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Fisheries Section
of the Network of Tropical Aquaculture
and Fisheries Professionals (NTAFP)

Editor : G. Silvestre

Population Parameters of Small Pelagic Fishes Caught off Tawi-Tawi, Philippines

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Abstract

Growth and mortality parameters, exploitation rates and annual recruitment patterns were estimated from monthly length-frequency samples for *Sardinella longiceps, S. fimbriata, S. albella, Decapterus macrosoma*, *Dipterygonatus balteatus, Rastrelliger faughni* and *Encrasicolina heteroloba.* These results provide the first sets of stock parameter estimates for these species off Tawi-Tawi, Philippines. The growth parameters derived were found comparable with previous estimates available for the same species from other localities. Recruitment was noted to be year-round and bimodal. Estimates of fishing mortality and exploitation rate were found to be presently above appropriate levels.

Introduction

The province of Tawi-Tawi comprises a number of island municipalities which form the Sulu archipelago and separate the Sulu Sea from the Sulawesi Sea (Fig. 1). A clearly defined geographical region which is now referred to as the Sulu-Sulawesi ecoregion was, by Presidential Proclamation No. 1028 in 1997, declared a Large Marine Ecosystem (LME) and aquatic resources research has since intensified in the area. Collecting fisheries statistics and monitoring catches and landings within and around this province is quite a challenging task because of the sheer diversity of the fisheries and the technical heterogeneity of the fishing units.

The pelagic stocks in this region are mainly exploited by the use of the ‘Bagnet’, a ringnet with 3.0 cm stretched meshes, operated from the ‘*Palakaya*’ - the local motorised fishing boats which range in capacity from 20-40 gross tonnes. The three sardinella species in this study are the most abundant of the few clupeids found in this area and they, together with the four other species covered in this study (Aripin et al. 1997) comprise the small pelagics that provide the highest commercial landings in this province.

Very little is known about the ecology and exploitation levels of fishes in this area and this study was undertaken to fill some of these gaps. This investigation is part of a more comprehensive program on the ecology of the local aquatic resources and the results contribute first estimates of important stock parameters for exploited teleosts in this part of the Sulu-Sulawesi LME.

Materials and Methods

The monthly length-frequency samples analysed in this study were drawn from fishing grounds around the provinces of Tawi-Tawi and Jolo (Fig. 1). The samples were taken on board ‘*Palakayas*’ using fishing gears that were identical in net design, structure and measurements. The sampling period lasted from August 1994 to September 1995. Total lengths (snout to caudal fin tip) of individuals were recorded to the nearest 0.1 cm. The analysis of data was done using the routines in FiSAT (Gayanilo et al. 1995). Preliminary estimates of L_∞ and also Z/K were obtained through the Powell-Wetherall Plot (Pauly 1986; Wetherall 1986). Final growth estimates (with or without seasonality) were obtained using the ELEFAN I routine (Pauly and David 1981).

The Phi-prime index,ϕ' (Munro and Pauly 1983; Moreau et al. 1986), was used to compare the growth performance of species studied with previous estimates contained in "FishBase 98" (Froese and Pauly 1998). Estimates of mortalities were derived from the linearised length-converted catch curve produced by the ELEFAN II routines. Natural mortality (M) was derived through the empirical equation of Pauly (1980); mean annual habitat temperature used was 28°C. Estimates of length-at-first-capture (L_{50}) were derived from probabilities of capture generated from the catch curve analysis. The annual recruitment pattern was produced following Moreau and Cuende (1991), through reverse projection of the restructured data onto the time axis. The exploitation rate (E) was obtained by dividing F by Z computed for each species (see Beverton and Holt 1956; Pauly 1984; Pauly and Soriano 1986; Silvestre et al. 1991)

Results and Discussion

Fig. 2, by way of example using *Decapterus macrosoma*, illustrates the analysis and outputs generated for the seven species during the course of this study. Growth estimates and their comparisons using the ϕ' are presented in Table 1. Estimates obtained through the Powell/Wetherall Plot and ELEFAN I were about the same for the clupeid species, but slightly lower in ELEFAN for the other species. The final estimates of growth parameters given here showed slight seasonality for most species. Among clupeid species, *S. longiceps* has shown the highest L_{max} but *S. albella*, which is the smallest in size of the three, showed the highest ϕ'-values.

All the species showed estimated ϕ'-values that were quite comparable to their respective mean values from previous studies. In the case of *S. fimbriata*, a previous estimate of ϕ'= 2.75 and L_∞=22.0 cm existed for Palawan (Pauly 1984) which is the nearest locality in the Philippines to the present study site. Among the few available estimates for *S. albella*, this study provides the highest ϕ' and L_∞ estimates so far noted; estimates of a smaller size (L_∞=18.4 cm) and faster growth (K=1.34 yr^{-1}) were noted from India (Pauly 1978). The same was observed for *D. macrosoma* when the present estimates were compared with those for more northern parts of the Sulu Sea provided by Lavapie-Gonzales et al. (1997).

This study shows new high values of L_∞ and ϕ' for *S. albella;* previous estimates are few, coming mostly from India; the highest K-value of 2.03 yr^{-1} (Pauly 1978) was from Sri Lanka.

All seven species showed year-round recruitment patterns having two peak periods (Table 1 and Fig. 2). This, noted earlier by Pauly and Navaluna (1983), is a typical feature of many Philippine fishes studied so far.

The Z-estimates from this study (Table 2) for *D. macrosoma*, *S. longiceps*, *R. faughni* and *S. fimbriata* were lower than those for Sulu Sea during the 1980s given in Lavapie-Gonzales et al. (1997). In the case of *E. heteroloba* there did not seem to have been any significant change: Z=3.88 yr^{-1} (this study); Z = 3.51 yr^{-1} (Lavapie-Gonzales et al. 1997). With the exception of *R. faughni*, high exploitation rates (E) exceeding 0.50 were noted for all species.

The species studied here

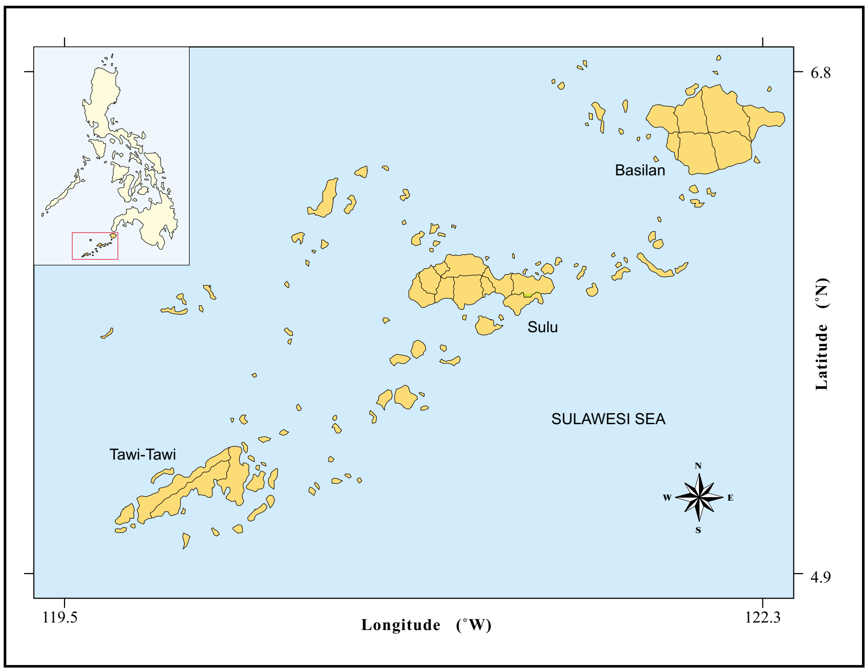

Fig. 2. Map of the Philippines showing the Sulu and Sulawesi Sea. The shaded area, enclosing the provinces of Tawi-Tawi and Jolo, indicate the general locality where the length-frequency samples for this study were drawn.

Table 1. Estimates of growth parameters from this study and the mean of ϕ'-values from previous studies.
(The authors for previous parameter estimates were obtained from FishBase 98 and are listed below. The estimates for **S. longiceps** ***came from India and Yemen; most of those for*** **S. fimbriata, Decapterus macrosoma*****,*** **Rastrelliger faughni*****, and*** **Encrasicolina heteroloba** ***were from Philippine waters; those for*** **S. albella** ***were mostly from India).***

Species	Parameter								
	L_∞ (TL, cm)	K (yr^{-1})	C	WP	ϕ' (this study)	ϕ' (mean)[a]	n	s.e. of mean[a]	NRP
S. longiceps	26.0	0.86	0.30	0.80	2.76	2.57	14	0.060	2
S. fimbriata	22.5	0.75	0.40	0.40	2.56	2.62	12	0.039	2
S. albella	20.2	1.60	0.20	0.20	2.82	2.45	7	0.033	2
D. macrosoma	24.9	0.77	0.15	0.05	2.68	2.82	34	0.196	2
D. balteatus	23.2	0.88	0.15	0.15	2.68	-	-	-	2
R. faughni	25.9	0.94	0.50	0.25	2.83	3.13	4	0.062	2
E. heteroloba	13.3	0.63	0.15	0.00	2.05	2.28	14	0.053	2

a./

D. macrosoma
Anon. 1985; Atmadja 1988; Boonraksa 1987; Corpuz et al. 1985; Dwiponggo et al. 1986; Ingles and Pauly, 1984; Jabat and Dalzell, 1988; Lavapie-Gonzales et al. 1997; Padilla 1991; Philbrick 1988; Sadhotomo and Atmadja 1985; Sousa and Gjøsaeter 1987; Sousa 1992; Tandog-Edralin et al. 1988;

E. heteroloba
Burhanuddin and Hutomo 1975; Dalzell and Wankowski 1980; Dalzell 1984; Ingles and Pauly 1984; Lavapie-Gonzales et al. 1997; Muller 1976; Padilla 1991; Paula de Silva 1992; Pauly 1978; Rawlinson 1989; Tham Ah Kow 1967;

S. albella
Dalzell and Ganaden 1987; Dayaratne and Gjøsaeter 1986; Makwaia and Nhwani 1992; Pauly 1978; Sekharan1955;

S. longiceps
Annigeri 1969; Antony Raja 1970; Antony Raja 1972; Banerji and Krishnan 1973; Banerji 1973; Biradar and Gjøsaeter 1989; Dayaratne and Gjøsaeter 1986; Edwards and Shaher 1987; Edwards and Shaher 1991; Kurup et al. 1989; Pauly 1978; Pauly 1980; Sanders and Bouhlel 1984;

R. faughni
Jabat and Dalzell 1988; Lavapie-Gonzales et al. 1997.

S. fimbriata
Ingles and Pauly 1984; Lavapie-Gonzales et al. 1997; Pauly 1978; Tandog-Edralin et al. 1988.

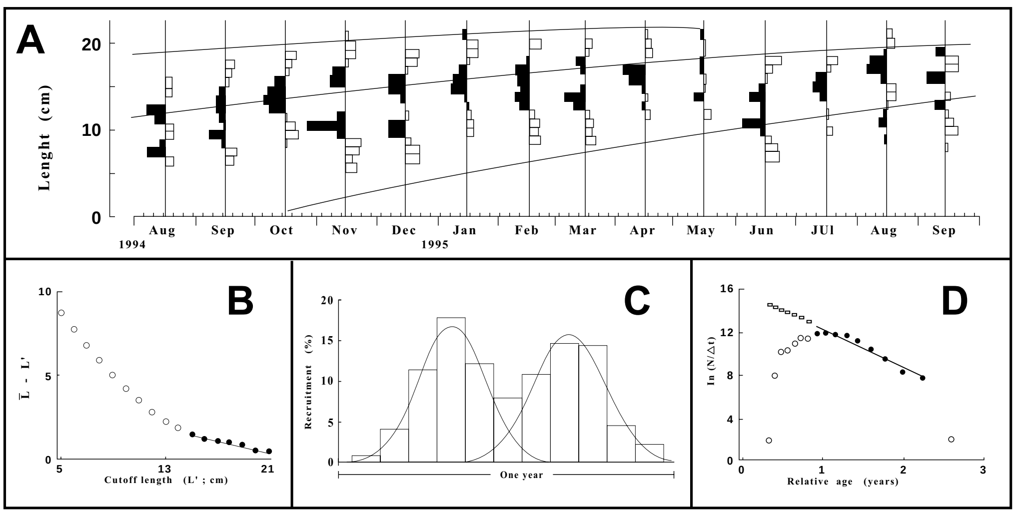

Fig.2. Results of analyses using FiSAT for **Decapterus macrosoma** ***from Tawi-Tawi, Philippines:***
(a) growth curve superimposed over restructured length frequency data.
(b) Power-Wethrall plot to estimate L_∞ and Z/K;
(c) annual relative recruitment pattern; and
(d) length-converted catch curve. See text and Table 1 and 2 for parameter estimates.

comprise the predominant small pelagic species in this area and the general conclusion to be drawn from these results is that the level of exploitation is already high for virtually all of them. This situation warrants closer attention (and greater insight into the whole issue should come from more reliable fisheries catch statistics). Many authors who have investigated the spawning periods of fishes in the Indo-Pacific region have drawn attention to the possible relationship between seasonalities in recruitment and the occurrence of the monsoons. The debate is still not concluded and it could be suggested here that a follow-up biological study on the annual sexual maturation cycles of these same species could be very useful. This kind of study could assist in correlating the spawning and recruitment cycles in the complex fisheries of these waters.

Table 2. Estimates of mortalities and related parameters derived in this study.

Species	Parameter				
	Z (yr^{-1})	F (yr^{-1})	M (yr^{-1})	L_{50} (cm)	E
S. longiceps	3.65	1.97	1.68	14.0	0.54
S. fimbriata	4.23	2.63	1.60	12.8	0.62
S. albella	6.10	3.48	2.62	11.3	0.57
D. macrosoma	3.49	1.90	1.59	11.6	0.54
D. balteatus	5.91	4.15	1.76	5.4	0.70
R. faughni	2.81	1.02	1.79	10.2	0.36
E. heteroloba	3.88	2.22	1.66	7.0	0.57

Acknowledgement

The authors acknowledge the support provided by Department of Science and Technology-Philippine Council for Aquatic and Marine Research and Development, Mindanao State University, Tawi-Tawi College of Technology & Oceanography and the Chancellor, Eddie M. Alih (who is also former Dean of the College of Fisheries) to see this study completed. Also acknowledged are the efforts of E.R. Baird, H.A. Aripin and other members of the field data collection team.

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