Growth and feeding ecology studies on coastal antarctic fishes

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Knowledge of growth rates and patterns of growth in antarctic fishes is necessary to develop our understanding of the biology and ecology of fishes in the antarctic marine ecosystem, and the functional relationship of fishes to other components of the ecosystem. Research on growth in antarctic fishes has been limited. Much of the previous work on aging these fish has relied on analyses of scale annuli which are often difficult to interpret (e.g., Everson 1970; Crisp and Carrick 1975; Shcherbich 1975; Shust and Pinskaya 1978; Hureau and Ozouf-Costaz 1980). Otoliths (calcium carbonate concretions in the inner ear of fishes) have been used less frequently since they are often small and difficult to analyze and interpret using conventional methods (Hureau 1964; Freytag 1980; Daniels 1983).

Microstructural growth rings present in antarctic fish otoliths (Townsend 1980) resemble daily growth increments present in the otoliths of temperate and tropical fishes. We are using recently developed techniques to examine otoliths and enumerate microstructural increments with scanning electron microscopy to determine very precisely age and growth rates for dominant antarctic fishes (Radtke and Targett in press). We are also investigating the effects of biotic and abiotic factors on growth processes and otolith microstructure.

During February and March, 1984 we worked at Palmer Station and aboard R/V *Hero* collecting fishes and conducting laboratory experiments to validate the presumed daily periodicity of microstructural growth rings, and investigate the effects of light duration and intensity on ring formation. Trawling was conducted around Low Island in the South Shetland Islands in February, and in Dallmann Bay north of Anvers Island during February and March. Eight species were captured in sufficient numbers of laboratory experiments: *Notothenia coriiceps neglecta*, *N. gibberifrons*, *N. larseni*, *N. nudifrons* and *Trematomus newnesi* (Nototheniidae—antarctic cods); *Chaenocephalus aceratus* (Channichthyidae—icefishes); *Harpagifer bispinis* (Harpagiferidae—plunder fishes) and *Parachaenichthys charcoti* (Bathydraconidae—dragonfishes).

Growth experiments. In the laboratory, fishes were injected intramuscularly with either tetracycline hydrochloride or acetozolamide at a dosage of 20 milligrams per kilogram. Both chemicals produce a permanent mark in otoliths at the time of

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Summary of experiments conducted to validate the daily periodicity of microstructural growth increment formation in the otoliths of Antarctic fishes

Fish species	Experimental conditions[a]	Otolith marker[b]	Approximate no. of fish	Maximum time maintained (days)
Nototheniidae				
Notothenia larseni	Natural light	T	14	6
N. nudifrons	Natural light	T	47	35
	Total darkness	A	17	32
	18D:6L @ 5 lux	A	17	32
	6D:6L:6D:6L	A	13	32
N. gibberifrons	Natural light	T	59	32
	Total darkness	A	6	32
	18D:6L @ 5 lux	A	3	16
	6D:6L:6D:6L	A	28	32
N. coriiceps neglecta	Natural light	A&T	15	30
	Artificial light cycle	A&T	7	40
Trematomus newnesi	Natural light	A&T	21	32
Channichthyidae				
Chaenocephalus aceratus	Natural light	T	16	33
Harpagiferidae				
Harpagifer bispinis	Natural light	T	20	13
	Total darkness	A	20	32
	18D:6L @ 5 lux	A	18	32
	6D:6L:6D:6L	A	16	32
Bathydraconidae				
Parachaenichthys charcoti	Natural light	T	8	33

[a] "Natural light" denotes an approximately 18 hour light:6 hour dark cycle. "18 D:6L @ 5 lux" denotes an 18 hour dark:6 hour light cycle at 5 lux light intensity. "6D:6L:6D:6L" denotes an alternating 6 hour dark:6 hour light cycle. "Artificial light cycle" denotes an irregular illumination regime.

[b] "T" denotes tetracycline hydrochloride and "A" denotes acetozolamide, injected at dosages of 20 milligrams per kilogram of body weight.

injection, providing a reference point from which to count growth increments deposited during subsequent experiments. Fishes were then maintained under various light/dark regimes: (1) natural light cycle (approximately 18 hours of light to 6 hours of dark), (2) total darkness, (3) 18 hours of dark to 6 hours of light cycle at 5 lux light intensity, or (4) a 6 hours of light to 6 hours of dark: 6 hours of light to 6 hours of dark cycle (table). During the course of the experiments, fish were sacrificed and the otoliths removed and stored in glycerol. Scanning electron microscope and light microscope analyses are now underway and initial results indicate that microstructural growth increments in the otoliths of antarctic fishes form once per day. *Trematomus newnesi* (figure 1), for example, maintained under natural light condi-

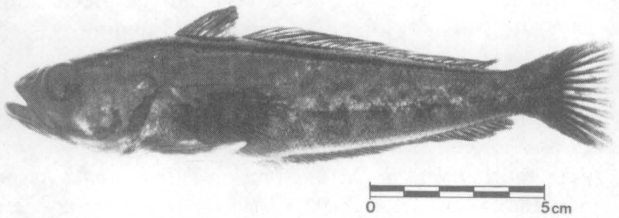

Figure 1. *Trematomus newnesi* a plankton feeding species which reaches approximately 24 centimeters (cm) total length.

tions for 32 days had between 30 and 35 increments subsequent to the tetracycline mark (figure 2). Using otolith microincrement counts from *N. larseni* we have determined that this species grows more slowly than has been previously indicated by other workers using conventional techniques on scales (Radtke and Targett in press).

During this research, otoliths from 800 fishes were removed from the above eight species as well as from *Pleuragramma antarcticum, N. rossii, T. hansoni, Champsocephalus gunnari, Chionodraco hamatus, Pseudochaenichthys georgianus, Prionodraco evansii,* and *Artedidraco skottsbergi.* These otolith samples are being examined, with those from a collection of 900 otoliths obtained in 1975 and 1976 around South Georgia, the South Sandwich, and South Orkney Islands. We are concentrating these efforts on developing growth models for *T. newnesi, C. aceratus, N. gibberifrons* and *N. nudifrons.*

Feeding experiments. Experiments were conducted to investigate processes of digestion and absorption of prey leading to growth in antarctic fishes. Five *N. gibberifrons* (a benthos feeder) and five *T. newnesi* (a plankton feeder) (Targett 1981) were maintained in separate aquaria and fed 2 percent rations of live krill (*Euphausia superba*) every 48 hours for 8–10 days. Fecal material was collected and samples of krill and fecal material were dried at 60°C. Caloric, biochemical, and carbon-hydrogen-nitrogen analyses are presently underway to determine digestion and absorption efficiencies for these two species preying on krill. Samples of gastric mucosa and anterior intestine were dissected from experimental fish as well as from fish which had not preyed on krill. These samples were frozen for later assays of chitinase activity.

Six *N. coriiceps neglecta,* an omnivorous benthic feeder, were fed species of macroalgae collected subtidally at Palmer Station. Algae removed from fecal material were dried with samples of fresh algae at 60°C. Caloric, biochemical, and carbon-hydrogen-nitrogen analyses will determine efficiencies of macroalgal digestion by this fish species. Gastric and intestinal pH were

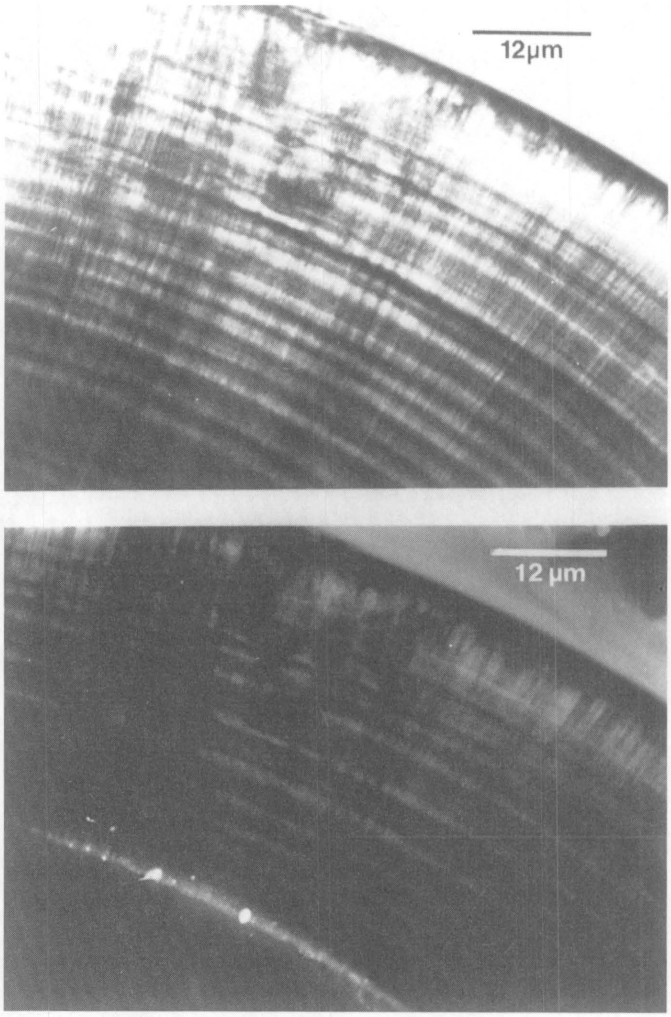

Figure 2. Light micrograph of microstructural growth increments at the margin of an otolith from a 18.5 centimeters total length *Trematomus newnesi.* The bottom panel was visualized with ultraviolet light and illustrates the fluorescent band deposited at the time of tetracycline injection. During maintenance under a natural light cycle, the fish produced 30–35 growth increments during 32 days, providing evidence of daily increment formation. Acetozolamide injections cause a physical disruption band in otoliths and these samples are presently being analyzed with scanning electron microscopy. ("µm" denotes micrometers.)

generally 2.5–3.2 and 7.7–8.2, respectively. Gastric pH appears to be sufficicent to lyse cell walls and make macroalgal material available for assimilation and contribution to the nutrition of this fish.

Other material collected. A small number of larval and juvenile fishes were collected from waters adjacent to Palmer Station. Otoliths will be examined for microstructural growth increments to provide information on larval and juvenile growth.

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