

DO OTOLITHS RECORD CHANGES IN SOMATIC GROWTH RATE? - CONFLICTING EVIDENCE FROM A LABORATORY AND FIELD STUDY OF A TEMPERATE REEF FISH, *PARIKA SCABER*

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Otolith increment widths in a temperate reef fish, *Parika scaber* (Pisces: Monacanthidae) have been shown to vary in different months and correlate with changes in somatic growth rate (Kingsford and Milicich 1987). Fish that were slower growing had narrower spacings between rings than those with a higher average growth rate. Thus, the relationship between otolith length and fish length remained constant for all fish sampled despite differences in monthly somatic growth rate. These data imply that variations in the pattern of ring spacing may be a reliable repository of past patterns of growth for an individual.

Similar documentation of a close correlation between otolith size and fish size has been described for a range of other species (e.g. Lough *et al* 1982; Ralston and Miyamoto 1983; Nishimura and Yamada 1984) and this evidence has been used to rationalise the backcalculation of prior somatic growth in larval and juvenile fish (e.g. Penney and Evans 1985; Victor 1986; Thorrold and Williams 1989).

However, few studies have carried out the necessary verification to show that otolith growth responds causally to changes in somatic growth; this evidence is critical if reconstructed growth trajectories are to be believed.

The aim of the present study was to subject presettlement juveniles of *Parika scaber* to a range of temperature and food regimes in order to induce changes in growth rate. It was hypothesised that these changes in growth rate were related to concomitant changes in otolith microstructure during the 10 day duration of the experiment.

Juveniles were subjected to two regimes of temperature (19-21°C and 24-26°C), and three feeding levels (fully-fed, partially-fed, and starved) of a diet consisting of larvae of *Opifex fuscus*, an endemic mosquito. Fish were individually tagged to ensure that changes in growth rate and any associated changes in otolith microstructure could be accurately determined for any individual.

Growth rates in untagged fish that were fully-fed were not significantly different to growth rates in tagged fish ($t=0.97$, $p>0.05$). This result suggests that any effects of tagging on *P. scaber* juveniles were minimal. The growth rate of fish prior to the experiment was estimated from field collections to be 0.5mm standard length (SL) (± 0.05 S.E.) day⁻¹ (n=60). This was higher than the maximum growth rate recorded for fish from the experiment (0.2mm SL ± 0.01 S.E. day⁻¹). Controlled feeding levels

affected the growth rates of fish, but the two different temperature levels in isolation or in combination with feeding levels, did not (two-way ANOVA). Fish that were fully-fed grew the most ($0.2\text{mm SL} \pm 0.01 \text{ day}^{-1}$), whilst fish that were starved did not grow at all. Partially-fed fish exhibited a size-hierarchy effect with larger fish increasing body size at the expense of smaller individuals.

In conflict with the field study, otoliths of fully-fed fish continued to increase at the same daily width despite the induced alteration in growth rate. Thus, otoliths were disproportionately large compared to estimates from the field. However, otoliths of starved fish were not as large as predicted from a continual production of daily rings at a constant width. Daily ring deposition probably ceased at different times during the experiment for the starved fish, dependant on body size.

From measurements of increment spacing and otolith size it is clear that although the growth rate of fish changed for all food treatments, this was not reflected by such predictable changes in increment spacing. Other studies where otolith growth has been shown to be uncoupled from somatic growth argue that factors such as temperature, photoperiod or changes in life-history may be responsible for the pattern of change in increment spacing (e.g. Volk *et al.* 1984; Campana and Neilson 1985; Mosegaard *et al.* 1988; Wright *et al.* 1990). Thus, increment spacings may not always change in a direction predicted by changes in somatic growth.

This is in direct contrast with other studies, where increment spacings have responded to environmental changes and the associated alteration of growth rate. Temperature, photoperiod, food availability, time and frequency of feeding, pH, and some interactions between these factors, have been shown to affect increment spacings in otoliths over 2-8 week periods (e.g. Wilson and Larkin 1982; Volk *et al.* 1984; Neilson and Geen 1985; Eckmann and Rey 1987; Hovencamp 1990; Maillet and Checkley 1990). However, no study

has yet demonstrated a daily response of increment spacing to growth rate for any species (see also Campana and Neilson 1985).

The most surprising and unique result from this study is the failure for increment spacings to track manipulated changes in somatic growth, despite strong indications from field collections (Kingsford and Milicich 1987) to the contrary. Evidence of a significant correlation of otolith scaling, even if accompanied by a description of how this may change with natural fluctuations in growth rate, is not sufficient evidence to allow growth parameters to be backcalculated at the daily or even at a weekly level of precision. Before the otolith can be used as a tool to reconstruct the growth histories of individual fish, some form of validation is required, and since responses of fish otoliths to environmental parameters and somatic growth changes are species-specific, validation must be conducted at this level.

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