Estimation of mortality rates, exploitation rates and ratios of Lepturacanthus savala (Cuvier) and Eupleurogrammus muticus (Gray)

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ABSTRACT
The contribution of ribbonfish to the total fish catch in the world has gone up from 1.1% in 1990 to 1.8% in 1998. However, ever since the pressure has increased in the coastal waters, the catches have started showing signs of decline. The same is also reflected in two species, Lepturacanthus savala and Eupleurogrammus muticus recorded from the dol net in Mumbai waters. In the present investigation the mortality rates and ratios of two species of ribbonfish are recorded. The pooled total, natural and fishing mortality of the former species is 4.15, 1.30, and 2.86 respectively whereas that of the latter species is 4.31, 1.15 and 3.16 respectively. The pooled exploitation ratio (E) and exploitation rate (U) of L. savala and E. muticus were 0.68 & 0.66 and 0.73 & 0.72 respectively. Though for both the species the E is well beyond the optimum E of 0.5, for E.muticus it is very much on the higher side. Thus, a reduction in the fishing effort is required to prevent future damage to the stock.

Introduction
Ribbonfishes are widely distributed in tropical and semitropical seas of the world, but commercial fishery have been reported only in few countries. The total ribbonfish fishery ranged from 877,104 to -10,683,364 t, contributing an average of 1.3% of the total marine fish landings in the world during 1991-98 (FAO, 1998).

Of the various species of ribbonfish, Trichiurus lepturus forms a good commercial fishery in China, India and Gulf of Mexico; Lepidopus caudatus in Portugal, South Africa and New Zealand; Aphanopus carbo in Portugal and France; and the other species of the family Trichiuridae in India, Korea, Oman, Nigeria, Indonesia, Hong and Philippines (FAO, 1997).

Ribbonfish is one of the important fishes in India with annual average production of around 1.07 lakh tonnes, contributing 4.57% to the total marine
Fish production during 1998. Among the exploited marine fishes of India, ribbonfish constitute an important component of pelagic species, ranking fifth among the finfishes and seventh in the various groups landed in 1998 (CMFRI, 2000).

During 1997-99 a total of 6,921.09 t of ribbonfish was landed by trawlers in Mumbai coast with species composition, T. lepturus 78.8%, L. savala 21.8% and E. muticus 3.4%, whereas in dol net the catch was 304 t and species contribution was T. lepturus 18.3%, L. savala 17.8% and E. muticus 63.9%.

Investigations on mortality parameters of T. lepturus have been carried out (Somavanshi and Joseph, 1989; Chakraborty, 1990 and Mohite and Biradar, 2001) from the west coast and (Narasimhan, 1983, 1994ab, and Reuben et al., 1997) from the east coast of India. However, there is no information about the mortality estimation of L. savala and E. muticus. In the present communication and attempt is made in this direction for the two species of ribbonfishes in Mumbai waters.

**Materials and methods**

Monthwise catch and effort data for the trawlers based at New Ferry Wharf and Versova landing centre were collected from the Fishery Resource Assessment Division of CMFRI, Cochin for the period 1997-99. The length composition data for the two species were collected weekly and raised to the observation days of landing, pooled monthly to raise to the estimated monthly landing. The monthwise length frequency data were further pooled and finally raised to the annual total of each of the species. The catch data from dol net for E. muticus (3965 specimens) were collected from Versova and Vasai landing centers and catch data from trawl for L. savala (7532 specimens) were collected form New Ferry Wharf, Versova and Vasai landing centres.

Growth parameters viz, L∞ (asymptotic length), K (growth coefficient) and t0 were obtained by Gulland & Holt plot (1959) using FISAT and the value obtained were used as inputs in the present analysis.

The mortality parameters were obtained by using FISAT (FAO - ICLARM Stock Assessment Tools) software developed by Gayanilo et al. (1996), comprising methods of Pauly (1978) and Rikhter and Efano's (1976), and also the method followed by Cushing (1968) and Srinath (1998) for M (natural mortality coefficient), length converted catch carve (Pauly 1983, 1984 a & b), Jones and van Zalinge plots (1981) and Alagraraja's method (1984) for estimation of Z (total mortality coefficient). Fishing mortality (F) was estimated by Z-M. Exploitation ratio (E) and Exploitation rate (U) were expressed by following formulae:

\[ E = \frac{F}{Z} \]
\[ U = \frac{F}{Z} (1 - e^{-z}) \]

**Results and discussion**

The estimated growth parameters L∞, K and t0 were 688 mm, 0.87 per year and 0.000251 for L. savala and 811 mm, 0.78 per year and 0.00544 for E. muticus. The instantaneous rates of total and natural mortality coefficient of L. savala and E. muticus from Mumbai coast as estimated by different methods employed in the present investigation are given in Table 1 and 2 respectively. It is seen that annual total mortality varied from 2.9 to 4.82 for L. savala and 4.31 to 6.30 for E. muticus and natural mortality varied from 0.95 to 1.88 for L. savala and 0.83 to 1.54 for E. muticus.
The pooled instantaneous rate of total mortality coefficient (Z) for *L. savala* and *E. muticus* estimated by length converted catch curve method were 4.12 and 4.34 respectively (Figs 1&2). The values obtained by Jones and van Zalings and Alagarajas methods were 4.82 and for *L. savala* and 6.30 and 5.84 *E. muticus*. Hence the result of pooled instantaneous rate of total mortality coefficient (Z) as obtained by length converted catch curve method 4.12 (*L. savala*), 4.34 (*E. muticus*) were selected for further estimation.

The instantaneous natural mortality (M) as obtained by the methods followed by Cushing (1968), Pauly (1980), Alagaraja (1984), Rikhter and Efano (1976) and Srinath (1998) were 1.88, 1.30, 1.40, 0.95 and 1.34 for *L. savala* compared with 1.54, 1.15, 1.15, 0.83 and 1.20 for *E. muticus* (Table 2). The maximum size of *L. savala* and *E. muticus* encountered were 688mm and 775mm respectively. Therefore the Tmax were found to be 3.3 and 3.99 years for *L. savala* and *E. muticus* respectively. The size at 50% maturity were 517 mm for *L. savala* and 612 mm for *E. muticus*, thus the age of massive maturation for respective species were 1.57 years and 1.83 years (Rizvi, 2001). However, instantaneous natural mortality (M) estimated by Pauly's empirical formula with temperature 28°C were 1.30 and 1.15 for *L. savala* and *E. muticus* respectively which appeared to be more

### Table 1: Total mortality, exploitation rate and exploitation ratio of *L. savala* and *E. muticus* during 1997-99.

<table>
<thead>
<tr>
<th>Methods</th>
<th>L. savala</th>
<th>E. muticus</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>3.63</td>
<td>4.85</td>
</tr>
<tr>
<td>Jones and van Zalinge (1981)</td>
<td>3.80</td>
<td>5.08</td>
</tr>
<tr>
<td>Alagaraja (1984)</td>
<td>2.61</td>
<td>4.49</td>
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<tr>
<td>Exploitation rate and ratio</td>
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<td></td>
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<tr>
<td>Exploitation ratio (E)</td>
<td>0.64</td>
<td>0.73</td>
</tr>
<tr>
<td>Exploitation rate (U)</td>
<td>0.62</td>
<td>0.72</td>
</tr>
</tbody>
</table>

### Table 2: Natural mortality for *L. savala* and *E. muticus* by different methods during 1997-99.

<table>
<thead>
<tr>
<th>Methods</th>
<th>L. savala</th>
<th>E. muticus</th>
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</thead>
<tbody>
<tr>
<td>Cushing (1968)</td>
<td>1.88</td>
<td>1.54</td>
</tr>
<tr>
<td>Pauly (1980)</td>
<td>1.30</td>
<td>1.15</td>
</tr>
<tr>
<td>Alagaraja (1984)</td>
<td>1.40</td>
<td>1.15</td>
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<tr>
<td>Rikhter and Efano's (1976)</td>
<td>0.95</td>
<td>0.83</td>
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<tr>
<td>Srinath (1998)</td>
<td>1.34</td>
<td>1.20</td>
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reasonable estimation of $M$ (Table 2). The fishing mortality coefficient ($F$) obtained was 2.82 for \textit{L. savala} and 3.19 for \textit{E. muticus}. The pooled exploitation ratio ($E$) and exploitation rate ($U$) calculated for \textit{L. savala} and \textit{E. muticus} were 0.66 and 0.68 and 0.72 and 0.73 respectively (Table 1).

Beverton and Holt (1956) pointed out that the natural mortality coefficient ($M$) of a fish is directly related to the growth coefficient ($K$) and inversely related to the asymptotic length ($L_{\infty}$) and the life span. In other words, fishes with higher growth coefficient have higher natural mortality and shorter life span, hence larger $L_{\infty}$ and those with longer life span have lower natural mortality coefficient and growth coefficient. The same appears to be true for the two species of ribbonfishes \textit{avala} which has comparatively higher growth coefficient ($K$) of 0.87 per year and lower life span of only 3.3 years was found to have relatively higher natural mortality coefficient of 1.30 per year as compared to \textit{E. muticus} with longer life span of 3.9 years, lower growth coefficient of 0.78 and natural mortality coefficient of 1.15 per year.

Among the ribbonfishes much work has been done on \textit{T. lepturus}, which is bigger in size with longer life span than \textit{L. savala} and \textit{E. muticus}. Various authors have reported natural mortality as 0.9 (Narasimhan, 1983), 1.08 (Ingles and Pauly, 1984), 0.8 (Somavanshi and Joseph, 1989), 1.05 (Chakraborty, 1990), 1.0 (Thiagarajan et al., 1992) and 0.7 (Mohite and Biradar, 2001) for \textit{T. lepturus}. Present estimates of natural mortality of 1.30 and 1.15 for \textit{L. savala} and \textit{E. muticus} respectively thus seem to be fairly reasonable.

The coefficient of total mortality of ribbonfishes increased in the year 1998-99. This may be attributed to increase in fishing effort. Similarly between the two species investigated \textit{E. muticus} showed higher total mortality than \textit{L. savala}, which may be attributed to higher fishing pressure on the former species.

\textit{E. muticus} is an inshore species which occurs in waters less than 30 m
depth and fished out by larger number of dol net. The dolnet at Versova, Vasai and Arnala regions are operated in 20-30 m depth using smaller cod end mesh of 10-15 mm size for the catch of non penaeid prawns (Raje and Deshmukh, 1989) which may be exploiting this resource very intensively. This is evident from the high exploitation rate (U) of 0.71 and 0.73 (Table 1) observed during both the years. On the other side L. savala is an offshore pelagic species therefore, is not as much vulnerable to intense dol net fishing. In the offshore region occurring at depth > 25-30 m off Mumbai, fishing is largely carried out by gill nets and shrimp trawlers. Since gill nets are mainly bottom set, L. savala is caught only occasionally. The shrimp trawlers being a demersal gear does not seem to exercises heavy pressure on this largely pelagic species, and hence the species did not show high exploitation ratio.

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**References**


