Use of Microstructure Analysis of the Sagittal Otoliths for Age Estimation of the Wahoo, *Acanthocybium solandri*, from Bermuda

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ABSTRACT

The preparation of sagittal otoliths for examination by light microscopy and by scanning electron microscopy (SEM) has revealed the presence of apparent daily growth increments which can be used to estimate the age of wahoo. This will provide estimates of important growth and reproductive parameters in this economically important pan-tropical species. Preliminary counts of the daily increments in a size range of specimens confirm that this is a relatively fast-growing species, in common with other commercially important scombroids. Validation of the daily increments will be attempted with tagging and injection with oxytetracycline (OTC). There are similarities in the microstructure of the sagittae of yellowfin tuna and wahoo which can be useful in verifying the estimates of growth rates in wahoo.

KEY WORDS: *Acanthocybium solandri*, age estimation, otoliths, wahoo

INTRODUCTION

The wahoo, *Acanthocybium solandri* (Cuvier, 1831) is a widely distributed scombrid species which is found throughout tropical and sub-tropical seas around the world (Collette and Nauen, 1983). In the Caribbean region, it is a species of considerable commercial importance, particularly around those islands which have narrow shelves and which are highly dependent on pelagic fisheries. Landings of wahoo on various islands of the Caribbean during the 1990s are reported by CFRAMP (1996) with Barbados and Grenada achieving maximum landings of 90 – 100 mt. In Barbados, wahoo have been an important component of the pelagic fishery for many years (Mahon, *et al.*, 1982). Despite its importance, relatively little research has been conducted on this species in the region. In St. Lucia, studies have been directed at the estimation of growth parameters using the ELEFAN program (Murray and Sarvay, 1987; Murray and Nichols, 1990). Trends in the exploitation of wahoo in the St. Lucian fishery are discussed by Murray and Joseph (In press). A recent contribution from the CFRAMP program examines wahoo landings in the Lesser Antilles and the problem of stock assessment with length-based methods (Neilson, *et al.*, in press). In addition, some initial tagging studies to document movement patterns have recently commenced (CFRAMP, 1996).

Outside the Caribbean, wahoo also have importance in recreational fisheries and have been the subject of fishery research programs. Hogarth (1976) studied aspects of the life history of wahoo off the coast of North Carolina and Manooch and Hogarth (1983) examined stomach contents and parasites from specimens collected along the south Atlantic and Gulf coasts of the United States.

In Bermuda, the relative importance of the pelagic fishery has been increasing for a number of years. Following the decline of the dominant grouper fishery from 1975 to 1981 (Luckhurst, 1996), pelagic species landings increased steadily from 20% of total landings in the late 1970's to over 40% in 1990 - 1991 (Butler *et al.*, 1993). Wahoo has consistently dominated pelagic species landings over the years and it has been the single most important commercial species taken in Bermuda waters since the 1980s. In 1995, reported commercial landings of wahoo were 93,484 kg, the highest figure recorded for this species to date. Despite its dominance in the fishery, relatively little is known about its fishery biology in Bermuda. This paper describes some preliminary results of a study on the age and growth of wahoo which is part of a broader study examining pelagic species in Bermuda.

MATERIALS AND METHODS

Wahoo specimens were obtained by dockside sampling with cooperative fishers and sagittal otoliths were removed at the laboratory of the Division of Fisheries. The sagittae are very fragile and difficult to remove without breaking. After removal, otoliths were rinsed in fresh water and air dried before storage in small plastic vials. Otoliths were prepared for analysis at the Belle W. Baruch Institute for Marine Biology and Coastal Research, University of South Carolina. Methods for preparing the otoliths for viewing generally follow the protocols in Secor et al.(1991). The preparation of otoliths for viewing with a scanning electron microscope (SEM) are as follows: the otolith is embedded in epoxy resin and is cut with a diamond saw into a thin section of about 1.5 mm. The surface is polished with a series of abrasives, starting with 300 grit wet-dry emery paper and concluding with a final polish using 0.3 μm abrasive. The surface is then decalcified with a saturated solution of EDTA at a pH of 7.4 and the surface is sputter-coated with gold thus providing the proper electron surface for the SEM.

RESULTS AND DISCUSSION

A scanning electron micrograph (SEM) of a whole sagittal otolith of a wahoo (Figure 1) shows the lateral surface of the sagitta from the edge of the core region to the posterior margin and is presented to provide a means of orientation to the SEM micrographs illustrating the microstruct ural features. The view of the otolith at 34X magnification shows the lateral surface with the core region at the center of concentric elliptical ridges. The various features of SEM micrographs are shown at progressively greater magnification in Figures 2 – 5. The ridges, illustrated in Figure 2, are probably the annuli observed by Hogarth (1976) with the presumed annuli clearly visible on the actively growing surface of the dorsal edge of the sagitta. We have observed similar, although not as exaggerated, features in marlin and sailfish. We speculate that future growth will probably fill in the incisions on the edge of the otolith but, at present, we do not know if new lobes continue to form.

Figure 3 is a micrograph (50X magnification) of the medial surface of a sagitta with the sulcus clearly visible as a deeply incised region. A higher magnification (700X) of this same preparation (Figure 4) illustrates the annulus and the presumed daily increments on the edge of the annulus which make up the daily growth zone (the white ridge-like feature). The presumed daily increments are easily viewed (Figures 4 and 6) and are 1.5 - 2.5 microns in width. These are exceptionally clear and appear to be consistent in the preparations we have made to date. A transverse section of the rostrum shows easily recognized features of presumed daily increments (Figure 5) with clearly visible daily growth and discontinuous zones. These features are readily seen in thin sections prepared for viewing on a compound microscope at 1,000X with an objective lens especially made for high resolution microscopy.

All of the microstructural features that we have seen to date are consistent with those features we have used to estimate the ages of other pelagic fishes such as yellowfin tuna, swordfish, blue marlin, sailfish, king and Spanish mackerel. It is possible to count daily increments over extensive areas of the otolith for age estimation.

Hogarth (1976) used presumed annuli to estimate the age of wahoo and developed a length-at-age key. The oldest specimen he examined in his samples was estimated at five years. However, in our study we do not yet have enough samples prepared to verify whether or not the structures we have observed are annuli. Further work will accomplish verification of the structural features of the otolith, including validation of the annulus with marginal increment analysis and we will attempt validation of daily increment formation with an otolith marking (OTC), tag- recapture program.

The otoliths of these fish indicate that wahoo probably have relatively rapid growth, which is consistent with other scombrids, and will reach sexual maturity in a relatively short period of their life span. The ability to provide individual age specific information will enable us to test and confirm or refute that hypothesis. We will be able to develop critical life history information such as age at first reproduction, life span,fecundity estimates at age, whether males and females have different von Bertalanffy growth rates and life spans, larval and juvenile growth rates and estimated date of hatch for individuals.

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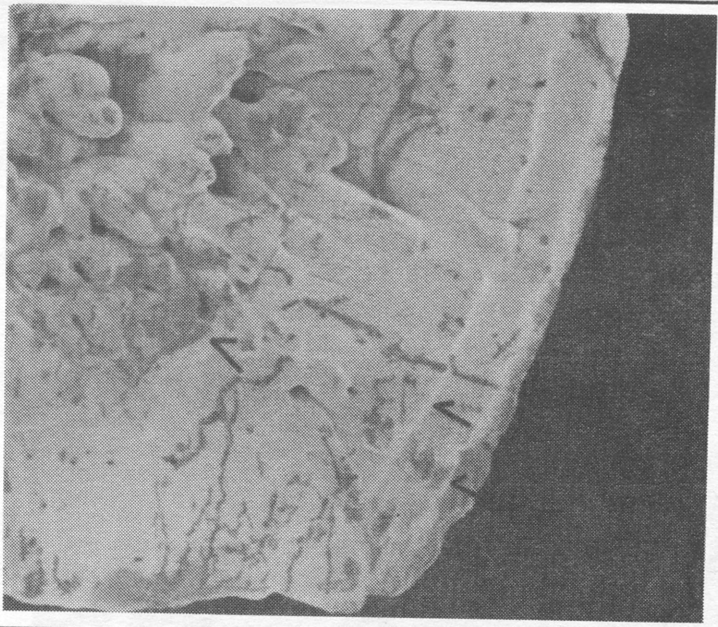

Figure 1. Arrows indicate presumed annuli on lateral surface of sagitta (magnification = 34X)

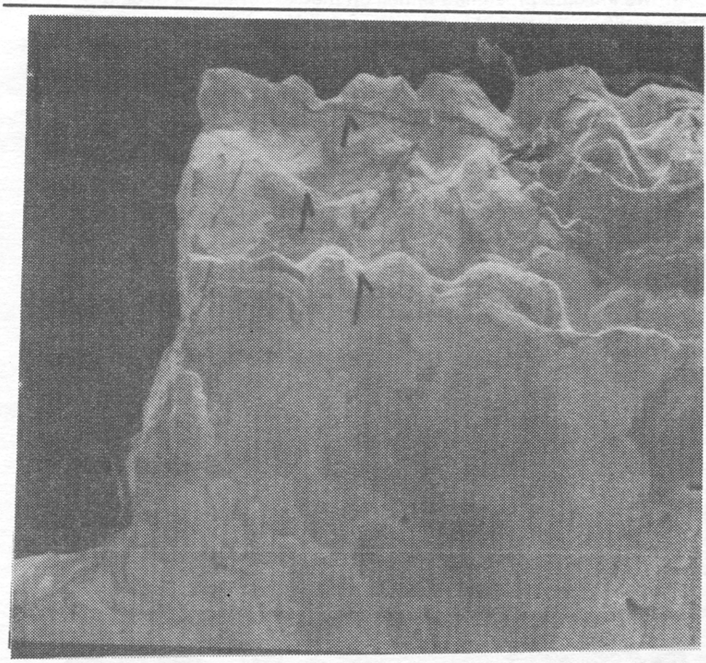

Figure 2. Arrows indicate presumed annuli on dorsal edge of sagitta (magnification = 50X)

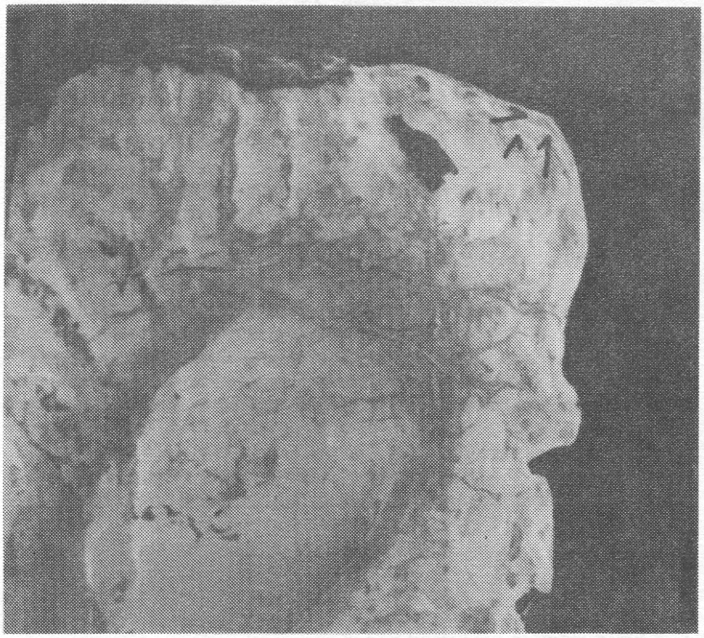

Figure 3. Arrows indicate presumed annuli on medial surface of sagitta (magnification = 50X). Note that sulcus is very obvious.

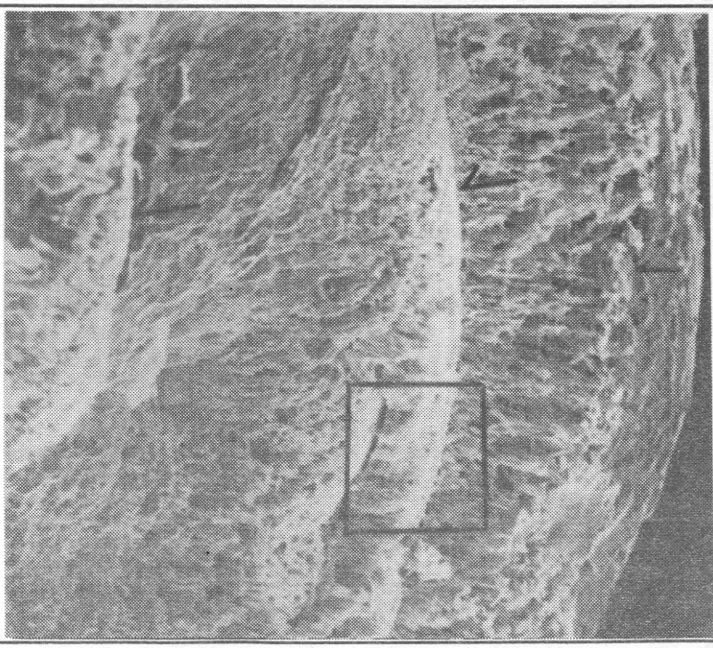

Figure 4. Detail of presumed annuli of the medial surface (magnification = 700X). The box shows presumed daily increments which are shown in Figure 6.

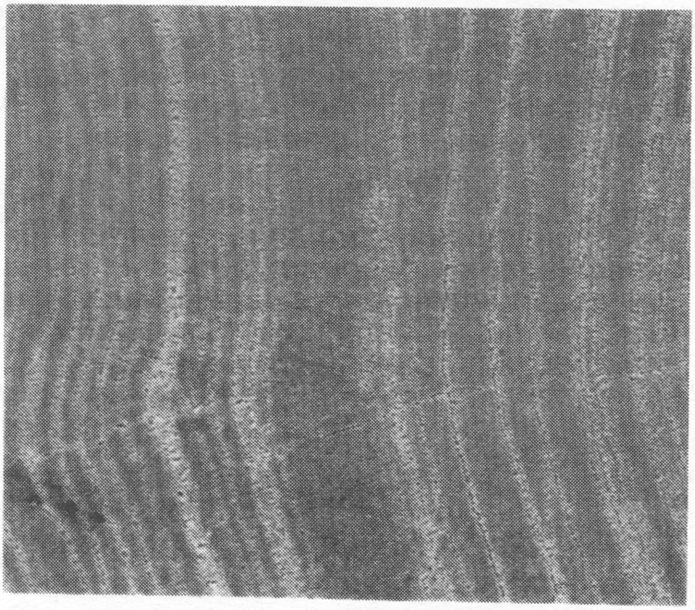

Figure 5. A thin section preparation of the sagitta showing the presumed daily increments (magnification = 600X).

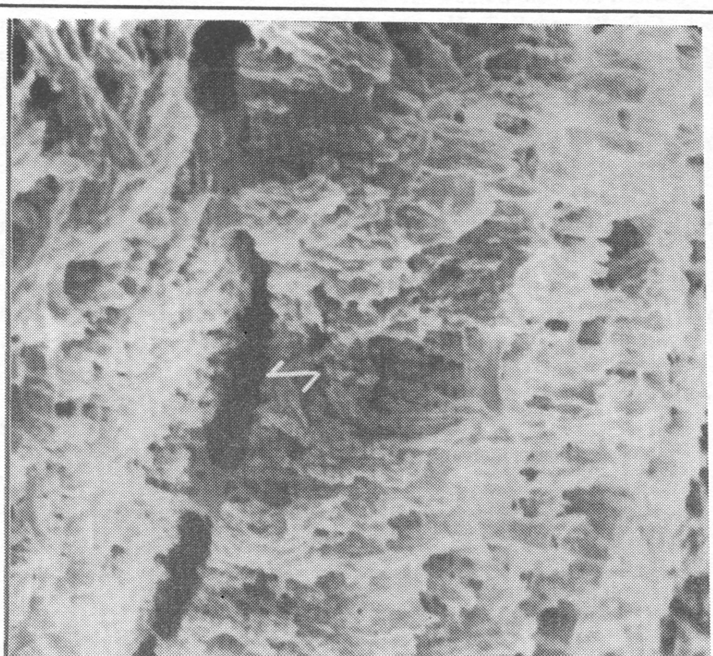

Figure 6. Detail of a presumed daily increment visible on the surface of the medial surface of the sagitta (magnification = 5.00K).

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