Fishery of full beaks and half beaks with special reference on the growth, mortality and stock assessment of *Ablennes hians* (Valenciennes) along the Tuticorin coast, Gulf of Mannar

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ABSTRACT

Belonids and hemiramphids commonly known as full and half beaks support a good fishery in Tamil Nadu and on an average 42.6% of this resource in India is landed in Tamil Nadu. They are exclusively exploited by a particular type of drift gillnet. The craft, gear and fishing method are dealt with and the catch statistics along with species composition and their abundance are also dealt with in detail. Four species of full beaks namely, *Ablennes hians, Tylosurus crocodilus crocodilus, Strongilurus leiura* and *S. appendiculatus* and two species of half beaks namely *Hemirhamphus far* and *H. georgii* have been observed to support the fishery.

The growth parameters of *A.hians* are L = 1,233 mm, K = 0.6052 and t = –0.1178 yr. Based on the length-weight relationship the W_∞ is estimated to be 3,768 g. The age at first capture th is 0.9825 yr and the age at recruitment is 0.6183 yr. The total mortality rate is estimated to be 3.87, 3.23 and 3.40 during 1990-'91, '91-'92 & '92-'93 respectively and the natural mortality rate is estimated to be 0.81. The fishing mortality rate for the above period is estimated as 3.065, 2.43 and 2.51 respectively. The exploitation rates estimated for the same period are 0.78, 0.72 and 0.74 which indicate that this species is exposed to a moderately higher fishing pressure by the drift gillnet.

Based on the cohort analysis average annual stock of *A.hians* is estimated to be 236.5t and the average standing stock is estimated to be 12.4 t along the Tuticorin coast. For Tamil Nadu the average annual stock of *A.hians* is estimated to be 3,469 t and the average standing stock is 182 t. For a judicious exploitation of this species either a reduction in the effort or an increase in the mesh size of the gear is suggested. Reduction in the effort may not be feasible. Since the aim of the gear is to exploit the full and half beaks the mesh size may be increased.

Introduction

Belonids and hemirhamphids, commonly known as full and half beaks are considered to be commercially important pelagic fishery resource in view of the good quality and better palatability of the meat. On an average 2,462.33 t of full beaks and half beks were landed in India during 1990-'93 and the percentages of contribution by the maritime states are Tamil Nadu 42.6, Kerala 25.6, Maharashtra 8.4, Karnataka 6.0, Andamans 5.1, Andhra Pradesh 4.6, Goa 3.3, Lakshadweep 2.6, Gujarat 1.2,

Pondicherry 0.3, Orissa 0.2 and West Bengal 0.1. Studies on the full and half beaks are limited and very little information are available on the fishery and biology of the component species (Devanesan, 1937; Chidambaram and Menon, 1948; Job and Jones, 1938; Talwar, 1960,1962 a&b; and Kasim, *et al.*, MS). In view of paucity of information on the population dynamics of the dominant species, the present study was carried out on one of the dominant species of full beaks *Ablennes hians* (Valenciennes) along Tuticorin coast in the Gulf of Mannar.

Materials and methods

Atleast 10% or a minimum of 10 units of the total drift gillnet units operated on the sampling day were observed at random once in a week at Tharuvaikulam landing centre, located about 12 km on the northern side of Tuticorin. Effort and catch particulars and length frequency of *A. hians* were collected. Monthly estimates were obtained by raising the basic data to the sampling days and then to respective months with respective raising factors. A sample of 2,976 specimens varying in fork length from 420 to 1,145 mm were measured of which 545 were weighed to obtain length-weight relationship as per Snedecor and Cochran (1967). These modes obtained from the length frequency data in 20 mm class intervals are given in Fig.1. The progression of the modes were traced as per the integrated method of Pauly (1980) and George and Banerji (1968).

The growth in length was estimated as per Bagenal (1955) method. The natural mortality coefficient (M) was
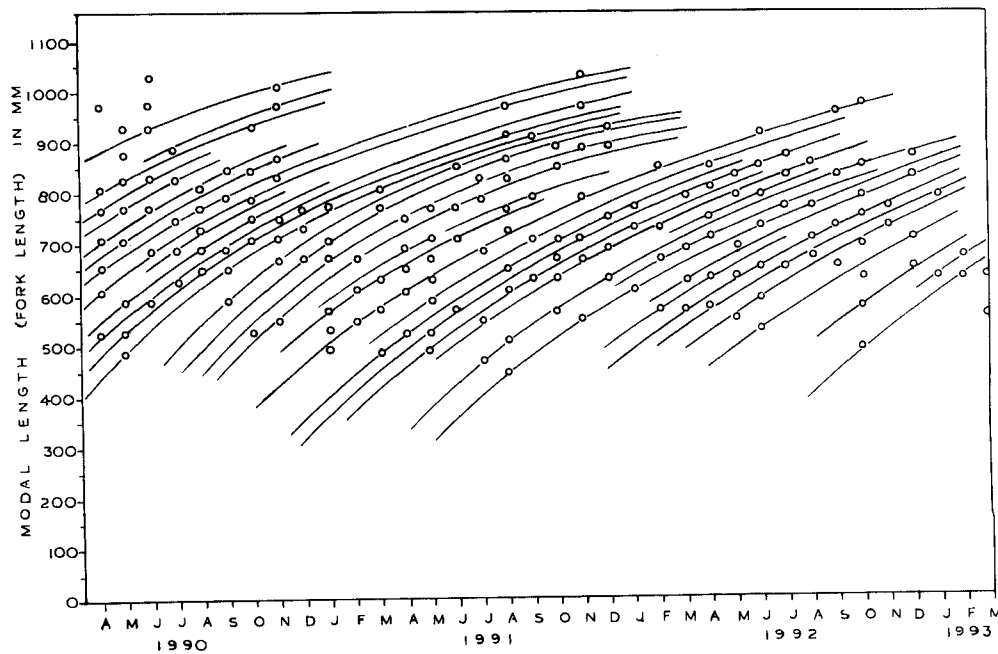

Fig. 1 Scatter diagram of modal length-month for *A. hians* obtained during 1990-'93 along Tuticorin coast.

estimated as per Pauly (1978) and the total mortality coefficient (Z) as per Pauly (1980). The estimates of age at first capture were obtained from the length converted catch curve as per Pauly (1984) and the age at recruitment is taken as the age of the smallest fish which suffered mortality by the gear. The yield per recruit was estimated as per Beverton and Holt model (1957) simplified by Ricker (1958). The optimum age of exploitation and potential yield per recruit were estimated as per the equation proposed by Krishnankutty and Qasim (1968). The cohort analysis was carried out as per Jones (1981).

Results

Craft and gear

The fishing craft is Tuticorin type plank-built boats called *Vallam* of 6-11 m in overall length fitted with 8 to 14 HP inboard engines. The gear operated is a type of drift gillnet called *Mural valai* and in structure it resembles more or less the *Podivalai* or *Vaalai valai*. Mesh size varies form 40 to 70 mm with the depth of the net varying from 5 to 10 m depending on the head rope length. Tubular wooden floats made from the dried stems of the plant *Euphorbia* sp. are used at regular intervals and the foot rope are devoid of any sinkers. Four to five persons go on board with an average of 5 nets per person and a total of 20 to 25 net pieces are joined together and operated. The net is allowed to drift along the water current and two to three hauls are made from late night to dawn.

Fishery

On an average 3,079 units of drift gillnetters landed an average total catch of 70.9 t of fish at the catch rate of 23 kg/unit during 1990-'93 at Tharuvaikulam in which 41.69 t were full beaks, 26.7 t half beaks and the rest 2.5 t were other fishes (Table 1). As indicated by the catch rate of total fish, the fishery was good in all the months except during December - February (Table 2).

Species composition

In all four species of full beaks, *Ablennes hians* (Valenciennes), *Tylosurus crocodilus crocodilus* (Peron & Le Sueur), *Strongilurus leiura* (Bleeker) and *S.appendiculatus* (Klunzinger) and two species of half beaks, *Hemirhamphus far* Ruppell and *H. georgii* (Valenciennes) supported the fishery. *Ablennes hians* was the dominant species among the full beaks and constituted 30.2% of the total catch followed by *T. crocodilus* (24.4%), *S. leiura* (3.5%) and *S. appendiculatus* (0.1%). Among half beaks *H. far* was the dominant species and it formed 32.5% of the total catch and *H. georgii* 5.2%. The balance 3.5% was constituted by other fishes such as carangids, *Sphyraena* and Chirocentrids (Table 1).

Abundance

Monthwise average effort of *Muralvalai* and catch per unit effort of different species of belonids and hemirhamphids are given in Table 2. As seen from the catch rates, the abundance of *A. hians* increased steadily from April onwards and reached a peak in September with a marginal decline in August and then continued to decline with minor fluctuations. The peak period of abundance of *T. crocodilus* was observed to be during May-July and October- November.

The abundance of *S. leiura* was observed to be good in May, July and

TABLE 1. *Estimated average monthwise landings (kg) of different species of belones and two species of hemirhamphids landed by "Mural valai" at Tharuvaikulam along Tuticorin coast during 1990-'93*

Month	Belonids				Hemirhamphids		Other	Total
	A.hians	*T.crocos*	*S.leiura*	*S.append.*	*H.far*	*H.georgii*	fish	
April	167.7	1,247.7	234.3	30.3	3,330.3	492.3	158.0	6,260.6
May	1,282.7	2,020.3	538.7	86.3	3,152.3	464.3	262.7	7,807.3
June	2,034.7	1,856.3	130.7	90.3	1,547.7	96.0	149.3	5,905.0
July	3,400.0	2,552.3	622.0	30.0	2,113.3	215.7	242.7	9,176.0
August	3,147.0	1,812.7	273.7	47.0	2,802.7	257.3	270.3	8,611.1
September	2,948.7	1,712.0	171.7	0.0	2,006.3	157.3	240.3	7,236.3
October	1,668.0	1,701.7	250.3	135.3	1,385.7	714.0	249.3	6,104.3
November	1,764.3	1,616.0	112.3	29.3	934.7	682.3	232.7	5,371.6
December	9,97.7	481.3	20.3	0.0	370.3	45.7	110.0	2,025.3
January	689.0	418.7	8.7	0.0	712.3	118.7	142.0	2,089.4
February	1,429.3	658.3	50.3	0.0	1,797.3	250.0	178.0	4,363.2
March	1,237.0	1,193.0	71.3	114.3	2,848.0	204.7	254.7	5,923.0
Total	21,366.1	17,270.3	2,484.3	562.8	23,000.9	3,698.3	2,490.4	70,873.1

October and that of *S. appendiculatus* was poor in all the months and it did not occur in the month of September, December, January and February. The abundance of *H. far* was good during March-May and in August and that of *H. georgii* was good in April, October and November. Except *S. appendiculatus* all the species occurred throughout the year (Table 2).

Age and growth

A. *hians* being the dominant species among the full beaks, the age and growth of this species have been studied based on the data on length frequency collected during 1990-'93. The progression of different modes in subsequent months was traced by scatter diagram (Fig.1.). Presence of multimodes in the length frequency indicates the recruitment of different broods into the fishery. By back tracing the curves of the modes

available at lower size ranges, the time of origin of these modes could be assessed as shown by broken lines in Fig.1. Keeping these time of origin as the reckoning point, the average size attained by this species in subsequent months was obtained by arranging the traced modes chronologically in tabular form as per George and Banerji (1968) and a single smooth empirical growth cruve is drawn through the plots (Fig. 2). A series of sizes at different ages were obtained from this curve and these data were used to estimate the growth parameters L, K and t. The growth in length of this species is expressed as per von Bertalanffy growth equation as follows:

$$L_t = 1233(1-e^{-0.6052(t+0.1178)})$$

Based on this equation A. *hians* is estimated to attain a size of 384.6, 606.2, 769.8, 890.8, 980.0, 1,046.0,

TABLE 2. *Estimated average monthwise effort of* "Mural valai" *and catch per unit effort (kg) of different species of belonids and hemirhamphids landed at Tharuvaikulam during 1990-'93*

| Month	Effort	Belonids				Total	Hemirhamphids		Total	Others	Grand total
		A.hians	T.croco	S.leiura	S.append.		H.far	H.georgii			
April	305	2.56	4.19	0.74	0.10	7.59	11.05	2.34	12.58	0.52	20.69
May	311	4.21	6.94	1.60	0.27	13.02	10.61	0.65	12.28	0.90	26.20
June	310	7.63	6.91	0.46	0.34	15.34	5.85	0.30	6.16	0.56	22.04
July	335	10.08	7.55	1.70	0.14	19.47	6.94	0.65	7.59	0.79	27.85
August	335	8.78	5.39	0.79	0.16	15.80	8.84	0.80	9.64	0.90	26.33
September	241	11.98	4.77	0.50	0.00	19.70	3.85	0.68	9.26	0.97	29.94
October	247	6.93	7.46	1.01	0.61	16.01	6.10	3.26	9.35	1.07	26.44
November	211	8.23	8.16	0.53	0.22	17.15	4.93	3.39	8.33	1.04	26.52
December	137	6.81	3.43	0.13	0.00	10.38	1.75	0.31	2.54	0.70	13.61
January	150	4.56	2.76	0.06	0.00	7.34	4.63	0.74	5.37	0.34	13.73
February	239	5.97	2.75	0.21	0.00	8.93	7.54	1.04	8.55	0.74	18.22
March	258	4.30	4.76	0.25	0.46	9.78	10.94	0.75	11.69	0.95	22.42
Annual	3,079	7.08	5.73	0.81	0.19	13.80	7.72	1.23	8.96	0.84	23.61
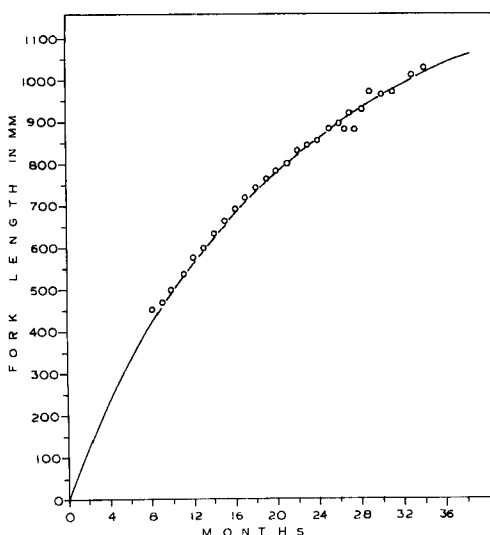
Fig. 2 Mean lengths at age in months based on the scatter diagram for *A. hians* and fitting of empirical growth curve.

1,094.9 and 1,131.0 mm at the age of 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5 and 4.0 years respectively. As per the length weight relationship equation Log W = –6.7624 + 3.3227 * Log L (r = 0.9874) (Kasim *et al.*, MS) the W is 3,768 g and the growth in weight may be expressed as per the von Bertalanffy growth equation as follows:

$$w_t = 3768 \; (1-e^{-0.6052 \, (t + 0.1178)^3})$$

According to this equation this species is estimated to attain a weight of 114.4, 447.7, 917.1, 1,420.7, 1,892.6, 2,301.5, 2,638.7 and 2,908.0 g at the age of 0.5, 1.0, 1.5, 2.0, 2.5., 3.0, 3.5, and 4.0 years respectively.

Total mortality coefficient (Z)

Z is estimated to be 3.87, 3.23 and 3.40 during 1990-'91, 1991-'92 and 1992-'93 respectively.

Natural mortality coefficient (M)

M is estimated to be 0.805 as per the equation proposed by Pauly (1978).

Fishing mortality coefficient (F)

F is estimated from the relation F = Z-M and it is 3.07, 2.43 and 2.60 in 1990-'91, 1991-'92 and 1992-'93 respectively.

The exploitation rate (U)

U is estimated to be 0.78, 0.72 and 0.74 in 1990-'91, 1991-'92 and 1992-'93 respectively as per the relation:

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

Age at first capture and recuritment

The size at first capture is estimated to be 632.4, 605.5 and 560.5 mm during 1990-'91, 1991-'92 and 1992-'93 respectively with an average of 599.5 mm. The corresponding average age at first capture is 0.9825 yr. The smallest fish which suffered mortality during these 3 years of study are 430, 450 and 450 mm respectively with an average of 443.5 mm and the corresponding average age at recruitment is 0.6183 yr.

Yield per recruit

Keeping the age at first capture constant at the prevailing level of 0.9825 yr and varying the F estimates of yield per recruit were obtained for 3 different M/K ratios of 1.0, 1.32 and 2.0 (Fig. 3). The yield increases with the increase in F to a certain level and then it tends to decline. The F_{max} which can produce the highest yield of 506, 409.8 and 299.9 g for the M/K ratio of 1.0, 1.32 and 2.0 are 1.25, 1.75 and 4.0 respectively (Fig. 3). Prevailing average F is 2.695 which is higher than F_{max} of 1.75 and it roughly shows that under the prevailing conditions *A. hians* is exposed to higher fishing pressure.

Yield estimates obtained from different combinations of age at first capture and varying F for the prevailing M/K ratio of 1.32 are given in Fig. 4 in the
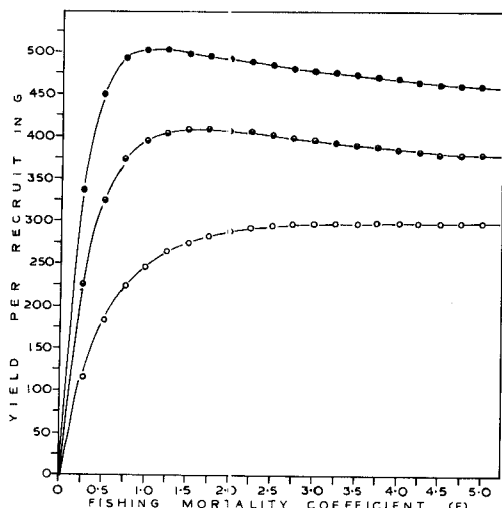
Fig. 3. Yield per recruit in gram at constant age at first capture and varying fishing mortalities at 3 different M/K ratio for *A.hians* along Tuticorin coast.
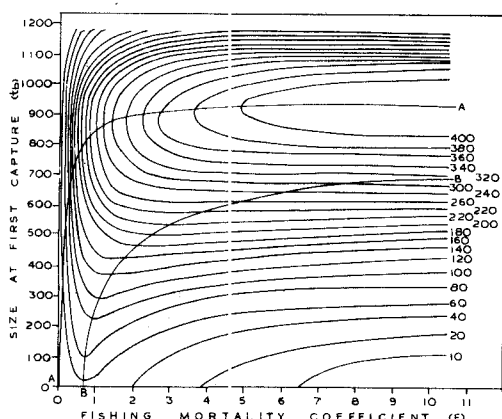

Fig. 4. Yield isopleth diagram obtained for varying age at first capture and fishing mortality rates at the prevailing M/K ratio 1.32 for *A. hians* along Tuticorin coast. The line A-A indicates the eumetric fishing curve and the line B-B indicates the Maximum Sustainable Yield curve.

form of yield isopleth diagram, wherein the line A-A indicates the eumetric fishing curve and line B-B indicates the MSY curve.

Cohort analysis

Sparre (1986) and Silas *et al.* (1986) have dealt in detail the basic formulation and the stepwise estimation of the numbers in the sea with the help of intervening estimates like Zdt, F/Z, Fdt and Z from the numbers landed. Average estimates of exploitation ratio, total and average numbers in the sea, total and instantaneous mortality rate for *A. hians* along Tuticorin coast are given in Table 3.

Stock assessment

The stock estimates in tonnes obtained from the cohort analysis of the average numbers landed during the period 1990-'93 are given in Table 4. Average annual landing of *A. hians* is 21.6 t, average annual stock is estimated to be 236.5 t and the standing stock 12.4 t. On an average 1,049.0 t of full beaks and half beaks are landed along Tamil Nadu coast in which *A. hians* formed 316.8 t. Average annual stock of *A. hians* is estimated to be 3,469.5 t and the standing stock is 187.9 t for Tamil Nadu.

Remarks

As there is no information available on the population dynamics of belones, and this is the first report on a component species of belones, no detailed discussion can be made. It is hoped that the results presented here will be useful for the purpose of proper management of the belone fishery as the gear employed is specifically designed and aimed to exploit the belones and hemiramphids.

As the data are only from the gill nets, the length samples may not truly reflect the population structure. However, for the first approximation, the

TABLE 3.   *Estimates of numbers in the sea, F/Z, F, Z and average numbers in the sea obtained from the average numbers caught during 1990-'93 for* A. hians *as per the cohort analysis*

Size	Average No. group	Numbers in caught	F/Z in the sea	F	Z	Average No. in the sea
420-439	13	78,623	0.005	0.004	0.804	3,183
440-459	147	76,064	0.055	0.047	0.847	3,154
460-479	276	73,395	0.100	0.089	0.889	3,119
480-499	552	70,624	0.183	0.180	0.980	3,074
500-519	747	67,612	0.236	0.248	1.048	3,018
520-539	1,261	64,451	0.349	0.428	1.228	2,944
540-559	1,488	60,835	0.395	0.522	1.322	2,852
560-579	1,689	57,065	0.435	0.615	1.415	2,747
580-599	1,915	53,179	0.477	0.728	1.528	2,629
600-619	2,655	49,161	0.572	1.069	1.869	2,484
620-639	3,819	44,519	0.676	1.672	2.472	2,284
640-659	4,093	38,873	0.715	2.007	2.807	2,040
660-679	4,240	33,148	0.749	2.385	3.185	1,778
680-699	4,100	27,485	0.773	2.716	3.516	1,510
700-719	3,568	22,177	0.780	2.842	3.642	1,256
720-739	2,789	17,605	0.771	2.691	3.491	1,037
740-759	2,463	13,987	0.784	2.904	3.704	848
760-779	2,386	10,845	0.817	3.569	4.369	669
780-799	1,784	7,924	0.814	3.509	4.309	508
800-819	1,004	5,733	0.760	2.538	3.338	396
820-839	1,105	4,413	0.819	3.616	4.416	306
840-859	830	3,063	0.825	3.769	4.569	220
860-879	607	2,057	0.832	3.953	4.753	154
880-899	375	1,327	0.817	3.563	4.363	105
900-919	241	867	0.805	3.299	4.099	73
920-939	135	568	0.765	2.598	3.398	52
940-959	63	391	0.663	1.576	2.376	40
960-979	173	296	0.898	7.006	7.806	25
980-999	28	103	0.757	2.494	3.294	11
1,000-1,019	10	65	0.606	1.230	2.030	8
1,020-1,039	—	48	—	—	0.800	7
1,040-1,059	—	42	—	—	0.800	7
1,060-1,079	37	—	0.500	—	—	—

estimated values of parameters might serve as indicators of the relative magnitude of the true values and there may not be significant deviations in the long term trend in response of yield to different exploitation levels as depicted in the present study.

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