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Dorab fishery of Gulf of Mannar waters and population characteristics of the species *Chirocentrus dorab* (Forsskal, 1775) and *Chirocentrus nudus* Swainson, 1839

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ABSTRACT

Dorab (wolf-herrings) fishery of Gulf of Mannar and species diversity, biology as well as population characteristics of the species, *Chirocentrus dorab* (Forsskal, 1775) and *Chirocentrus nudus* Swainson, 1839 were studied to understand the dynamics of the resource, evaluate extent of their exploitation and to propose appropriate strategies for sustaining the stock and yield. Almost all gears operating along the coast exploit dorabs. About 1,142 t dorabs were landed annually during the period. Fishery was supported by two species dominated by *C. dorab*. Growth estimates indicated that both species grow much faster than the earlier estimates from the same region. Stock assessment shows that both species were under heavy fishing pressure and subjected to overexploitation resulting in low production below the MSY level. Strategies for enhancing stock and yield are discussed.

Keywords: *Chirocentrus dorab, Chirocentrus nudus*, Dorab fishery, Gulf of Mannar, Population characteristics, Wolf herring

Introduction

Dorabs enjoyed wide distribution in Indian waters along both east and west coast and have good local demand as food fishes. They are non-shoaling fishes and are generally caught as bycatch along with other fishes. Two species, *Chirocentrus dorab* (Forsskal, 1775) and *Chirocentrus nudus* Swainson, 1839 contribute to the commercial fishery. As per the estimates by the Central Marine Fisheries Research Institute (CMFRI), the annual production of wolf herring was about 22,141 t during 2008 in India. This forms about 0.7% of the total marine landings of the country. Although the dorab fishing extends along the entire east and west coasts, the CMFRI database for 2006-08 shows that the major contribution is from east coast; wherein the bulk of the catch (42.4%) is from West Bengal (Fig. 1). Tamilnadu contributed 20% of the dorab catch, with bulk from the Gulf of Mannar and Palk Bay region.

Though some studies on their biology and population characteristics dated back to nineteen fifties and eighties (Prabhu, 1953; Luther, 1968; 1973; 1985a,b,c, 1987a,b and Luther and Dharmaraja, 1987) were available, recent studies are lacking from Indian waters. The present study was aimed to understand fishery and biology of the species contributing to the fishery along the Gulf of Mannar region. Such information are the essential pre-requisites for developing appropriate scientific management strategies for regulating the fishery inorder to sustain the stock and production.

Material and methods

Dorab fishery and biology of the species, *C. dorab* and *C. nudus* contributing to fishery along the Gulf of Mannar coast were monitored during 2006-2008. About 3,883 length measurements of *C. dorab* and 2,742 measurements of *C. nudus* landed by gillnet were collected during the period and raised to monthly length frequency data. Using the monthly length frequency data, growth parameters, mortality and recruitment pattern of species were estimated. L_∞ and K were estimated following Ford-Walford plot (Ford, 1933; Walford, 1946) and using FiSAT software (Gayanilo *et al.*, 1997). Age at zero length (t_o) was estimated as in Bertalanffy (1934) and size at first capture (L_c) as in Pauly (1984). Natural mortality (M) was estimated using Pauly's empirical formula (Pauly, 1980), using 29 °C as the mean sea surface temperature. Total mortality (Z) and exploitation ratio (E) were estimated from the catch curve and exploitation rate (U) from the relation; $U = F/Z^* (1 e^{Z})$; where, F is the fishing mortality as in Pauly (1983).

Yield per recruit at different levels of exploitation was estimated as in Marten (1978) and potential yield per recruit and optimum age of exploitation as in Krishnankutty and Qasim (1968). Total stock (P) was computed from the relation; P = Y/U; where, Y is the yield in ton and U the exploitation rate. E_{max} and maximum sustainable yield (MSY) were estimated graphically as per Corten (1974).

Results

Fishery

Dorabs were exploited as a targeted resource by medium meshed gillnet (35to 65 mm mesh) locally known as *valavalai.* Almost all other gears landed dorabs in small quantities as bycatch. Catch and catch rate of dorabs in these gears varied over the years. About 81.4 % of the catch is realised by gillnets, followed by trawls (11.3%) and the rest by seine nets, bagnets and hooks and line (Table 1). Average annual yield and catch rate by gillnet was 930 t and 1.2 kg per unit effort respectively. In trawls it was 129 t and 2 kg per unit effort respectively. Fishery occurred round the year with peak fishery during January-April along the region. About 51.7% of the annual catch was realised during the peak season. A second and small peak realising 20% of the annual catch was observed in July. Catch in trawls, sardine gillnets and shore seines are supported mainly by small to medium sized fishes. Two species dominated by dorab wolf herring, *C. dorab* (52.3%) and whitefin wolf-herring, *C. nudus* (47.7%) supported fishery.

Table 1. Monthwise average annual catch of wolf herrings along the Gulf of Mannar coast during 2006 - '08

Gear	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Trawl	4	1	17	0	0	8	6	8	18	15	33	21	129
Gillnet	134	63	45	82	4	7	126	6	29	170	92	172	930
Seines	5	0	3	5	0	0	8	0	3	42	10	8	83
Total	144	64	64	87	4	15	139	14	49	227	135	200	1142

Population characteristics of species

Size composition in the catch

C. dorab catch in gillnet was supported by 22-102 cm fishes with 52.1 cm as mean size. In trawls 11.5-79 cm fishes with 50.7 cm as mean comprised the catch. They enter trawl fishery at 11.5 cm size and in gillnets at 22.2 cm size and *C. nudus c*atch in gillnet was supported by 21-92 cm fishes with 49.2 cm as mean size. In trawls 12.0-82.0 cm fishes with 40.4 cm as mean formed the catch. They enter trawl fishery at 12.3 cm size and in gillnets at 21.4 cm size.

Growth and age

C. dorab

Growth parameters, L_∞, K and 't_0' estimated from length frequency data are 104.9 cm, 0.73/year and -0.019 years respectively. Growth estimate by von Bertallanffy growth equation shows that they grow fast and attain 55, 80.9, 93.3 and 99.3 cm respectively by the end of 1st, 2nd, 3rd and 4th year. Size of the species at first capture in drift gillnet was 36.2 cm and in trawls 29.4 cm. The optimum size of their exploitation is 53.1 cm.

The age of the species at recruitment in trawl fishery (11.5 cm) is estimated as 1.7 months and in gillnet fishery (22.2 cm) as 3.7 months. Their age at first capture in the above gears was estimated respectively as 5.1 and 6.7 months corresponding to the L_c values of 29.4 and 36.2 cm. The age (t_y) corresponding to the optimum size of exploitation (53.1 cm) is 11.4 months.

C. nudus

Growth parameters, L_α, K and 't_0' were estimated as 98.7 cm, 0.78/year and -0.022 years respectively. Growth estimate shows that species grow fast and attain 54.2, 78.3, 89.4 and 94.4 cm respectively by the end of 1st, 2nd, 3rd and 4th year. Size of the species at first capture in drift gillnet was 34.8 cm and in trawls 24.3 cm. The optimum size and age of their exploitation are 52.2 cm and 11.3 months respectively.

The age of the species at recruitment in trawl fishery (12.3) is estimated as 1.8 months and in gillnet fishery (21.4 cm) as 3.5 months. Their age at first capture in the above gears was estimated respectively as 4.1 and 6.4 months corresponding to the L_c values of 24.3 and 34.8 cm. The age (t_y) corresponding to the optimum size of exploitation (52.2 cm) is estimated as 11.3 months.

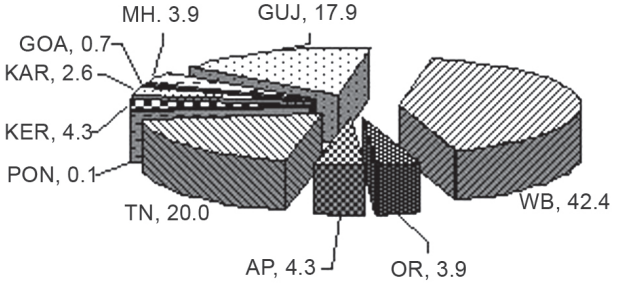

Fig.1. Statewise contribution of dorabs to the national dorab production

Food and feeding

Both species are highly carnivores in feeding habit with occasional cannibalistic tendency, relying mainly on small pelagics, small crustaceans, cephalopods and their own young ones. Major components of their food are sardines, anchovies, scads, small crabs, prawns, squids, small dorabs *etc.* in the order of dominance.

Maturity and spawning

C. dorab

Maturity studies shows that fishes with different stages of gonadal developments were available almost round the year in the population. Major share of the catch was constituted by immature fishes below 40 cm. In gillnets immature fishes constituted 48.1% and in trawls 73.6% of the total catch in number.

Full gonadal maturity was observed in the species from the 44 cm TL onwards. Size at first maturity at 50% maturity level was estimated using probability curve method. It was estimated as 48.6 cm TL for males and 49.2 cm TL for females. Age of males and females at maturity was estimated to be over 10 (10+) months. Presence of mature and spent fishes along with young ones in the catch, indicate that the species spawn round the year with peak spawning and recruitment during September-October (Fig. 2). Fecundity estimates showed that a fish of 58.7 cm TL (mean size) is capable of releasing around 60,268 eggs in a single spawning during the peak season.

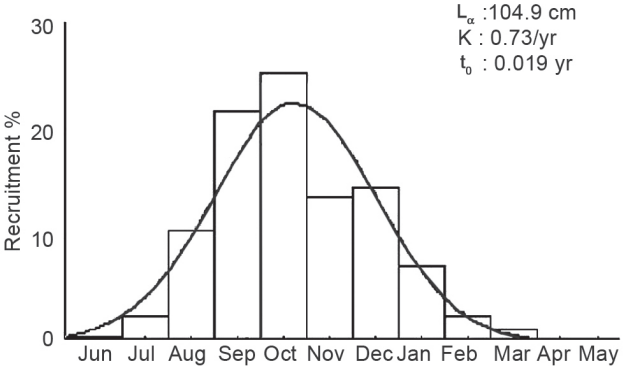

Fig. 2. Recruitment pattern of *C. dorab* in the Gulf of Mannar

C. nudus

Fishes with different stages of gonadal developments were available almost round the year in the population. Major share of the species landings comprised immature fishes below 38 cm size. In gillnets immature fishes formed 51.1% and in trawls 70.4% of the catch in number.

Full gonadal maturity was observed in species from 39.6 cm TL onwards. Size at first maturity was estimated as 41.7 cm TL for males and 43.4 cm TL for females. Age of both males and females at this size was 8+ months. Presence of mature and spent fishes along with young ones in the catch, indicate that they spawn round the year with peak spawning and recruitment during May-July period (Fig 3). Fecundity estimates showed that a fish of 52.6 cm TL (mean size) is capable of releasing around 56,108 eggs in a single spawning during the peak season.

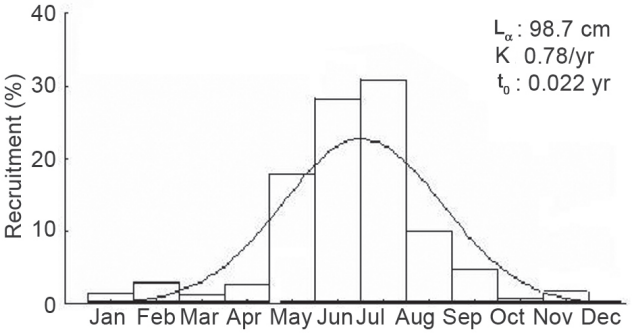

Fig. 3. Recruitment pattern of *C. nudus* in Gulf of Mannar waters

Presence of mature males and females of both species in the population with gonads at different stages of development almost round the year indicates the possibility that after attaining maturity, the same individual may spawn more than once in a year.

Mortality and exploitation rate

C. dorab

Mortality in the population are attributed to natural causes and fishing. Natural mortality was estimated as 2.16. Total mortality varied between 4.97 (2006) and 6.14 (2007) with 5.57 as mean. Mean fishing mortality was 3.41 and it varied between 2.81 and 3.98. The mortality estimates shows that major loss from the stock was due to fishing than natural causes.

Exploitation rate fluctuated between 0.565 and 0.648 with 0.612 as mean. E_{max}, that give maximum yield for the species is 0.598, which is small compared to present exploitation rate (Fig. 4), indicating that the stock is slightly overexploited.

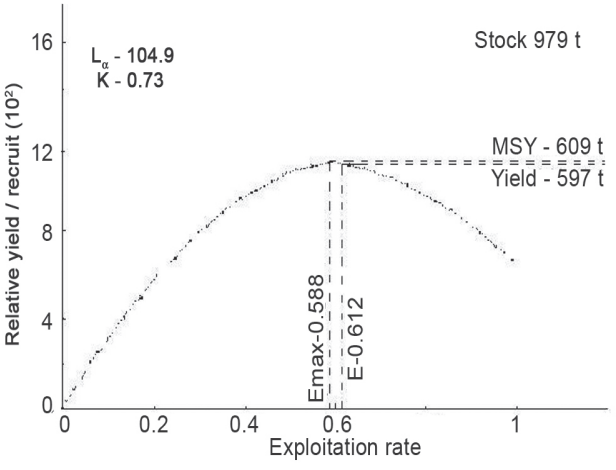

Fig. 4. Relative yield/recruit curve of *C. dorab* at different exploitation levels, superimposed with stock/yield bar showing MSY.

C. nudus

Natural mortality in the population was estimated as 1.07. Total mortality varied between 3.87 (2006) and 4.82 (2007) with 4.34 as mean. Mean fishing mortality was 3.28 and it varied between 2.8 and 3.75. The mortality values show that major loss from the stock was due to fishing as compared to natural causes, which accounted for more than three times of natural losses.

Exploitation rate fluctuated between 0.72 and 0.778 with 0.756 as mean value. E_{max}, that gives maximum yield for the species is 0.704, which is small as compared to present exploitation rate (Fig. 5), indicating that the stock is under intensive fishing pressure and is being over-exploited.

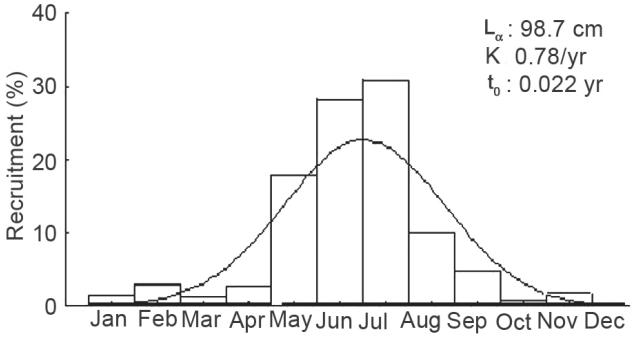

Fig. 5. Relative yield/recruit curve of *C. nudus* at different exploitation levels, superimposed with stock/yield bar showing MSY.

Stock, biomass and sustainable yield

C. dorab

Stock and biomass of the species in the fishing grounds fluctuated during the period. Average total stock for the period was 979 t (Fig. 4) and it fluctuated between 829 t (2006) and 1325 t (2007). Spawning stock biomass was estimated as 1,225 t and maximum sustainable yield (MSY) as 609 t.

C. nudus

Stock and biomass of the species fluctuated during the period. Average total stock for the period was 721 t (Fig. 5) and it fluctuated between 617 and 829 t. Spawning stock biomass of the species was estimated as 335 t and maximum sustainable yield (MSY) as 594 t.

Discussion

Several studies on various aspects of fishery and biology of dorabs from Gulf of Mannar region is available (Prabhu, 1953; Luther 1968, 1973, 1985a, b; 1987a, b and Luther and Dharmaraja, 1987). These studies provided many biological reference points on the population. Present estimates shows that both species grow much faster compared to the earlier estimates of Prabhu (1953) from the region. They grow twice as fast as compared to earlier estimates. However, the estimate of size at first maturity was very close to the earlier estimate. Large size groups of both species were observed in the catch during the present study than reported earlier and it can be attributed to the extension of fishing operations to deeper areas. According to Prabhu, (1953) fishes move to deeper waters for spawning. They may remain in deeper waters and become unavailable for shallow coastal water fishing units.

Catch and catch rates of dorabs fluctuated over the years. Yield and catch rate correlated directly with stock, suggesting that fishery depended entirely on stock abundance. As has been described above, fishery of both species was supported mainly by zero year groups with size at first capture much smaller than their size at maturity and optimum size of exploitation in both gillnet as well as trawl. Since both species spawn round the year, a major proportion of mature fish may get a chance to spawn at least once before being caught. This suggested limited stress on the spawning stock and recruitment.

Exploitation rate over the years indicated that both species were overexploited at present. As indicated by the E_{max} the production can be increased marginally by reduction in fishing effort. The size composition of the catch further indicated that by reducing the catch of small fishes and by increasing the size at capture close to size at maturity or optimum length (L_{opt}) fishing stress on stock can be reduced. This may help in restoring the yield to MSY level.

Gillnets were found to be more ideal for exploitation of dorabs, as proportion of immature fishes were relatively low in the catch. Reduction in the use of small meshed gillnets (below 40 mm mesh) will considerably reduce the capture of immature fishes. Simultaneous increase in effort input by large meshed gillnets, which exploit mainly adult fish may be encouraged.

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