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

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ABSTRACT

The contribution of ribonfish 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 inthe 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 form 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 spcimens) were collected form New Ferry Wharf, Versova and Vasai landing centres.

Growth parameters viz, $L\infty$ (asymptotic length), K (growth coefficient) and t_0 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 Efanov'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:

$E=F/Z$ and $U=F/Z\ (1-e^{-z})$

Results and discussion

The estimated growth parameters $L\infty$, K and t_o 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 mortaliy 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 Efanov (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^{0}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.

Methods	*L. savala*			*E. muticus*		
Length converted catch curve (Pauly 1980)	1997-98 3.63	1989-99 4.85	Pooled 4.12	1997-98 4.11	1989-99 4.59	Pooled 4.34
Jones and van Zalinge (1981)	3.80	5.08	4.82	5.57	6.23	6.30
Alagaraja (1984)	2.61	4.49	2.9	4.05	6.67	5.84
Exploitation rate and ratio						
Exploitation ratio (E)	0.64	0.73	0.68	0.72	0.74	0.73
Exploitation rate (U)	0.62	0.72	0.66	0.71	0.73	0.72

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

Methods	*L. savala*	*E. muticus*
Cushing (1968)	1.88	1.54
Pauly (1980)	1.30	1.15
Alagaraja (1984)	1.40	1.15
Rickhter and Efanov's (1976)	0.95	0.83
Srinath (1998)	1.34	1.20

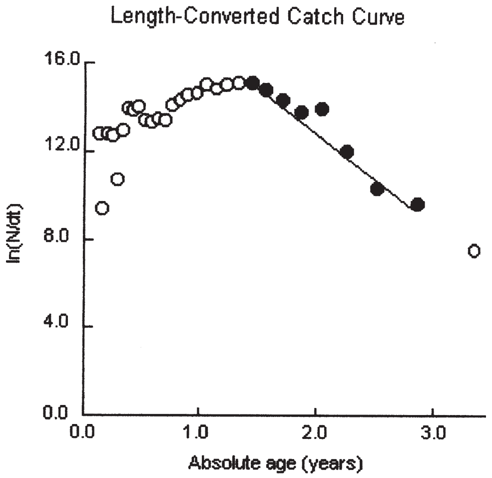

Fig.1. Estimation of total mortality for *L.savala* from length converted catch curve method.

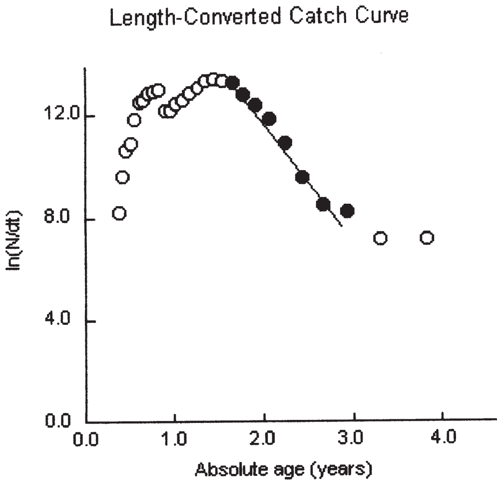

Fig.2. Estimation of total mortality for *E.muticus* from length converted catch curve method.

reasonable estimation of M (Table 2). The fishing mortality coefficient (F) obtained was 2.82 for *L.savala* and 3.19 for *E.muticus.* The pooled exploitation ratio (E) and exploitation rate (U) calculated for *L.savala* and *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 with higher growth coefficient have higher ntural mortality and shorter life spann, 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 *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 *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 doen on *T. lepturus,* which is bigger in size with longer life span than *L. savala* and *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 *T. lepturus.* Present estimates of natural mortality of 1.30 and 1.15 for *L.savala* and *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 *E. muticus* showed higher total mortality than *L. savala,* which may be attributed to higher fishing pressure on the former species.

E. muticus is an inshore species which occures 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 occasinally. The shrimp trawlers being a demersal gear does not seem to exercies heavy pressure on this largely pelagic species, and hence the species did not show high exploitation ratio.

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Referencs

Alagraaja, K. 1984. Simple methods for estimation of parameters for assessing exploited fish stocks. *Indian J. Fish.*, **31**: 177-208.

Beverton, R.J.H. and S.J. Holt 1956. A review of method for estimating mortality rates in exploited fish population, with special reference to source of bias in ctch sampling. Rapp. P. - V. Reun. *CIEM,* **140**: 67-83.

Chakraborty, S.K. 1990. Fishery, age, growth and mortality estimation of *Trichiurus lepturus* (Linnaeus) from Bombay waters. *Indian J. Fish.*, **37** (1): 1-7.

C.M.F.R.I. 2000. *Annual Report, Central Marine Fisheries Research Institute.*

Cushing, D.H. 1968. *Fisheries biology, A Study in Population Dynamics.* Univ. Wisconsin Press, Madison: 200pp.

FAO, 1997. *Fisheries statistics, catches and landings.* FAO Year book Vol-8, Rome 1997.

FAO, 1998. *Fisheries statistics, catches and landings.* FAO Year book Vol - 9, Rome 1998.

Gayanilo, F.C. Jr, P. Sparee and D. Pauly 1996. *FAO - ICLARM Stock assessment tools (FiSAT). Computer software package* (Ver-1.1, September, 1995) series manual. FAO computerized information series *(Fisheries)* **8:** 126pp.

Gulland, J.A. and S.J. Holt 1959. Estimation of growth parameters for data at unequal time intervals J. cons. *CIEM,* **25** (1): 47-49.

Ingles J. and D. Pauly 1984. An atlas of growth mortallity and recruitment of Philippine fishes. *ICLARM Tech. Rep.,* **13:** 1-127.

Jones, R. and N. P. van Zalinge 1981. Estimation of mortality rate and population size for shimp in Kuwait waters. *Kuwait Bull. Mar. Sci.,* **2:** 273 - 288.

Mohite, A. and R.S. Biradar 2001. Mortality estimation of Indian ribbonfish *Trichiurus lepturus* off Maharashtra coast. *J. Indian Fish. Assoc.,* **28:** 23-29.

Narasimham, K.A. 1983. On fishery, mortality rates and yield-per-recruit of ribbonfish *T. lepturus. Indian J. Fish.,* **30**: 99-109.

Narasimham, K.A. 1994a. Fishery and population of the ribbonfish *Trichiurus lepturus* Linnaeus, off Kakkinada. *J. mar. biol. Ass. India,* **36**: (1&2): 23-27.

Narasimham, K.A. 1994b. Maturity, spawning and sex ratio of the ribbonfish *Trichirurus lepturus* Linnaeus, off Kakkinada. *J. mar. biol. Ass. India,* **36** (1&2): 200-207.

Pauly, D. 1978. A discussion of the potential use in populatin dynamics of the interrelationships between natural mortality, growth parameters and mean environmental temperture in 122 stocks. *ICES, C.M. demersal fish committee,* **21**: 36pp.

Pauly, D. 1980. On the inter-relationships between natural mortality, growth parameters and mean environmental temperature in 175 fish stocks. *J. Cons. CIEM,* **39** (3): 175-192.

Pauly, D. 1983. Length - converted catch curves. A powerful tool for fisheries research in the tropics. (Part-I), *ICLARM fishbyte,* **1** (2): 9-13.

Pauly, D. 1984 a. Length - converted catch curves. A powerful tool for fisheries research in the tropics. (Part-II), *ICLARM fishbyte,* **2** (1): 17-19.

Pauly, D. 1984 b. Length - converted catch curves. A powerful tool for fisheries research in the tropics. (Part-III: Conclusion), *ICLARM fishbyte,* **2** (3): 9-10.

Raje S.G. and V.D. Deshmukh 1989. On the dol net operation at Versova, Bombay. *Indian J. Fish.,* **36** (3): 239 - 249.

Reuben, S., K. Vijayakumar, P. Acharaya and R.V.D. Prabhaker 1997. Biology and exploitation of *Trichiurus lepturus* (Linnaeus) from Visakhapatanam waters. *Indian J. Fish.,* **44** (2): 101-110.

Rikhter, V.A. and V.N. Efanov 1976. On one of the approaches to estimation of natural mortality of fish population. *ICNAF Res. Doc.,* **76/**VI/ 8: 12pp.

Rizvi, A.F. 2001. *Studies on two ribbonfish from Mumbai waters.* Ph.D. Thesis, 305 pp.

Somavanshi, V.S. and A. Joseph 1989. Population dynamics and assessment of *Trichiurus lepturus* (Linnaeus) stock in north-west coast of India. Studies on fish stock assessment in Indian waters. *Special Publicatin* No **2,** Fishery Survey of Indian P. 1-32.

Srinath, M. 1998. Empirical relationship to estimate the instantaneous rate of natural mortality. *Indian J. Fish.,* **45** (1): 7-11.

Thiagarajan, R., S. Lazaras, Y.A. Sastry, M.Z. Khan, H.M. Kasim, and K.S. Scariah 1992. Stock assessment of the ribbonfish, *Trichiurus lepturus* (Linnaeus), from the Indian waters. *Indian J. Fish.,* **39** (3&4): 182-194.

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