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Age, Growth, and Length-Weight Relationship of Vermilion Snapper, *Rhomboplites aurorubens* from North Carolina and South Carolina Waters[1]

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ABSTRACT

Scales and otoliths were used to determine age of vermilion snapper, but only scales were used to back-calculate lengths. Scale annulae are laid down in March–April and their formation is well correlated with increasing photoperiod, preparation for spawning, and rising bottom water temperature. The von Bertalanffy growth equation fitted to back-calculated lengths (L, mm total length; t, years) is: $L_t = 626.5[1 - e^{-0.198(t-0.128)}]$. Maximum longevity of females is at least 10 years but males may only live 8 years. The length-weight (W, g) relationship ($r = 0.97$) is: $W = 0.00001722\ L^{2.946}$.

The vermilion snapper, *Rhomboplites aurorubens*, a small lutjanid attaining a maximum size of about 600 mm total length (TL) and 2,800 g, is distributed from North Carolina and Bermuda, throughout the West Indies and Gulf of Mexico, south to southeastern Brazil (Bohlke and Chaplin 1968; Cervigon 1966). In 1972 and 1974 it was the second most frequently caught species in the Carolina headboat[3] fishery, which landed between 590 and 726 metric tons of reef fishes (Huntsman 1975).

Vermilion snapper are associated with two reef habitats of the continental shelf of North Carolina and South Carolina. The shelf-break zone occurs at depths of 55–183 m where the relatively flat continental shelf slopes abruptly downward, becoming the continental slope, and is a rugged area of jagged peaks, precipitous cliffs, and rocky ledges composed primarily of algal limestone and shell hash with some sandstone. The second habitat lies on the relatively flat shelf shoreward of the shelf-break zone. Scattered over this area between depths of 26–55 m are numerous low rock ridges, outcroppings, and coral patches. Base rock is primarily of relict sandstone usually covered with recent coral and encrusting limestones (Macintyre and Milliman 1970). Water temperatures are relatively warm year-round due to the influence of the Gulf Stream.

The only age and growth data available are for two tagged specimens from Florida (Beaumariage 1964; Beaumariage and Whittich 1966). This paper gives the results of aging vermilion snapper by scales and otoliths, describes the length-weight relationship, and compares results to similar data for co-occurring species also important in the Carolina headboat fishery.

METHODS

Most fish were obtained from the recreational fishery throughout the study area; however, some specimens were collected by hook and line from research vessels and juveniles were collected by trawl.

Scales were removed from beneath the left pectoral fin (ventral to the lateral line) of each specimen because I found fewest regenerated scales there. Annular rings were identified by cutting-over of circuli at the postero-lateral margin of the scale and increasing and decreasing inter-circuli distances. Compound or complex rings usually occurred at the fourth or later ring. Scales from 935 fish were examined and it was possible to ascertain reliably the number of rings on 706 or 75.5%. The 229 unreadable scales contained no rings, many irregularly

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[3] Headboats are vessels on which anglers pay for a day's fishing on a per person (thus per head) basis.

TABLE 1.—*Mean back-calculated total lengths (mm) at age for vermilion snapper collected in 1972 and 1973.*

		Annulus number									
Age-group	N	1	2	3	4	5	6	7	8	9	10
I	39	96.1									
II	136	96.2	172.5								
III	227	96.1	178.1	235.9							
IV	175	98.8	185.0	252.2	304.9						
V	103	102.7	194.1	266.2	326.1	374.8					
VI	69	105.9	200.3	277.6	338.4	392.8	433.8				
VII	36	111.0	211.9	299.9	370.4	423.5	467.9	505.3			
VIII	15	107.1	201.3	283.7	341.1	390.5	430.9	467.6	504.3		
IX	10	115.2	221.1	299.4	360.6	405.9	441.3	481.2	507.9	541.6	
X	5	120.2	194.3	267.4	315.8	365.6	401.1	437.1	465.2	465.5	527.9
Weighted mean		99.6	185.5	255.7	324.3	389.5	441.9	487.9	498.9	516.1	527.9
Annual increment		99.6	85.9	70.2	68.6	65.2	52.4	46.0	11.0	17.2	11.8
Size at capture											
Scale-aged		158.5	209.9	275.7	345.5	419.8	483.8	528.7	528.4	564.8	573.1
Otolith-aged		121.3	160.6	234.1	311.4	393.5	463.8	523.1	554.9	569.3	606.5

placed rings, or were badly eroded or opaque. Total fish length was related to scale radius ($r = 0.978$) by the equation $TL = 0.619\ SR^{1.171}$ (TL, mm; SR, scale projector units). Otoliths were collected for confirmation of scale data. By observing otoliths in reflected light from specimens captured throughout the year, I determined that a narrower translucent (hyaline) band was formed during winter–spring growth. These narrow bands gradually merged with broader opaque bands that represent summer–fall growth. The inner margin of the translucent band was distinct, and counted as the annulus. This caused ages to be underestimated, because spawning occurs in spring and summer (Grimes 1976).

RESULTS AND DISCUSSION

I consider scale marks to be valid annuli. Back-calculated fish lengths agree reasonably well with lengths at capture for the same inferred ages, particularly for younger fish (Table 1). For any age, the mean length of fresh specimens should be larger than the back-calculated one, because some growth has occurred since the most recent annulus, and the data show this.

Ages agreed in 171 of 228 paired comparisons between scales and otoliths. The mean sizes at capture for fish aged by otoliths were smaller than those for scale-aged fish for the first 7 annuli (Table 1). This size difference was not evident for 7-, 8-, and 9-year-old fish, but scales and especially otoliths were more difficult to read in older fish perhaps explaining the inconsistency. Compared with the annual growth increments (Table 1), these size differences suggest that the hyaline layer of otoliths is initiated 4–6 months before scale annuli are formed. I observed hyaline layers to develop around November; by extrapolation, scale-annulus formation should occur during March–May. This is the time when bottom waters begin to warm and photoperiod begins to lengthen, and is just prior to the spawning season (May–September: Grimes 1976). Attempts to verify this timing by measuring the distance from the scale margin to the most recent annulus were inconclusive.

The back-calculated size at any specific age tends to be larger in older fish (Table 1). This, the reverse of the Lee phenomenon, is a fairly common observation among fish (Tesch 1968). The most likely explanation in this case is size-specific differences in natural mortality, perhaps concentration by predators on the smaller members of an age-group.

A fit of the von Bertalanffy growth model to the weighted mean back-calculated lengths of Table 1 has the form $L_t = 626.5\ [1 - e^{-0.198(t-0.128)}]$, where L is total length in mm and t is years. The theoretical maximum length, 626.5 mm, is close to that of the largest specimen observed, 618 mm. The growth of males and females does not differ until age 8, when females are larger (563 vs. 535 mm; the difference is significant at $P = 0.05$). No males older than 8 years were found, but females reach at least 10 years of age.

These data agree with the limited published observations of vermilion snapper. From Florida waters, Beaumariage (1964) and Beaumariage and Whittich (1966) recovered two fish 232- and 216-mm standard length 450 and 348 days after tagging, respectively. Their length increases were 65 and 85 mm, or an average of 75 mm per year. According to my results, both fish were in their third year of life, when the average (back-calculated) increment is 70 mm.

The total length-weight relationship (L, mm; W, g; $r = 0.968$) of 1,804 vermilion snapper ranging from 52 mm to 618 mm is $W = 0.00001722\,L^{2.946}$. There was no significant difference between males and females.

Total length, standard length (SL), and fork length (FL) are highly correlated ($r = 0.999$); conversion equations are SL = −3.869 + 0.78 TL; TL = 2.348 + 1.105 FL; and SL = −2.037 + 0.863 FL.

Growth rate as indicated by the von Bertalanffy k, is higher for vermilion snapper (0.198) than for co-occurring species also important in the Carolina headboat fishery. The rate function (k) is 0.096 for red porgy, *Pagrus pagrus* (Manooch and Huntsman 1977); 0.108 for the white grunt, *Haemulon plumieri* (Manooch 1978a); 0.121 for gag grouper, *Mycteroperca microlepis* (Manooch and Haimovici 1978) and 0.179 for red grouper, *Epinephelus morio* (Moe 1969). These growth differences accompany trophic differences. Vermilion snapper are epibenthic or pelagic macro-planktivores (Grimes 1978) that feed at a lower trophic level than the benthic predators, red porgy (Manooch 1978b), white grunt (Manooch 1978a), and gag grouper. Higher growth rates (and thus greater productivity) and a shorter food chain may suggest more favorable fishery potential for vermilion snapper.

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REFERENCES

BEAUMARIAGE, D. S. 1964. Returns from the 1963 Schlitz tagging program. Fla. Board Conserv. Tech. Ser. 43. 34 pp.

———, AND A. C. WHITTICH. 1966. Returns from the 1964 Schlitz tagging program. Fla. Board Conserv. Tech. Ser. 47. 49 pp.

BOHLKE, J. E., AND C. C. CHAPLIN. 1968. Fishes of the Bahamas and adjacent tropical waters. Livingston Publ. Co., Wynnewood, Pa. 771 pp.

CERVIGON, F. 1966. Los peces marinos de Venezuela. Fundacion LaSalle de Ciencias Naturales Monagrafia No. 11. 951 pp.

HUNTSMAN, G. R. 1975. Offshore headboat fishing in North Carolina and South Carolina. U.S. Nat. Mar. Fish. Serv. Mar. Fish. Rev. 39:13–23.

GRIMES, C. B. 1976. Certain aspects of the life history of the vermilion snapper, *Rhomboplites aurorubens* (Cuvier) from North and South Carolina waters. Ph.D. Thesis. Univ. N.C. Chapel Hill. 239 pp.

———. 1978. Diet and feeding ecology of the vermilion snapper, *Rhomboplites aurorubens*, from North Carolina and South Carolina Waters. Bull. Mar. Sci. In press.

MACINTYRE, J. G., AND J. D. MILLIMAN. 1970. Physiographic features on the outer shelf and upper slope, Atlantic continental margin, southeastern United States. Geol. Soc. Am. Bull. 81:2577–2598.

MANOOCH, C. S. III. 1978a. Age, growth, and mortality of the white grunt *Haemulon plumieri* (Lacepede) (Pisces: Pomadasyidae), from North Carolina and South Carolina. Proc. 30th Annu. Conf. Southeast. Assoc. Game Fish Comm., Jackson, Miss. In press.

———. 1978b. Foods of the red porgy, *Pagrus pagrus* Linnaeus (Pisces: Sparidae), from North Carolina and South Carolina. Bull. Mar. Sci. In press.

———, AND G. R. HUNTSMAN. 1977. Age, growth, and mortality of the red porgy, *Pagrus pagrus*. Trans. Am. Fish. Soc. 106(1):26–33.

———, AND M. HAIMOVICI. 1978. Age, growth, and mortality of the gag grouper, *Mycteroperca microlepis*. Trans. Am. Fish. Soc. 107(2):234–240.

MOE, M. A. 1969. Biology of the red grouper, *Epinephelus morio* (Valenciennes), from the eastern Gulf of Mexico. Fla. Dep. Nat. Resour. Mar. Res. Lab. Prof. Pap. Ser. 10. 95 pp.

TESCH, F. W. 1968. Age and growth. Pages 98–130 *in* W. E. Ricker, ed. Methods of assessment of fish production in fresh waters. Blackwell Scientific Publ., Oxford.