mannar. Bulletin of Central Marine

Fisheries Institute. 1994; 47:128-129.
15 Ramachandran S, Ali DM, Varghese BC. Age, growth and maturity of brown stripe snapper *Lutjanus vitta* (Quoy&Gaimard, 1824) from south-west coast of India. Journal of Marine Biological Association of India. 2013; 55(2):61-68. doi: 10.6024/jmbai.2013.55.2.01638-10.
16 Bertalanffy L von. A quantitative theory of organic growth (Inquiries on growth Laws.2). Human Biology. 1938; 10:181-213.
17 Pauly D, David NC. ELEFAN I, a BASIC program for the objective extraction of growth parameters from length frequency data. Meeresforschung. 1981; 28: 205-211.
18 Pauly D. Theory and management of tropical multispecies stocks: a review, with emphasis on the Southeast Asian demersal fisheries. ICLARM Studies and reviews. 1979; 1:35.
19 Shepherd JG. A weekly parametric method for estimating growth parameters from length composition data. In Pauly D, Morgan GR (Eds). Length-based methods in fisheries research. ICLARM Conference Proceedings. 1987; 13:113-119.
20 Powell DG. Estimation of mortality and growth parameters from the length frequency in the catch. Rapports et Proces-Verbaux des Reunions. CIEM. 1979; 175:167-169.
21 Wetherall JA. A new method for estimating growth and mortality parameters from length -frequency data. ICLARM, Fishbyte. 1986; 4(1):12-14.
22 Pauly D. Some simple methods for the assessment of tropical fish stocks. FAO, Fisheries Technical Paper. 1983; 234:52.
23 Pauly D. On the interrelationships between natural mortality, growth parameters and mean environmental temperature in 175 fish stocks. Journal du Conseil / Conseil Permanent International pour l'Exploration de la Mer. 1980; 39:175-192.
24 Krishnamoorthi B. An assessment of Nemipterus fishery of Andhra-Orissa coast based on exploratory fishing. Proceedings of the Symposium. Living resources of the seas around India. CMFRI: Special Publication. 1971, 496-516.
25 Vivekanandan E, James DB. "Population dynamics of *Nemipterus japonicus* (Bloch) in the trawling grounds off Madras", Indian Journal of Fisheries, 1986; 33(2):145-154.
26 Philip KP. Studies on the Biology and fishery of fishes of the family *Priacanthidae* (Pisces-Perciformes) of Indian waters. Ph. D Thesis, Cochin University of Science and Technology.1995.
27 Ambak MA, Mohsin AKM, Mohd-Said MZ. Growth characteristics of *Lutjanidae* off the east coast of Peninsular Malaysia, Ekspedisi Matahari. 1986, 85.
28 Corpuz A, Seager J, Sambilay Jr. V. Population dynamics of commercially important fishes of Philippine waters. Dept. of Marine Fisheries. Univ. of the Philippines, Technical Reports. 1985; 6:99.
29 Ralston S. Mortality rates of snappers and groupers. In: Tropical snappers and groupers: biology and fisheries management (Polovina JJ, Ralston SR. Eds.).Westview Press, London, UK. 1987, 375-404.