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Growth of the Buccaneer Anchovy *Encrasicholina punctifer* off Mozambique, Based on Samples Collected in Research Surveys

by

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ABSTRACT

Growth of *Encrasicholina punctifer (Engraulididae)* is estimated, based on samples obtained during five surveys on Sofala Bank (central Mozambique). The estimated values of the von Bertalanffy growth function, TL_∞ = 12 cm and K = 2.0 $year^{-1}$ are compared with results of growth studies elsewhere in the Indo-Pacific region, based mainly on the index $\phi' = \log_{10} K + 2 * \log_{10} L_\infty$, assumed to be constant within species. This comparison is rendered difficult by the uncertain taxonomical status of stolephorid anchovies.

RESUMO

Com base em amostras colhidas durante cinco cruzeiros de investigação no Banco de Sofala, estimaram-se os parâmetros de crescimento K e L_∞ da anchoveta pirata, *Encrasicholina punctifer*. Os valores adoptados, TL_∞ = 12 cm e K = 2.0 por ano, são comparados com outros resultados obtidos na região IndoPacífica, utilizando o índice $\phi' = \log_{10} K + 2 * \log_{10} L_\infty$, que se pode considerar constante para cada espécie. A comparação torna-se difícil devido à posição sistemática incerta das anchovetas.

INTRODUCTION

Anchovy was found to be the main fish resource of Mozambique, as far as total biomass is concerned, during the acoustic surveys by R/V "DR. FRIDTJOF NANSEN" (Saetre & Paula e Silva, 1979). Further confirmation of high biomass levels, associated with wide fluctuations of abundance, was obtained by subsequent acoustic assessments by the same vessel (Brinca et al., 1981, 1983, 1984).

In 1984, a project was launched, with the assistance of the Norwegian Government, to perform experimental fishing and associated technological studies to initiate the development of a fishery on this resource. The project vessel, M/S "ATLϕY VIKING" was also used for research surveys, aimed at developing an understanding of the Mozambican marine fish resources. These surveys provided the main source of material used for the present study.

MATERIALS AND METHODS

Catch per haul and length-frequency observations from five surveys performed by M/S "ATLϕY VIKING" and from one survey by the R/V "Dr. FRIDTJOF NANSEN" were used (Table 1).

The surveys covered Sofala Bank (central Mozambique), where the main fish resources are concentrated (see Fig. 1).

Table 1. Basic information on surveys of Mozambican waters used as sources of data on *Encrasicholina punctifer*.

Survey #	Vessel	Period	No. of samples
1	F. Nansen	May - Jun 83	9
2	A. Viking	Oct - Nov 85	5
3	A. Viking	Nov 85	5
4	A. Viking	Sep 86	8
5	A. Viking	Feb - Mar 87	14
6	A. Viking	Jul - Aug 87	6

All catches were done with pelagic trawl, except for three samples from survey #1 and five from survey #3, which were taken from shrimp trawl hauls. The original data are summarized in the respective cruise reports (Brinca et al., 1984; Paula e Silva, 1985, 1986, 1987a, 1987b).

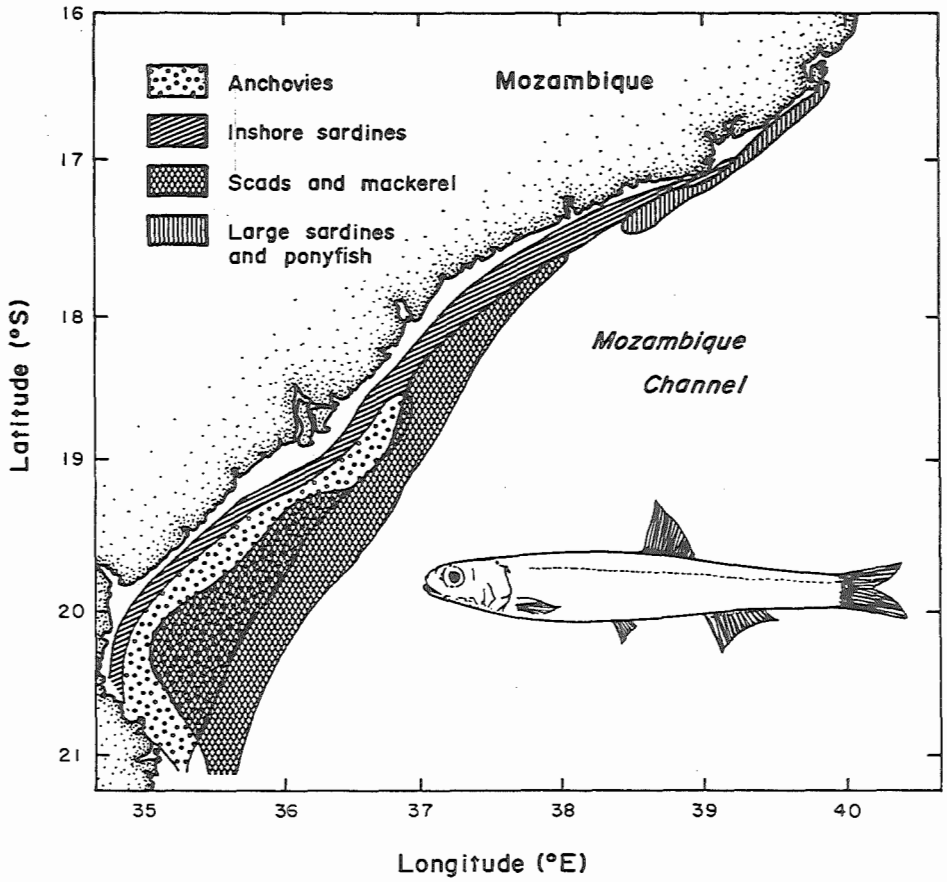

Fig. 1. Illustrating the distribution of the main pelagic species of Sofala Bank, (adapted from Brinca et al., 1983), and Encrasicholina punctifer *Fam. Engraulididae (adapted from Whitehead & Wongratana, 1984).*

Some samples from the F. NANSEN survey consist of a mix of two closely allied species, *Encrasicholina punctifer* and *E. heteroloba*. Since the size composition of the samples from these two species are very similar, the samples were used as is, such as to obtain an extra sample representing the periods between February-March and July-August.

Total catch in weight was estimated (rather than measured) during the surveys, and the number of anchovies caught was then obtained through a raising factor computed from the weight of subsamples. These numbers were then raised to the respective catch.

All processing was performed using the Compleat ELEFAN software package (Pauly, this vol.). The catch-at-length data were grouped for each survey, then pooled into an artificial year using weights corresponding to the square root of sample size. Table 2 lists the six resulting "monthly samples" used for growth analysis.

Table 2. "Artificial year" composed of the combined samples of anchovy raised to the catch.

Mean length (FL-cm)	Feb	Jun[a]	Aug	Sep	Oct	Nov
2.75		7				
3.25		59		107		
3.75	180	59		108		
4.25	21724	164	235	73032		
4.75	58170	7	33891	242433	5	32
5.25	87029	38	124503	64187	5	0
5.75	23380	1442	46131	2683	5	808
6.25	6448	8672	23540	6074	0	13792
6.75	31152	33954	15084	1719	210	251311
7.25	63207	106099	15191	6134	4326	573181
7.75	97344	267452	6170	8611	6299	242642
8.25	67499	265862	2585	48289	12497	79980
8.75	4017	212039	4627	14647	26828	4777
9.25	194	7397	8555	5149	3265	177
9.75	1	64	1224		363	2
10.25	7		1			4
Sum	460352	903315	281747	473173	53803	1166706

[a]Includes a mix of *E. punctifer* and *E. heterolobus*; sample numbers divided by ten, for compatibility with the other samples.

As described in Pauly & David (1981), the estimation of growth parameters using the ELEFAN I program is performed by identifying the von Bertalanffy curve that gives the best fit to the length-frequency data, as restructured by running averages. Different sets of values of L_∞ and K can be entered or made to vary, as well as for the parameters which express seasonality in growth. These are "C" or amplitude of the seasonal oscillation, and "WP", or winter point expressing the period of the year when minimum growth occurs.

In order to compare the estimates obtained with other results in the literature, the index $\phi' = \log_{10} K + 2\log_{10} L_\infty$ was used, as described in Pauly & Munro (1984); to obtain more comparable values for comparisons, some published data were reprocessed, using the method of Gulland & Holt (1959).

RESULTS AND DISCUSSION

Growth Patterns

Fig. 2 shows two growth curves with the selected parameters superimposed on the "artificial year" obtained by pooling the available length-frequency samples.

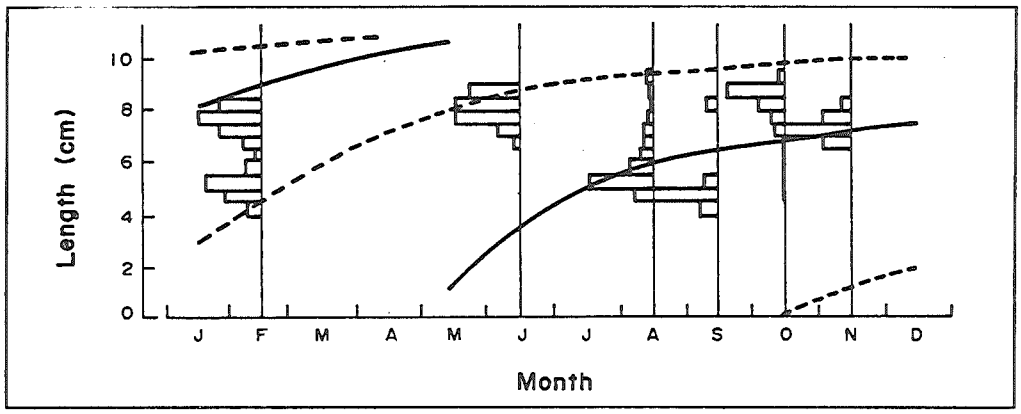

Fig. 2. Growth pattern of Encrasicholina punctifer, *shown by two curves linking the main components of the samples. The growth parameters of the two curves are:* TL_∞ *= 12 cm;* $K = 2.0$ *year ;* $C = 0.6$*;* $WP = 0.8$

As might be seen, the two main modes of the length distributions are "hit" by the curves, of which each represents a recruitment event. Similar results were obtained when placing the different samples at their original distances in time (plot not shown).

Table 3 compares different values of L_∞, K, and ϕ' available in the literature with those resulting from the present study.

Length-frequency data collected in discrete surveys can be suspected not to be optimal to study the biology of anchovies. These small fishes have short life cycles and thus several surveys per year would be necessary to track the rapid changes in their overall abundance and/or size composition. Furthermore fixed stations from a research survey are bound to be affected by random phenomena linked to the schooling and the patchy distribution of the fish.

Taxonomical Status of Stolephorid Anchovies

The uncertain taxonomical status of the small Indo-Pacific *anchovies* has been responsible for frequent changes in scientific nomenclature, hampering the progress of the group's knowledge. Although recent revisions exist (Whitehead et al., 1988), field identification of the different genera and species continues to be difficult.

Moreover, the schooling behavior of these fishes is odd, in the sense that different species and size composition appear in survey catches from neighboring stations (Brinca et al., 1984), as well as in landings from nearby areas (Tiews et al., 1970).

Table 3. Comparison of growth parameters available in the literature for *E. punctifer* and *E. heterolobus*.

Species and source	Area sampled (year)	L_∞	K (cm, TL)	ϕ'^a ($year^{-1}$)
Encrasicholina punctifer[b]				
Ingles & Pauly (1984)	Manila Bay (1957)	10.10	1.10	2.05
" " "	" " (1958)	10.60	1.85	2.32
" " "	" " (1961)	9.20	1.15	1.99
Tiews et al. (1970)				
This study	Sofala 1983-1987	12.00	2.00	2.46
Encrasicholina heteroloba[c]				
Tierney (1979)	Papua New-Guinea[d]	8.95	3.65	2.47
Dalzell et al. (1980)	(1976-1979)[e]	9.60	4.09	2.58
Dalzell et al. (1980)	(1976-79)[d]	9.58	4.02	2.57
Dalzell et al. (1980)	(1976-79)[f]	8.31	3.65	2.40
Ingles & Pauly (1984)	Manila Bay, 1958	12.10	1.60	2.37
Ingles & Pauly (1984)	Manila bay, 1961	11.40	0.95	2.09

[a] $\phi' = \log_{10} K + 2\log_{10} L_\infty$.
[b] = *Stolephorus punctifer, S. buccaneeri and S. zollingerii.*
[c] = *Stolephorus heterolobus.*
[d] Otolith readings, our estimates (Gulland & Holt plot).
[e] Modal progression analysis, authors' results.
[f] Modal progression analysis, our estimates.

Until 1983 the anchovy resource off Mozambique was considered, based on Whitehead (1974), to consist of only one species, *Stolephorus buccaneeri* (Saetre & Paula e Silva, 1979; Brinca et al., 1981, 1983). Thereafter more attention was given to this group and up to four species were identified in survey catches (Brinca et al., 1984); using Whitehead & Wongratana (1984) the main species was then identified as *S. punctifer*, a junior synonym of *Encrasicholina punctifer* (Whitehead et al., 1988).

Size Composition of the Resource

As previously shown by Brinca et al. (1984), positive hauls usually consist of fish of uniform size, probably representing a single cohort. However quite different mean lengths have been found in the same survey. In the data analyzed here it was generally possible to discriminate up to three components.

This suggests that several cohorts are produced every year, the most likely number of these being two. However, identification of spawning/recruitment periods was difficult as similar curves drawn

with slightly different, but also acceptable values of L_∞ and K suggested very different spawning/ recruitment periods. This is probably due to the limited quality of the data analyzed here.

Growth Parameters

TL_∞ was fixed at 12 cm, just above the biggest fish measured, although this is a higher value than found in the literature, except for Tiews et al. (1970). Nevertheless it produced reasonable values of Rn for $K \approx 2.0$ year^{-1}.

This value of the growth constant seems acceptable, both in terms of a short-lived species, as this is believed to be, and also considering the ϕ' value obtained, which is well within the range of the values computed from the literature.

Seasonality in Growth

The "best fitting" growth curves were obtained considering seasonal oscillation of growth. Such seasonal oscillations are plausible, in view of the subtropical conditions and shallow depths which characterize the biotope of *E. punctifer*.

Nevertheless the amplitude of the seasonal oscillation of growth was not very high (C = 0.5) for the "best fit". On the other hand the position in time of the winter point (WP = 0.8, corresponding to mid-September) is compatible with the notion that the "aquatic winter" occurs 1.5 to 2 months after the lowest temperatures occur ashore. Furthermore, August-September is a season of strong winds, which can significantly decrease the water temperature. Thus, growth parameter estimates appear to be reasonable, although they might eventually be revised as better data become available.

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