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Notes on the Assessment of the Stocks of Small Pelagic Species on the Basis of Length Frequency Analysis and Converted Catch Curves[1]

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1. Introduction

Difficulties are usually encountered when small pelagic species stocks are assessed with the simplest classical methods such as the surplus production models, for the following reasons:

- the year to year variations of recruitment driven by climate (widely stressed by several authors);
- the changes in catchability in relation to climate or to the abundance of fish.

The consequences of this natural variability have been described in Csirke and Sharp (1983) and particular reference for West Africa is given in Garcia (1984). This brief note aims at illustrating how these two types of variation also seriously affect the results obtained by analytical methods.

2. Interannual variations of recruitment and fishing patterns

Important pelagic resources, such as those off Mauritania, tend to be exploited by sophisticated industrial fisheries (factory ships, purse seiners, pelagic stern trawlers, etc.) which are able, because of their high technological flexibility, to shift rapidly from a species whose abundance appears to be decreasing, to a more abundant species.

These transfers of effort are usually provoked by natural fluctuations in recruitment and are translated into large fluctuations of the fishing intensity globally applied to a given species.

The variations of recruitment result in large variations in the age and size structure of the fish population, especially for species which have a short life-span or are very heavily exploited. They also result in variations in the geographical distribution of the overall biomass available. Horsemackerels, sardinellas and young mackerels are usually encountered in large commercial concentrations on the inner part of the continental shelf. The concentrations of adults are, on the contrary, exploited on the outer shelf, above the continental slope. When recruitment is particularly good during two or three years, the biomass of young fish grows on the shelf and the fleets concentrate their effort on the shelf on the young, small-sized, fish (especially when the final product is fish meal). However, when recruitment is poor for two or three years, the shelf biomass of young fish diminishes and the residual biomass, comprised essentially of old fish, is localized at the offshore edge of the shelf where the remainder of the fleet concentrate, still targeting on that species (situations A and B in Figure 1).

The result of this is that the natural variations of recruitment result not only in variations of fishing mortality (more so when a large part of the fleet is foreign) but also in variations of the fishing pattern (vector of fishing mortality at age).

3. Consequences for the use of analytical methods

The estimation of population parameters for these stocks, using methods which often assume equilibrium (of recruitment and of fishing), meets with serious difficulties in interpretation.

After a series of good recruitments (situation B, Figures 2, 3 and 4), the age structure will be dominated by young fish, and the total mortality (and therefore the fishing mortality) will be overestimated and the age at first capture will appear to be low because of the concentration of the fleet on young fish schools inshore.

After a series of poor recruitments (situation A, Figures 2, 3 and 4) the age structure of the declining stock will be dominated by old fish, the total mortality will be underestimated and the age at first capture will appear to be high because of the transfer of the fleet offshore in order to capture schools of older fish living near the shelf edge.

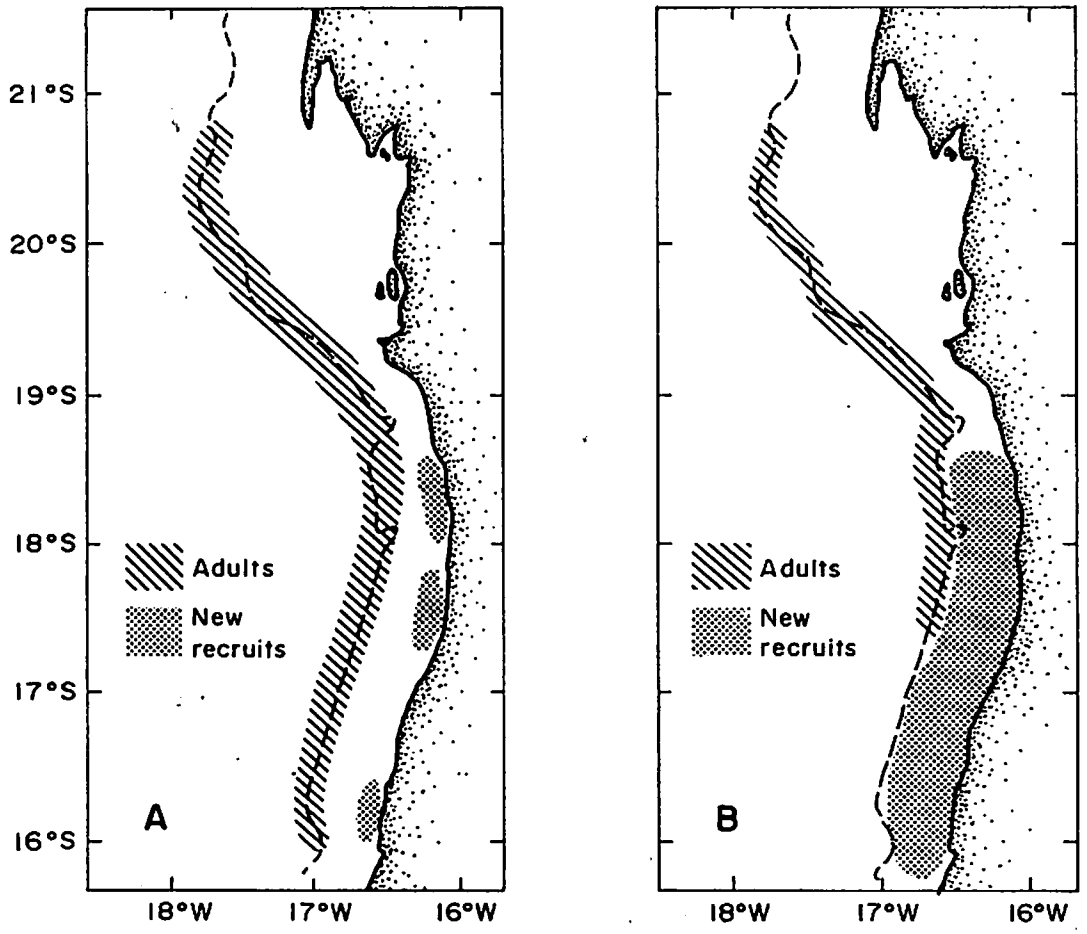

Fig. 1. Theoretical relative distribution of new recruits and adults in situations A & B.

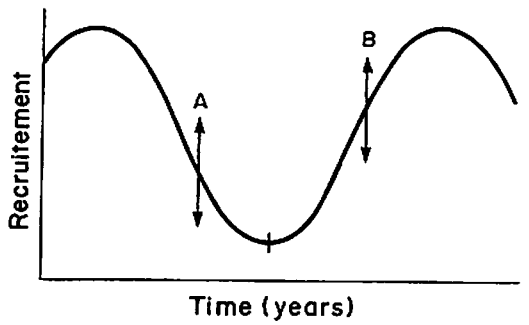

Fig. 2. Cycle of natural variation of long-term recruitment and position in the cycle of situations A & B cited in the text. A = diminished stock, series of weak recruitment; B = reconstituted stock, series of high recruitment.

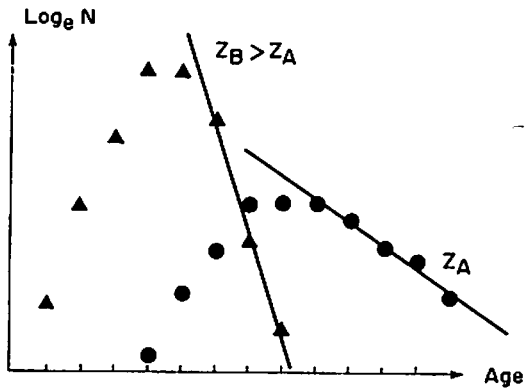

Fig. 3. Catch curves of situations A & B.

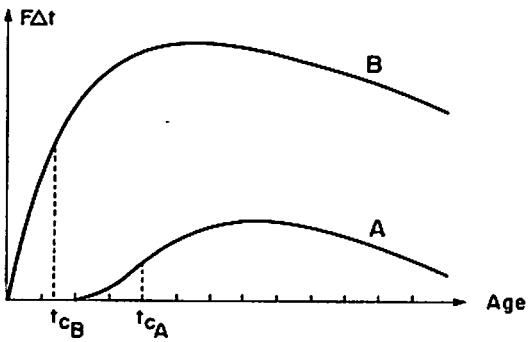

Fig. 4. Exploitation curves for situations A & B.

4. Discussion

The description of the events and their consequences given above largely corresponds to what is already known about small pelagic resources and their exploitation and is therefore not original. It is, however, necessary to "dot the i's" at a time when the use of length frequency distributions for fish stock assessment is developing rapidly in the tropical zone.

It is wrongly assumed that the data reflect a situation of equilibrium, which in the real world probably never exists. A stock of pelagic fish, decimated by excessive fishing during its rapid growth phase and may even, during this decline (situation A, Fig. 5), periodically appear to be underexploited in terms of yield per recruit, in spite of the rapid decrease of catch rates and biomass. In the opposite situation (B, Fig. 5) the stock which is rapidly rebuilding appears very overfished.

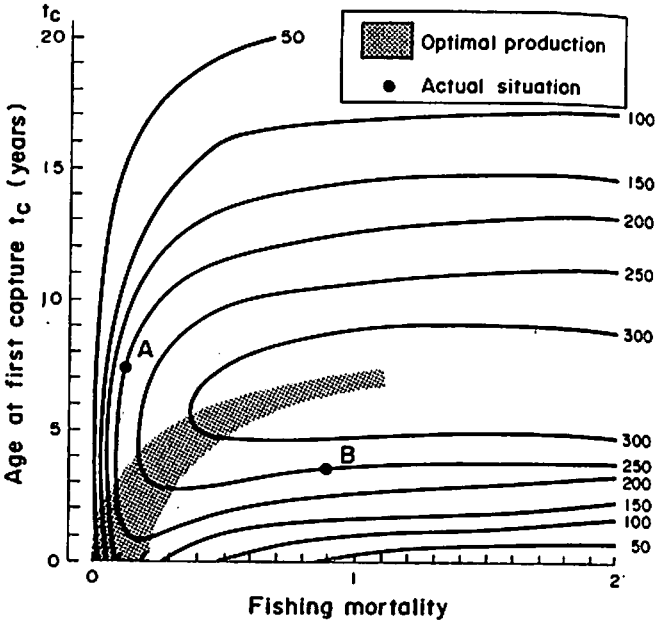

Fig. 5. Theoretical yield curves of recruits showing the position of situations A & B.

This may lead to apparent contradictions between the conclusions derived from production models and from yield per recruit models respectively and also with observations of the landings. This is particularly true in a pelagic multispecies fishery where the effort effectively applied to a given species cannot be estimated with sufficient precision.

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[1]The original of this paper was published as Annex R in E. Josse and S. Garcia (1986) Description et evaluation des ressources halieutiques de la ZEE Mauritanienne. Rapport de Groupe de travail CNROP/FAO/ORSTOM, Nouadhibou, Mauritania, 16-27 September 1985. COPACE/PACE Series/86-37.