1975

Occurrence Of Elvers Of Synaphobranchus-Affinis On Continental Slope Off North-Carolina

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THE OCCURRENCE OF ELVERS OF *SYNAPHOBRANCHUS AFFINIS* ON THE CONTINENTAL SLOPE OFF NORTH CAROLINA[1]

Members of the family Synaphobranchidae are demersal eels which are widely distributed in the Atlantic and Indo-Pacific oceans (Castle 1964). Data from a June 1973 cruise in the Norfolk Canyon area indicate that they are an important part of the fish community in both numbers and biomass in depths around 1,000 m (Virginia Institute of Marine Science unpubl. data). Bruun (1937) reported on the life histories and larval development of several synaphobranchids, and Castle (1964) listed synonomies in addition to keys to genera and species. Robins (1971) gave osteological, meristic, and morphometric data and also discussed the life history and ecology (Robins 1968).

Although Robins (1971) intensively examined 46 *Synaphobranchus affinis* Günter 1877 greater than 193 mm in total length, the occurrence of elvers or unpigmented juveniles of this species is unreported. The purpose of this report is to provide a record of capture, meristic and morphometric data, and some observations in food habits of *S. affinis* elvers.

Materials and Methods

A total of 89 elvers of *S. affinis* (Figure 1) were collected during a ½-h otter trawl haul from 1745 to 1815 h EST aboard the RV *Eastward* on 29 April 1973 at Eastward station 22039, lat. 34°03.2′N, long. 75°52.0′W at depths from 550 to 600 m. The gear used was a 30-foot shrimp trawl with a ¼-inch stretch-mesh cod end liner.

Total length of all specimens was measured to the nearest millimeter. A subsample of 40 elvers was taken for meristic analysis using a table of random numbers (Rohlf and Sokal 1969). Elvers were cleared in 2% potassium hydroxide, stained with alizarin red-S in 2% KOH, passed through a graded series of glycerine, and stored in 100% glycerine to which thymol was added. Three replicate counts were made of the following meristic characters: total vertebrae; dorsal, anal, caudal, and left and right pectoral fin rays; left and right branchiostegals. The presence and position of vertebral deformities (fused or partially fused vertebral centra; extra, fused, or distorted neural or hemal spines) were noted and representative types were drawn with the aid of a camera lucida.

To determine if osteological deformities might result in differential mortality of *S. affinis* during later life, 40 additional specimens ($\bar{x}$ total length = 220 mm, extremes 173-305 mm) collected on 13 June 1973 aboard the RV *Columbus Iselin* in 630 m of water with a 45-foot otter trawl at lat. 37°03.2′N, long. 74°34.1′W were examined. These fishes were X-rayed, vertebrae counted, and the presence or absence of deformities noted. Frequency of occurrence of deformities in elvers and larger fish were compared by χ^2 analysis (Sokal and Rohlf 1969).

Morphometric measurements were taken following the method of Robins (1971) with either dividers and dial calipers or a binocular microscope fitted with a calibrated ocular micrometer.

Results and Discussion

Eels of the genus *Synaphobranchus* are characterized by confluent branchial apertures with a slitlike opening on the midline of the throat (Robins 1971). Synaphobranchid eels commonly encountered in trawls on the continental slope near Cape Hatteras, N.C. are *Synaphobranchus kaupi*, *S. affinis*, and *Ilyophis brunneus* (Markle 1972; Virginia Institute of Marine Science unpubl. trawl records). Members of this group show varying degrees of plasticity and overlap in morphometric characters but also show mean differences (Robins 1971). The specific identification of these elvers as *S. affinis*, therefore, was based on vertebral counts.

Mean, 95% confidence interval, and the frequency distribution of vertebral counts are shown in Figure 2. Vertebral counts of the 40 specimens had extremes of 130 and 136 with a mode of 134. This is within the range of values for 44 *S. affinis* given by Robins (1971) ($\bar{x}$ = 133.1, extremes 128-139) and outside the range of the other species of synaphobranchids common to this region (*S. kaupi*: $\bar{x}$ = 148.0, extremes 146-150; *Ilyophis brunneus*: $\bar{x}$ = 147.5, extremes 144-151). Means, 95% confidence intervals, and frequency distributions of other meristic characters are found in Figure 2. Paired t tests (Sokal and Rohlf 1969) showed no significant differences between the number of left and right pectoral fin rays (t = 1.00, df = 39) or the number of left and right branchiostegals (t = 0.42, df = 39). Dorsal and

[1]Virginia Institute of Marine Science contribution no. 652.

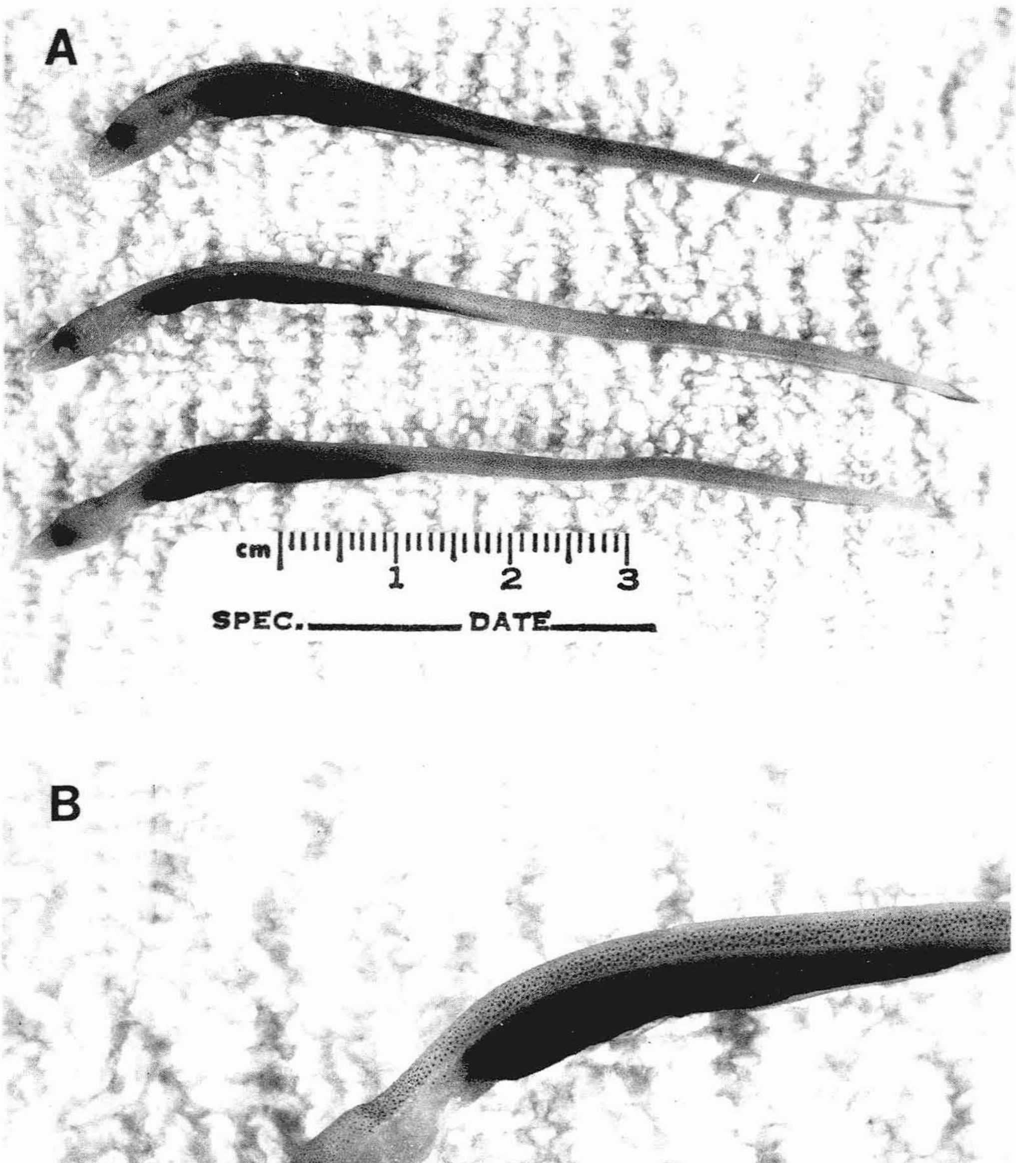

FIGURE 1.–(A) Photograph of a series of *Synaphobranchus affinis* elvers. (B) close-up view of anterior region of one elver of *S. affinis* showing dark, bluish-black peritoneum and slight pigmentation above lateral line.

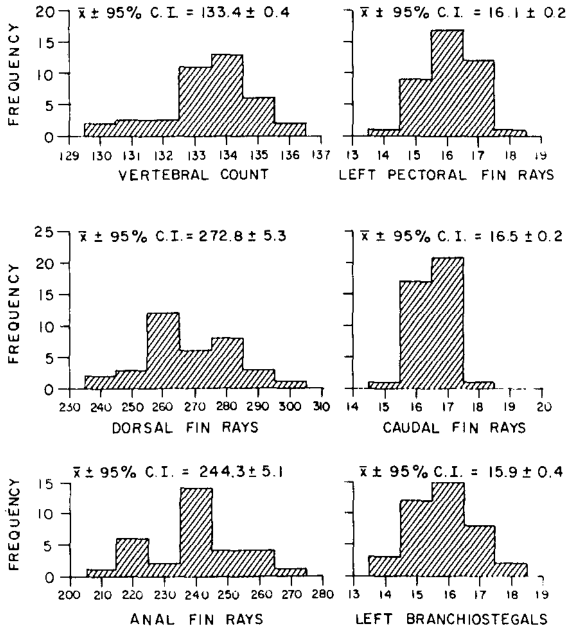

FIGURE 2.–Means, 95% confidence intervals (C.I.), and frequency distributions of various meristic characters of *Synaphobranchus affinis* elvers.

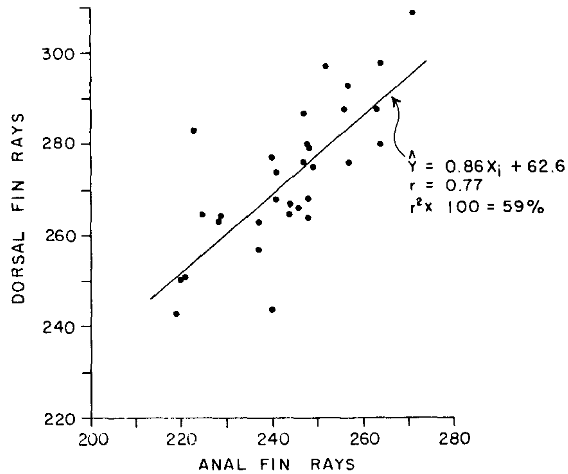

FIGURE 3.–Regression relationship between dorsal and anal fin rays of *Synaphobranchus affinis* elvers, where y = dorsal fin rays, x = anal fin rays, r = correlation coefficient, and $r^2 \times 100\%$ = coefficient of determination.

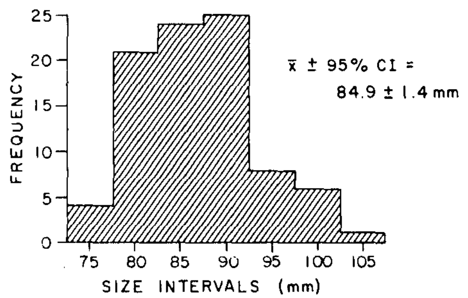

FIGURE 4.–Frequency distribution, mean, and 95% confidence interval (C.I.) of total length of *Synaphobranchus affinis* elvers.

anal fin rays showed a great degree of variability which is also characteristic of the American eel, *Anguilla rostrata* (Wenner 1972), and the snake eel, *Pisodonophis cruentifer* (Wenner unpubl. observations). Dorsal fin rays had extremes of 243 and 309 whereas anal fin rays had extremes of 219 and 271. Plots of dorsal against anal fin rays suggested a correlation and therefore the linear regression equation, correlation coefficient, and coefficient of determination were calculated (Figure 3). Fifty-nine percent of the variation in the number of dorsal fin rays was associated with the number of anal fin rays.

Mean length of the *S. affinis* elvers was 89 mm with extremes of 72 and 105 mm. Length-frequency distribution is found in Figure 4. Means, 95% confidence intervals, and extremes for morphometrical measurements are given in Table 1. All values fell within the ranges of those of *S. affinis* presented by Robins (1971).

Osteological deformities associated with the vertebral column were found in 72.5% of the 40 elvers and in 60% of the larger *S. affinis* examined. In both instances, most deformities were in the caudal part of the vertebral column, generally in the last 30 vertebrae. Illustrations of some representative deformities are shown in Figure 5

TABLE 1.–Summary of morphometric characters of elvers of *Synaphobranchus affinis*. C. I. refers to confidence interval.

Morphometric character	Mean ± 95% C.I.	Extremes	*n*
% total length			
Preanal length	27.7 ± 0.5	25.6-32.0	39
Predorsal length	30.0 ± 0.7	25.6-34.7	39
Head length	13.0 ± 0.2	11.3-14.2	40
% head length			
Gape length	66.9 ± 1.1	58.3-74.5	40
Horizontal eye diameter	16.8 ± 0.4	14.8-21.0	40

and a summary of the major types is in Table 2. X^2 analysis showed that there was no significant difference between elvers and larger immature fish (X^2 = 1.72, df = 39), suggesting that these deformities do not result in differential mortality in fishes possessing them.

It is conjectural whether these specimens

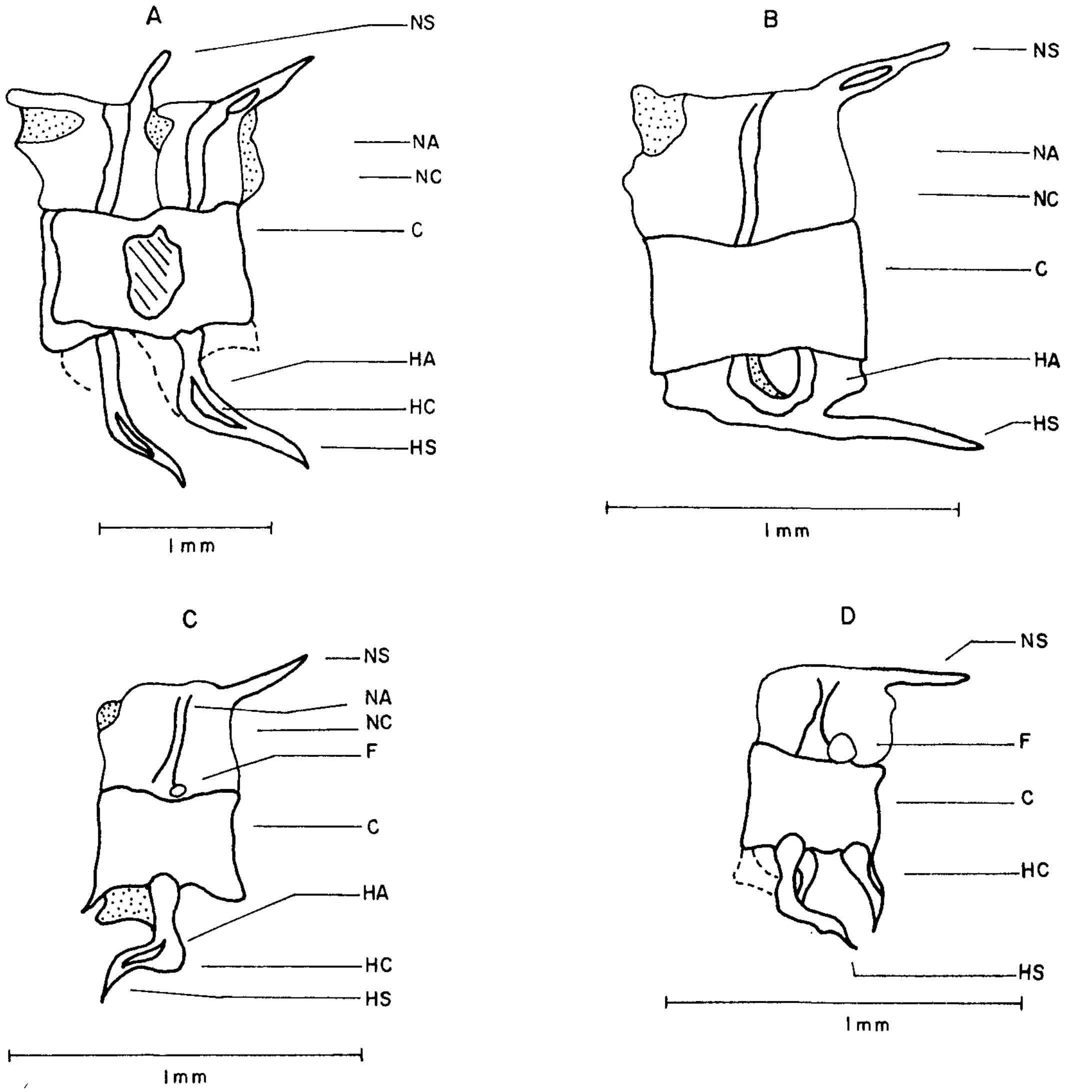

FIGURE 5.—Lateral views of various osteological deformities associated with the caudal vertebrae of *Synaphobranchus affinis*. Dashed lines in figures represent areas of incomplete ossification. NS = neural spine; NA = neural arch; NC = neural canal; C = centrum; F = foramen; HA = hemal arch; HC = hemal canal; HS = hemal spine; TL = total length in millimeters. (A) Fused centra with a bony knob projecting laterally; TL = 92. (B) Two sets of hemal spines which are fused together forming an arch; TL = 102. (C) Hemal spines projecting anteriorad rather than posteriorad; TL = 91. (D) Extra unfused set of hemal spines with one set projecting anteriorad and one set posteriorad; TL = 79.

represent the size at which the elvers descend to the bottom from the pelagic realm, where they pass their larval existence, because closing and mid-water nets were not used.

Of the 40 cleared and stained specimens, 12 had material in the gut cavity. Three contained crustacean appendages whereas nine had discernable fish remains such as disarticulated vertebrae. One elver contained an intact gonostomatid which had been swallowed head first. Gonostomatids are mesopelagic but the elver could have ingested it while in the trawl.

Acknowledgments

This research was supported in part by NSF Grant GA-37561, J. A. Musick principal investigator. The specimens were collected on cruise 73-1 of the RV *Eastward* supported by NSF Grant GA-27725.

TABLE 2.–Summary of the types of vertebral anomalies in *Synaphobranchus affinis* elvers expressed as percent of specimens with anomalies. The sum of the percentages is greater than 100% because some individuals had more than one type.

Item	Elvers	Larger immature fish
Sample size	29	24
Abnormal hemal spines	81.6	83.3
Abnormal neural spines	3.4	0.0
Fused or partially fused vertebrae	13.6	16.7
Multiple anomalies	57.8	16.7

I thank J. A. Musick of the Virginia Institute of Marine Science and D. M. Cohen of the Systematics Laboratory, National Marine Fisheries Service (NMFS), NOAA, National Museum of Natural History, Wash., D.C. for critical evaluation of the manuscript. B. B. Collette of the Systematics Laboratory, NMFS, NOAA, kindly provided X-ray facilities. R. Bradley illustrated the text and Ken Thornberry photographed the specimens. Thanks are also in order to my fellow students, Labbish Chao and D. Markle, for encouraging me to complete this project.

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CATCHES OF ALBACORE AT DIFFERENT TIMES OF THE DAY

The purpose of this study is to examine the hypothesis that diel variations occur in the catches of albacore by boats trolling surface jigs off Oregon. Although albacore fishermen talk of "morning bites" and "evening bites," no published data exist, to our knowledge, confirming these trends.

Studies on the feeding habits of tunas, however, provide evidence for intense feeding activity during certain periods of the day. Based on the quantity of food in stomachs, Iverson (1962) concluded that major feeding periods of albacore occurred in early morning and late afternoon-evening. Similarly, Nakamura (1965) and Dragovich (1970) found evidence for morning and late afternoon peaks in the stomach fullness of skipjack and yellowfin tunas. Food consumption of captive skipjack was greatest between 0630 and 0830 h, and skipjack tuna in only one of three tanks fed intensively in late afternoon (Magnuson 1969). This was in agreement with Uda (1940) who reported that catches of skipjack tuna with pole and live bait peaked in early morning hours and were usually followed by successively lower peaks later in the day.

Fishermen were solicited to record data on 1969 and 1970 albacore catches in special logbooks. Several entries per day were requested. The records of five boats fishing off Oregon during July, August, and September 1969 were used for this study. These five skippers kept detailed records averaging eight entries per day. In 1970 the records of 12 boats were used that recorded catches at least every 4 h during the fishing day for 20 July-2 August 1970. All boats were 45-60 feet in length.

Average catches per boat were calculated for each hour fished, usually 0500-2200 h or 2300 PDT, for 3 mo in 1969 and 2 wk in 1970. When the interval between logged catches was greater than 1 h, the catch for the interval was divided by the number of hours fished, and this average number was distributed uniformly within the interval. Because the selected boats did not necessarily fish in the same locality or during the same days of the months, the data provide only an estimate of the general trends in hourly catches of albacore off Oregon.

The catches of albacore versus hours of the day are shown in Figure 1. Chi-square tests of the