BODY LENGTH VARIABILITY IN FISH SCHOOLS AND COHORTS; APPLICATION TO FISHERIES BIOLOGY IN TROPICAL WATERS

(Summary only)

by

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SUMMARY

In pelagic fish populations, individuals of similar size assemble in schools, which can be defined as a physical grouping of gregarious fish "mutually attracted to each other" (Shaw, 1980). The fishery biologist is more interested, in the dynamics of population studies, by the concept of cohort defined as a set of animals from the same species and issue from a same spawning period, but this concept seems to be ignored by the fish.

Except for size, a cohort or a school is mainly characterised by the mean length of individuals and by the spread around this mean. The relations between these two parameters have been studied in cohorts and schools of tropical small pelagic fish, in order to improve the knowledge of fish aggregation mechanisms and their consequences on fisheries biology.

From a theoretical point of view, if each individual is assumed to grow according to the Von Bertalanffy's equation with fixed parameters but these parameters differ among individuals, it is then to be expected that variability in length at a given age is mainly due to three factors; first: differences in birth dates (to_i), second: differences between growth rates (k_i), and third: differences between maximal length ($L_{\infty i}$) for adults (Fig. 1).

Data from sardine-like fish (mainly *Sardinella aurita*) in the Central-East Atlantic and from menhaden (*Brevoortia tyrannus*) in the Central-West Atlantic have been studied. This analysis, applied to cohorts, shows an early decrease in the standard deviation of length when plotted against mean length, which suggests a stronger influence of variation in to_i and k_i comparatively to $L_{\infty i}$ (Fig. 2). As applied to schools, the standard deviation of length increases constantly with mean length, providing a constant coefficient of variation. For schools of mixed species, the results are the same, suggesting that regroupment is more related to length similarities than to species groups (Fig. 3).

Comparison between figures obtained from cohorts and schools belonging to the same species shows an inadequacy of length spread between these two structures (Fig. 2). In consequence the scheme of small pelagic aggregations can be summarized in the following three stages:

- during the first stage, not observed under natural conditions, it is possible for fish issued from a same cohort and born within few days interval to remain grouped in the same school or in schools with similar length frequency distributions;

- however, the data strongly suggest that a cohort rapidly disperses into schools of narrower length spread, due to the high degree of variability in the cohort, especially for tropical species which present a spawning period spread over a long time and have high growth rates;

- during the third stage, the cohort length variability decreases to such a degree that it is possible to encounter fish from different cohorts in the same school.

In general a school cannot be considered as representative of the cohort length frequency distribution (Fig. 4).

In pelagic fisheries, the school corresponds generally to the catch unit target and the concept of cohort does not have anymore meaning for fishermen than for fish. It is then the fisheries biologist who must estimate the numerical importance of cohorts through complex sampling methods. The usual stratified sampling methods are recommended, but it is often difficult to define homogeneous strata due to species migrations not related to fishing grounds.

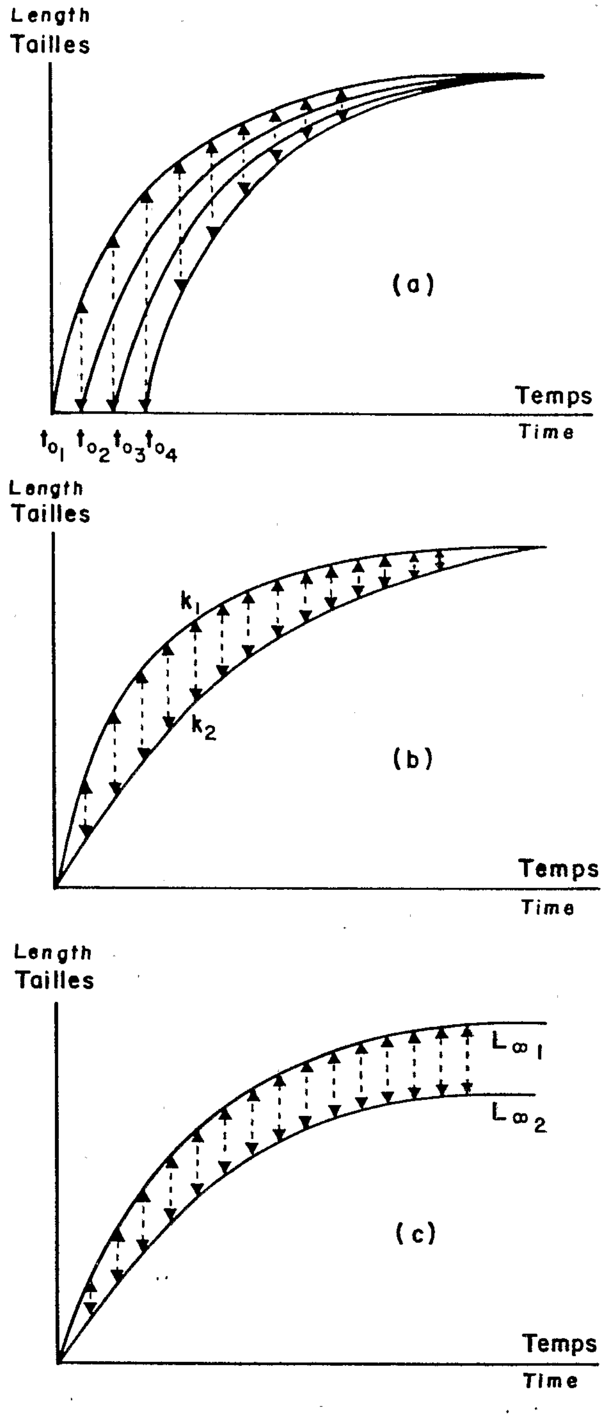

Fig. 1. Theoretical sources of variability inside a cohort which individuals would present different parameters of Von Bertalanffy's equation.

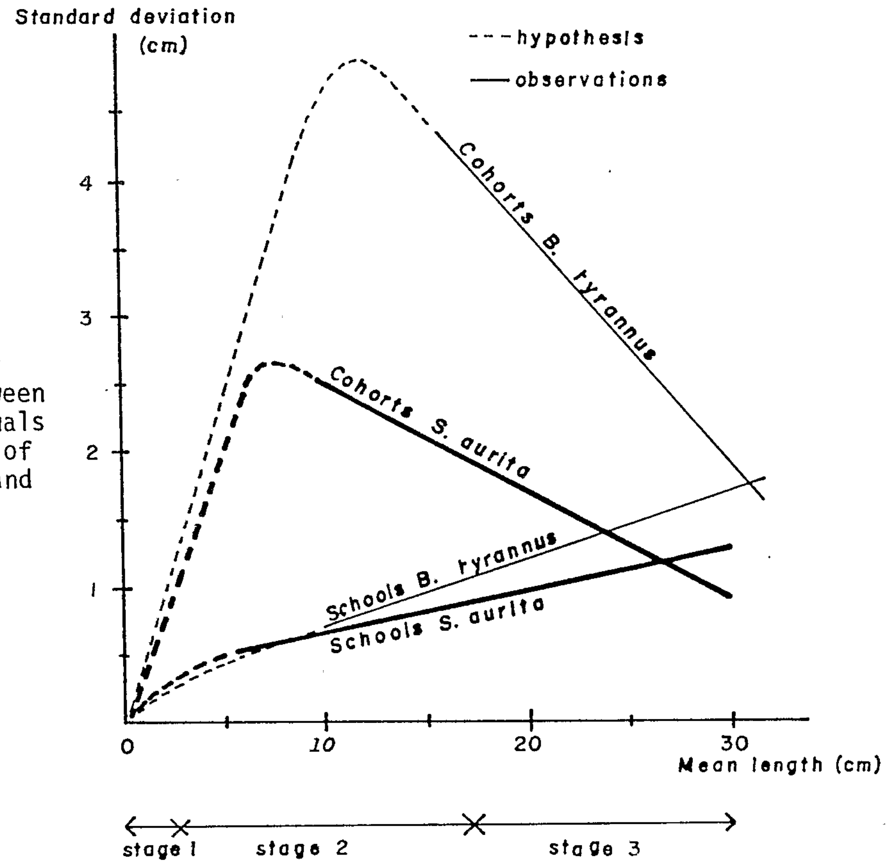

Fig. 2.
Combined scheme showing apparent relations between mean length of individuals and standard deviation of length inside cohorts and schools of *Sardinella aurita* and *Brevoortia tyrannus*.

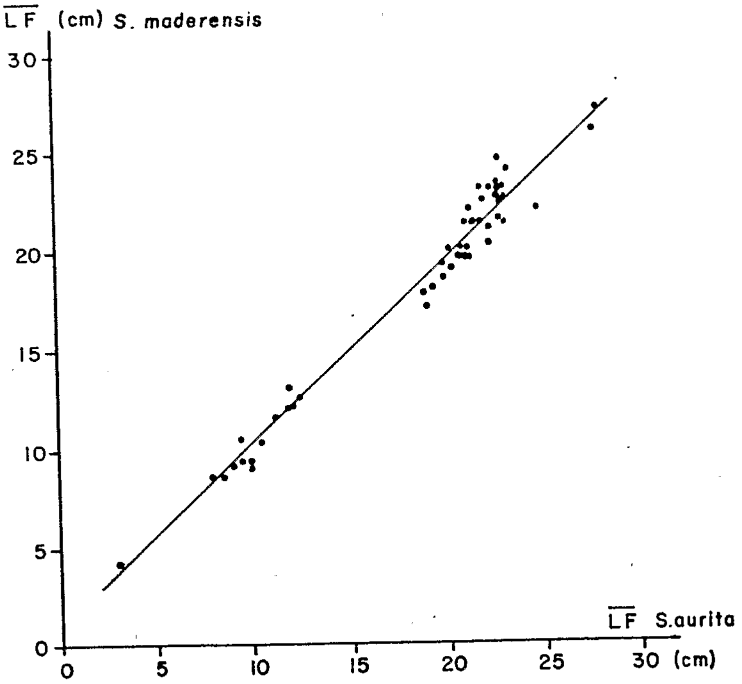

Fig. 3.
Relationship between individual mean length (LF) of *Sardinella aurita* and of *Sardinella maderensis* when encountered in the same school.

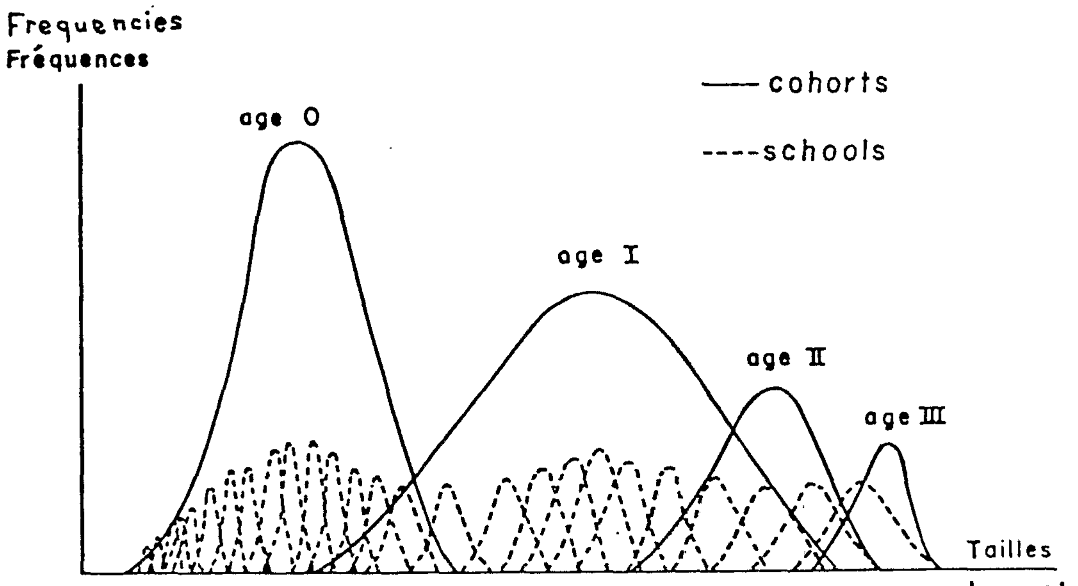

Fig. 4. Scheme of length frequency distributions inside cohorts and schools (to improve scheme understanding, frequency scale is greater for schools than for cohorts).

Fish concentrations where several schools with similar length and age distributions flock together, theoretically constitute ideal strata. However they are often difficult to identify, except in some cases as the sardine fishery in Senegal. Furthermore, homogeneity of concentration is probably not a universal rule valid for all small pelagic species. This homogeneity is needed at the highest level if the double sampling method on length and age is used, because it supposes a similar age distribution inside length classes for different schools within the same concentration.

Contrary to bottom trawls, most of small pelagic fishing gears are not length selective inside the exploited fraction of the population, and under these circumstances the fisheries biologist is indeed happy. Unfortunately, the aggregation mode in coastal pelagic species is such that a school catch, realized with a purse seine for example, can be considered as a catch realized by a very selective trawl-net (mesh-size selectivity and avoidance) on a randomly distributed population, using as many trawl types as there are school types. For this reason, as for demersal species, one must be careful in the choice of sampling methods used to determine age-length keys or growth parameters through hard body part studies. Furthermore, when Petersen's method or derivations are used for indirect growth rate estimations, the hazard is to assign an age class to a modal length class corresponding to nothing more than a school or a concentration which has been over-sampled. Using this method will be much more dangerous if applied to non-regrouped samples, which is commonly done for studying young fish growth. Modal progression with respect to time obtained by such methods can be non-related with growth.

Because of high individual growth rate in tropical coastal pelagic fish, the usual computation of Von Bertalanffy's growth equation parameters for the whole population introduces an under estimate of K, especially if data on growth increment are considered, and not age composition.

In some cases, the biomass percentage of a specific species when encountered mixed with other species in schools is more than 60%. It is then impossible to think in any form of mono-specific model of exploitation.

All these sources of bias on biological parameters and population structure can invalidate conclusions reached with any kind of production model used for stock management and assessment.

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