

is our impression that the sculpins are more specialized for detecting prey via the lateral line than are the nototheniids. Hence, there may be limits to their ecological convergence, likely due to either differences in ecological requirements or constraints due to ancestry.

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Ageing studies on the early life stages of antarctic fishes

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tance of antarctic fishes, knowledge of the population dynamics of their early life stages is still limited, although the available information has substantially increased recently (Kellermann 1989c; North in press).

The pelagic stages of the primarily demersal notothenioid fishes form temporal, but integral, parts of the midwater communities. Consequently, knowledge of the interactions of the various larval and post-larval stages with their planktonic environment is essential to understand the functional relationships that must exist between the timing of the life history stanzas and the seasonal dynamics of their environment. The key parameter to assess properly the duration of the yolk-sac stage and the subsequent larval stages is age. Age and larval growth are directly related, because mortality may be to growth (Houde 1987). Stage-specific growth-rate analyses on the background of ambient conditions will, therefore, provide essential information to describe growth and survival patterns for the early stages of antarctic fishes.

The only hard parts in larval fishes that can be used for ageing are the otoliths. They form around primordia that are the first structures to become visible during embryogenesis (Brothers 1984). Multiple primordia cause multiple cores in the otoliths of some species, but have not yet been observed in antarctic fishes. Although several primordia have been found in one core, all species so far studied show a single core of 40–100 micrometers in diameter (Hourigan and Radtke 1989; Radtke et al. 1989; Radtke 1990; Radtke and Kellermann in press). Fish otoliths are calcified structural components of the inner ear's equilibrium and auditory sensory system, and may contain a historical record of biological and ecological information encountered during a fish's lifespan. They consist of a protein matrix into which calcium zones are deposited with a daily, anticyclic periodicity (Mugiya 1987) moderated by metabolic cycles as synchronized to ecological and environmental parameters. The daily nature of microincrement formation has

been demonstrated for larvae and/or adults of the antarctic fishes *Nototheniops nudifrons* and *Trematomus newnesi* (Hourigan and Radtke 1989; Radtke et al. 1989). During periods of slow growth, more calcium and less protein is deposited. Critical events in early life history, including larval hatch, first feeding and yolk adsorption, or ossification may be documented in otolith microstructure by distinct marks, providing information on the relative time scales of larval ontogeny.

In several antarctic fishes, the larval phase is known to extend throughout the winter months (Kellermann 1989a, 1989c). Samples collected in May and June, i.e., early winter in the Antarctic Peninsula area, indicated that larvae of, e.g., the nototheniids *Notothenia kempfi* and *Trematomus scotti* occurred in the epipelagic waters, and abundance levels in some species suggested that at least early winter conditions did not imply severe limitations on the survival of larvae (Kellermann and Schadwinkel in press). Sagittal microincrement analysis in the channichthyids *Pagetopsis macropterus* (figure 1) and *Pseudochaenichthys georgianus* revealed that both species hatch in winter, i.e., May and August/September, respectively (Radtke and Kellermann in press). During the winter cruise of R/V *Polar Duke* in 1989, ichthyoplankton was caught as incidental bycatch in small plankton nets. The presence of young larvae indicated that hatching of the batch-spawning myctophid *Electrona antarctica* continues throughout the period from June through August. Notothenioid larvae constituted only minor fractions of the ichthyoplankton in contrast to the samples collected in May and June. This might reflect their lower abundance levels later in winter, but the different nets used in the two surveys, i.e., net avoidance by the larger larvae, or year-to-year variations in abundance and distribution must be considered. Recently hatched larvae of *Trematomus eulepidotus* confirmed previous assumptions based on laboratory rearing that hatching occurs in winter (Ekau 1989). Otolith microincrement analyses are currently being undertaken to assess hatching periods and winter growth rates in the most abundant species.

Summer samples of ichthyoplankton were taken in the Antarctic Peninsula region during the expedition Me 11/4 with

R/V *Meteor* in December/January 1989–1990. As in previous years (Kellermann 1986, 1989a), notothenioid larvae were most abundant but were chiefly confined to waters of Weddell Sea origin in the southern and eastern parts of the Bransfield Strait. Icefish larvae *Chionodraco rastrospinosus* were caught in unusually high numbers. The assumed spawning area of *Notothenia kempfi* to the southwest of Anvers Island was sampled for larvae on a mesoscale station grid. A few recently hatched larvae caught in the southwest off Adelaide Island indicated that the hatching season was about to commence by the end of the cruise (mid January). The cyclonic gyre system to the west of the Peninsula which is assumed to retain larval *N. kempfi* in the shelf areas (see Kellermann and Schadwinkel in press) was indicated by sea-surface temperature distribution during the cruise. Larvae and age-group 1 juveniles of *Pleuragramma antarcticum* which are usually abundant in the area were extremely scarce. Early stages of the myctophid fish *Electrona antarctica* will be used to compare hatching periods and summer growth rates, decoded from otolith microstructure, with the data obtained during the preceding winter 1989.

Eggs of the nototheniid fish *Notothenia neglecta* (figure 2) were collected in June through August 1989 from R/V *Polar Duke* and brought to Palmer Station, from where they were later transferred by plane to the lab at the University of Hawaii at Manoa, Honolulu, for further rearing and to validate the periodicity and symmetry of otolith deposition zones. Eggs were reared in 60-liter plastic tanks. After hatching, larvae were removed and placed in smaller tanks for continued rearing under controlled temperature and light regimes. Water temperature varied between -1.0 and 1.8 °C, and the light cycle was standardized to 16 hours light/8 hours dark. Larvae were reared under different feeding regimes, including total starvation, food offered after initial starvation, and excess food from hatching onward. Survival of starving larvae was up to 42 days, with 80 percent of larvae still having yolk at death. This suggests that the yolk-sac stages of antarctic fishes use the maternal energy reserves efficiently resulting in long yolk absorption periods. Microincrement patterns of sagittae of these reared larvae will be compared with those obtained from larvae hatched from field-caught eggs (Kellermann 1989b; Radtke, Kellermann, and Schafer 1989) and will provide information on the effect of different feeding conditions on growth increment formation.

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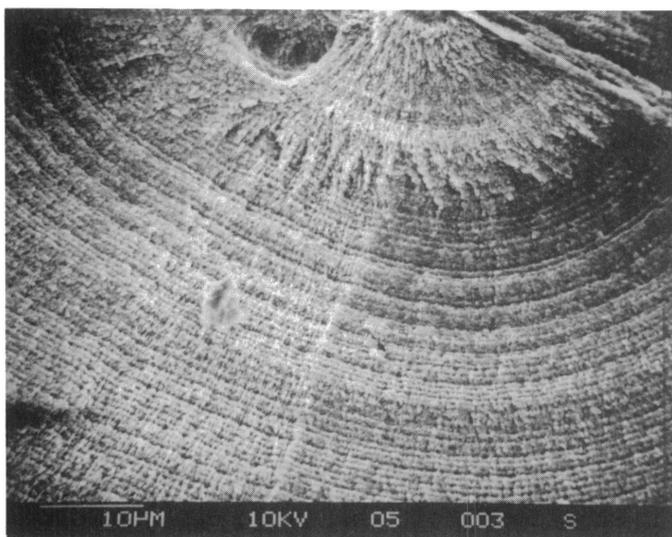


Figure 1. Scanning electron micrograph of a central portion of the sagitta of a transforming larva of *Pagetopsis macropterus* of 38.2 millimeters (fresh) standard length. In the upper right corner of the micrograph, the central nucleus is visible, followed by a sequence of narrow, regular increments. Large radial aragonite crystals are visible next to the nucleus. (μm denotes micrometer.)

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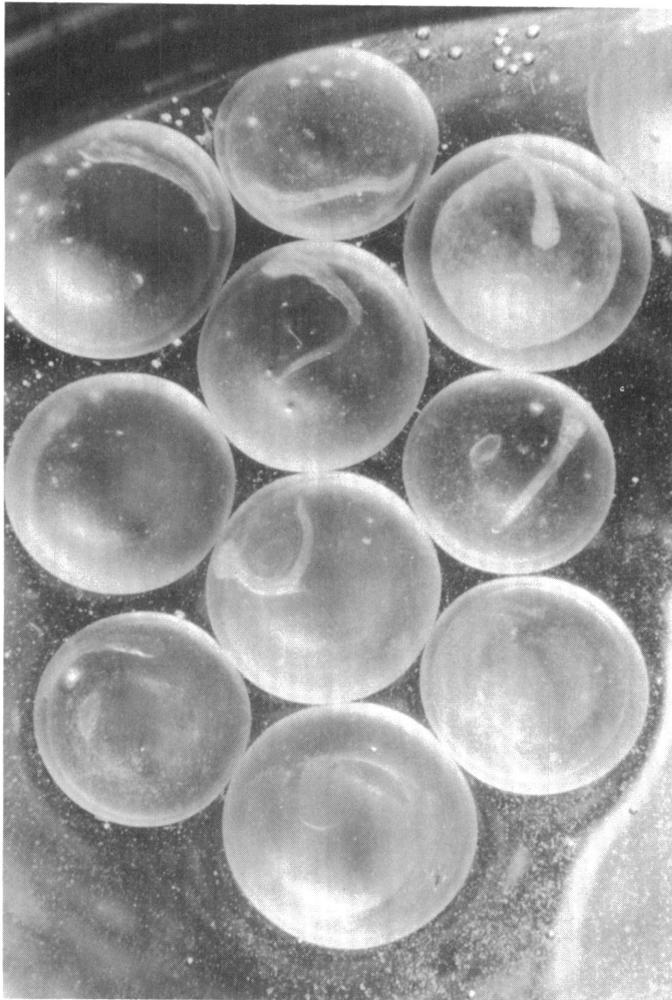


Figure 2. Eggs with embryos of *Notothenia neglecta*, caught in Gerlache Strait, Antarctic Peninsula, 9 July 1989. Eggs were 4.3–4.5 millimeters in diameter.

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