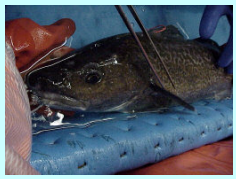
PACIFIC COD
Gadus macrocephalus
IN CAPTIVITY



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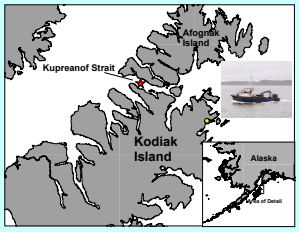
Abstract

Pacific cod *Gadus macrocephalus* were held in captivity in an attempt to validate aging techniques for this species using oxytetracycline (OTC) injections. Five different concentrations were used to mark the otoliths of adult Pacific cod. They were also successfully spawned in captivity and reared to hatching for verification of daily growth increments on larval cod otoliths. Incidental mortalites allowed verification of the OTC mark. Analysis on the optimum OTC concentrations and otolith formation for adult and larval cod will be completed upon termination of the study. Egg development was consistent with past studies, while spawning in captivity occurred between February and March.



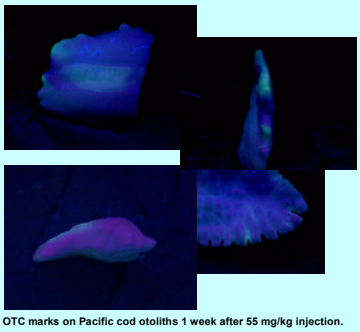
Introduction

Discrepancies over the interpretation of the annular patterns on Pacific cod otoliths have suspended production aging by National Marine Fisheries Service, the Pacific Biological Station in Canada (Roberson 2001) and Alaska Department of Fish and Game (ADF&G) (K. Munk, ADF&G, Juneau, pers. comm.). The importance of age for stock assessment in Gulf of Alaska and Bering Sea prompts a need to reevaluate aging techniques of Pacific cod. Currently there has been little success on the validation of existing aging techniques for this species. One of the more common validation techniques is using oxytetracycline (OTC) injections to mark otoliths (Weber and Ridgway, 1963; Beamish et al. 1983). OTC binds with proteins in the blood and is incorporated into newly formed and mineralized bone and cartilage (Frost et al. 1961; MacFarlane and Beamish 1987). The goals of this study were to determine optimum concentrations of oxytetracycline (OTC) to mark Pacific cod otoliths, attempt to verify otolith formation of one year's growth in adult Pacific cod using OTC marking, and successfully spawn cod in captivity for validation of daily growth increments on larval otoliths.

OTC

Annular patterns can be difficult to distinguish, especially in older fish.

Injecting OTC into the intraperitoneal cavity of the Pacific cod.



OTC marks on Pacific cod otoliths 1 week after 55 mg/kg injection.

Methods

Pacific Cod were collected using the R/V Resolution from Kupreanof Strait off the north end of Kodiak Island and transported to the NMFS seawater laboratory in the City of Kodiak on November 1, 2001. The fish were held in flowing seawater tanks at ambient water temperatures, with no attempt to control light or disease and fed to satiation on a diet of Pacific herring. Each fish was measured and tagged for identification. Five different concentrations of OTC (25-100 mg/kg) were injected into the intraperitonieal cavity of 15 fish on December 17, 2001. The fish are being held for one year after injection then sacrificed. OTC marks on the otoliths can be observed when examined under ultraviolet light. OTC marks will be verified, distance to the edge measured when possible and each otolith aged. Fish were spawned in the lab and we recorded spawning timing and behavior and egg and larval development. Larval fish were retained for daily growth analysis.

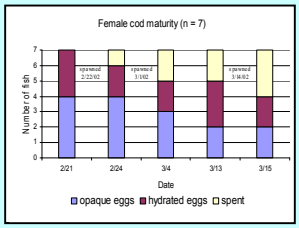
Results

OTC. Pacific cod sizes ranged from 49 to 70 cm FL (fork length) and showed increases in growth during their time in captivity, from 0 to 2 cm. For one week period, we would assume no mortality (probability of survival approximately 99%). After a week 2 fish had died. Using a binomial test, we found there were significant mortalities in the first week after treatments ($p \leq 0.05$) (Devore 1995). Mortalities were not associated with higher levels of OTC, so most likely due to handling. Gas bubble disease, fungal infections, increases in temperatures, and "jumpers" proved to be a problem affecting cod survival. Stress related mortalities allowed an initial look at the OTC marks on the otoliths. Marks were discernable for all levels of OTC injections. Optimum levels of OTC and measurements of growth on the otoliths will be determined upon completion of the project.

Spawning. Spawning commenced on February. 22, 2002 and was completed by March 15, 2002. All the males and most females matured in captivity. Size of the laboratory tanks were not conducive for spawning. Manual spawning was necessary in some fish to prevent hyperhydration of the eggs and consequential mortality (Y. Sakurai, Hokkaido University, Japan, pers. comm.). Of 7 females, 3 fish spawned on their own, 2 were manually spawned and fertilized, and 3 died from hyperhydration. Pacific cod broadcast the semi-adhesive eggs into the water column before fertilization and settling on the bottom. Eggs hatched 20 days after spawning. Hatching continued over a 14 day period. Three hundred larval were retained and sacrificed over a 6 week period for daily growth analysis (Steve Porter, NMFS, Seattle, pers. comm.).

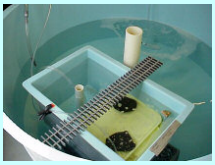
Spawning

Extracting hydrated eggs.



Egg maturity and spawning time.

Pacific cod eggs.



Egg incubator.

Egg development to hatching (time after fertilization)

Conclusions/Future Research

OTC marking has proven to be a good method for age validation (Weber and Ridgeway 1962; Beamish et al. 1983), with potential for Pacific cod. The challenges of keeping adult cod in captivity need to be overcome. Future analysis after a year of growth on the remaining cod in captivity and a repeat experiment under more optimal conditions for Pacific cod survival will further this research. Egg development is consistent with past studies (Forrester 1964), with spawning period from late winter through early spring (Sakurai and Hattori 1996). Analysis of the daily growth increments on larval Pacific cod otoliths has yet to be completed.

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