

ENERGY DENSITY AND LIPID CONTENT OF SARDINE (*SARDINA PILCHARDUS*) AND ANCHOVY (*ENGRAULIS ENCRASICOLUS*) IN THE CATALAN SEA, NORTHWESTERN MEDITERRANEAN SEA

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Abstract

In order to develop a bioenergetic model and obtain the adequate data on energy allocation to growth and reproduction, samples of two small pelagic fishes (anchovy, *Engraulis encrasicolus* and sardine, *Sardina pilchardus*) were collected off the Catalan Sea to study their annual cycle in the context of Dynamic Energy Budget theory. Seasonal lipid content (% of wet weight, W_W) was determined in both species as well as the energy density (E_D , $\text{kJ g}^{-1} W_W$) of individuals from summer and winter by direct calorimetry. Sardine has higher lipid content than anchovy and both species present their maximum in spring. The E_D values obtained are 4,48 - 4,61 $\text{kJ g}^{-1} W_W$ for anchovy and 4,74 - 4,97 $\text{kJ g}^{-1} W_W$ for sardine. The present study provides for the first time energetic data from direct analysis in this region.

Keywords: Pelagic, Fishes, Models, North-Western Mediterranean

Introduction

Bioenergetic models can yield important information on the life cycle dynamics of the involved species. For *E. encrasicolus*, different models have already been implemented to distinct populations, e.g., Black Sea [1], Bay of Biscay [2] and northern Aegean Sea [3]. Due to the fact that the interaction between growth and reproduction is one of the most important trade-offs in fish, our aim is to obtain the required data to develop bioenergetics models for anchovy, *E. encrasicolus* and sardine, *S. pilchardus* detailing the energy allocation to growth and reproduction during an annual cycle. Here we present the first analysis to reach the data to implement these models: seasonal lipid content of muscle and energy density of individuals in the Catalan Sea.

Material and methods

Individuals of anchovy (total length (TL): 6,4 to 16,2 cm) and sardine (TL: 8,8 to 19,6 cm) were collected monthly off the Catalan Sea, from April 2012 to March 2013. For this study individuals of both sexes and different TL classes were selected and grouped seasonally. Fulton's condition factor ($CF = W_W / TL^3$) was determined on each fish and averaged in each group. Total lipid of both species was extracted from dorsal muscle according to the Folch method [4]. Finally, the lipids were weighed and expressed as % of W_W . The energy content was measured on individual fishes from summer (anchovy spawning season) and winter (sardine spawning season) by direct calorimetry by means of a Parr 6725 Semimicro Oxygen Bomb Calorimeter. Individuals were oven-dried at 70°C to constant mass (24 to 48h). After determining their dry weight, they were mixed to obtain a homogenized powder of each individual. The E_D was determined in two samples (150 to 200 mg) from each individual.

Results and Discussion

The average of lipid content was calculated (fig. 1.) and, as expected, the values were higher in sardine, being more obvious in spring, when the maximum lipid content was recorded in both species (Sardine: 2,035% and anchovy 0,98%). Seasonal variation was also higher in sardine as well as the variance between individuals. Sardine fat content varies widely with season [5], as anchovy feeds during their spawning season [6], fact that could explain the fairly seasonal variation of lipid content in this species. According to the CF (fig. 1.), the maximum of lipid content in spring could be explained by an increase of feeding activity. More studies, as fat composition, are needed to better understand the seasonal changes in lipid content and their relationship with the energy reserves of the animal.

The E_D doesn't differ between summer and winter, nor between anchovy and sardine, even it seems to be fairly higher in sardine (tab. 1.). The values in E_D observed for anchovy (4,48 - 4,61 $\text{kJ g}^{-1} W_W$) are similar to those observed in the Adriatic Sea [7] (3,34 - 5,6 $\text{kJ g}^{-1} W_W$), whereas they are lower than the values of the anchovy in the Bay of Biscay [6] (6,04 - 8,44 $\text{kJ g}^{-1} W_W$). More calorimetric determinations are needed, mainly at the beginning of the spawning seasons (spring for anchovy and autumn for sardine) in order to infer the possible energy storage before the peak of spawning. Further calorimetric determinations on gonad and liver will provide us with adequate data to infer energy allocation to growth and reproduction during the annual cycle.

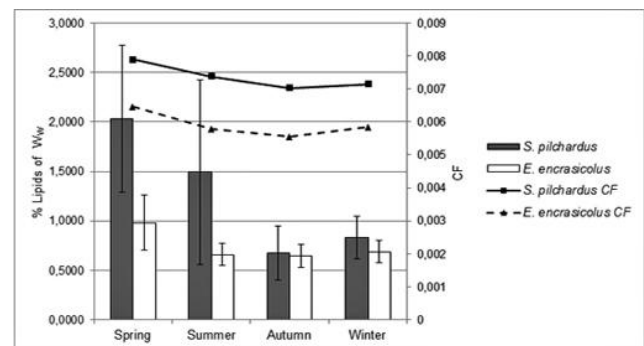


Fig. 1. Lipid content of muscle (bars) and CF (lines) of anchovy and sardine.

Tab. 1. Mean values (sd) for the E_D of anchovy and sardine.

Season	<i>E. encrasicolus</i>		<i>S. pilchardus</i>	
	E_D $\text{kJ g}^{-1} W_W$	(sd)	E_D $\text{kJ g}^{-1} W_W$	(sd)
Summer	4,48	(0,20)	4,97	(0,36)
Winter	4,61	(0,09)	4,74	(0,15)

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