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Nutritional condition, starvation status and growth of early juvenile Japanese sea bass (*Lateolabrax japonicus*) related to prey distribution and feeding in the nursery ground

Md. Shahidul Islam*, Masaru Tanaka

Division of Applied Biosciences, Graduate School of Agriculture, Kyoto University, Kyoto 606-8502, Japan

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Abstract

The nutritional condition and protein growth rates of Japanese temperate bass larvae and juveniles were studied in relation to prey distribution and feeding habits in the nursery grounds in Chikugo estuary, Ariake Sea, Japan. Samples were collected from a wide spatial area covering the nursery grounds of the fish in March and April 2003. Food habits of the fish were analyzed by examining the gut contents. Fish condition was evaluated by using RNA/DNA ratio and other nucleic acid-based indices and protein growth rates. The nucleic acid contents in individually frozen larvae and juveniles were quantified by fluorometric method. Two distinguished feeding patterns, determined by the distribution of prey copepods, were identified along the nursery ground. The first pattern showed the dependency of the fish on the calanoid copepod *Sinocalanus sinensis*, which was the single dominant prey in low saline upper river areas and the second pattern involved a multi-species dietary habit mainly dominated by *Acartia omorii*, *Oithona davisae* and *Paracalanus parvus*. Values of RNA, DNA, total protein, growth rates and for all the nucleic acid-based indices were higher in upstream areas than in the downstream areas. The proportion of the starving fish was higher in the downstream areas than in the upstream areas. Condition of juvenile sea bass was not equal throughout the nursery grounds; fish in the upper river were in better condition than those in the lower estuary. We speculated that utilization of *S. sinensis*, which appears a suitable prey item and provide a better foraging environment in the upstream nursery ground, is one of the key factors for early survival and growth of Japanese temperate bass larvae and juveniles in the Chikugo estuary.

Keywords: Nutritional condition; RNA/DNA ratio; Starvation; Protein growth rate; Japanese temperate bass; Ariake Sea

1. Introduction

The condition of fish larvae may affect the probability of their survival because larvae in poor condition are not only more vulnerable to predation, disease and unfavorable environmental conditions but also are

* Corresponding author. Tel.: +81 75 753 6225; fax: +81 75 753 6229.

E-mail address: msi@kais.kyoto-u.ac.jp (Md.S. Islam).

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less efficient in foraging (Amara and Galois, 2004). Therefore, assessment of the nutritional condition of field-caught larvae helps to predict larval survival and year-class fluctuations (Richard et al., 1991). RNA/DNA ratio has been proven as a useful and reliable indicator of nutritional condition and growth of larval and juvenile fishes that has been widely applied to laboratory-reared as well as wild fishes (Buckley, 1980; Clemmesen, 1987, 1988; Robinson and Ware, 1988; Bailey et al., 1995; Rooker and Holt, 1996; Canino, 1997; Chicharo, 1997, 1998; Chicharo et al., 1998a,b; Buckley et al., 1999). The quantity of DNA in most animal cells is believed to be normally stable but RNA quantity varies with physiological status, the requirement for protein synthesis and growth (Buckley et al., 1999). Because mRNA, tRNA and rRNA are essential for the biosynthesis of protein, the quantity of bulk RNA in a cell varies in response to changes in demand for protein synthesis. RNA quantities are high in rapidly growing organisms (Bergeron, 1997; Buckley et al., 1999); any factor preventing or slowing growth is reflected by a reduction in RNA quantities. Among such factors, the nutritional condition seems to be the most studied and the most widely used. Nutritional condition is associated with food supply and feeding success of the fish and, therefore, variability in the trophic environment is reflected in the nutritional condition of fish. Since the larval stage of fish is characterized by rapid exponential growth (i.e., rapid protein synthesis), RNA/DNA ratio is a good index of relative growth rate (Buckley et al., 1999), reflecting the role of variable trophic environment in the field.

Japanese temperate bass (*Lateolabrax japonicus*), one of the dominant members of the fish assemblage of Ariake Sea, is an important species of the commercial as well as sport fishery and a highly promising species for sea farming in winter (Matsumiya et al., 1982). This is also an ecologically important species because, in Ariake Sea, the fish is an endemic species and is genetically unique and an independent population. Nursery grounds of the fish are located in the estuarine waters and the life history is characterized by river ascension to arrive in fresh water nursery areas from the sea. Therefore, the species is highly suitable for the study of larval ecophysiology because the fish is exposed to severe environmental changes. However, the role of different habitats in supporting larval and juvenile Japanese sea bass and the nutritional condition of the bass in the nursery grounds have not been clarified yet. In the present study, we have described the spatial patterns in dietary habits of the larval and early juvenile Japanese sea bass and have attempted to investigate the growth rates and condition of larval and early juvenile Japanese sea bass along the estuary using RNA/DNA ratio and other nucleic acid-based indices.

2. Materials and methods

2.1. The study area and sampling

The Ariake Sea, the largest tidal wetland of Japan, is located at the southwestern part of Japan. The Chikugo estuary is the largest estuary of the Ariake Sea, with the highest tidal differences in Japan. Seven sampling stations were set up along Chikugo estuary (Fig. 1). The sampling stations are lined along the tideway of the Chikugo River. Among them, four stations were positioned along the river (R4–R1) and the other three were outside the river mouth along the estuary (E1–E3). Station R1 is located at the river mouth and R4 is the uppermost station, 16 km upstream from the mouth and with little seawater influence even at spring high tide. Starting from the river mouth, the estuarine stations were positioned on the tidal flat and E3 is the most distant station with the highest salinity.

Larval and juvenile fish samplings at selected stations were carried out by two research cruises in March and April 2003. Samples were collected by surface towing with a larval ring net (1.3 m mouth diameter, 1 mm mesh size along the body and 0.33 mm mesh size at the cod end) for 10 min against tidal flow. Sea bass samples were sorted and immediately frozen on dry ice on board and transported to the laboratory for subsequent storage in a deep freezer at −85 °C. All larvae and juveniles were counted, total length (TL) was measured to the nearest 0.1 mm with a digital slide calipers and weight was measured with a sensitive electronic balance to the nearest 0.1 mg.

During each cruise, hydrographic data and plankton samplings were also carried out. Temperature and salinity were recorded at each station by an Environmental Monitoring System (YSI 650 MDS, YSI Incorporated, USA). Copepod samples were collected by