

## **Growth in a Variable Pelagic Environment: The Impact of Current Rings on Reef Fish Larvae**

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### **ABSTRACT**

Previous work has shown that reef fish populations at Barbados, West Indies, are largely self-recruiting and that North Brazil Retroflection Current rings frequently impinge upon the island and surrounding waters. In order to examine the impact of these rings on the growth and survivorship of reef fish larvae, we examined the otolith record of successful recruits to the island. New recruits of the bluehead wrasse, *Thalassoma bifasciatum*, were collected from nearshore reefs every two weeks for 18 months. Examination of the otolith record demonstrated that larvae encountering rings exhibited slower growth rates, leading to longer pelagic larval durations. This was especially true for those larvae encountering a ring early in their larval life. Larval growth rates were directly correlated with the salinity of nearshore waters. However, this generally negative impact of rings on larval growth sometimes can be countered by increased larval retention rates during ring events.

**KEY WORDS:** Current rings, reef fish larvae, retention rates

### **CRECIMIENTO EN UN MEDIO AMBIENTE PELAGICO VARIABLE: IMPACCION DE "RINGS" SOBRE LARVAS DE PECES DE CORALES**

Estudios anteriores han demostrado que las poblaciones de peces de corales en Barbados, Indias Occidentales, son en gran parte reclutados localmente, y que frecuentemente, "rings=anillos" de la retrofleccion de la corriente Nor Brasil inciden sobre la isla y las aguas que la rodean. Para estudiar el impacto de estos "rings" sobre el crecimiento y la supervivencia de larvas de peces de corales, hemos examinado el record de los otolitos de los reclutos exitosos en la isla. Nuevos reclutos de *Thalassoma bifasciatum* fueron colectados en las arrecifes costera cada dos semanas por 18 meses. Analisis de los otolitos demostró que las larvas que se encontraron con "rings" exhibieron un crecimiento mas lento, resultando en un periodo larval más largo. Esto fue mas aplicable para las larvas que encontraron un eddy temprano durante su vida pelágica. Crecimicuto larval estuvo directamente corelacionado con la salinidad de las aguas costeras. Sin embargo, este impacto generalmicute nagotivo de los "rings" en el crecimiento larval puede ser balanceado por el aumento de las tosas de retention duraule los "rings" eventos.

PALABRAS CLAVES: "rings=anillos", larvas de peces de corales, las tosas de retention

### INTRODUCTION

As the easternmost island in the Lesser Antilles, Barbados is geographically isolated from the mainland or other islands (its nearest neighbor is 140 km to the east. Lying within the predominantly northwest flowing Guyana Current, Barbados has well-developed coral reefs that support a diverse fish fauna that, due to the island's upstream location, is considered to be largely self-recruited. Larvae settling to island reefs are likely those that spent their pelagic larval period within surrounding waters.

Although the island is situated within a generally uni-directional flow, the waters flushing by the island are not of uniform consistency. This region is regularly dominated by significant, oceanographically distinct features: large anti-cyclonic rings shed at the retroflexion of the North Equatorial Counter Current (NECC) and the North Brazil Current (NBC), which move to the northwest along the South American coast. Rings entrain water low salinity water from the Amazon River and translate toward the Lesser Antilles. These low-salinity rings typically encounter the Barbados-Tobago ridge, veer to the north slightly, and pass directly by or around Barbados. These low salinity features frequently impact the pelagic environment surrounding Barbados. Data from satellite altimetry data and temperature-salinity recorders moored off the west coast of Barbados reveal that NBC rings may pass Barbados four to five times each year.

NBC rings potentially influence larval fishes in nearshore waters by affecting their transport or by influencing their growth and survivorship. This presentation will focus on the later. Our working null hypothesis is that growth rates of reef fish larvae that encounter a current ring during some portion of their pelagic larval period will not differ from those that do not experience a current ring.

### APPROACH AND METHODS

To examine the effect of major oceanographic features such as the NBC rings on the growth of pelagic larvae and subsequent recruitment strength, juvenile bluehead wrasse, *Thalassoma bifasciatum*, were censused and collected biweekly along the west coast of Barbados for 20 months (April 1996-November 1997). *Thalassoma bifasciatum* was selected as the focal species because it is common throughout the Caribbean and previous studies have documented many aspects of its life history. For each census at each of three sites, two divers censused new recruits (juveniles < 15 mm SL) in 10 randomly placed 1 X 5 m quadrats. To obtain an accurate age as well as a record of larval growth, recruits were collected by divers using hand nets and the anesthetic Quinaldine. Specimens were stored in 95% ethanol until they could be dissected in the laboratory.

The otoliths (ear bones) of *Thalassoma bifasciatum* have an internal structure that enables calculation of an individual's age, timing of settlement, daily growth

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rates, and relative size at different ages. Previous studies have confirmed that otolith increments in *T. bifasciatum* are deposited daily and that the transition from the pelagic larval stage to the benthic juvenile, including the metamorphic period, is recorded in the otoliths. Studies have shown that the relationship between fish length and otolith length is strongly correlated in *T. bifasciatum*.

To identify the age structure of new recruits, individuals were selected randomly from each bi-weekly collection for otolith analysis. Standard procedures were used to dissect, read, and interpret the sagittal otoliths. All increments were identified as larval, metamorphic or juvenile and enumerated along the longest radius from the otolith core to the edge. From these data, we obtained measures of larval duration, juvenile age (post-emergence age), timing of settlement, and otolith growth rates (increment widths) for the larval and juvenile periods.

Measurements of the strength and timing of settlement were combined to create a settlement record for the entire 20-month period. This record then was compared to the timing of NBC ring impingement at Barbados. The presence of NBC rings in the vicinity of Barbados was determined from hydrographic records from a CT sensor moored off the south coast of the island. A ring was considered to be present on days when salinities of the 25 m depth bin were less than 34.5 psu.

In order to examine specific growth rates of larvae in the presence or absence of NBC rings, individual otolith records were examined on a daily basis. Mean daily otolith increment widths during the larval period and mean pelagic larval duration were compared for fishes that had encountered a ring for at least seven days during the first half of their larval period (during day 1-20), and those that encountered a ring during days 21-40, to those that encountered no ring at any time during their larval period.

Temperature has the potential to influence larval growth, so to tease apart this potential effect from the influence of NBC rings, we plotted mean larval otolith growth against the mean water temperature during each time period. We similarly examined larval otolith growth versus mean salinity during each event. Temperature and salinity values were obtained for the 25 m depth bin from the CT sensor moored off the south coast of Barbados.

## RESULTS AND DISCUSSION

Fishes that encountered a ring during their larval period grew more slowly than did fishes that did not encounter a ring. These growth differences resulted in a difference in the length of the larval period. Fishes that encountered a ring during their larval period spent longer in the plankton. This theoretically should result in lower survivorship. There was no correlation between mean increment width (proxy for larval growth) and water temperature, but otolith growth was directly correlated with salinity.

Examination of the raw settlement recruitment record demonstrates that the low growth associated with rings does not always translate into low recruitment events. Occasionally there are large recruitment events immediately following the passage

of a NBC ring. This suggests that the generally negative effect of NBC rings on larval fish growth can be countered by changes in larval transport. Recent work has shown that depending on the specific angle of approach, the impingement of NBC rings can result in an increase in larval retention at Barbados. Recruitment events are likely the result of successful larval growth and survivorship as well as successful larval retention or transport events.