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The ribbonfish fishery and stock assessment of *Trichiurus lepturus* Linnaeus off Kakinada, east coast of India

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Abstract

Ribbonfish fishery in Kakinada is supported by six species viz., *Trichiurus lepturus, T.russelli, Lepturacanthus gangeticus, L.savala, Eupleurogrammus muticus* and *E.glossodon*. They were exploited by trawls and gillnets throughout the year with peak during November-February. Production increased from 53 ton in sixties to 3,073 ton in nineties due to improved fishing effort and extension of fishing to distant deeper waters. Production of the main species, *T. lepturus* varied between 1,759 and 4,685 ton during 1995-2000, stock from 2,172 to 7,809 ton and biomass from 408 to 2,519 ton. Maximum sustainable yield is 3,886 ton. Mainly zero year fishes supported the fishery. The species matures and spawns during the first year itself. Spawning and recruitment occur round the year with peak during November-March. Survival of spawn to present exploitation size varied between 0.004 and 0.04% during the period. The estimated fecundity was 40,250/fish or 100,628/kg body weight. Studies revealed that currently the resource is under heavy fishing pressure. Strategies for the management of stock and fishery are discussed.

Keywords: Ribbonfish, species diversity, fishery, stock assessment, management brief

Introduction

Ribbonfishes are widely distributed in the seas around India. They form one of the major components of exploited marine fishery resources and have good domestic and export demand. Considerable information is available on the fishery and biology of many species (Prabhu, 1955; James, 1967; Thampi *et al.*, 1968; Narasimham, 1970; 1972; 1974; 1976; 1983; James *et al.*, 1978; 1986). Considerable improvements occurred in the fishing technology in recent years, resulting in increased efficiency in exploitation. However, information on the impact of these changes on the fishery and biology of the species is limited. The present study will give an insight into the changes occurred in the fishery over the decades and the characteristics of the major species along the coast.

Materials and methods

Fishing effort, catch and species composition of ribbonfishes by trawl and gillnets at Kakinada were monitored during 1995-2000 at weekly intervals. Biology of *Trichiurus lepturus* was studied simultaneously. Gonadal development and maturity were studied following James (1967). Size at first maturity was estimated from probability curve. Catch and effort data available with the institute for 1967-'94 period were also utilized for studying changes in the fishing pattern over the years. Growth, growth parameters, mortality rates and recruitment pattern were estimated from the monthly length frequency data of the species in the catch. Growth and growth parameters were estimated by ICLARM's FiSAT software (Gayanilo and Pauly, 1997). Size at first capture (Lc_{50}) was estimated as in Pauly (1984) and age at zero length (t_0) using von Bertalanffy plot (Bertalanffy, 1934). Natural mortality (M) was estimated as in Pauly (1980), by taking the mean sea surface temperature as 29°C and total mortality (Z) from catch curve as in Pauly (1983). Exploitation rate was estimated from the equation $E = F/Z$ and exploitation ratio from $U = F/Z * (1-e^{-Z})$; where, F is the fishing mortality rate.

Yield per recruit of the species was estimated following Marten (1978) and potential yield per recruit and optimum age of exploitation as in Krishnankutty and Qasim (1968). Stock was computed from the relation; $P = Y/U$ and biomass from $B= Y/F$; where, Y is the yield and U the exploitation rate. Maximum sustainable yield (MSY) was estimated graphically as in Corten (1974).

An empirical relationship was developed to quantify spawning and survival in *T. lepturus* and to correlate the same with stock and yield of the ensuing years. It was based on the assumption that the fish spawn only once in an year and by considering the total number of fishes with spent and resting gonads in the catch and that part of the stock which escape fishing together as spawning stock. Total stock of the species in number (Pn) was estimated from the relation for stock and yield as $Pn = Yn/U$, where; Yn is catch in number. Total number of fishes that escaped fishing during the year is Pn-Yn and that with spent and resting gonads in the catch is Yn x S, where; S is proportion of fishes with spent and resting gonad in the catch,.

$$Pn - Yn = Yn/U - Yn = Yn\ (1/U - 1).$$

Spawning stock in number, $Ps = (Yn \times S) + (Pn - Yn) = (Yn \times S) + Yn\ (1/U-1)$

$$= Yn \times (S + (1 / U - 1))$$

Then the total number of ova released by the spawning stock during the period,

$$Ot = Ps \times fy \times fm$$

$$= [Yn \times (S + (1 / U - 1))] \times fm \times fy$$

$$= Yn \times fm \times fy\ (S + (1 / U - 1))$$

Where; fm- proportion of females in the catch and

fy- average fecundity per fish.

Results

***Fishing effort*:** Ribbonfishes were exploited mainly by trawls and to a small extent by gillnets. Effort by trawls increased gradually and steadily during 1967-2000. Average annual fishing effort was 7,624 units/year during later half of 1960's, 33,300 units during 70's, 43,075 units during 80's and 49,961 units during 90's. Rate of increase was slow during 80's and 90's compared to sixties and seventies. Duration of active fishing by trawls also increased from 34,118 hrs/year during late 60's to 769,030 hrs during 90's. It was 238,646 and 344,131 hours respectively during 70's and 80's. The sharp increase in active fishing time during 90's was attributed to the introduction of voyage fishing. About 16,632 units of gillnets were operated annually during 1995-2000, spending 44,331 active fishing hours.

***Catch*:** Over the decades there has been considerable increase in catch from 54 ton/year in 60's to 3,073 t in 90's (Fig. 1). It was 746 and 1,047 ton/year respectively in 70's and 80's. Catch rate also increased from 7 to 62 kg/unit effort during the same period. Catch/unit time of trawling was 2 kg/hr in 60's and it increased to 4 kg in 90's. Percentage representation of ribbonfish in total fish catch increased from 4% in 60's to 11% in 90's. Gillnets landed 64 ton ribbonfishes annually at a catch rate of 4 kg/unit effort. They constituted 3% of the total fish catch in the gear.

***Species composition and seasonal abundance*:** Six species supported the fishery. *T. lepturus* dominated the fishery by representing 92% of resource catch during 1995-2000. Other species represented in the catch are *T.russelli* (2.6%), *Lepturacanthus gangeticus* (1.7%), *L. savala* (0. 9%), *Eupleurogrammus muticus* (2.3%) and *E. glossodon* (0.4%). The resource was exploited round the year with 70% of the catch during October-February. Catch and catch rate of most species were also high during this period.

***Growth*:** Growth parameters, L_∞ and K were 128.2 cm and 0.72/year respectively and 't_0' is –0.003 years and the growth can be described by von-Bertallanffy growth equation as;

$$Lt = 128.2\ [1 - e^{-0.72(1 + 0.003)}]$$

This relationship showed that they grew to 212, 388, 535 and 658 mm respectively by the end of 3, 6, 9 and 12 months. They attained 978 mm by the end of 2nd year and 1134 and 1210 mm respectively by 3rd and 4th years.

***Size and age composition*:** Fishery was supported by 8-114 cm fishes (Fig 2), with 52.1 cm as mean size. Zero year groups represented 92% of the catch. Juveniles (8 cm) entered the fishery in large numbers during August-September and to a small extent during March and May. Their age at this stage was 1.2 months. Size of the species at first capture was 40.9 cm and age was 6.4 months. Optimum age of exploitation (ty) of the species is 1.73 years, which corresponds to 90 cm in total length.

***Sexual maturity*:** The size at first maturity is 47.3 cm and age is 7.7 months. However, gonadal development and sexual maturity in the species is observed from 38 cm onwards. This shows that they spawn during the first year itself.

***Spawning and recruitment pattern*:** Recruitment pattern (Fig 3), presence of small fishes and those with ripe, spent and resting gonads in the catch indicated that they spawn round the year with peak during December-Feb-

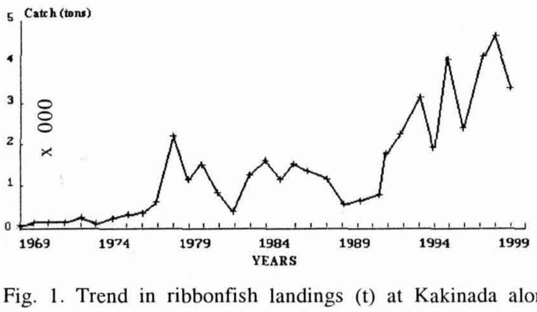

Fig. 1. Trend in ribbonfish landings (t) at Kakinada along the east coast of India during 1967-2000.

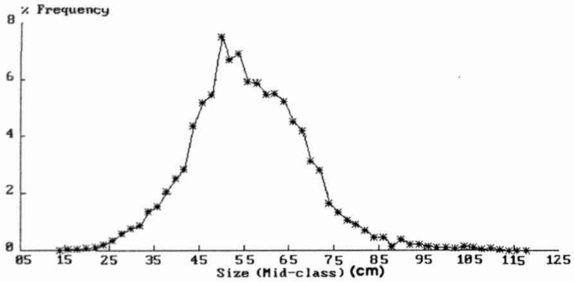

Fig. 2. Average annual size distribution of the ribbonfish, *T. lepturus* in the catch.

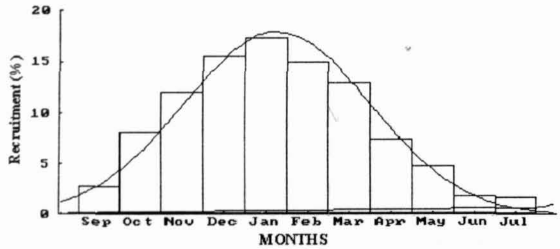

Fig. 3. Recruitment pattern of the ribbonfish, *T. lepturus* along the east coast of India.

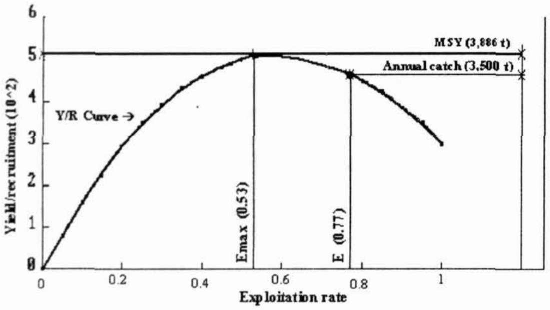

Fig 4. Relative yield/recruit of the ribbonfish, *Trichiurus lepturus* at different levels of exploitation, super-imposed with yield bar showing MSY

ruary. Estimate shows that 24 to 54% of the stock spawned and released 1.29 x 10^{11} to 6.60 x 10^{11} ova annually during 1995-2000 (Table 1). Estimate of spawn survival up to the present exploitation size varied between 0.004 and 0.04%. Proportion of the fishes with spent and resting gonad in the catch decreased over the years. It was 36% during 1995-'96 and it declined during the subsequent years to 6.7% by 1998-'99. Fecundity of 63-82 cm size fishes was estimated as 40,250 ova/fish. It accounts approximately 1,00,628 ova/kg body weight of the fish.

Feeding habits: Species is highly carnivorous and cannibalistic and preys on a variety of fishes, crustaceans and cephalopods. Fishes landed by gillnets are mainly (48-67%) in well fed condition with full guts; whereas that by trawls were in poorly fed condition (59-76%). This may probably be due to vomiting of the preys during their struggle to escape from the trawl. Some fishes were found to ingest preys as high as 9.4% of their body weight.

Mortality and exploitation rates: Total mortality varied between 2.84 and 5.48 with 4.32 as mean during 1995-2000. Natural mortality was 0.98 and fishing mortality 3.34 and the latter varied between 1.86 and 4.5 during the period. Exploitation rate varied between 0.65 and 0.82 with 0.77 as mean whereas, E_{max} was low, 0.53 (Fig 4).

Yield, yield per recruit, stock and biomass: Yield of the species at the present level of fishing pressure is 74.6 g/recruit and potential yield corresponding to optimum age of exploitation is 109.8 g/recruit. Average production of the species was 3,500 ton during 1995-2000 and maximum sustainable yield was 3,886 ton/year (Fig 4). Their stock in the present fishing ground varied between 2,172 and 7,809 ton with an increasing trend during the period. Biomass also varied between 408 and 2,519 ton. Statistical interpretation showed a positive correlation between spawn survival and stock, but not at significant level (P>0.05). However, no relation could be established between spawning rate and stock.

Table 1. *Estimates of annual catch of* T. lepturus, *their stock, spawning rate, total ova released and survival of the spawn up to exploitable stock during 1995-2000.*

Period	Catch in nos. (*Yn*) (x 10000)	% of spent & resting fish (*S*)	Stock in Nos. (*Pn*) (x 10000)	Spawning rate (% of the stock)	% of females catch (*fm*)	No. of ova Released (*Ot*)	Spawn survival (%)
1995-96	3385	36	4702	54	53	5.4 x 10^{11}	3.9 x 10^{-3}
1996-97	1677	22	2070	37	42	1.3 x 10^{11}	3.9 x 10^{-2}
1997-98	3431	9	5046	38	54	4.2 x 10^{11}	1.21x 10^{-2}
1998-99	4178	7	5095	24	55	2.7 x 10^{11}	2.39 x 10^{-2}
1999-00	5095	9	6062	45	60	6.6 x 10^{11}	-

Discussion

Catch, catch rate and percentage representation of ribbonfishes in the total fish catch increased during 1967-2000. These increases were more pronounced during nineties, after the introduction of voyage fishing and is attributed to the extension of fishing to distant deeper waters. James *et al.* (1986) have reported the availability of the resource in waters at depths between 25 and 75 m.

Estimates showed that a spawn survival of 0.01 to 0.02% is sufficient to maintain the stock. Compared to this, the present estimates of spawn survival are much high. This and their fast growth observed in the study indicated prevalence of better condition for their growth and survival. Removal of large quantum of fishes, which include predators and competitors by fishing, might have created favourable conditions for them. It can also be possible from increased biological productivity of the seas owing to increased nutrient discharge and eutrophication following industrialisation and urbanisation in the recent past as reported by Tatara (1981, 1981a). Cause of increased production of other small pelagics during the period can also be attributed to this.

Though they attained full sexual maturity at an age of 7-8 months and spawn round the year, the present exploitation pattern, which harvest mainly zero year fishes may not permit large number of them to spawn atleast once in their life. This indicated stress on spawning stock and can be addressed only by enhancing their size and age at exploitation. As young ones of the species feed on small fishes and shrimps in the shelf area, probability of they being caught in large numbers in shrimp trawls is very high. Moreover, fishery being multi-resource represented by large number of species, it is neither simple nor easy to implement any measures for the management of a specific species or resource.

Present estimate of L_α is low compared to 145.4 cm reported by Narasimham (1976), whereas growth coefficient is large against earlier estimate of 0.29/year from the same area. It indicated reduction in the size of the fish and their longivity over the period. Fishing mortality is higher than the earlier estimate by Narasimham (1983) and is more than 3.4 fold of the natural mortality. These, together with a larger exploitation rate, yield below MSY and decreasing proportion of spent fishes in the catch indicated that stock is over-exploited. Present fishing grounds being under intensive exploitation, scope for further increase in production is limited. The only alternative left is to limit total fishing intensity in each fishing zone at optimum level to maintain the production below MSY by diverting surplus effort to deeper under-exploited grounds for other resources. This not only would improve ribbonfish fishery but also other valuable resources.

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References

Bertalanffy, L. von. 1934. Unter suchungen uberdie Gesetzlichkeiten des wasdestums I. Allgemeine Grundlagen der Theorie. *Roux. Arch. Entwicklungsmech. Org.*, 131: 613-653.

Corten, A. 1974. Recent changes in the stock of Celtisea herring (*Clupea harengus* L). *J. Cons. Perm. Int. Explor. Mer.*, 35: 194-201.

Gayanilo, Jr. F.C. and D. Pauly (eds.) The FAO-ICLARM stock assessment tools (FiSAT). Reference manual. *FAO computerised information series (Fisheries)* No.8. Rome, FAO, 1997: 262 pp.

James, P.S.B.R. 1967. The ribbonfishes of the family, Trichiuridae of India. *Memoir I.* Marine Biological Association of India, 226 pp.

————, T.R. Chandrasekhara Gupta and S.L.Shanbhogue. 1978. Some aspects of the biology of the ribbonfish, *Trichiurus lepturus* Linnaeus. *J. Mar. Biol. Ass. India,* 20 (1&2):_120-137.

————., K.A. Narasimham, P.T. Meenakshi Sundaram and Y. Appanna Sastry. 1986. Present status of ribbonfishes of India. *C M F R I, Special Publication* No. 24: 49 pp.

Krishnan Kutty, M. and S.Z. Qasim. 1968. The estimation of optimum age of exploitation and potential yield in fish populations. *J. Cons. Perm. Int. Explor. Mer.*, 32(2): 249-255.

Marten, G.G. 1978. Calculating mortality rates and optimum yield from length samples. *J. Fish. Res. Bd., Canada*, 35(2): 197-201.

Narasimham, K.A. 1970. On the length-weight relationship and relative condition in *Trichiurus lepturus* Linnaeus. *Indian J. Fish.*, 17: 90-96.

———— 1972. Occurrence of early juveniles of the ribbonfish, *Trichiurus lepturus* Linnaeus in the Kakinada area with notes on their food. *ibid,* 19: 210-214.

——————— 1974. Some observations on the biology of the ribbonfish *Eupleurogrammus muticus* (Gram). *ibid,* 21(2): 479-494.

——————— 1976. Age and growth of ribbonfish, *Trichiurus lepturus* Linnaeus. *ibid,* 23(1&2): 174-182.

——————— 1983. On fishery, mortality rates and yield per recruit of ribbonfish *Trichiurus lepturus* Linnaeus. *ibid,* 30(1): 99-109.

Pauly, D. 1980. A selection of simple methods for the assessment of tropical fish stocks. *FAO. Fish. Circular* No. 729, *FIRM/129:* 54 pp.

———————1983. Some simple methods for the assessment of tropical fish stocks. *FAO. Fish. Tech. Paper* No. 234: 1-52.

———————1984. Length-converted catch curves: A powerful tool for fisheries research in the tropics (Part II). *FISHBYTE,* 2 (1): 17-19.

Prabhu, M.S. 1955. Some aspects of the biology of the ribbonfish, *Trichiurus haumela* (Forsskal). *Indian J. Fish.,* 2 (1): 132-163.

Tatara, K. 1981. Relation between the primary production and the commercial fishery production in the fishing ground. *Bull. Nansei. Reg. Fish. Res. Lab.,* (13): 111-113.

——————— 1981a. Productivity of the inshore fishing grounds. Changes of productivity in the Seto Inland Sea. *ibid,* (13): 135-169.

Thampi, P.R.S., P.T. Meenakshi Sundaram, S..Basheeruddin and J.C. Gnanamuthu. 1968. Spawning periodicity of the ribbonfish, *Trichiurus haumela* (Forskal), with a note on its growth. *Indian J. Fish.,* 15(1&2): 53-60.

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