AGE AND GROWTH OF DOLPHIN, *CORYPHAENA HIPPURUS*, AS DETERMINED BY GROWTH RINGS IN OTOLITHS

The dolphin, *Coryphaena hippurus* Linnaeus, is a large, schooling, pelagic fish with a worldwide distribution in warm seas. Its range extends from the Tasman Sea (Shcherbachev 1973) to Nova Scotia (Vladykov and McKenzie 1935). It supports important game and commercial fisheries in the Caribbean (Mahon et al. 1982), Southeastern United States (Beardsley 1967), East Africa (Williams 1956), Taiwan, Japan, China, and Hawaii (Hagood et al. 1981).

Growth rates of dolphin have been estimated using scale annuli (Beardsley 1967; Rose and Hassler 1968), modal progression of length-frequency distributions (Wang 1979), and captive fish of known age (Herald 1961; Beardsley 1971; Hassler and Rainville 1975; Hagood et al. 1981). However, scale annuli are not present in all dolphin populations (Schuck 1951; our study population) and are of limited use in aging a short-lived species. Modal progression of length frequencies, when appropriate, provides little information on intrapopulation growth variability; and fish growth in captivity is not necessarily representative of growth in the wild.

Daily rings on otoliths have now been used to age temperate and tropical fish (e.g., Pannella 1971, 1974; Brothers et al. 1976; Taubert and Coble 1977; Uchiyama and Struhsaker 1981; Rosenberg 1982; Campana and Neilson 1982). In this paper, we describe the sagittal otoliths of dolphin and suggest that they can be used to estimate age and growth in this species.

Materials and Methods

Dolphin were caught between January 1981 and June 1982, 10-40 mi offshore Barbados, using trolling lines for adults and surface gill nets for juveniles. Each fish was measured for standard length (SL) to the nearest mm. Monthly length-frequency distributions were drawn. Changes in mean length of a cohort were used to estimate the growth rate of adults.

The sagittal otoliths of the dolphins were removed from the sacculi, mounted on a glass slide in the syn-

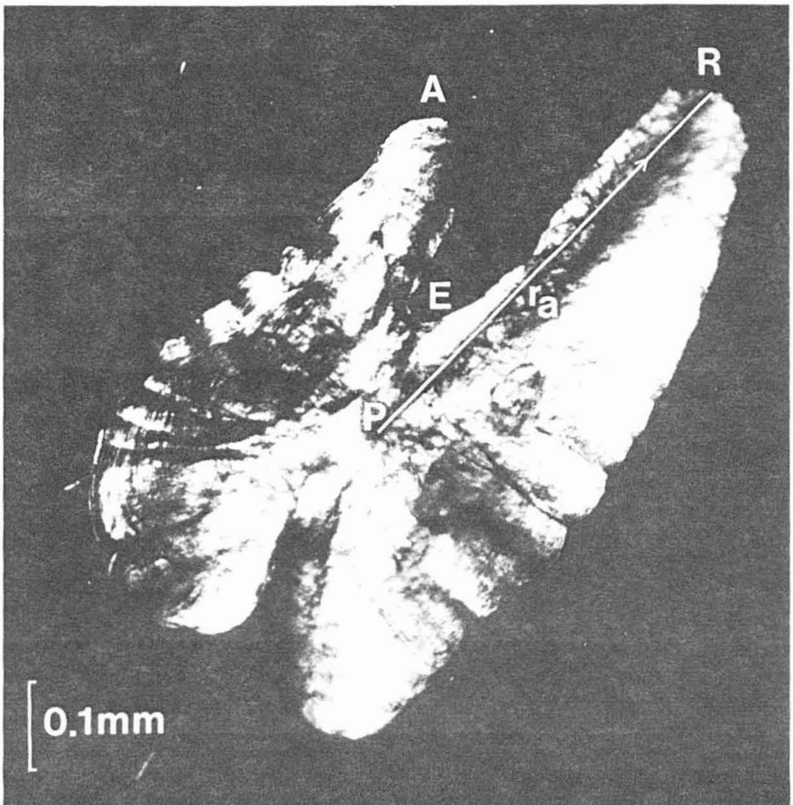

FIGURE 1.—Right sagitta of *Coryphaena hippurus* (307 mm SL) viewed from the lateral surface. R = rostrum, A = antirostrum, E = excisural notch, P = primordium, r_a = radial measurement.

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thetic mounting medium Covermount, and viewed under a compound light microscope with bright field illumination at 100× and 400× magnification. A radial measurement from the primordium to the rostrum margin was taken on the right sagitta of each fish, to the nearest 0.01 mm.

The sagittae were thin enough that growth rings could be read with no further preparation. Five counts were made using both the right and left sagittae at 400× and repeat counts were made at 100×. A plot of fish standard length against the number of sagittal rings (*N*) was drawn, and from this an average growth rate was calculated.

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

Results and Discussion

The sagittae of *C. hippurus* are extremely small (2.6 mm in a fish of 1,100 mm SL). The rostrum is exaggerated and separated from the antirostrum by a deep V-shaped excisural notch (Fig. 1). Rings are clearly visible on the lateral or convex surface of the sagittae from the primordium to the margin (Fig. 2). These could be counted accurately on all specimens

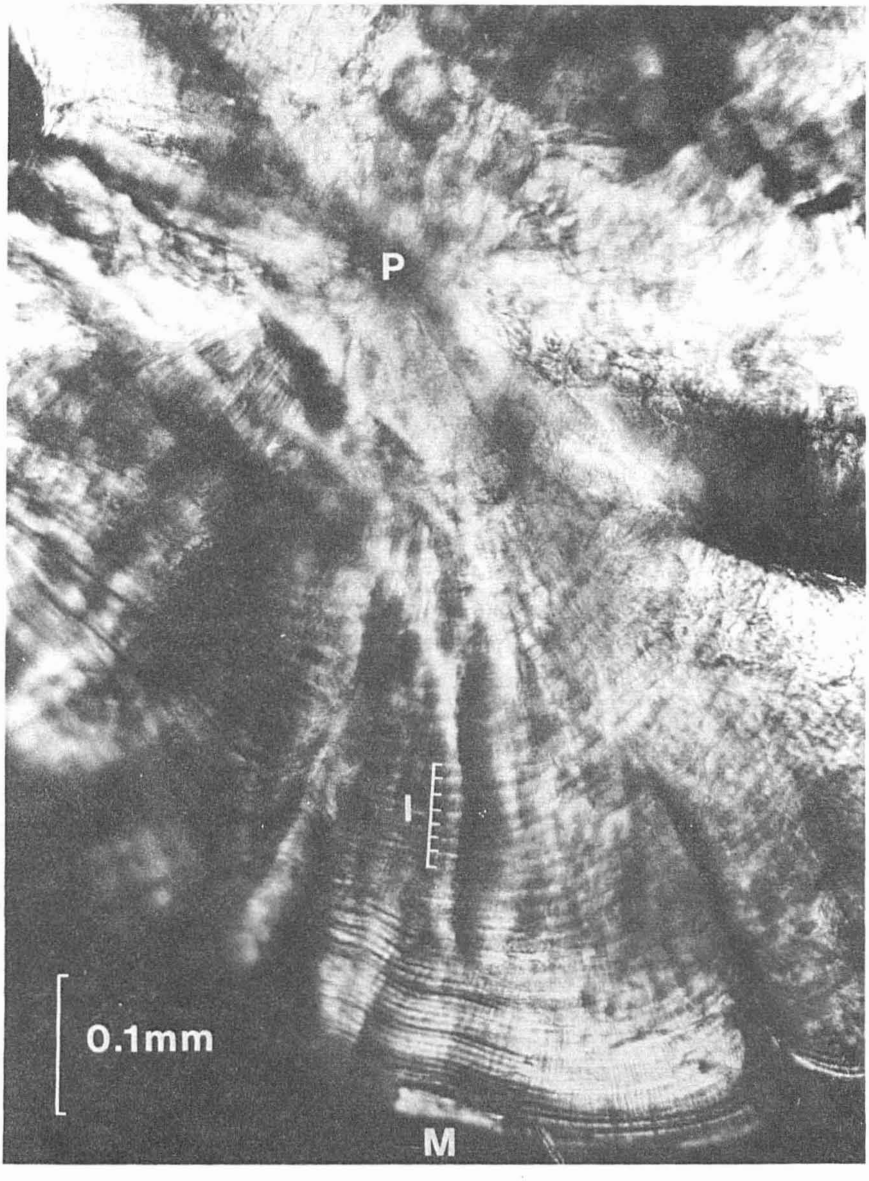

FIGURE 2.—Lateral surface of sagitta of *Coryphaena hippurus* showing 51 increments from the primordium to the margin. P = primordium, I = increments, M = margin.

(174-1,100 mm SL) at 100×.

There is a close correlation between the number of sagittal rings and fish standard length (mm SL) = $58.608 + 4.709N$; $r = 0.95$; Fig. 3). Assuming that the rings are daily, the average growth rate for all fish is 4.71 mm/d: the average growth rate for adults (size range 700-1,100 mm SL) is 1.43 mm/d (mm SL) = $711.574 + 1.425N$; $r = 0.57$; Fig. 3). Using changes in mean length of a cohort (Fig. 4), the average growth rate for dolphin of size range 600-1,200 mm SL is 1.53 mm/d.

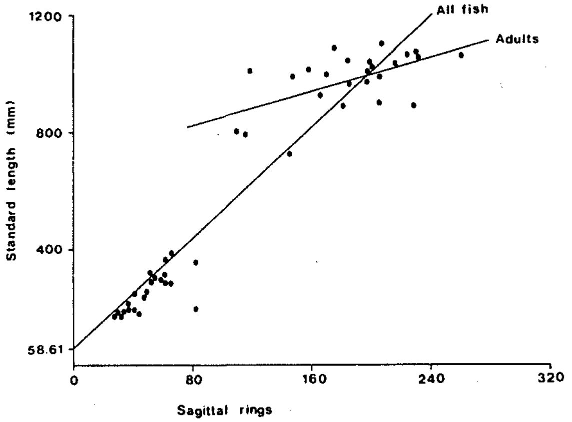

FIGURE 3.—The relationship of dolphin standard length to number of sagittal rings. The upper line (adults) represents the upper set of scatter points only.

The close correlation between number of sagittal rings and fish standard length suggests that ring formation is periodic. The similarity in growth rates obtained for the same population, using length-frequency distributions and the otolith rings, suggests that periodicity of the ring formation is daily.

Data published on growth rates of dolphin vary considerably (Table 1). These differences may reflect use of fish of different ages (the present study suggests that adults grow slower than juveniles), or may result from differences in aging techniques, in water temperatures, or in health and degree of provisioning of captive specimens.

We conclude by suggesting that daily rings occur in the otoliths of all sizes of dolphin fish (174-1,100 mm SL) and, therefore, that counts of otolith rings provide an alternative method of estimating age in this species. Moreover, since there is a linear correlation

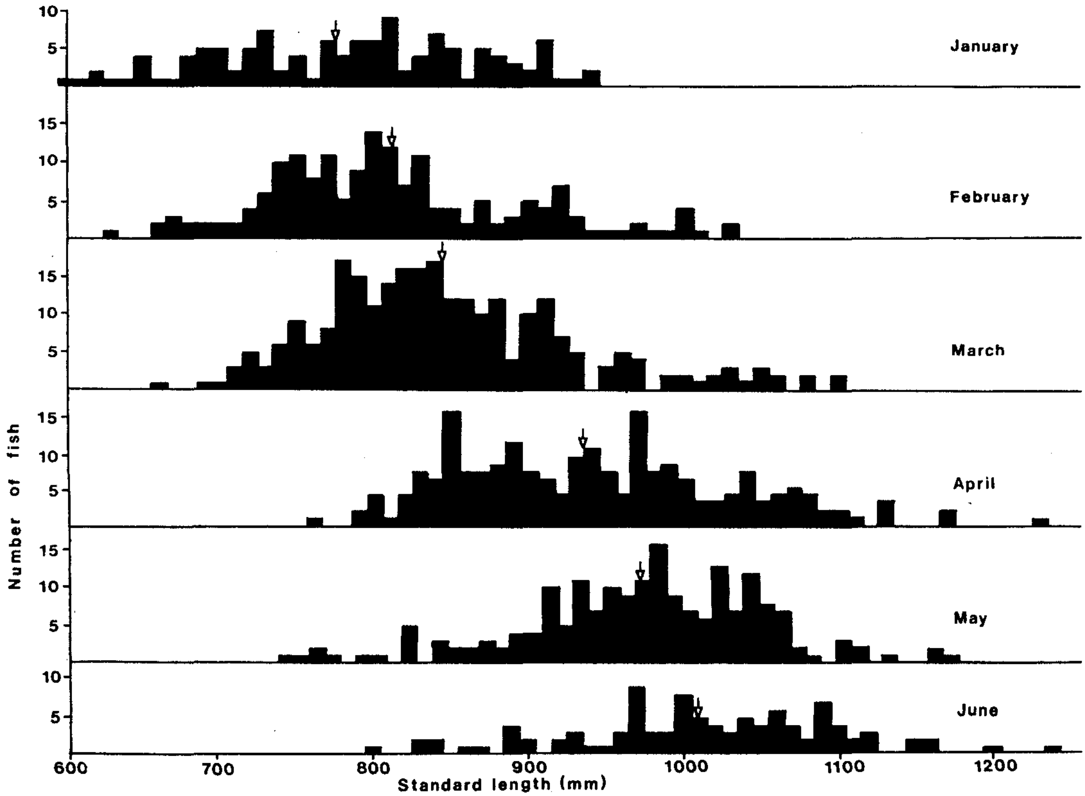

FIGURE 4.—Monthly length-frequency distributions of adult dolphin landed in Barbados between January and June.

TABLE 1.—Estimated growth rates of *Coryphaena hippurus*.

Location	No. of fish	Aging method	1st year growth rate (mm SL/d)	Reference
Laboratory reared	26	days known	1.07	Hassler and Rainville 1975
North Carolina	593	scale annuli	1.64	Rose and Hassler 1968
Straits of Florida	121	scale annuli	1.82	Beardsley 1967
Waters adjacent to Taiwan	?	progression of size-frequency	2.96	Wang 1979
Laboratory reared	?	days known	3.03	Schekter[1]
Laboratory reared	94	days known	3.56	Hagood et al. 1981
Florida Marineland	2	days known	4.80	Herald 1961
Miami Seaquarium	1	days known	5.28	Beardsley 1971
Laboratory reared	30	days known	5.88	Hassler and Hogarth 1977

[1]Richard Schekter, Research Associate, Division of Biology and Living Resources, University of Miami, 4600 Rickenbacker Causeway, Miami, FL 33149, pers. commun. February 1982.

between sagittal radius and fish standard length ($r = 0.95$) and between sagittal radius and the number of rings ($r = 0.88$), it may be possible to estimate the length and age of a fish from the sagittal radius alone.

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