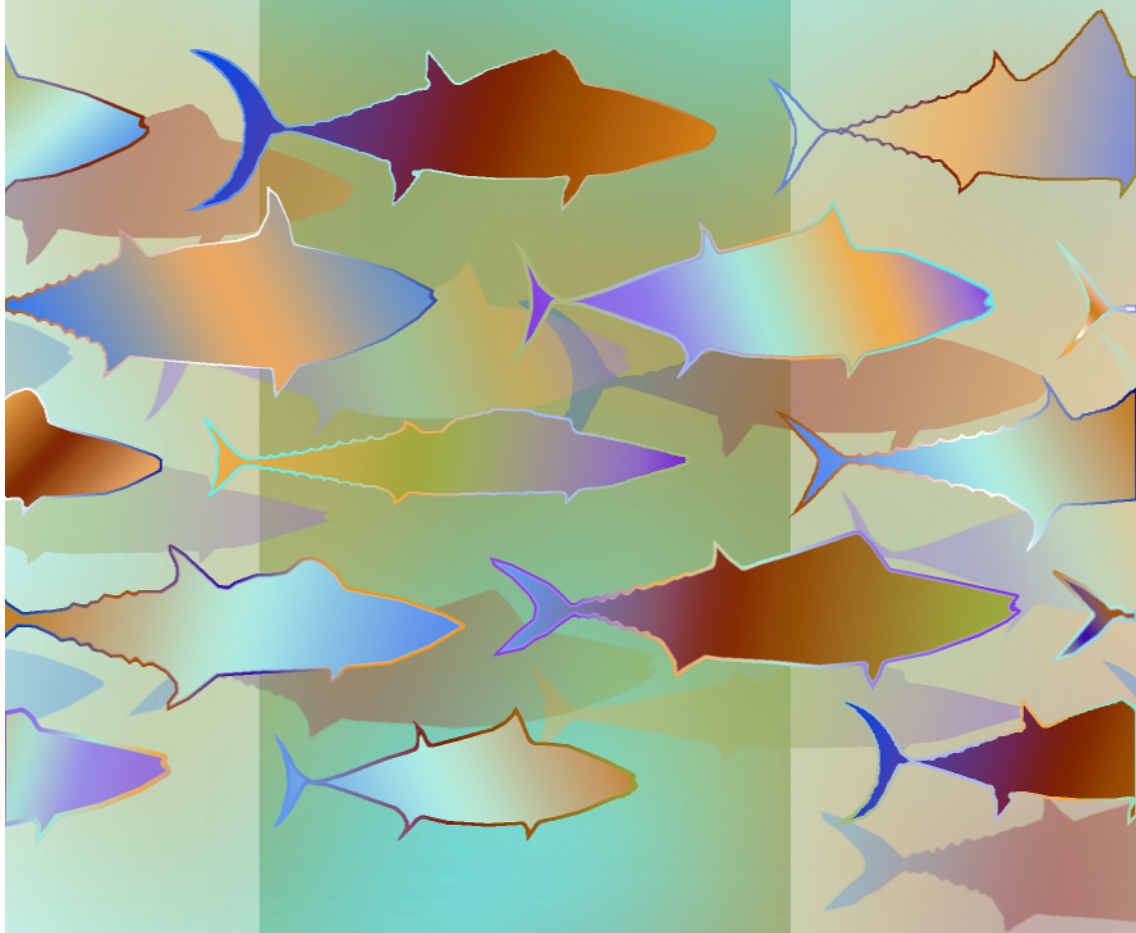


Status of Exploited  
Marine Fishery  
Resources of India



**STATUS OF EXPLOITED  
MARINE FISHERY  
RESOURCES OF INDIA**

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## Lizardfishes, Pomfrets and Bullseye

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|                             |     |
|-----------------------------|-----|
| 1. Lizardfishes .....       | 141 |
| 1.1 Introduction .....      | 141 |
| 1.2 Production trends ..... | 142 |
| 1.3 Management .....        | 147 |
| 2. Pomfrets .....           | 147 |
| 2.1 Introduction .....      | 147 |
| 2.2 Production trends ..... | 147 |
| 2.3 Stock Assessment .....  | 151 |
| 3. Bullseye .....           | 152 |
| 3.1 Introduction .....      | 152 |
| 3.2 Production trends ..... | 152 |
| 3.3 Stock assessment .....  | 155 |
| 3.4 Management .....        | 155 |
| 4. Suggested reading .....  | 156 |

## 1. Lizardfishes

### 1.1. Introduction

Lizardfishes (Family: Synodontidae) constitute an important component of the demersal fish resources of India. The world lizardfish production was 50,576 t. (average during 1982-91) and India contributed to 18,680 t. (37 %). This group is reported as an important bycatch in shrimp trawlers in tropical and subtropical seas. Though considered as a supporting fishery, this group assumes significance by virtue of the high nutritive value and their acceptance as food both in the fresh and dry condition. Nevertheless, information on their fishery, biology and utilisation is fractional. Therefore, an attempt has been made here to bring out the present status of the fishery, biology and utilization of lizardfish resources in India.

## 1.2. Production trends

The All India lizardfish landings indicated a steady increase from 500t during 1956-60 period to 29,600 t during 1991-95, which however, declined to 23,100t during 1996-99. The contribution of lizardfishes to the total marine fish landings also increased correspondingly ranging between 0.1% during 1956-60 to 1.3% during 1991-95 (Fig. 1).

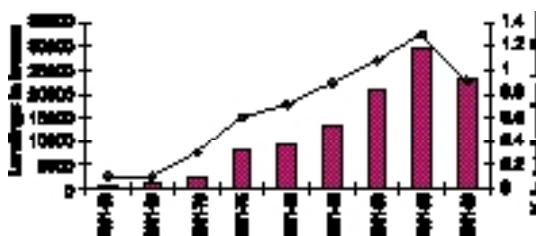


Fig. 1. All India Lizardfish landings during 1961-99

### Statewise landings

It may be seen that Kerala with an average landings of 10,426 t contributed to the maximum of 43.3% of the All India lizardfish landings,

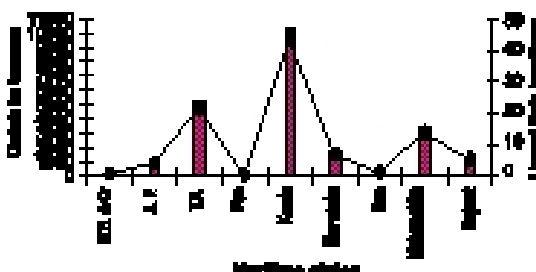


Fig. 2. Statewise average landings of Lizardfishes during 1961-95 (Average)

followed by Tamil Nadu (5,231t; 21.7%), Maharashtra (3,415t; 14.2%), Karnataka (1,757t; 7.3%), Gujarat (1,427t; 5.9%) and Andhra Pradesh (1,115t; 4.6%) (Fig. 2).

### Seasonal abundance

Particulars regarding the quarterwise catch rate (kg) of lizardfishes landed in trawlers during January to December 2000 are presented in Table 1. Along the northwest coast, off Gujarat, the catch rates (CPUE) were high during the IV quarter (October-December), the values ranging between 80 kg in November to 238 kg in December. Off Maharashtra, the first 3 quarters from January to October indicated generally good catch rates ranging upto 22 kg in September. In Kerala, III quarter (July-September) has brought higher catch rates, the values ranging upto 123 kg during August at Calicut (Puthiappa), 84 kg during August at Baypore and 193 kg in September off Cochin. Along the east coast, in Tamil Nadu, III quarter brought the maximum catch, the CPUE ranging upto 0.9 kg during September. Andhra Pradesh with generally lesser catches brought higher catch rates ranging upto 34 kg during September.

Table 1. Seasonal abundance (CPUE-kg/unit) of Lizardfishes in trawl during January to December 2000

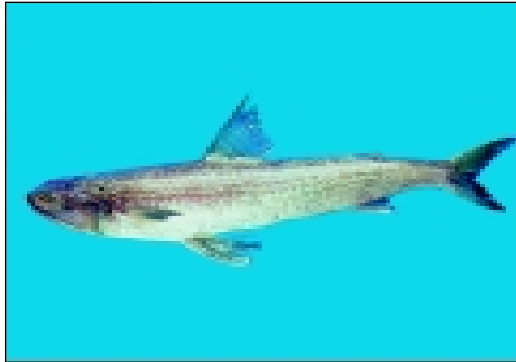
| Centres            | States               | Jan. | Feb. | Mar. | Apr. | May  | Jun  | Jul. | Aug.  | Sep.  | Oct.  | Nov. | Dec.  |
|--------------------|----------------------|------|------|------|------|------|------|------|-------|-------|-------|------|-------|
| Veraval            | Gujarat              | 92.5 | 49.3 | 34.0 | 46.2 | 18.5 | -    | -    | -     | 80.2  | 124.4 | 80.4 | 238.5 |
| Mumbai             | Maharashtra          | 7.6  | 6.0  | 8.2  | 7.8  | 10.6 | 4.8  | 0.6  | 7.2   | 22.0  | 16.3  | -    | -     |
| Calicut            | Kerala               |      |      |      |      |      |      |      |       |       |       |      |       |
| a.Puthiappa        |                      | 0.3  | 8.7  | 11.6 | 40.6 | 15.4 | -    | -    | 122.8 | 97.6  | 41.3  | 3.2  | 5.0   |
| b.Bey pore         |                      | -    | 3.2  | 11.2 | 25.5 | 38.6 | 4.5  | -    | 84.0  | 77.2  | 76.1  | -    | -     |
| Cochin             | Kerala               | 0.1  | 1.9  | 10.1 |      | 15.8 | 45.9 |      | 52.1  | 193.2 | 47.4  | 4.8  | -     |
| Chennai            | Tamil Nadu<br>(C/hr) | 0.2  | 0.3  | 0.2  | 0.5  | 0.4  | 0.6  | 0.8  | 0.7   | 0.9   | 0.8   | 0.5  | 0.4   |
| Visakha-<br>patnam | Andhra<br>Pradesh    | 17.8 | 7.3  | 6.0  | 3.6  | -    | 10.2 | 11.0 | 17.2  | 34.3  | 22.8  | 25.1 | 22.7  |

#### Depthwise landings

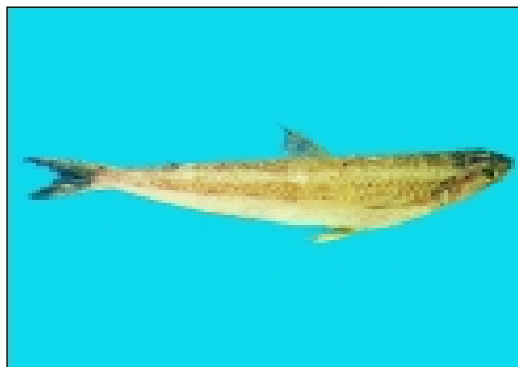
The present fishing fleet including the mechanised boats and offshore shrimp trawlers operate from within 70m depth. However, exploratory surveys conducted along the Indian EEZ have indicated that the abundance of lizardfish increased from 20-40 m depth upto 150-200 m depth.

#### Species composition

Along the west coast of India, lizardfish fishery is represented by species such as the greater lizardfish, *Saurida tumbil* (Fig. 3)

Fig. 3. *Saurida tumbil*

brush toothed lizardfish, *S.undosquamis* (Fig. 4); blunt nose lizardfish,

Fig. 4. *Saurida undosquamis*

*Trachinocephalus myops* (Fig. 5) and *Synodus englemani*. Along the east coast, other species such as *Saurida longimanus* (Fig. 6) and *S. micropectoralis* (Fig. 7) also have been found to contribute to the fishery.

The vernacular names of the two dominant species such as *S.tumbil* and *S.undosquamis* followed in the different maritime states are almost same. They are

known as Bhungar in Gujarat, Chor bombil in Maharashtra, Arana meenu in Karnataka, Arana meen/Uluvachi/Veepili in Kerala, Thumbili in Tamil Nadu, and Budinote/Andolla in Orissa.

#### Changes in species composition

It has been observed that off Veraval, along the north west coast of India, the contribution of *S.tumbil* was found to increase from 75% during 1995 to 94%

during 2001 with a corresponding decrease in the catch of *S.undosquamis* from 25% in 1995 to 6% during 2001. Likewise, at Cochin, also an increase in the



Fig. 5. *Trachynocephalus myops*



Fig. 6. *Saurida longimanus*

contribution of *S.tumbil* from 23% during 1994 to 73% in 2000 was noticed with the percentage contribution of *S.undosquamis* decreasing from 77% to 26% during 1994 to 2001. It is interesting to note that a regional variation exists in the distribution of the two major species such as *S.tumbil* and *S.undosquamis*, the former being dominant along the northwestern centres such as

Veraval (Gujarat) and Bombay (Maharashtra). Along the east coast, at Chennai, *S.undosquamis* formed 100% of the landings. However, at Visakhapatnam species such as *S. micropectoralis* and *S.longimanus* also have been found to occur in the catches.

#### Length composition

*S.tumbil* examined during 1997-2002 at Veraval (Gujarat) showed a maximum size of 559 mm with a corresponding high mean size (322 mm in 2001-02) when compared to that observed at Cochin where the maximum size obtained was only 475 mm (mean size: 286 mm in 2001-02). Likewise, in *S.undosquamis*, the maximum size (315 mm) and

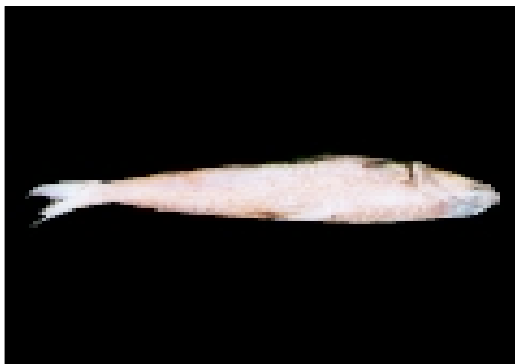


Fig. 7. *Saurida micropectoralis*

mean size (188 mm) observed were lower at Chennai than at Cochin (maximum size: 370 mm; mean: 255 mm). Such regional variations in the size range may be attributed to various biotic and abiotic factors including smaller mesh size of the gears used.

#### Contribution of juveniles to the landings

Juveniles of *S.undosquamis* constituted 48.2%, 54.7%, 32.1%, 40.2% and 50.7%, of the exploited population during 1997-98, 98-99, 99-2000, 2000-01 and 2001-02 respectively at Chennai. The exploitation of juveniles was very high during February-May (more than 50%) and low during November (less than 30%). The reason for this may be attributed to smaller cod end mesh size (10-15 mm) used in the trawl net.

#### Utilization of landings

In India, lizardfishes constitute about 3-4% of the bycatch in shrimp trawlers and fish above 20cm are used for human consumption, while smaller ones are used as animal feeds and fertilisers. Of the species used for human consumption, *S.tumbil* has better acceptance when supplied in fresh condition. Lizardfishes in general are graded "Very Good" for the preparation of Surimi. In Thailand, one particular item that has found both export and local marketing success is fish "Satey" made from lizardfish (*Saurida* spp.). While the flesh of *S.tumbil* is used for the preparation of fish sauce, its dried air bladder is also used for preparation of fish maws (isinglass). Though a by catch of shrimp trawlers, the multifarious utilisation of these have also helped in alleviating the problem of traditional fishermen with alternate income generating opportunities.

#### Biology of *Saurida tumbil* (Bloch)

Spawning periodicity: Spawning and spent females were observed from September to March off Veraval and Bombay along North west coast compared to ovaries in stage V-VII recorded during August to November off Cochin. Along the north western part of the Bay also the species indicated a protracted spawning extending from October to March with a peak during November to December.

Size at maturity of *S.tumbil* off Mumbai was estimated as 228 mm. At Mangalore, it was 250mm and 264mm in male and female respectively.

Fecundity in *S.tumbil* off Mumbai ranged between 39,106 - 76,110 compared to 33,759- 2,14,981 eggs observed in fishes caught off Karnataka.

The ratio of males to females in *S.tumbil* off Bombay was 1:1.23 thus showing significant departure due to preponderance of females

Food habits: The juveniles of *S.tumbil* studied along Madras coast fed chiefly on crustaceans (*Lucifer*, *Acetes*, *Mysis*) and fishes (*Stolephorus* spp., *Gazza* spp. and *Clupeids*) while the adults fed mainly on prawns (*Penaeus* spp.) and on larvae and adults of teleost fishes such as *Stolephorus* spp., *Engraulis* spp., *Trichiurus* spp.,

and *Leiognathus* spp. Besides, small amount of copepods, cirripid larvae, larval decapods and *Sagitta* spp. also were found in the stomach of adults of *S.tumbil*.

Length-weight relationship:

Males :  $\text{Log } W = -2.02504853 + 2.9208636 \text{ Log } L$  ( $r = 0.98283187$ )

Females :  $\text{Log } W = -2.2256211 + 3.1082118 \text{ Log } L$  ( $r = 0.99286271$ )

Growth: *S.tumbil* off Veraval coast showed an  $L_{\infty} = 544$  mm at a K value of 0.74/year. The species studied off Bombay showed an  $L_{\infty} = 547$  mm at an annual K value of 0.8.

Biology of *Saurida undosquamis* (Richardson)

Spawning periodicity: *S.undosquamis* has been reported to have an extended spawning season from October to March with a peak in November-December along the upper east coast as well as off Mumbai, Mangalore and Cochin.

Fecundity: The fecundity of *S. undosquamis* in the size range of 257-320 mm varied from 16,542 to 78,942 along the upper east coast. The species in the size range of 178-316 mm at Mangalore indicated a fecundity varying from 32,529 to 1,91,924 compared to 1,23,162-1,26,805 eggs observed in specimens collected off Mumbai. At Mangalore, the sex ratio between males and females of *S.undosquamis* was 1:1.84.

Length at first maturity: The minimum size at maturity of *S.undosquamis* along the upper east coast is 240 mm while along Karnataka coast males and females have been found to mature at 167 mm and 207 mm respectively. Off Cochin, the species has been found to mature when 205 mm in total length.

Food habits: The fish is a carnivore and cannibalistic. Stomach contents of *S.undosquamis* observed from Bombay waters contained teleost fishes as the major food item (68%) followed by cephalopods (27%) and crustaceans (3.5%). The species within the size range of 17.5cm to 24.5cm was found to feed on *Caranx* spp., *Secutor ruconius*, *Tetraodontidae*, *Nemipterus* spp., and teleost remains. Fishes (*Stolephorus* spp.; *Saurida* spp., *Nemipterus* spp.; *Platycephalus*, *Leiognathus* and *Cynoglossus*) followed by cephalopods (*Loligo*) and crustaceans (*Parapenaeopsis stylifera*, *Soloenocera* spp.) were the major food items of *S.undosquamis* off Karnataka. Studies at Cochin revealed that the species preferred fishes, crustaceans, etc. as the major food items.

Length weight relationship:

Males :  $\text{Log } W = -5.12721 + 3.001526 \text{ Log } L$  ( $r = 0.980003$ )

Females :  $\text{Log } W = -5.72846 + 3.249100 \text{ Log } L$  ( $r = 0.971692$ )

Growth: At Visakhapatnam, the growth parameters of the species observed were  $L_{\infty} = 395$  mm,  $K = 0.31/\text{yr}$ . The mortality rates estimated were  $Z = 1.81$ ,  $F = 1.05$ ,  $M = 0.76$  and  $E = 0.476$ .



The growth parameters estimated were  $L_{\infty} = 379$  mm,  $K = 0.6/\text{yr}$  while the mortality rates were  $Z=2.69$ ,  $M = 1.18$ ,  $F = 1.51$ ,  $E = 0.686$  at Cochin. Off Maharashtra the species indicated an  $L_{\infty}$  of 421 mm and a  $K$  value of 0.51. The mortality parameters were  $F = 1.42$ ,  $Z=2.52$  and the Exploitation rate 0.56.

### 1.3. Management strategies

As a conservation measure to protect the spawning and juvenile population, the governments of various maritime states have implemented a ban on trawling as detailed below:

Along the Veraval coast, during June to September period, fishing activity is suspended depending upon the monsoon. Off this coast, fishing is reported to be affected by cyclones, increase in fuel and labour charges and other security measures. Along Kerala coast, a ban on trawling is imposed every year for 45 days from 15 June. Along the east coast, Government of Tamil Nadu observes a closed season on fishing for 45 days from 15 April from 2001 onwards. The Government of Andhra Pradesh also is imposing a complete ban for 45 days from 16 April to 30 May from 1999 onwards.

## 2. Pomfrets

### 2.1. Introduction

Pomfrets are one of the most delicious food fish available along Indian coast. These fishes are of export quality and command high unit value. This endearing resource caught in trawl, gill net and dol net of late is under threat of overexploitation and hence warrants measures of conservation. The present account discusses the status of the fishery and biological aspects of the pomfrets and stipulates management interventions required to sustain production.

### 2.2. Production trend

Pomfret landings indicated a steady increase from 13,600t in 1951-55 to 47,200t during 1981-85, which however, declined to 38,300t in 1986-90 and to 40,200t and 41,000t during 1991-95 and 1996-99 respectively. The contribution of pomfrets fishery to total marine landings in India however, showed fluctuating trend ranging between 1.7% in 1996-99 to 3.1% during 1981-85 period. (Fig. 8).

#### Statewise landings

Maharashtra with an average catch of 11,958 t (31.2%) contributed to the maximum of pomfret landings in India during the period 1985-95. Gujarat accounted for the



Fig. 8. All India landings of Pomfrets during 1951-99

next higher landings (9,809t; 25.6%) followed by Orissa (4,218t; 11%), Andhra Pradesh (3,308t; 8.6%), West Bengal (2,325t; 6.1%), Kerala (2,034t; 5.31%) and Tamil Nadu (1,534; 4%) (Fig. 9). It has been reported that Mahanadi River and Sandhead region are productive fishing grounds for pomfrets.

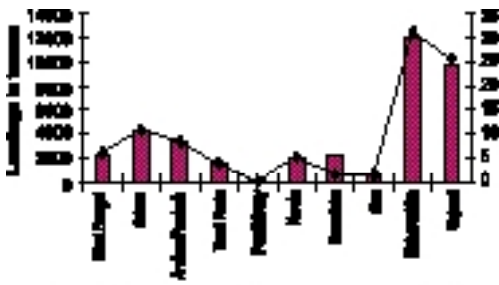


Fig. 9. Statewise average landings of Pomfret in India during 1990-93

#### Seasonal abundance

An evaluation of the seasonal abundance of pomfret landings during the period 1985-93 showed that off Maharashtra and Gujarat the catch was more during the IV and I quarters. Along Karnataka coast, III and IV quarters were productive while off Kerala, IV quarter brought higher catches (Table 2).

Table 2. Quarterwise production (tonnes) of pomfrets in India during 1990-93

|     | Kerala |      |      |     | Karnataka |      |      |      | Maharashtra |      |      |      | Gujarat |      |      |    |
|-----|--------|------|------|-----|-----------|------|------|------|-------------|------|------|------|---------|------|------|----|
|     | I      | II   | III  | IV  | I         | II   | III  | IV   | I           | II   | III  | IV   | I       | II   | III  | IV |
| 90  | 203    | 1162 | 1143 | 296 | 106       | 251  | 1702 | 3236 | 2008        | 2913 | 4877 | 1436 | 1139    | 1637 | 2511 |    |
| 102 | 108    | 240  | 793  | 204 | 49        | 1287 | 1436 | 2870 | 2398        | 2679 | 8349 | 2444 | 1136    | 2841 | 3594 |    |
| 346 | 223    | 223  | 1809 | 153 | 150       | 908  | 1020 | 2456 | 1318        | 1546 | 2764 | 2411 | 1673    | 2611 | 2736 |    |
| 534 | 518    | 373  | 1229 | 503 | 238       | 187  | 1309 | 1874 | 3750        | 597  | 3119 | 1321 | 1126    | 2594 | 5881 |    |

#### Gearwise landings

Pomfret landing during 1997-98 to 2000-01(average) at Mumbai was contributed by gill net (685.5t; 50.2%), followed by trawl (664.1t; 48.6%) and dol net (16.14t; 1.2%).

#### Depth wise landings

Exploratory surveys conducted off northeast coast indicate that pomfrets occur in depth zone from 20-75 m with higher catch rates realized from 20-40 m and from 70-75 m. The catch was poor from 45-65 m depth. The high yield in shallow and deeper waters and low yield in the zones of moderate depth is suggestive of their possible migration from deeper to shallow areas and vice versa.



Fig. 10. Pampus argenteus

### Species composition

The pomfret resource is represented by the silver pomfret (*Pampus argenteus*; 62.5%) (Fig. 10), black pomfrets (*Parastromateus niger* = *Apolectus niger* = *Formio niger*), 34.5%) (Fig. 11) and the Chinese pomfret (*Pampus chinensis*, 2.98%). Though the black pomfret does not belong to the family Stromateidae, the information available on the species also is presented here.

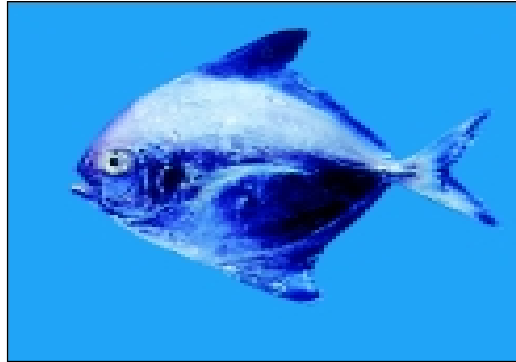


Fig. 11. *Parastromateus niger*

The vernacular name of the silver pomfret is Vichudo in Gujarathi (G), Paplet/Saranga in Marathi (MR), Boldhu manji in Kannada (K), Veluthavoli in Malayalam (M), Vellavaval in Tamil (TN), Tella chandua in Telugu (T), Ghee chandi in Oriya (O) and Baul chandi in Bengali (B).

The Chinese pomfret is called Kefro vichudo (G), Kalwad/Kafri (MR), Veluthavoli (M), Vella vaval (TN), Dhala chandi (O) and Firka (B). The black pomfret is known as Halvo/Adadio (G), Halwa (MR), Kappu manji (K), Karuthavoli/Machan (M), Karuvava (TN), Nalla chandua (T), Kalachandi/Bahala (O) and Baul (B).

Silver pomfret was more represented from Maharashtra and Gujarat, Orissa and Andhra Pradesh while black pomfret was landed the maximum from Maharashtra, Gujarat, Karnataka and Andhra Pradesh. The Chinese pomfret supports a minor fishery and the maximum production was from Karnataka (Fig. 12).

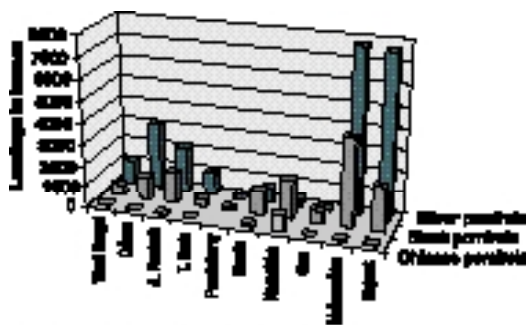


Fig. 12. Catch (t) of different species of pomfrets in India during 1985-86 (Average)

size range of 61-309 mm and a mean size of 109.5 mm. Recent studies indicated that the size range of *P. argenteus* was 110-360 mm in the drift net, 110-330 mm in trawl and 15-299 mm in dol net.

### Length composition

An evaluation of the data collected during 1997-02 (average) showed that *P. argenteus* landed at Mumbai by trawl were mostly in the size range of 51-319 mm (mean size 125.7 mm) while those exploited by gill net were in the size range of 71-349 mm (mean size of 188.7 mm). The species caught off Versova (Mumbai) showed a

#### Contribution of juveniles to the landings

Off Mangrol along Gujarat coast, unusually heavy landings of juveniles of *P.niger* by gill net (50-55 mm mesh size) to the tune of 25 t is reported (Fig.13). Simultaneously, the trawlers off Veraval also landed juvenile black pomfrets to the tune of about 10-50 kg/boat.

The price of juveniles was only Rs. 5-6/kg while adults fetched a higher rate of Rs. 50-60/kg. Further the capture of juveniles during 1996 has resulted in a decline in landings of *P.niger* during 1998-99 period. These observations warrant regulatory measures such as increasing the mesh size to prevent capture of juvenile pomfrets.



Fig. 13. Juvenile of *Parastromateus niger*

#### Utilization of landings

Pomfrets in fresh condition are in good demand though a portion is deep frozen and stored for future use, filleted and frozen for export trade or brined and sundried. The larger specimens of pomfrets are sorted out from bycatch and sold fresh as well as in dry condition, which fetch higher price than mixed species.

#### Biology of *Pampus argenteus* (Euphrasen)

**Spawning periodicity:** Studies made on the maturation and spawning of *P.argenteus* off Orissa, indicated that the species has a prolonged spawning period extending from February to August with 2 peaks during February to April and during June to August. The size at maturity of the species was observed to be 150 mm (SL) for males and 170 mm (SL) for females. The fecundity ranged between 40,610 to 90,640 eggs in specimens measuring between 191-238 mm (SL). Sex ratio between males and females was 1:1.09.

**Food habits:** Specimens of *P.argenteus* within a size range of 18 mm to 26 mm were found to feed on copepods (*Paracalanus parvus*), *Oithona* spp., *Euterpina* spp., *Macrosetella* spp., *Temora* spp., *Acartia* spp., Harpacticoid copepods) ostracods, amphipods, larval stages of squilla and Lucifer. Filamentous algae mainly *Trichodesmium* spp. were also encountered in the diet. In the adults of *P.argenteus*, crustaceans such as copepods (*Oithona* spp., *Euterpina* spp., and *Eucalanus* spp.), copepod nauplii, ostracods, amphipods, lucifer and zoea larvae were noticed. They were also found to feed on larger crustaceans (*Penaeus* spp., *Acetes* spp., squilla, and anomurans). Other food items encountered were polychaetes, larval decapods, foraminiferans, *Sagitta* spp. and sand particles. The species indicated different feeding habits at different depths.

### Biology of *Parastromateus niger* (Bloch)

The spawning season extends from July to October with peak during August/September off Saurashtra coast. The appearance of juveniles during September corroborates the spawning period determined for the species. Sex ratio between males and females was 1:1.1. Size at maturity for females was 32 cm and 30 cm for males.

Food habits: *P.niger* is a carnivore mainly feeding on zooplankton (Thaliaceans, prawns), fish scales, crustacean larvae, amphipods, cuttle fish remains, polychaetes and medusae.

### Biology of *Pampus chinensis* (Euphrasen)

Compared to other species, the Chinese pomfrets is less attempted for biological studies. The species feeds mainly on zooplankton (copepods, jellyfishes and decapods) with less preference to phytoplankton. In contrast to other pomfrets, the Chinese pomfret does not change the larval habitat and remains surface feeder throughout its life.

Length-weight relationship:

*P.argenteus* (pooled for male and female)

$$\text{Gujarat} \quad : \quad \text{Log } W = -4.67166 + 3.07696 \text{ Log } L.$$

$$\text{Maharashtra} \quad : \quad \text{Log } W = -4.49568 + 3.005864 \text{ Log } L.$$

*P.niger* (pooled for male and female)

$$\text{Kerala} \quad : \quad \text{Log } W = -4.26513 + 2.7921841 \text{ Log } L.$$

Growth: The growth parameters of pomfrest are given in Table 3.

Table 3. Growth parameters of various species of pomfrets

| States      | Growth parameters        | <i>P.argenteus</i> | <i>P.niger</i> |
|-------------|--------------------------|--------------------|----------------|
| Gujarat     | $L_{\infty}$ (mm)        | 395                | -              |
|             | $K$ ( $\text{yr}^{-1}$ ) | 0.7                | -              |
| Maharashtra | $L_{\infty}$ (mm)        | 390                | -              |
|             | $K$ ( $\text{yr}^{-1}$ ) | 0.7                | -              |
| Karnataka   | $L_{\infty}$ (mm)        | 360                | -              |
|             | $K$ ( $\text{yr}^{-1}$ ) | 0.69               | -              |
| Kerala      | $L_{\infty}$ (mm)        | -                  | 560            |
|             | $K$ ( $\text{yr}^{-1}$ ) | -                  | 0.73           |

### 2.3. Stock assessment

Information available on the stock assessment of pomfrets from some of the maritime states are given below.

*Pampus argenteus*: Off Gujarat, the instantaneous mortality co-efficient ( $Z$ ) was 3.165 for the period 1981-84. The relative  $Y_w/R$  indicated  $E_{max}$  at 0.413 mm with  $L_c/L_{\infty}$  ratio of 0.12 and  $M/K$  was 1.5. MSY was estimated as 16,265t with an average yield of 10,038t with  $F/Z=0.668$  indicating a 38% reduction in effort. Low size at first capture ( $L_c=46$  mm) and high  $F/Z$  indicate growth overfishing.

Off Maharashtra, the studies during 1993-95 indicated the value of  $Z$  to be 4.033,  $F/Z=0.74$ ,  $L_c=232.2$  mm and  $B_{max}$  based on  $L_c/L_{\infty}=0.59$  and  $M/K=1.5$ . The present  $F/Z$  of 0.74 indicate scope for effort increase. The MSY based on the  $E_{max}$  (0.561) is estimated at 10,231t and the average current yield is 4,740 t.

Off Karnataka, the species has  $Z$  value of 5.054 and MSY 374 t with an average catch of 346 t. The relative fishing effort of 0.5 indicated that the stock of silver pomfret in this state is under heavy fishing pressure.

*Parastromateus niger*: In Kerala, the estimated  $Z$  was 4.4 and MSY 1,055 t at relative fishing effort of 0.8 suggesting the need to reduce the effort by 20%.

Karnataka also gave a similar trend with  $Z$  as 6.45 and MSY 1,856 t at a relative fishing effort of 0.413 indicating that the effort should be decreased by 60%.

### 3. Bullseye

#### 3.1. Introduction

The Bullseye or Bigeye (Family: Priacanthidae) is one of the major nonconventional fishery resources which of late has assumed significance as an emerging demersal fishery resource in the commercial landings. The nutritive value of bullseye compares well with that of other popular table fishes. Besides, they have good export potential as they are considered excellent food fishes in Japan and other south east Asian countries. Being an emerging resource in the commercial landings, information on their biology and population characteristics is not well documented. The following account, therefore, is an attempt to present the status of Bullseye resource in the Indian EEZ.

#### 3.2. Production trend

The landings of priacanthids were high at Beypore (818 t; 26 kg/E) and at Puthiappa 733 t; 21 kg/E) in Calicut; Veraval (522 t; 6 kg/E) and at Cochin (290 t; 10 kg/E) during 1996-97 which, however, showed a decline during 1997-98 and 1998-99 at all these centres. At Mumbai, along Maharashtra coast, the catch increased from 237 t (5 kg/E) during 1996-97 to 743 t (26 kg/E) in 1998-99. At centres along the east coast (Tamil Nadu and Visakhapatnam) the catches were low, but indicated an increasing trend in landings during the study period (Table 4). Being an emerging resource, the percentage contribution of bullseye in the total marine landings was low ranging between 0.1% to 3% at various centres.

Table 4. Catch particulars of Bullseye (*Priacanthus* spp.) landed at selected centres along the Indian coast during 1996-99.

| Coast/<br>zone State | Centre /<br>subcentre | Depth<br>of<br>operation<br>(m) | Bullseye 1996 - 97 |            |   | Bullseye 1997- 98 |              |   | 1998 - 99                |              |   |     |
|----------------------|-----------------------|---------------------------------|--------------------|------------|---|-------------------|--------------|---|--------------------------|--------------|---|-----|
|                      |                       |                                 | landings<br>(t)    | CPUE<br>Kg | % in<br>total<br>marine<br>landings of<br>the centres | landings<br>(t)   | CPUE<br>(kg) | % in<br>total<br>marine<br>landings of<br>the centres | Bullseye<br>landings (t) | CPUE<br>(kg) | % in<br>total<br>marine<br>landings of<br>the centres |     |
| West coast           |                       |                                 |                    |            |   |                   |              |   |                          |              |   |     |
| Gujarat              | Veraval               | 80-100                          | 522                | 5.8        | 0.58  | 294               | 3.2          | 0.3   | 291                      | 5.0          | 0.54  |     |
|                      | Mangrol               | 80-100                          | 76                 | 3.0        | 0.39  | 41                | 1.8          | 0.2   | 70                       | 3.6          | 0.44  |     |
| Maharashtra          |                       |                                 |                    |            |   |                   |              |   |                          |              |   |     |
| NFW/SD               | Mumbai                | 20-75                           | 237                | 5.3        | 0.58  | 548               | 17.8         | 0.58  | 743                      | 26.3         | 1.58  |     |
| Kerala               |                       |                                 |                    |            |   |                   |              |   |                          |              |   |     |
|                      | Calicut               | a) Puthiappa                    | 20-80              | 733        | 20.6  | N.A               | 208          | 4.9   | N.A                      | 94           | 3.4   | N.A |
|                      |                       | b) Beypore                      | 40-140             | 818        | 25.9  | N.A               | 268          | 9.2   | N.A                      | 241          | 10.2  | N.A |
|                      | Cochin                | 30-150                          | 291                | 10.5       | 2.06  | 208               | 8.3          | 1.55  | 164                      | 8.9          | 0.87  |     |
| East coast           |                       |                                 |                    |            |   |                   |              |   |                          |              |   |     |
| T.Nadu               | Chennai               | 10-80                           | 72                 | 0.093*     | 0.27  | 35                | 0.04*        | 0.13  | 189                      | 0.14*        | 0.59  |     |
| A.Pradesh            | Visakha-<br>patnam    | 20-60                           | 21                 | 2.6        | 0.99  | 71                | 5.8          | 2.06  | 90                       | 9.0          | 2.27  |     |

NFW = New Ferry Wharf, S.D. = Sasoon Dock, N.A = Data not available, \* = Catch rate in Kg / hr.

#### Seasonal abundance

Bullseye landings along Veraval, Mangrol and Mumbai indicated two peaks during January- March and October-December period. At Calicut, the peak landing was observed during December-March, July-September and November-December period, while at Cochin, the peak production was during August and October. Along the east coast, bullseye landings at Chennai indicated a distinct peak during July-September period, while at Visakhapatnam, higher catch rates were obtained during March-April and July (Table 5).

Table 5. Monthly variation in CPUE\* at selected centres along the Indian coast (Av. 1996-99)

| Months | Centres and CPUE |         |        |           |        |                    |         |
|--------|------------------|---------|--------|-----------|--------|--------------------|---------|
|        | Veraval          | Mangrol | Mumbai | Calicut # | Cochin | Visakha-<br>patnam | Chennai |
| Jan    | 8.0              | 2.6     | 29.1   | 39.3      | 6.4    | 3.9                | 0.0     |
| Feb    | 3.7              | 3.7     | 31.2   | 63.9      | 6.4    | 3.1                | 0.1     |
| Mar    | 6.5              | 6.7     | 25.9   | 29.6      | 2.6    | 8.5                | 0.0     |
| Apr    | 3.1              | 2.1     | 9.3    | 15.9      | 2.6    | 6.8                | 0.0     |
| May    | 1.9              | 2.9     | 18.6   | 18.3      | 9.0    | 2.9                | 0.0     |
| Jun    | 0.0              | 0.0     | 0.0    | 13.3      | 8.3    | 1.5                | 0.1     |
| Jul    | 0.0              | 0.0     | 0.7    | 0.0       | 8.4    | 11.0               | 0.4     |
| Aug    | 0.0              | 0.0     | 2.3    | 24.8      | 12.5   | 4.6                | 0.2     |
| Sep    | 2.9              | 0.8     | 0.5    | 8.7       | 15.2   | 4.4                | 0.1     |
| Oct    | 3.4              | 2.4     | 5.5    | 0.3       | 13.4   | 5.5                | 0.0     |
| Nov    | 5.0              | 0.8     | 15.2   | 12.6      | 8.5    | 3.7                | 0.0     |
| Dec    | 0.0              | 6.4     | 6.7    | 27.8      | 9.3    | 5.5                | 0.0     |

#= CPUE for Beypore and Puthiappa are given together

\* = CPUE in Kg/hr.

#### Gearwise and depth wise landings

The trawlers only exploit the resource. In general, depth of operation of trawlers was 20-150 m along the west coast and 10-80 m depth along the east coast. However, exploratory surveys indicated that the maximum abundance of the Bullseye is in the 80-300 m depth zone in the Indian EEZ.

#### Species composition

A total of 4 species of Priacanthids namely Priacanthus hamrur (Fig. 14), P. macracanthus, P. tayenus and P. blochii were reported from Indian seas. However, only P. hamrur (Forsskal) formed the most dominant species recorded in the commercial landings though another species namely Cookeolus boops (Fig. 15) was also represented from Veraval and Cochin. P. hamrur (dusky-finned bullseye) is called Rotado/Dorali in Gujarathi, Disco menu in Kannada, Chempallikutty in Malayalam and Yerrichappalu in Telugu. The blood-coloured bullseye (P. cruentatus) is called Alta punti in Oriya and Bengali.



Fig. 14. Priacanthus hamrur



Fig. 15. Cookeolus boops

#### Length composition

P. hamrur caught off Veraval were in the size range of 121-339 mm (mean size = 214 mm) while at Mumbai the size range of the species landed was 61-309 mm (mean size = 178 mm). At Cochin the size range noticed varied from 115-349 mm (234 mm).

#### Contribution of juveniles

At Mumbai, younger size groups (61 mm onwards) were also represented in the catches especially during September and December.

#### Utilization of landings

Bullseye are among those fishes used for the preparation of fish balls, noodles, sauces and seasonal minces in the south east Asian countries like Thailand. With a higher protein content of 20.8% (on wet weight basis), the fish powder produced from the edible meat of P. hamrur is reported to have a balanced amino acid content. Other products prepared are fishmeal from filleting wastes.



### Biology of *Priacanthus hamrur* (Forsskal)

Spawning periodicity: The ovaries and testes could be identified in 7 successive maturity stages. *P.hamrur* off Cochin has a protracted spawning season extending from April- July shedding two batches of eggs. The size at maturity is 181-190 mm for males and 191-200 mm for females. Fecundity ranged between 1,55,800-7,22,313. Sex ratio showed dominance of females in the population. In *P.macracanthus* the spawning period is short. Spawning takes place from November to February off Visakhapatnam and the species has been found to shed a single batch of eggs. The average fecundity is 1,09,411

Food preference: *P.hamrur* is a carnivore, feeding mainly on pelagic crustaceans followed by fishes and smaller molluscs. Among crustaceans, Euphausiids, which occupied second rank in the menu was the most preferred food item followed by crabs (*Megalopa* larvae of *Brachyuran* crab, *Porcellanid* crab, *Portunus* spp.) penaeid shrimps and stomatopods (*Squilla* and *Alima* larvae) were represented in the diet. Among teleosts a variety of species such as *Stolephorus* spp., silverbellies, *Saurida* spp, flatfishes and flatheads were the next preferred group. Juveniles of squids, cuttlefish and *Octopus* spp., and also smaller gastropods dominated the molluscan components in the diet.

Length-weight relationship:

Males :  $-4.034868+2.626081 \log L$  ( $r = 0.981071$ )

Females :  $-4.307500+2.743857 \log L$  ( $r = 0.984473$ )

Growth and life span: Off Maharashtra coast, the species indicated an  $L_{\infty}$  of 345.5 mm and a K value of  $0.66 \text{ yr}^{-1}$  but along the northeast coast the values obtained were 283.9 mm and 0.37 respectively. The estimated fishing mortality (F) was 1.57, total mortality (Z) 2.50 and the exploitation rate (E) 0.627. *P.hamrur* attains a total length of 171 mm, 260 mm, 308 mm and 334 mm during the I-IV year of its life respectively.

### 3.3. Stock assessment

The biomass of Bullseye has been estimated as 3.95 lakh t. Later studies during 1993 indicated the biomass to be 1.17 lakh t from the Indian EEZ. The potential yield estimated by different authors also varied from 54,000 t to 1 lakh for an area of 1,58,500 sq.km in the EEZ. In exploratory surveys, such variations in the estimation are expected depending upon specification of the gears, the extent of the area fished and the season. Therefore, a detailed analysis of the commercial landings of Bullseye resource is essential to obtain an idea about the potential availability of the resource from the Indian seas.

### 3.4. Management

About two decades ago the Bullseye were considered a non-conventional resource. With expansion of the fishing to deeper grounds the fish is a common sight in most of the markets. However, the resource has not gained marketability

and acceptance mostly due to the lack of information regarding the nutritive value. Because of their comparatively deep water habitat, they are not accessible to the commercial trawlers except during the movement of the resource towards the inshore waters. It is therefore suggested that while attempts are made to exploit this resource from the deeper waters using more sturdy vessels, it is all the more necessary to popularise this item both in the fresh condition and as by products.

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