SETTING UP AN EGG-DENSITY MODEL FOR EUROPEAN ANCHOVY, *ENGRAULIS ENCRASICOLUS*

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Abstract

The vertical distribution of pelagic fish eggs is an important issue in modeling and fisheries science. Knowledge on the influence of egg-density is a key aspect in IBM's where satisfactory equations to simulate realistic spatial variation are required. The egg-density of European anchovy is poorly known and only some studies on Atlantic provide information about it. An equation was fitted to describe changes in egg-density across development time. We found that the egg-density of anchovy in the Mediterranean is higher than in Atlantic waters. A functional model suitable for Mediterranean and Atlantic waters was established.

Keywords: Fishes, Density, Ichthyoplankton, Models, Spawning

Introduction

Small pelagic fish populations have a reproductive strategy resulting from past natural selection pressure, which make them adapted to the constant structural instability where they persist [1]. One adaptation is the buoyancy of eggs due to density changes through development [2]. This is an important issue in fisheries and modeling science, because they affect the vertical distribution of eggs, and therefore the transport [3]. The Individual Based Models IBMs that study the transport of fish eggs from spawning to nursery grounds is a novel approach that might be useful to further understand the recruitment variability [4]. In the southern Benguela ecosystem,simulations on the effects of physical and biological variables on the transport of anchovy (*Engraulis capensis*) eggs including a buoyancy model scheme maximize the average particle transport success [3, 5]. Modeling studies that include a fixed value for egg density overestimate the effects of the egg-buoyancy in the transport. However, the density of pelagic fish eggs is not constant and the egg-density changes during development [6, 7]. We fit an equation to describe the egg-density of European anchovy through development. A better knowledge of egg-density could improve the present models of
transport on IBM's.

Materials & Methods

Ichthyoplankton samples from the Gulf of Lions were collected in May–June 2008 survey. The samples were immediately taken to the laboratory onboard. We identified anchovy eggs and their stages; only early stages (I-II) were selected for the experiment. Egg-density measurements were carried out in a Density Gradient Column (DGC) [6]. The eggs were introduced in DGC and their height was measured at intervals until hatch. The height of eggs in DGC is an indication of their density. The DGC was kept at 18.5°C. The total duration of incubation of anchovy eggs varies with temperature; some egg-stages being more or less durable than others. By merging equations (Fig.1) we obtained a polynomial equation (eq.3) to calculate egg-density considering the time from fertilization, the effect of temperature and the spawning and hatching densities. With the resulting equation we built a model (Fig.1c) by comparing the egg-density in the Bay of Biscay [7] and in the Gulf of Lion. Additionally, we include the egg-density model in ICHTHYOP [8] analyzing the
effect of buoyancy in the egg transport.

Results

We found that the egg-density of anchovy in the Mediterranean is higher than in Atlantic waters. However, the curve shape describing the egg-density trough development is the same (Fig. 1c). The main factors influencing the egg-density changes in the model are the seawater densities at spawning and hatching points. The incubation time is determined by the seawater temperature [9]. We found differences in simulated trajectories patterns of anchovy eggs when: 1) egg-density was not considered, 2) a fixed egg-density was included and 3) with a variable egg-density equation.

Discussion

Knowledge on reproductive habitats is a key aspect for management of small pelagic fishes. The IBM's focuses in transport are an important tool for these aspects. However, satisfactory biological equations to simulate realistic spatial variation are required. The egg-density and subsequently buoyancy are poorly known. Some models include the assignation of a fixed value to egg-density and its movements according to Stoke's law. However, we found differences when variable egg-density is considered. In Mediterranean waters the incubation of anchovy eggs during peak spawning is approximately 48 hours, in other words during the first 48 hours of transport the egg-density is influencing the horizontal and vertical trajectories, routes and hatching zones. Additionally, during this time anchovy eggs experience different temperatures, salinities and densities. It is then essential to include an egg-density equation into transport
models to improve the current IBM models.

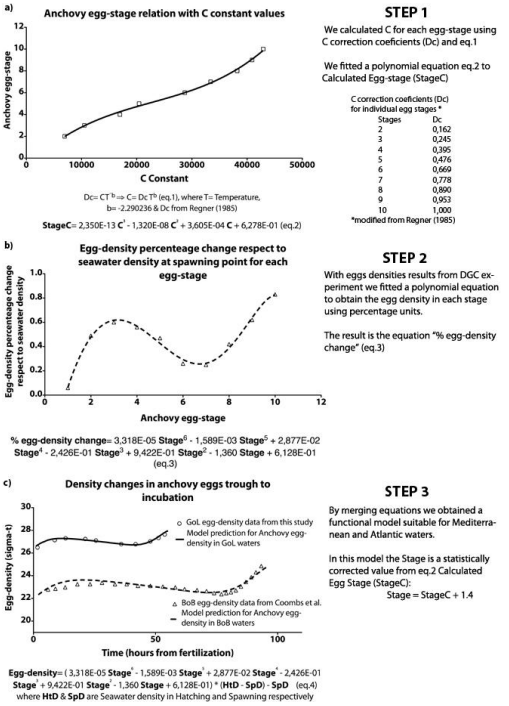

Fig. 1. Steps for the obtention of an anchovy egg-density model

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