

DETERMINATION OF AGE AND GROWTH RATE IN *EUTHYNNUS ALLETERATUS* AND *E. AFFINIS* USING VERTEBRAE (1)

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Vertebral centra were chosen for age and growth studies after a comparison with scales, otoliths and opercular bones showed that vertebrae have the most distinct and consistent markings. It is fortunate that in both *Euthynnus alleteratus* and *E. affinis* the longest vertebra of the body is situated in the peduncle, an easily identified and accessible bone bearing the anterior portion of the keel: this is the 33rd vertebra or 7th from the caudal end. For the studies reported here, fish tails were collected from factories and retail stores as well as from samples brought to the laboratory. They were boiled to remove flesh and fins. After drying, the 33rd vertebra was sawed longitudinally, slightly off centre, in the dorso-ventral plane to reveal two cones. In *E. alleteratus* these cones are equal in size or nearly so, while in *E. affinis* the posterior cone is longer and narrower.

In all fish which have passed one winter (age I) or more, the vertebral centra are marked with concentric ridges bordered by brownish translucent lines. The latter markings are clearly seen in transverse section on the cut face of the vertebra when it is polished, showing up against a white opaque background. Along this flat surface a ruler was laid to measure, under low magnification, in tenths of a mm, the four radii from the vertex of the cone to each of the rings (v_1 , v_2 , etc.) and to the margin of the vertebra (V).

The author measured bones of *E. alleteratus* taken in 1963 and found that the relationship of average vertebral radius (V) to fish length (LS) was slightly curvilinear. Measurements on the 1964 material, all done by M. Ze'ev ROTMAN, differed only for the larger fish, and resulted in a linear regression the particulars of which are given below. SNEDECOR, 1946 was followed (Statistical Methods, 4th ed.). LS, standard length (distance from snout to insertion of caudal fin) was measured to the nearest 10 mm and ranged from 300 to 860 mm. V. ranged from 5.0 to 17.5 mm.

$$LS = 45.85 V + 72.62$$

$$N = 267$$

$$s_{y,x} = 17.23 \text{ mm (standard deviation from regression)}$$

$$s_y = 1.06 \text{ to } 1.32 \text{ (standard error of population mean)}$$

Mean length can be predicted to within 5 mm at the 95 p. 100 confidence level. Back calculations from v_1 , v_2 , etc. were made directly from a chart linking V and LS. Ratios (v/V) were not used.

In *E. alleteratus* from the Mediterranean coast of Israel ring formation has been followed through two annual cycles. A strongly marked ring, henceforth to be called the annulus, is formed during the winter and spring, beginning as early as December and ending as late as May. Apparently, the fish grows very little over this period.

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However, the task of assigning a fish to its age class is complicated by the fact that a second and sometimes a third ring is formed during the summer, in July or August, and this ring is often as clearly accentuated as the annulus. From age II onward, the summer rings are generally formed close to the annuli, resulting in couplets or triplets, more compact in each succeeding year until the rings within an annual series coalesce. The first summer ring or set of rings most often appears only as a slight rise and depression less than half way from the first to the second annulus; sometimes there is a clearly marked ridge and brown ring resembling an annulus. The main criterion for identification of the second annulus is its occurrence in a couplet. With additional evidence from bone coloration, amount of marginal growth, and the relative intensity and spacing of the rings, very few fish could not be confidently assigned to one age class or another.

Year Class	No. samples		Annulus						
	63	64	1	2	3	4	5	6	7
1962	48	118	359	542					
1961	43	65	352	544	635				
1960	34	26	361	519	630	685			
1959	5	9	376	558	639	702	739		
1958	4	7	363	555	679	728	764	809	
Older	1	5	370	533	643	727	760	793	810
Overall mean			358.4	539.1	637.2	701.9	755.0	801.5	810
Range (cm LS)			28-49	46-68	54-75	61-79	65-84	74-86	75-84
Approx. mean wt. (kg (1)			0.8	2.8	4.5	6.0	7.5	8.5	9.0

(1) Taken from length-weight regressions for March to May.

TABLE 1. — Mean back-calculated length (mm. LS) of *E. alleteratus* from the Mediterranean Sea.

The frequency distribution curve for observed lengths shows modal groups roughly corresponding to year classes in the hook-and-line and purse-seine (summer) fisheries. Samples from the gill-net fishery taken December to May supply data on frequency distribution of observed lengths at the time of ring formation: in the 1963-4 season, nearly all fish with their first ring at the margin were below 430 mm standard length, whereas those fish with two or more rings nearly all exceed 480 mm. Table 1 shows an overlap in the range of back-calculated length of ages I and II, but there are actually very few individuals falling between 430 and 480 mm. Had the summer ring been regarded as an annulus, there would have been a modal group in this range.

More difficulty was encountered in the age determination of *E. affinis*. Most of our material was derived from relatively large fish caught in the southern Red Sea (coast of Ethiopia) in 1964 by hook and line. June samples from the southern Red Sea were a mixture of fish caught by hook and line and by purse-seine, making it difficult to interpret length-frequency data. From Eilat Bay there were available only fish taken by standing nets, — they were nearly all small (see tabl. 2 and 3).

While in *E. alleteratus* a couplet or triplet of rings is formed annually, in *E. affinis* there are sets of four to six rings, more closely spaced in each succeeding set until they coalesce. Quite often the rings of the first two sets are so widely spaced and dimly marked that it is difficult to assign the fish to an age group. Apparently, growth continues during the winter months. The annual set is complete or nearly complete by May.

There is an obvious contrast in growth rate and life expectancy between the two species of *Euthynnus* in the areas investigated. In both species the male grows slightly faster than the female from the second year onward. Without separating the sexes L_{∞} was estimated by the graphical method: 840 mm LS for *E. alleteratus* (using back calculations) and 580 mm LS for *E. affinis* (using observed values). We have seen several 12-kilo specimens of *E. alleteratus* and fish of 15 kilos have been reported by fishermen. Age IV to VII are common in the hook-and-line fishery. The oldest *E. alleteratus* represented in our bone collection belonged to age group X and its length is estimated at about 860 mm LS or one meter in total length. In contrast, the largest *E. affinis* in our samples was 620 mm LS, only a little over five kilos, and was assigned to age group VI.

Age	No. of fish	Length (LS) in mm		Approx. Mean Wt. (kg)
		Range	Mean	
I (')	28	310-430	345	0.9
II	11	370-520	456	2.1
III	18	470-560	511	2.8
IV	25	520-590	544	3.3
V	10	520-600	554	3.5

(1) From June samples only.

TABLE 2. — Observed age, length and weight of *Euthynnus affinis* taken April-June 1964 in the southern Red Sea.

Age	No. of fish	Length (SL) in mm		Approx. Mean Wt. (kg)
		Range	Mean	
I	78	320-340	370	1.0
II	2	505 and 525		3.0

TABLE 3. — Observed age, length and weight of *Euthynnus affinis* caught in the Bay of Eilat, Red Sea, May 1964.

In *E. alleteratus*, younger fish especially age I, grow rapidly from May to August acquiring nearly all their annual increment in that period, while age III hardly show an appreciable gain until the fall. Analysis of the length-weight relationship reveals that « condition » depends on size, — in general, the larger fish are fatter but lose weight in the early summer while the smaller fish are gaining.

The difference may be related to fertility and feeding habits. Older fish have a longer spawning season-ripe gonads can be found from may to September in fish of age III and over, while the gonads of ages I and II do not become ripe until July and may be spent in August. Also, since the larger fish are caught in Israeli waters mostly in the spring and summer, we might speculate that they go further afield than the small fish in search of better feeding grounds in fall and winter.

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