BIOLOGICAL PARAMETERS OF BULLET TUNA IN THE LIGURIAN SEA

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SUMMARY

In the period 2006 – 2007, more than one hundred Auxis rochey were sampled in the Ligurian Sea in the framework of a morphological and genetic study of this species, supported by MIUR (Ministero dell'Università e della Ricerca). This material gave the opportunity to ascertain some biological parameters of bullet tuna in a Western Mediterranean area, scarcely covered by this kind of studies. Information is given about: reproductive season, by GSI, in the period March to November; length / weight relationship; growth, by spine section reading; feeding ecology.

KEYWORDS

Bullet tuna, Growth, feeding, gonadosomatic index

Introduction

In the framework of an Italian project, funded by MIUR (Ministero dell'Università e della Ricerca), on morphology and genetics of the bullet tuna, *Auxis rochei*, we had also the opportunity of investigate some aspects, scarcely studied in Mediterranean Sea, of the biology of this species. The main objectives of our study were: to identify the reproductive season, to study the feeding habits and to compute basic biological parameters such as the length / weight relationship and the growth curve.

Material and methods

Given the necessity to cover, as far as possible, an extended period of the year, the analysed material derive from different gears of the Ligurian Sea professional fishery: the main used were small driftnets targeting bullet tuna, a small tuna trap, the "tonnarella" of Camogli and purse seines. A total of 83 Auxis were sampled during two different period: May – November 2006 and March – August 2007; other fish was measured at landings to obtain length / frequencies distributions.

In tab 1, we summarize the details of the sampled fish such as time, sex, number per sex and size ranges, and in fig. 1 the size / frequency distribution of the same materials.

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Table 1. Main characteristics of studied material.

	Sampling periods	N Tot	FL (cm) range	N male	FL (cm) range	N Female	FL (cm) range	Indeterminated sex	FL (cm) range
Ligurian Sea	02/05/06 - 08/11/06 15/03/07 – 13/08/07	83	27-46.5	31	30.5-46.5	45	28-45.5	7	27-34.5

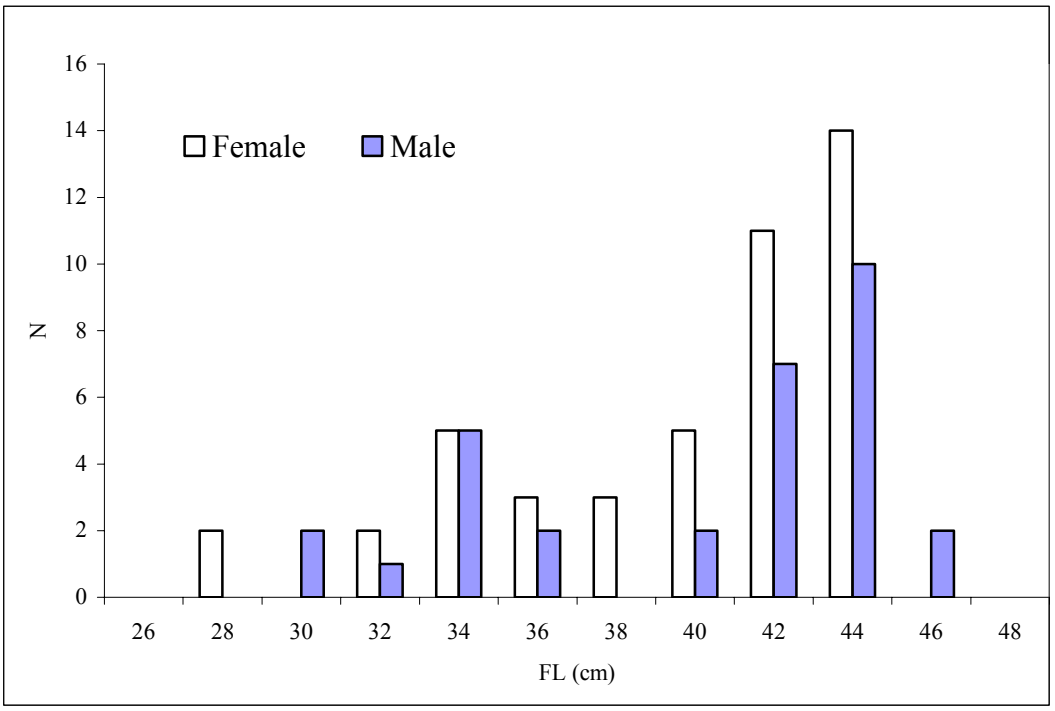

Fig. 1 – Size / frequency distribution, per sex, of sampled *Auxis*.

From each specimen, in addition to size and weight data, the following materials has been collected:

1. The first ray of the first dorsal fin, according ICCAT methodology (Compean-Jimenez, 1980) for age and growth studies
2. Gonads, for sex determination, gonadosomatic index (GSI) and for the evaluation of maturity stage
3. Gastric contents, for the study of trophic aspects

Sections of the fin rays, 0,6-0,8 mm thick, were obtained with a low speed saw and analyzed under the dissection microscope both in reflected and transmitted light, to read growth bands which corresponds to a seasonal deposition.

To study the feeding ecology of bullet tuna, collected samples were examined at the stereo microscope and determination of prey was carried out with the help of comparison collections, achieving, usually, the level of species for the ingested prey.

From all samples the gonads were taken out and weighted (in grams); the study of spawning season was carried out with the gonadosomatic index (GSI) which is the ratio (in %) between the gonads weight and the weight of the fish, in monthly time series.

Results

Length/weight relationships

The Length/weight relationship was obtained from a sample of 83 individuals from the Ligurian Sea in the size range between 27 cm to 46.5 cm. The Ligurian sample revealed a highly significant correlation coefficient (fig. 2).

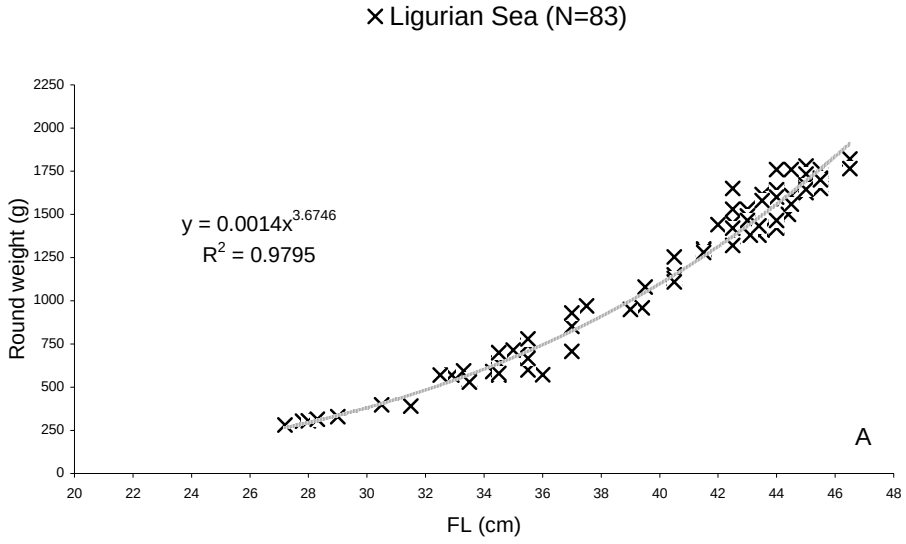

Fig. 2 - Length/weight relationship of *Auxis rochei* from the Ligurian Sea, both sexes.

Length / weight relationships, separate by sexes, were also elaborated; there was no evidence of significant differences between males and females (fig. 3).

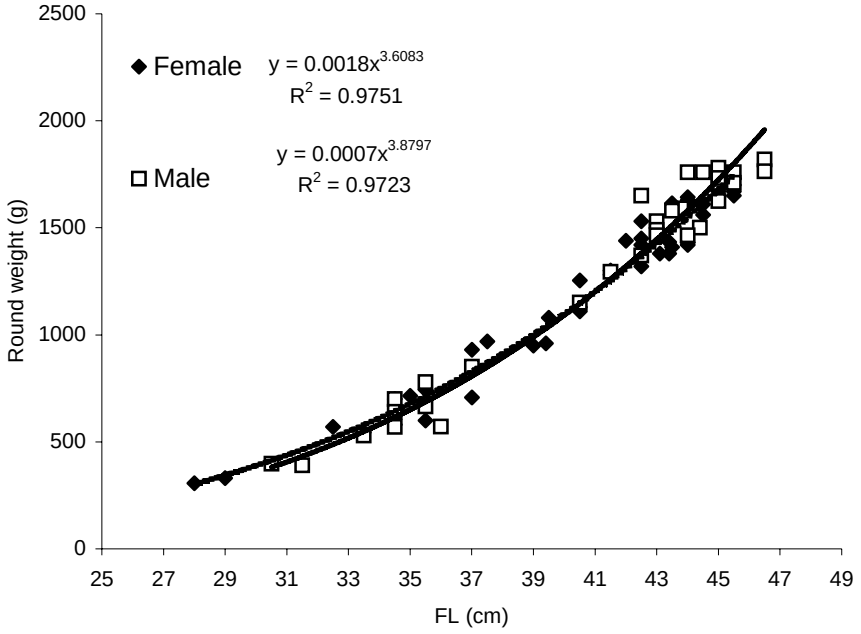

Fig. 3 - Length/weight relationship of *Auxis rochei* from the Ligurian Sea, per sex.

Reproduction

In the studied sample, the sex of 7 individuals remained indeterminated, the others were identified as 45 females and 31 males, with a sex ratio of 1,45:1.

The gonadosomatic index (GSI) was calculated for all individuals; the maximum value for females was found to be 12.28 for an individual of 37 cm (FL) (caught on 13/07/07); for males the maximum value was 13 for an individual to 35.5 cm (FL), (caught on 13/08/07).

Minimum reproductive size was 32.5 cm (FL) in females and 33.5 cm (FL) in males.

The extension of sampling over several months, from spring to autumn, gave us the opportunity to follow the evolution over time of GSI, to identify the main spawning period. The peak resulted in July for females and in July-August for males. Outside this period (before and after) it is still possible to find mature individuals so, probably, the spawning period is extended in time from May until September for both sexes (fig. 4).

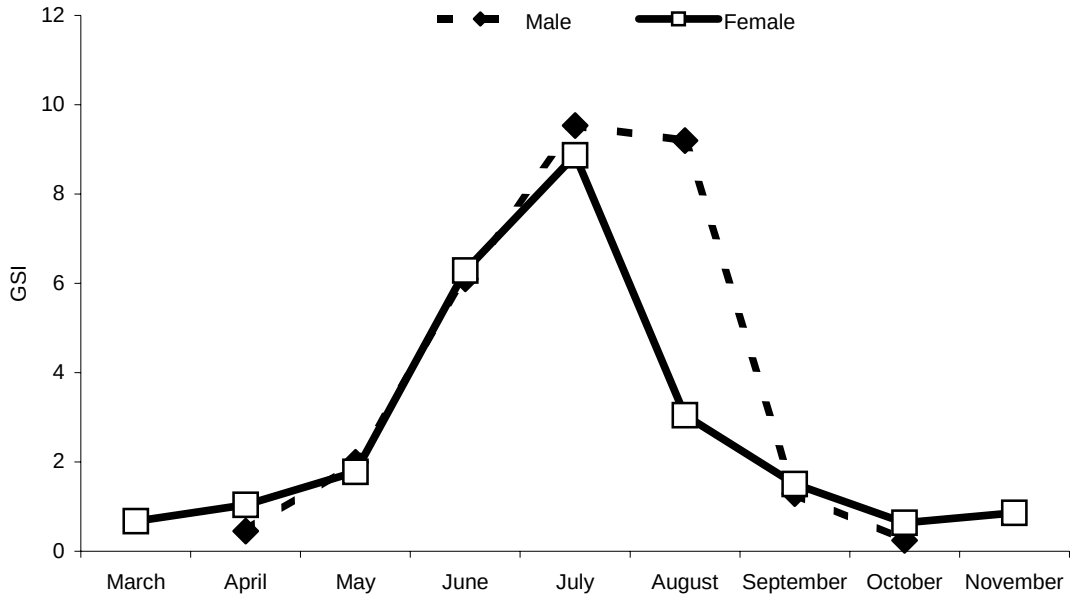

Fig. 4 – Evolution of GSI, per sex, of *Auxis rochei* from the Ligurian Sea

Age and growth

Given that juvenile fish is scarcely present in the sample, and the fin ray lectures of this component are not homogeneous, we present a growth curve as a working hypothesis, which needs confirmation by larger samples (Fig. 5 and tab. 2). The growth function is based on the following assumption:

1) The births occur on July 15, as suggested by the trend of gonadosomatic index.
2) The size at birth is 3 mm (Sanzo, 1908); this age / size is used as starting point of the function.
3) Fluent fish of the range 32 – 36 cm (FL), observed in July – August, represent age 2 (Rodriguez Roda, 1983; Bok and Oray, 2001; Macias *et al*., 2006), also if in our sections the majority of this fish could be assigned to age 1 (we have considered the possibility of re absorption of the central part of the sections as occurs in other species of tuna).

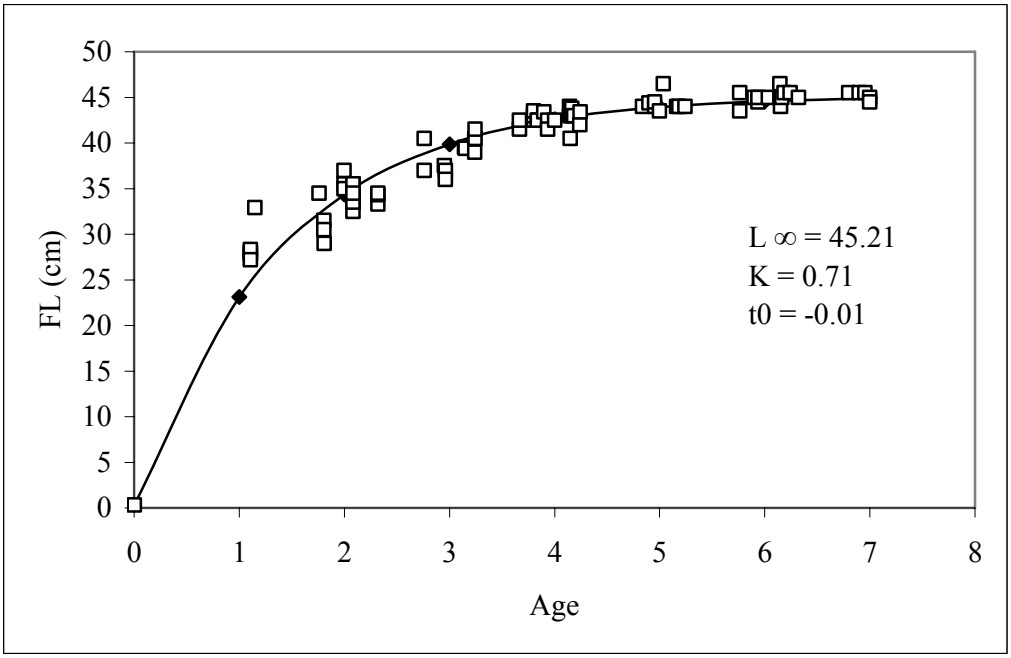

Fig. 5 – Von Bertalanffy growth curve for Ligurian *Auxis.*

Tab. 2 – Length at age, for the Ligurian Sea *Auxis rochei*.

AGE	Fork length (cm)
0	**0,3**
1	**23,1**
2	**34,4**
3	**39,9**
4	**42,6**
5	**43,9**
6	**44,6**
7	**44,9**

Feeding

From an preliminary analysis appears the high index of vacuity in the Ligurian samples, about 43.4%.

In the stomach contents, the most important prey are fish and Euphausiacea (Crustacea), both in quantity and in frequency. It is interesting to evidence that it is possible to discern the individuals sampled in coastal waters from those sampled in off shore waters: in the first prevail anchovies and Euphausid (i.e. *Nyctiphanes couchi*), while in the latter is more present another Euphausid species, *Meganyctiphanes norvegica*, which often constitutes monospecific meals. The cephalopods resulted absent in the food items, while only occasionally other species of fish were found, both pelagic (belonging to the genus *Trachurus*) and mesopelagic (*Paralepis coregonoides* and *Maurolicus*

muelleri). Considering the frequency of appearance, other species of crustaceans, such as *Pasiphaea sivado*, Pteropoda and pelagic Anfipoda, are less represented.

Discussion and conclusion

It is possible that *A. rochei* is forming a population unit in the Western Mediterranean as well as *Sarda sarda* (genetic results in *Auxis* are in preparation; for *Sarda sarda* see Vinas *et al*., 2004; Orsi Relini *et al*., 2005).

So we have tried to compare biological characteristics in this area.

In the case of length / weight relationship, there are several studies from Spanish authors that are presented in fig. 6. The studied samples comes from Gibraltar Strait (Rodriguez Roda, 1966), Western Mediterranean and Atlantic Ocean (Ramos *et al.*, 1985) and Western Mediterranean (Macias *et al*., 2006; De la Serna *et al*., 2005).

As shown in the fig. 6, it is possible to note that there are very small differences between curves; in particular, our results are more or less coincident with the curve obtained by De la Serna *et al*. (2005).

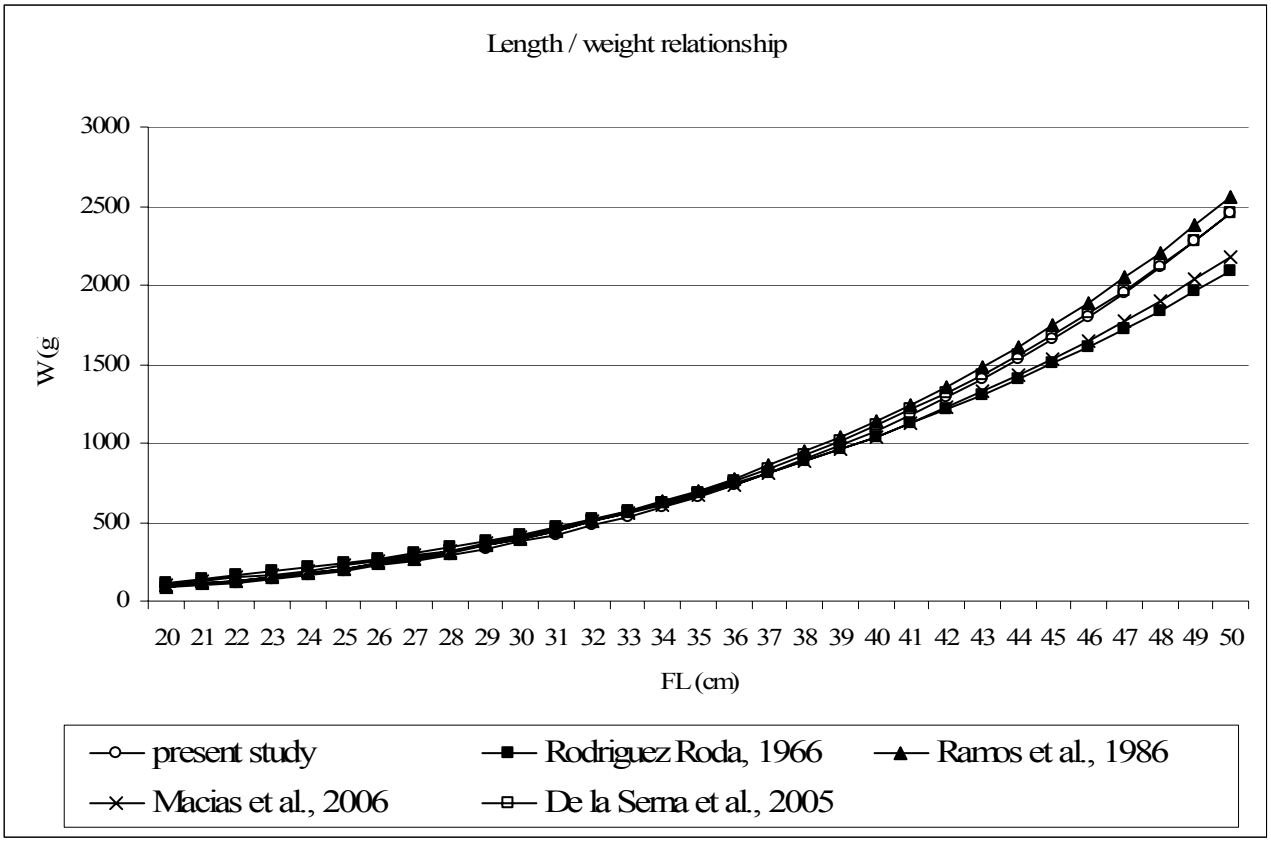

Fig. 6 – Comparison between length / weight relationships from different authors and areas.

In our study, the reproductive period result extended from May to September, that is similar to the period presented by other authors for other areas: Ionian Sea (Santamaria *et al*., 1996), Sicily (Sanzo, 1908), Aegean Sea and Eastern Mediterranean (Bok and Oray, 2000).
Also the size at first sexual maturity resulted from our analysis corresponds to the size obtained in the study from Macias *et al*. (2005), i.e. 32.5 cm (FL).

It was very difficult to study the growth increment in the spine sections, because the obtained results were usually not homogeneous: for this reason, the presented von Bertalanffy growth curve, is only a preliminary approach. Looking for similar study in literature, we found the length at age key published by Rodriguez Roda in 1983. Despite of the data were obtained from the reading of growth traces in vertebrae, the trend is very similar to our curve (Fig. 7).

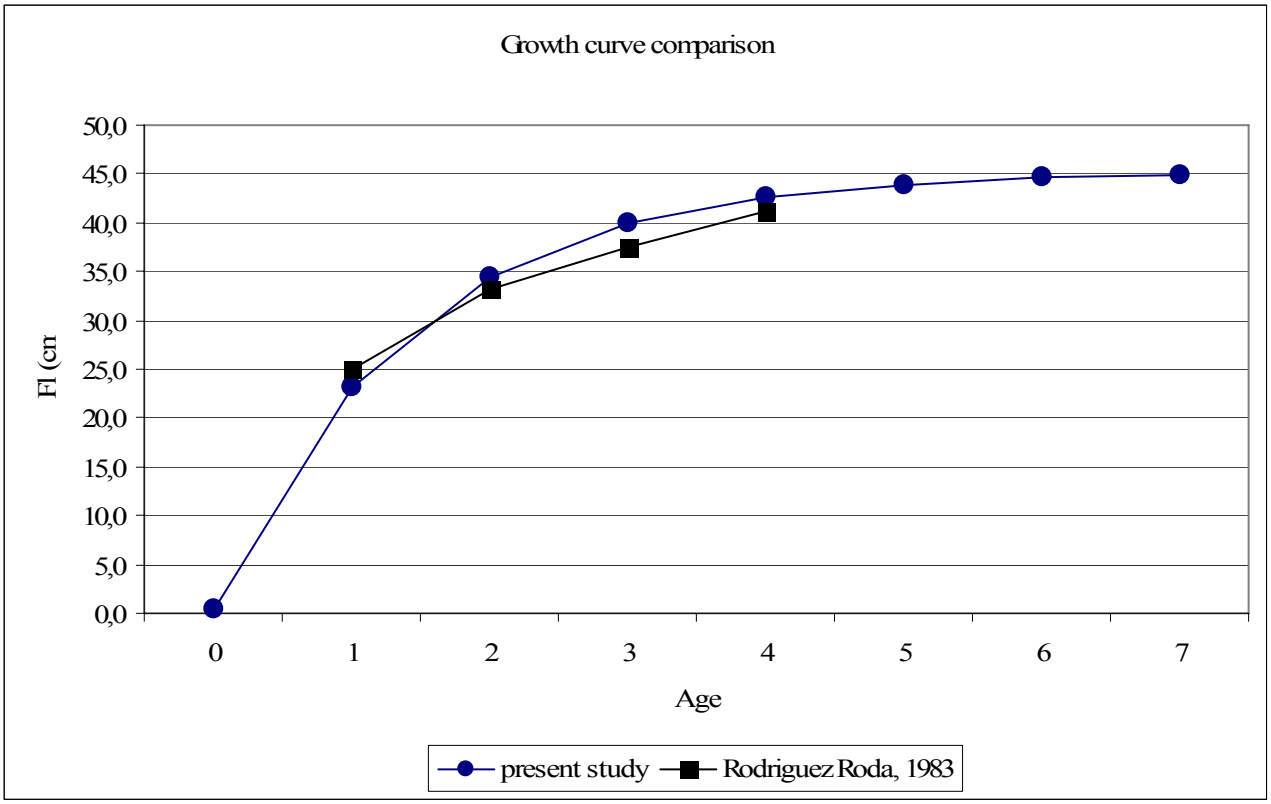

Fig. 7 – Growth curves comparison.

At this moment, however, the life cycle of this fish it is still not sufficiently explored, especially during the first two years of life; in fact literature includes some different, and sometimes contrasting, observations and conclusions. For example, a Russians study (Grudtsev, 1992), which collected abundant samples of young Auxis from oceanic fishery in the Saharan area, juvenile growth is very slow, with average sizes around 21,6 - 26,8 - 31,3 - 33, 7 cm (FL) in the first four years of life.

On the contrary, an Italian study (Santamaria *et al.*, 2000), carried out by reading growth increments in otholits (considered daily) in fish of 9-25 cm (FL), has given ages of 20-75 days, with the very fast daily growth rate of 3 mm.

In our opinion, most of the difficulty we face studying of the biology of *Auxis rochei*, derives from the particular migratory behavior of this species. In fact, during the annual migrations along the coast, many different cohorts can follow one another; the fishery therefore, exploit, sometimes one or more of these cohorts, producing samples of difficult interpretation in terms of age.

We think that the only solutions for this kind of problem, i.e. to clarify some doubtful aspects of the growth biology, should be to increase the sampling effort both in number of individuals and in times and places of sampling.

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