Journal of Experimental Marine Biology and Ecology 503 (2018) 72–79

Contents lists available at ScienceDirect

Journal of Experimental Marine Biology and Ecology

journal homepage: www.elsevier.com/locate/jembe

Stable isotopes as tracers can reveal resource allocation in juvenile golden gray mullets (*Liza aurata*, Risso, 1810)

Como S.[a,*,1], Carpentier A.[b,1], Rossi F.[c], Dupuy C.[d], Richard P.[d], Feunteun E.[e], Lefrançois C.[d]

[a] CNR–IAMC, National Research Council, Institute for Coastal Marine Environment, Località Sa Mardini, Torregrande 09072, Oristano, Italy
[b] EA 7316, Université de Rennes 1, Campus de Beaulieu, Av. du Gl Leclerc, Bat. 25, 35042 Rennes Cedex, France
[c] CNRS, UMR 9190, Place E. Bataillon, University of Montpellier, Montpellier 34000, France
[d] Littoral, Environnement et SociétéS (LIENSs), Université de La Rochelle, UMR 7266 CNRS-ULR, 2 rue Olympe de Gouges, 17000 La Rochelle Cedex, France
[e] CRESCO, MNHN, 38 rue du port blanc, 35800 Dinard, France

ARTICLE INFO

Keywords:
Resource allocation
Stable isotope tracing
Metabolism
Growth
Coastal areas

ABSTRACT

Studies on the nutritional physiology of predator fish in the marine environment have contributed to our understanding of how they adapt to the environment and how they have evolved. Despite the fact that herbivorous and omnivorous fish species are numerous and play a significant role in the ecosystem, there is little information on how they process nutrients and how these are allocated to different tissues. This information could be particularly important for the juvenile stages, when small-sized fish are under high predation pressure and have a limited capability to intake and digest large quantities of food. The mullet *Liza aurata* ingests surface sediment and obtains its nutritional requirements from the organisms associated with the sediment, including microalgae and bacteria or small invertebrates. This paper examines how the carbon and nitrogen derived from benthic micro-organisms are allocated to the liver and muscle tissues of newborn (young-of-the-year, YOY) and one-year-old (OYO) individuals. After the animals were left feeding on ^{13}C-enriched microalgae and ^{15}N-enriched bacteria for 1 h, we traced the ^{13}C and ^{15}N in the liver and muscle tissues as well as in the blood and the gut. The YOY allocated 99% of the ^{13}C and 88% of the ^{15}N to the muscles, while the liver had a negligible amount of tracers (0.4% and 11% for ^{13}C and ^{15}N). Conversely, in the OYO experiment, the tracers were uniformly distributed throughout the muscle and liver (57% of ^{13}C and 45% of ^{15}N were found in the muscle, whereas 43% of ^{13}C and 55% of ^{15}N were in the liver). Negligible amounts were traced in the blood (< 0.1%), while a part of the tracers was not assimilated and remained in the gut of both YOY and OYO fish. These results indicated a size-related shift in resource allocation during first year of growth of *L. aurata*, probably related to changes in the survival strategies among juveniles. Our results also indicated that stable isotope enrichment can be a helpful tool for studying resource allocation in fish.

1. Introduction

The nutritional physiology of a consumer is of considerable interest for understanding ecological and evolutionary processes (Evans and Claiborne, 2006). Apart from the baseline knowledge of nutrition for a few aquaculture fish species (Houlihan et al., 2000), most of the studies on feeding and nutrition on marine fish have been focused on different species of predators (e.g. Litvin et al., 2011; Sogard and Spencer, 2004; Stallings et al., 2010). Very little is known about the feeding and nutrition of herbivorous and omnivorous fish, despite their evolutionary and ecological diversity and the key roles they play in ecosystem processes (Clements et al., 2009; Whitfield et al., 2012). Furthermore, most of this work has focused on food acquisition (Como et al., 2014; Raubenheimer et al., 2005; Smith, 2008) and digestive processes (German et al., 2004; Moran et al., 2005; Moran and Clements, 2002). Yet, once food is digested, how the carbon and nitrogen derived from it are allocated to different tissues is unknown. This information could be particularly important for juveniles, because these stages are often considered critical for animal survival and, in turn, for population growth and fish stock maintenance (Biro et al., 2005; Sogard and Spencer, 2004; Stallings et al., 2010). Such difficulties are related to their small size and to their reduced ability to escape predators, to migrate and/or to withstand periods of food depletion (Domenici, 2010; Sogard, 1997).

* Corresponding author.
E-mail address: scomo71@libero.it (S. Como).
[1] Two first authors equally contributed to the paper.

https://doi.org/10.1016/j.jembe.2018.01.009
Received 4 April 2017; Received in revised form 8 December 2017; Accepted 27 January 2018

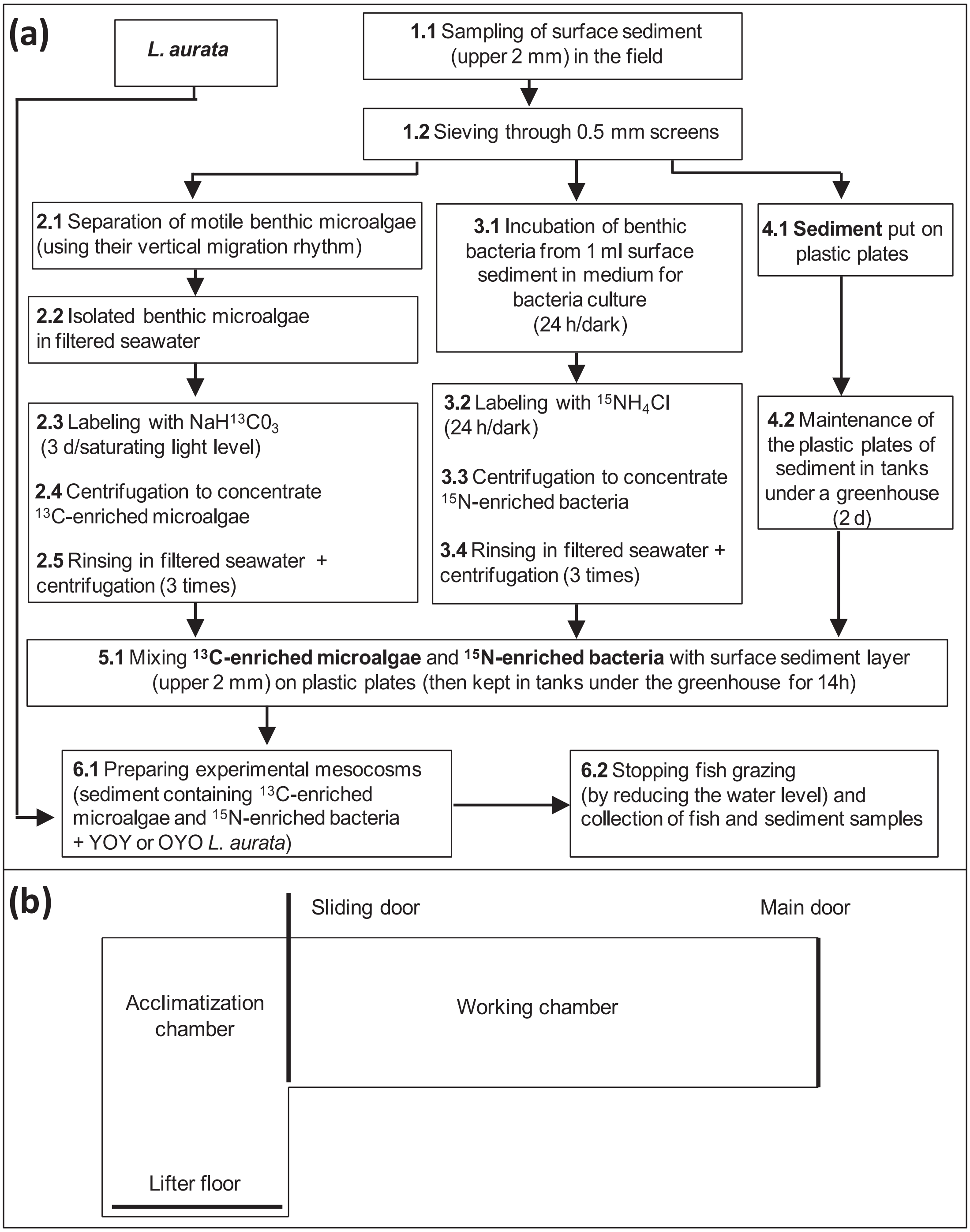

Fig. 1. (a) General protocol; main steps in the preparation of the experimental mesocosms and sample collection. The experimental mesocosms consist in sediment containing ^{13}C-enriched microalgae and ^{15}N-enriched bacteria and young-of-the-year (YOY) or one-year-old (OYO) *L. aurata*; (b) Schematic illustration of the mesocosm (viewed from the side). Not shown: the video-tracking system, which consisted of four polychrome video cameras (25 image s^{-1}), a multichannel video interface and a DVD recorder to follow the fish during feeding. The cameras were placed along the longest side of the working chamber in order to provide a lateral view. There was also a series of lamps connected to a timer which provided a supplementary light source in addition to the natural illumination, and a buffer tank connected to a thermostat which controlled temperature, circulation and the water level inside the mesocosm.

This study investigates the allocation of carbon and nitrogen to the somatic tissues of juvenile golden gray mullets, *Liza aurata* (Risso, 1810). This species is one of the most abundant omnivorous fish inhabiting the Mediterranean Sea and the Northwest Atlantic coasts (Carpentier et al., 2014; Hotos and Katselis, 2011; Lebreton et al., 2011). It is a euryhaline catadromous species that spawns in the open sea (Abdallah et al., 2013; Hotos et al., 2000; Parlier et al., 2006). The offspring recruit in shallow coastal areas, including estuaries and lagoons, where juveniles reside for at least 2 years of their life cycle (Hotos et al., 2000; Hotos and Katselis, 2011; Parlier et al., 2006). *L. aurata* is described as a generalist deposit feeder. After ingesting surface sediment, the animals derive their nutritional requirements, including carbon and nitrogen, from detritus and associated benthic micro and macro-organisms, particularly microalgae, bacteria and meiofauna (Carpentier et al., 2014; Lebreton et al., 2011; Vizzini and Mazzola, 2003).