Growth, Mortality and Recruitment of Exploited Small Pelagic Fishes in the Gulf of California, Mexico

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Abstract

Preliminary, length-based von Bertalanffy growth parameter estimates for *Sardinops caeruleus, Opisthonema libertate, Scomber japonicus, Etrumeus teres,* and *Engraulis mordax,* caught in the pelagic fishery based in Guaymas, Gulf of California, Mexico, are presented along with estimates of natural mortality and the seasons of recruitment to the fishery.

Introduction

Sardine and sardine-like fishes represent the most important fishery resource of México by weight landed. On average, 80% of the country's annual sardine catch comes from the Gulf of California, where a fleet of 50 purse seiners operates from Guaymas, Sonora State (Fig. 1). The sardine fishery in the Gulf began in the mid-1960s after the collapse of the sardine stock off California, USA and the Pacific coast of Baja California, México (Lluch et al., 1986). During the 1987/88 fishing season, landings at Guaymas reached 204,000 t.

Species composition, local common names, and percentages included in the landings at Guaymas are: 1) *Sardinops caeruleus* (sardina monterrey, 85%); 2) *Opisthonema libertate* (sardina crinuda, 7%); 3) *Scomber japonicus* (macarela, 5%); 4) *Etrumeus teres* (sardina japonesa, 2%) and 5) *Engraulis mordax* (anchoveta, 1%).

The commercial landings at Guaymas are sampled regularly by personnel of the Centro

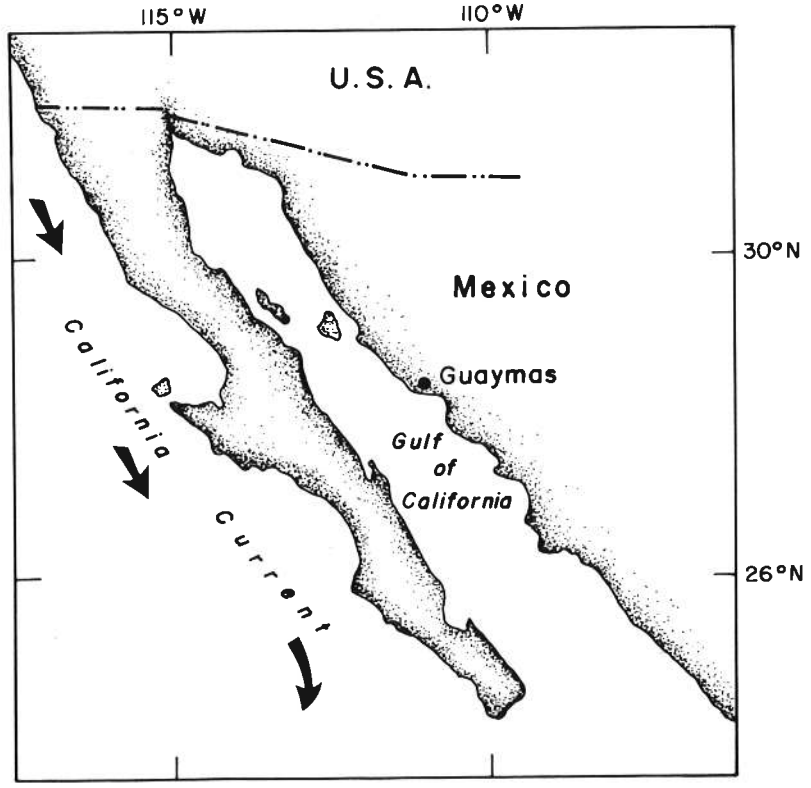

Fig. 1. Location of the Gulf of California, also known as the "Sea of Cortez".

Regional de Investigaciones Pesqueras. However, except for *S. caeruleus* and *E. mordax*, it has proven difficult to determine the age composition of the various stocks based on the readings of hard structures (i.e., otoliths and scales). On the other hand, a large amount of length-frequency data has been accumulated for the five species, part of which was used to investigate their growth, mortality and recruitment to the fishery. The objectives were: 1) to provide first estimates of growth parameters and natural mortality rate for some of the five species; 2) to compare these results with existing data obtained using hard structures; and 3) to analyze the recruitment patterns of the five species.

Materials and Methods

Daily samples of a predetermined size were taken from the commercial landings in Guaymas, with the aim of obtaining monthly catch-at-length distributions. However, due to the dominance of *S. caeruleus* in the catches, complete sets of monthly-size distributions could not be obtained for the other four species for any fishing season; hence, the seasons with the most complete data sets were chosen for the analysis.

For *S. caeruleus*, the data of two consecutive seasons (23 months) were analyzed simultaneously. *E. mordax* being a new resource in the Gulf of California, all available samples (11 months) were used for the analysis. The number of monthly distributions considered for the rest of the species were seven for *O. libertate*, ten for *S. japonicus* and six for *E. teres*.

The recent version of the ELEFAN software presented in Pauly (1987) and Gayanilo et al. (1988) was used to estimate the von Bertalanffy growth parameters (SL_∞ in mm and K, $year^{-1}$); no seasonal oscillations in growth were considered. The annual recruitment patterns and natural mortality rates (M) for the five species were also estimated. The mean temperature for the species habitat (required to calculate M) was estimated by averaging surface and 30 m depth temperatures for the fishing localities (information from the fishermen) using temperature data in Robinson (1973). After converting SL to TL, rough estimates of t_0 were obtained from L_∞ and K using an empirical relationship in Pauly (1979).

Results and Discussion

The results of analyses of growth, mortality and recruitment for the five species are give in Table 1. For *S. caeruleus* the estimates of the growth parameters were different from those obtained using otoliths which were SL_∞=197 mm, K=0.34 and t_0=-0.26 (Estrada et al. 1986). For *O. libertate*, the results are similar to those based on scalimetry: SL_∞=220 mm, K=0.51 and t_0=-0.88 for females, and L_∞=206 mm, t=-0.81 and K=0.57 for males (García and Molina 1986). No previous estimates of M have been published for these two species. Moreover, for the Gulf of California stock of *E. teres*, this represents the first study of growth, mortality and recruitment.

For *E. mordax* fished off California, the reported parameters are: L_∞=165 mm, K=0.30, t_0=-1.71 and M=0.55, derived from otolith readings of fish sampled from both trawl surveys and the commercial catch (Anon. 1983). Although latitudinal differences in growth parameters were found in the stocks of anchoveta from the California current (Vrooman et al. 1981), we caution that our results for the Gulf of California stock are probably biased, because some of the captains of the purse seiners avoid catching small anchovies due to the trouble of cleaning the net after a set. Thus, our results should be taken with care and considered as preliminary, and be validated when otolith readings are available.

The published parameters for *S. scombrus* from California waters are L_∞=436 mm, K=0.24, t_0=-3.02 and M=0.50 (Parrish and MacCall 1978). These estimates were based on otolith readings, and M from the intercept of a regression of total mortality on fishing effort. At least part of the differences in the parameter values reported for California versus

Table 1. Results of analyses of growth and mortality for five species of small pelagic fishes taken in the sardine fishery in the Gulf of California (see also Table 2).

Species	SL_∞ (mm)	K ($year^{-1}$)	t_0 ($year^{-1}$)	M ($year^{-1}$)	SL_r (mm)	No.[a]
S. caeruleus	225	0.60	0.15	1.10	85	23
O. libertate	216	0.50	0.18	1.14	103	7
S. japonicus	293	0.50	0.17	1.01	138	10
E. teres	231	0.86	0.10	1.54	113	6
E. mordax	153	0.70	0.14	1.49	68	11

[a]No. of the monthly distributions considered

the present study are most probably due to the effect of different lengths at age, i.e., fish 6 years of age measure 388 mm off California, but only 268 mm in the Gulf of California.

In the Gulf, the peak spawning of *O. libertate* occurs in late June, while that for the other species considered here occurs in January (Estrada et al. 1986; Cisneros et al. 1987). Considering the growth curves derived from the present analysis (Fig. 2), the actual maximum recruitment for *S. caeruleus*, *E. teres* and *O. libertate* should be during late summer (September), in autumn (November) for *E. mordax*, and in spring (April) for *S. japonicus*. Table 2 compares the expected and actual months of maximum recruitment as determined from the available growth curves.

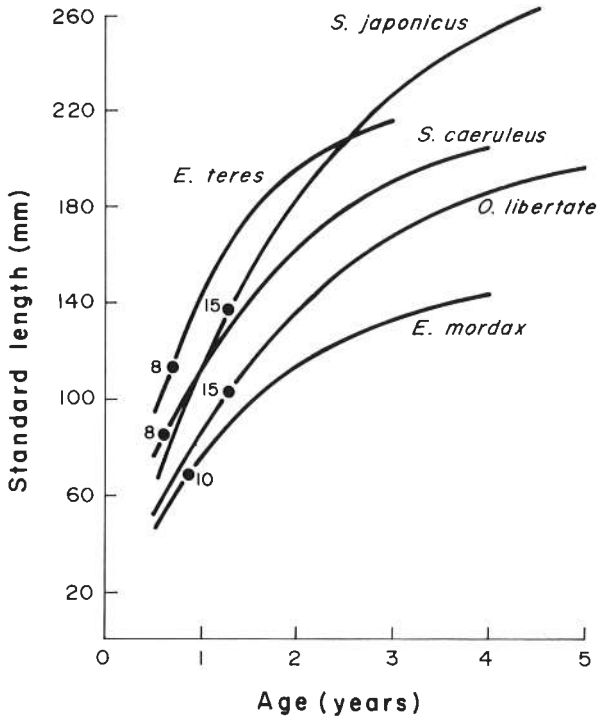

Fig. 2. Estimated growth curves for the six fish species included in the study. The dots indicate the length at recruitment into the fishery; the adjacent numbers indicate the month of recruitment.

Table 2. Recruitment of five species of small pelagic fishes taken in the sardine fishery of the Gulf of California. The elapsed time (months) from spawning to recruitment is given, along with the month of expected maximum recruitment (as estimated using the ELEFAN II program) and the actual months of peak spawning.

Species	Expected recruitment	Actual recruitment
S. caeruleus	September	September
O. libertate	October	September
S. japonicus	May	April
E. teres	August	September
E. mordax	September	November

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