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Growth of larval Pacific Anchovy, *Engraulis japonicus* in the Yellow Sea as indicated by otolith microstructure analysis

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INTRODUCTION

The Pacific anchovy, *Engraulis japonicus*, is now the most important species in the Yellow Sea and the East China Sea where both larvae and adults are commercially usable as fishery resources and ecological niche (Hwang, 1998). Research on growth and mortality rates during the early life stages is fundamental to elucidating recruitment potential (Houde 1987). The variability of growth rate between cohorts can be elucidated by back-calculated daily growth estimates (Wang & Tzeng, 1999; Takahashi *et al.*, 2001).

The objective of this study was to determine the hatch date, and the growth rate of anchovy larvae caught in the Korean western sea by examining the microstructure of otoliths. The difference in growth rates among cohorts were compared to growth rates of anchovy from other areas in order to surmise possible effects on growth rate variability. In addition, new information on the deposition of daily growth increments during the yolk-sac absorption phase that could impact estimates of hatch date in other areas is presented.

MATERIALS AND METHODS

Larval anchovy were sampled from commercial catches of the bag net fishery that operated around Wi Island in the Korean western sea from June to November, 1996. For age estimation, the sagittal otoliths were prepared for microstructure observation according to Lee & Byun procedure. Back-calculated lengths at earlier ages for a subsample of the otoliths were estimated using the Fraser-Lee procedure. Daily growth rate ($mm \cdot day^{-1}$) was estimated for each fish by dividing size at capture by estimated age (days).

RESULTS AND DISCUSSION

There were eight sampling dates between 28 June and 14 November 1996. Throughout the sampling season, there was a continuous presence of small fish (20-50 mm) demonstrating that the range of cohorts were being captured.

Scanning electron microscopy has allowed us to identify daily growth increments prior to the first feeding mark on Pacific anchovy larvae otoliths. Estimated age ranged from 33 to 118. The estimated spawning dates ranged from 19 March to 1 October.

Three cohorts were distinguished based on back-calculated spawning dates: spring cohort (March-April spawned); early-summer (May-July) and late-summer (August-September) cohorts. Growth rates between cohorts varied, with higher growth rates for late-summer cohorts (0.60 $mm \cdot day^{-1}$) than either the spring or early-summer cohorts (0.31 and 0.29 $mm \cdot day^{-1}$). It is likely that the spring cohort larvae captured in the study area from June to July were spawned in southern waters and convected northward. The early-summer cohort and the late-summer cohort that were sampled from mid-July through November were also spawned in the study area. Early growth rates was positively related to surface water temperature, and optimum temperatures for larval growth occurred during the late-summer when water temperatures are between 20-26C.

Our study forms the basis for future research that focuses on Pacific anchovy recruitment for incorporation into assessment and management. Management of larval and juvenile Pacific anchovy fisheries should consider the ecology of early life stages and account for differences in ecosystems.

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