

Reproductive characteristics and body condition of chub mackerel (*Scomber colias*) in the south of Bay of Biscay, 2011-2013

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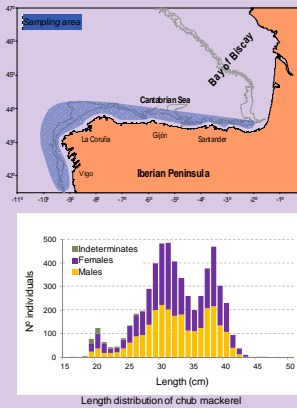
INTRODUCTION

The Atlantic chub mackerel (*Scomber colias*) is a pelagic fish distributed in warm and temperate Atlantic waters and in the Mediterranean Sea. In eastern Atlantic, chub mackerel occurs from the Bay of Biscay to southern waters.

Chub mackerel populations are not assessed, however, its fishery has increased since the early-mid 2000s in southern Bay of Biscay, and the advice on this population may be required in the near future. The biological parameters of this population are also a new requirement of the EU Data Collection Framework (DCF) for Spain in recent years (since 2011). This increase in landings may also reflect a further north shift in its distribution, possibly associated with climatic variation, and it could interact with the dynamics of other species, as sardine (Martins et al., 2013). Therefore, to know the main biological characteristics of this species is important, being they very limited in the Bay of Biscay.

This work studies aspects of the reproductive biology of the chub mackerel in ICES Div. VIIIc and IXa, including the maturation process, timing of spawning and size at first maturity (L50) during a three-year period (2011-2013). Monthly evolution of sex ratio, gonadosomatic index, gonadal development and condition factor were analysed and discussed.

MATERIAL & METHODS



Samples of around 100 individuals were monthly collected from landings of commercial vessels during a three-year period (2011-2013) from the Spanish fish markets (Vigo and Santander, ICES Div. IXa and VIIIc, respectively). In addition, during 2013 one sample every three months were collected from the Spanish fish market of A Coruña to cover the western area of ICES Div. VIIIc.

A total of 5603 specimens (length 16-50cm) were sexed and the maturity stages determined according to the macroscopic Maturity Key used for mackerel (Walsh et al., 1990). Gutted weights of 2663 specimens and gonad weights of 2419 of them were also obtained. The data were analyzed as a whole (both ICES Div. and the three years together) to ensure a good monthly representation of specimens by length (cm).

Spawning period was determined by analyzing the seasonal changes of the maturity stage over the annual period. Only potentially mature individuals were used, i.e. individuals with length > L25. The L25 value chosen for both sexes was 25 cm, as estimated in exploratory analysis and previous studies (Martins, 1996; Lucio, 1997). Four maturity stages were used: Immature, Maturing, Active (including stages Pre-spawning, Spawning and Post-spawning of the Walsh Maturity Key) and Resting.

Gonadosomatic index (GSI) and Le Creen condition factor (CF) were calculated using the gutted weight values:

$$GSI = Wg / We \times 100; \quad CF = We / a \times Lt^b$$

where: Wg = Gonad weight (g); We = Gutted weight (g); Lt = Total length (cm); a and b = parameters of the length/weight relationship.

Maturity ogives by length were constructed using only data collected during the spawning period, when a high percentage of mature (active stage) fish was observed (March to June). Specimens collected from research surveys held during that spawning season (in March and April, 2011-2013) were also included in the analyses for a better representation of the immature part of the population, which is more difficult to obtain from the commercial catches.

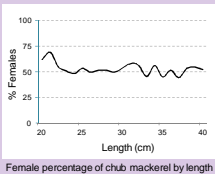
The INBIO (v 1.2) R-package was used for estimating the biological parameters and their uncertainties by simulation techniques (Sampedro et al., 2005).

RESULTS & DISCUSSION

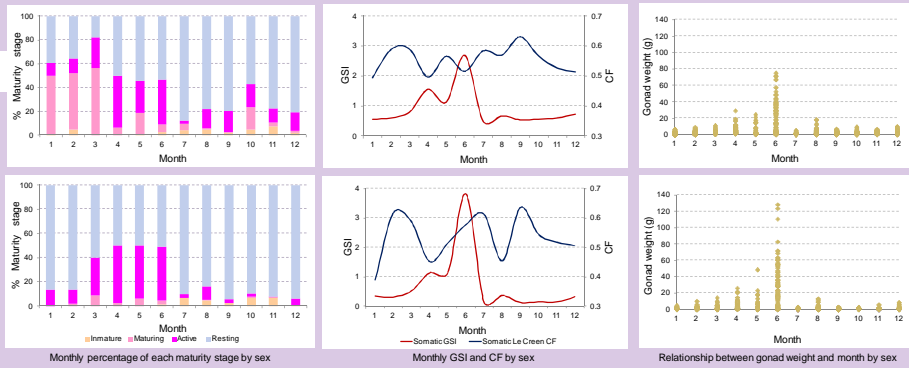
Sex ratio

The sex ratio was of 52.96% of females and is similar to those obtained in previous studies in several Atlantic waters (Table 1).

Sex ratio does not varies with length. The higher abundance of females < 24 cm may be due to a better identification of immature ovaries than testes, more than to a real difference in sex ratio.



Female percentage of chub mackerel by length



Higher percentages of mature (active stages) males and females occurred from March to June, being more evident from April to June.

GSI shows higher values from April to June in both sexes with an apparent maximum in June. CF decline in December-January, April, June and August. The decrease in the condition in April and June may be related to reproduction, while that of December-January may be due to other causes not related with it, as a lower condition by trophic and environmental reasons.

The gonad weight was higher between April and June. These results are in concordance with that observed in the monthly percentage of maturity stages in both sexes.

According to all these results, the spawning period was considered that occurs between March and June.

Spawning period

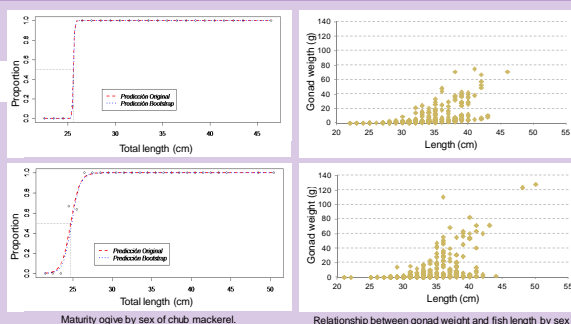


Relationship between gonad weight and maturity stage

A gradient of spawning periods is observed along east Atlantic waters when considering previous studies (Table 1), being from November to February in lower latitudes (Canary Islands) until from March to June in Iberian waters. This gradient could be related to temperature as the main spawning season of chub mackerel occurs mainly when water temperature is at least 10°C and most often when it is 15 to 20°C (Castro and Santana, 2000), as occurs in other migratory species such as mackerel (ICES, 2014).

Maturity ogive

The L50 values of around 25 cm obtained are in the range of those estimated in previous studies in Atlantic, but smaller than those from Iberian waters (Table 1). This may be due to differences in environmental conditions among the areas and the different period when each study took place. In general, higher L50 values are obtained in Iberian waters (Martins, 1996; Lucio, 1997) than in Atlantic Islands (Lorenzo Nespereira, 1993; Vasconcelos, 2006). Being the Bay of Biscay the northern boundary of this species distribution and having colder waters, the spawning conditions present in this area later in time.



The maturity ogive of females shows a drastic change from an immature stage to a mature one at 25 cm. In males, this change is smoother. As expected, there is a positive relation between gonad weight and fish length.

Table 1. Sex-ratio, spawning period and lengths at first maturity (L50) of chub mackerel

Area	ICES Div.	Author	Years	Sex-ratio (% females)	Spawning period	L50 (cm)		
						Males	Females	Comb. sexes
Bay of Biscay	VIIIb, VIIIc	Lucio, P. (1997)	1989-1993, 1997	48.50 (range 30-39 cm)	May-June*	30.80**	29.00**	-
Bay of Biscay	VIIIc, IXa	Present study	2011-2013	52.96	March-June	24.73	25.59	25.54 (CV=0.013) (CV=0.01) (CV=0.005)
Portuguese coast	IXa	Martins, M.M. (1996)	1986-1995	48.73	February/March - May/June	27.00	27.00	-
Azores Island	X	Westhaus-Ekau (1982)	1980-1982	-	March-June***	-	-	-
Madeira Islands	-	Vasconcelos, J. (2006)	2002-2005	49.17 - 53.46 (2002-2005)	January-May	22.12	21.55	21.87
Canary Islands	-	Lorenzo Nespereira et al. (1993)	1988-1989	51.80	November-February	19.82	19.90	20.00

* Samples from only May and June ** L50 estimated with few immature specimens *** No samples in May and June

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