

Age Determination in Larval and Juvenile Sheepshead, *Archosargus probatocephalus*

Pannella (1971) first demonstrated the existence of daily growth increments in the otoliths of several species of teleosts. Enumeration of these daily increments is particularly useful for age determination in larval and juvenile fishes. Verification of daily growth rings in individual fish species has generally been approached in one of two ways: laboratory rearing (Brothers et al. 1976; Struhsaker and Uchiyama 1976; Taubert and Cable 1977; Barkman 1978; McGurk 1984; Davis et al. 1985;) or by using chemical marking techniques either in the wild or in the laboratory. Oxytetracycline hydrochloride has been used to produce a fluorescent mark for examination of daily growth increments in otoliths of the starry flounder, *Platichthys stellatus* (Campana and Neilson 1982), and juvenile Hawaiian snapper, *Pristipomoides filamentosus* (Ralston and Miyamoto 1983). Otolith microstructure and its use in fish age determination was reviewed by Campana and Neilson (1985).

The early life history of the sheepshead, *Archosargus probatocephalus*, is poorly known. In this study, daily growth rings in the otoliths of larval and juvenile sheepshead were examined and validation was accomplished using tetracycline-marked specimens held in the laboratory. The daily rings of wild caught specimens were counted to obtain information on the age at transition from larva to juvenile.

Materials and Methods

Sheepshead larvae and juveniles were collected from Bayboro Harbor, St. Petersburg, FL, between 21 April 1983 and 7 May 1985. Larvae (5–8 mm SL) and juveniles (greater than about 8 mm) were collected from a seawall using a dip net fished at the surface. All specimens were preserved in 95% ethanol. Subsamples of larvae were measured (SL) using an ocular micrometer, and the sagittal otoliths were teased out and mounted on microscope slides using Pro-texx¹ mounting media. In the largest individuals (about 10 mm SL), one otolith was mounted on a microscope slide in thermoplastic cement and polished with 3 μ grit microtome

¹Reference to trade names does not imply endorsement by the National Marine Fisheries Service, NOAA.

paper. The otoliths were polished until the rings near the primordium were clearly visible (Fig. 1).

The daily nature of the growth increments was validated using 29, (7–10 mm SL) wild-caught larvae collected on 1 May 1984. Larvae were placed in 38 L aquaria containing oxytetracycline hydrochloride at a concentration of 10–15 mg/L, left for 7 hours, and then were removed to untreated tanks. Fish were fed *Artemia salina* nauplii and allowed to grow for 6 or 15 days, after which they were preserved in 95% ethyl alcohol and stored in the dark. The position of the tetracycline mark was determined by preparing these otoliths as described above and alternately viewing them under ultraviolet and visible light.

Otoliths were examined at 630–1000 \times magnification using a compound microscope equipped with a high resolution closed circuit television to improve contrast. Daily growth increments were independently counted by two readers. Counts were considered in agreement if they differed by two or less increments. When the counts differed by two increments, the median value was used; when they differed by one increment, the greater value was used. If counts differed by three or more, those otoliths were reexamined by both readers in a joint effort to resolve the differences. About 5% of the otoliths were excluded from the data set because differences in counts could not be resolved.

Results

Approximately 2,000 larval and juvenile sheepshead, ranging in size from about 5–10 mm, were collected during the study (Fig. 2). About 90% of the individuals were 6.5–8.0 mm (mean = 7.0 mm); fish larger than approximately 8 mm represented less than 2% of the sample. Rings in otoliths of larval and juvenile sheepshead were clear (Fig. 1), and results of the validation experiment confirmed daily increment formation, at least between 7 and 10 mm. Of 26 specimens sacrificed six days after tetracycline treatment, 19 showed clear marks and had produced six increments beyond the reference mark. Reference marks could not be located on six of the remaining specimens, and the increments could not be counted on one specimen. The specimens sacrificed after 15 d post-treatment showed clear reference marks and had produced 15 increments.

A sample of 129 larval and juvenile sheeps-

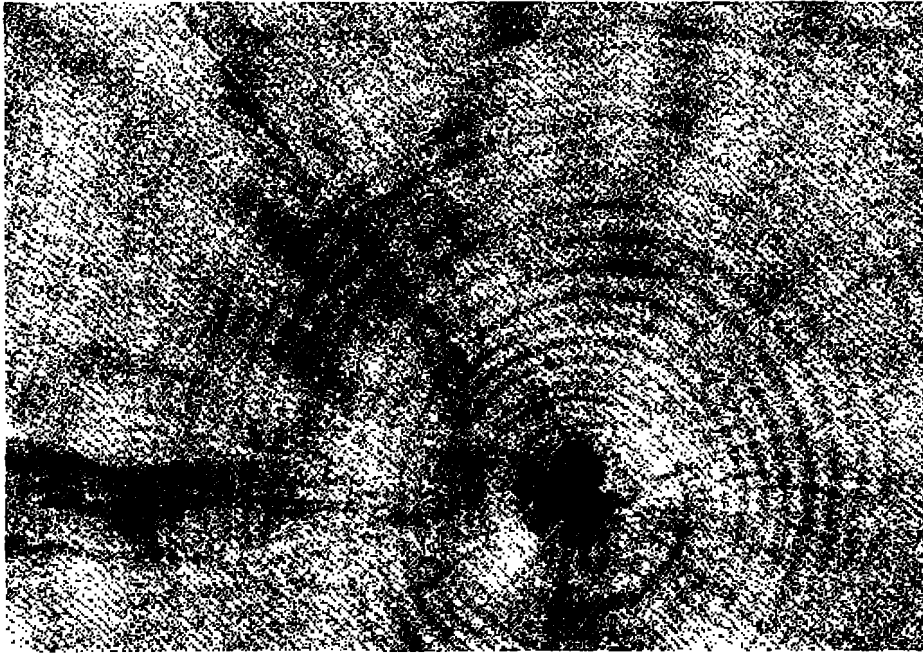


FIGURE 1.—Photomicrograph through the central region of an otolith taken from a 10.5 mm sheepshead (80× magnification). This otolith was polished to increase ring clarity.

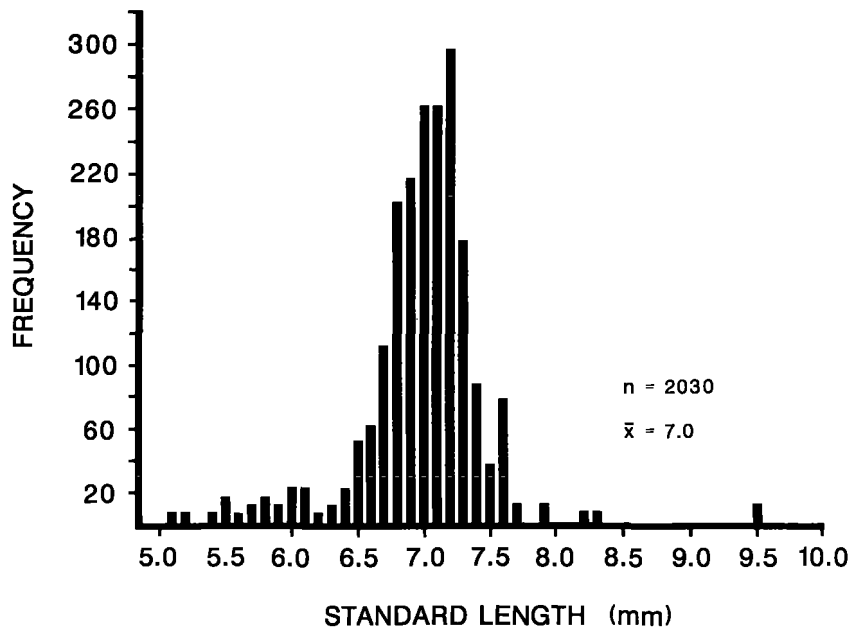


FIGURE 2.—Length-frequency distribution of all sheepshead collected by dip net from the Bayboro Harbor site.

head (5.1–10.5 mm SL) were aged. First increment formation was assumed to begin at hatching such that the otolith age equals the “real” age. Of this sample, 93 specimens were taken

from field collections, the remainder were tetracycline treated individuals held in the laboratory. Figure 3 shows the results of these age determinations.

Discussion

Once daily periodicity in increment formation was validated in sheepshead otoliths through the use of tetracycline marking, it was possible to determine the timing of life history transitions. The time required for transition from larval to juvenile stage has been determined for a number of species (Brothers et al. 1983; Campana 1984). The data presented in Figure 2 indicate that by about 8 mm SL most sheepshead larvae have disappeared from dip net collections. This coincides with the size at beginning of transformation as reported by Mook (1977). The disappearance of larvae from collections may reflect their ability to avoid capture or their movement out of the pelagic environment, both facilitated by increased swimming ability acquired after metamorphosis. Sheepshead are substrate-oriented fish, and a "settling" of larvae may occur at metamorphosis. Using the data presented in Figure 3, the minimum and maximum age of an 8 mm fish can be roughly estimated at about 30 and 40 days, respectively. If daily increment formation begins at hatching (see Brothers et al. [1983] for a discussion of this assumption) then the pelagic stage of the sheepshead under the environmental conditions of Bayboro Harbor is between about 30 and 40 days. Other species

possessing similar ages/sizes at transition include the spot, *Leiostomus xanthurus*, which transforms at 8 mm after 40 days (Fahay 1983; Warlen and Chester 1985) and the Atlantic croaker, *Micropogonias undulatus*, which transforms at 10 mm after 60 days (Fahay 1983; Joann Lyczkowski-Shultz²). The results presented here suggest that sheepshead larvae develop more slowly than the larvae of the closely related sea bream, *Archosargus rhomboidalis*. Sea bream larvae reared in captivity began transformation at the same size as sheepshead (8 mm) but only 15 days after hatching (Houde and Pothoff 1976). It is noteworthy that five sheepshead larvae (7.9–8.1 mm), held in the laboratory during tetracycline treatments, were found to have a mean age of 36.8 days (range = 35–38 days) (Fig. 3). These comparisons must be cautiously interpreted, however, because growth acceleration or retardation may occur in captivity.

Acknowledgments

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²J. Lyczkowski-Shultz, Gulf Coast Research Laboratory, P.O. Box 7000, Ocean Springs, MS 39564, pers. commun. March 1989.

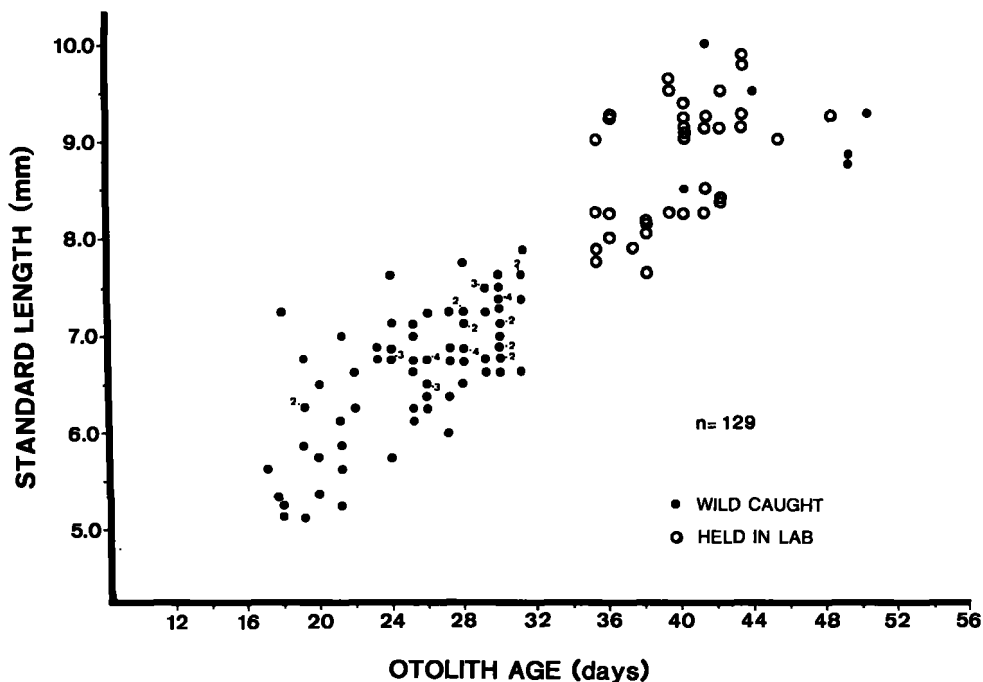


FIGURE 3.—A scatter plot of length on age for larval and early juvenile sheepshead between 5 and 10 mm SL.

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Reproductive Status of Dover Sole, *Microstomus pacificus*, off Northern Oregon

Dover sole, *Microstomus pacificus*, range latitudinally from northern Baja California to the Bering Sea (Hart 1973) but are commercially abundant only from central California to British Columbia. They inhabit a wide depth range, from shallow, inshore waters (juveniles) to at least 1,000 m. Maximum recorded size is 71 cm total length (Hart 1973). On the basis of biomass, Dover sole is the most abundant species of flatfish landed commercially off Oregon (Demory et al.¹) and dominates the Columbia Slope Assemblage (located at depths >220 m) described by Gabriel and Tyler (1980). Landing and effort statistics for this species in the International North Pacific Fisheries Commission (INPFC) Columbia Area (lat. 43°00'-47°30'N) were relatively stable for the 20 years prior to 1977, but have since almost tripled (Demory et al.²).

From data extending back to 1951, Demory et al. (fn. 2) suggested a decline in age-specific length for this species during the last several years (mean length at age 10 years was about

¹Demory, R. L., M. S. Hosie, N. TenEyck, and B. O. Forsberg. 1976. Marine resource surveys on the continental shelf off Oregon, 1971-74. Unpubl. rep. Oreg. Dep. Fish Wildl., Newport, OR 97365.

²Demory, R. L., J. T. Golden, and E. K. Pikitch. 1984. Status of dover sole (*Microstomus pacificus*) in INPFC Columbia and Vancouver areas in 1984. Unpubl. rep. Oreg. Dep. Fish Wildl., Newport, OR 97365.