

# Comparisons in the use of the lateral line for detecting prey by notothenioids and sculpins

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The antarctic and arctic (especially one boreal lake, Lake Baikal, Siberia) have benthic fish faunas dominated by notothenioids and cottoids, respectively. The benthic habit of certain antarctic notothenioid fishes, particularly those of the family Nototheniidae, and morphological similarities to the boreal cottoids (sculpins) suggest that nototheniids and sculpins are ecological replacements of each other (Marshall 1962). The ancestors of sculpins and nototheniids, and most members of both groups, lie on the bottom and feed on benthic invertebrates. Although all nototheniids and sculpins lack swimbladders, a few species are found off bottom (table). Besides

being most speciose in cold habitats, many nototheniids and cottoids occupy habitats that are dark due to either the extended polar night, thick ice, or great depth. Even where they live in shallow water and in temperate zones, sculpins tend to feed at night (Hoekstra and Janssen 1985; Brandt 1986).

It has been suggested that the lateral line system is important to fishes that need to operate in biologically lightless conditions. This system consists of clusters of hair cells, called *neuromasts*. (Hair cells also constitute the sensory cells in the ears of all vertebrates). The hair cells have specialized cilia imbedded in a gelatinous cupula. Water flow moves the cupula and cilia causing the hair cell to stimulate neurons. The neuromasts may be freely exposed on the skin surface or in canals in the skin. Pores connect the canals to the ambient water. Neuromasts on the skin surface and neuromasts in canals respond differently to water movements (Denton and Gray 1988, 1989; Kroese and Schellart 1987). Unfortunately, very little is known about how fish use lateral line information.

Under conditions in which there are no visual cues, nearly all nototheniids (except *Trematomus centronotus*) and all sculpins studied respond to live prey or a vibrating plastic sphere by biting. (Fish are blinded by eye removal, have black plastic coverings over their corneas, or are viewed under infrared illumination.) Regardless of habit (table), nototheniids and sculpins studied respond only when they are either motionless, usually on the bottom, or have stopped swimming and are about to lie on the bottom. The benthic nototheniids and sculpins appear to be ambush predators, so responding only while motionless (or nearly so) is not surprising. *Trematomus hansonii*, which frequently clings to aquaria walls by using its pectoral and pelvic fins as a sucker, also responds while clinging.

We have noted several differences between the nototheniids and sculpins in their response to vibrating stimuli and live prey (amphipods). While sculpins responded to stimuli near the head and trunk, none of the nototheniids responded to vibratory stimuli near the trunk. The sculpins we have studied (table) reorient to a near-trunk stimulus by a quick "flip" which repositions the snout accurately near the stimulus, which it then bites at (detailed for *Cottus bairdi* in Hoekstra and Janssen 1985, 1986).

The fact that nototheniids and sculpins use different postures while on bottom may relate to the contrasting response to stimuli along the trunk. Nototheniids hold the pectoral fins appressed to the trunk, while sculpins hold the pectoral fins in a spread position, so the trunk lateral line is fully exposed to stimuli above and below the lateral line.

A difference that may affect sensitivity to prey is that sculpins cease respiratory movements when "listening" for prey but nototheniids do not. When the lateral lines of sculpins are briefly stimulated they hold the opercula in a spread position (Janssen, Coombs, and Pride in press). This presumably helps to minimize stimulation of the lateral line by the fish's own movements and respiratory flow.

We think the comparisons between nototheniids are interesting for two major reasons. First, the nototheniids are able to locate prey via the lateral line and so are equipped to feed in the winter darkness or beneath thick sea or glacial ice. This confirms the suggestion by Montgomery and MacDonald (1987) and Montgomery, McDonald, and Housley 1988 (based on neurophysiology of the lateral line) that these fishes should be able to feed using the lateral line to detect prey. Second, because sculpins respond to prey along the trunk as well as along the head and suppress respiration when stimulated, it

## A list of nototheniids (McMurdo) and cottoids (Laurentian Great Lakes and Lake Baikal, Siberia) used in behavioral observation on the use of the lateral line for feeding

Nototheniids studied		Habitat and depth
<i>Trematomus (Pagothenia) bernacchii</i>		Benthic
<i>Trematomus loennbergi</i>		Benthopelagic
<i>Trematomus centronotus</i>		Benthic
<i>Pagothenia borchgrevinkii</i>		Cryopelagic
<i>Trematomus hansonii</i>		Benthic
Cottoids studied		Habitat and depth
		Location
<i>Cottus bairdi</i>	GL	Benthic
<i>Cottus cognatus</i>	GL	Benthic
<i>Myoxocephalus thompsoni</i>	GL	Benthic
<i>Cottus kessleri</i>	LB	Benthic
<i>Paracottus kneri</i>	LB	Benthic
<i>Batrachocottus baikalensis</i>	LB	Benthic
<i>Batrachocottus multiradiatus</i>	LB	Benthic
<i>Cottocomephous grewinkii</i>	LB	Benthopelagic
<i>Procottus jettelesi</i>	LB	Benthic

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

Fishes of the percomorph suborder Notothenioidei are the predominant group of the antarctic coastal fish fauna. These fishes are key components of the marine ecosystem. The bottom-dwelling species are top predators in the benthic food web, whereas the few pelagic and benthopelagic fishes have occupied trophic niches in the copepod and krill systems of the antarctic midwaters. In turn, notothenioid fishes form the diet of some warm-blooded predators such as birds, seal, and whales (Kock 1985). Demersal fishes are also the target of a large-scale commercial fisheries for more than a decade, which in some species has led to a serious depletion of stocks (Kock et al. 1985). In spite of the ecological and commercial impor-