

X-RAY VISION - A NEW METHOD OF EXAMINING AN OLD PROBLEM

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Attention was drawn to the fact that the theme of this Symposium has been covered many times elsewhere. It is a recurring theme and addresses an old but important problem. Particularly appropriate, in this context, are the proceedings of the 30th Annual Tuna Conference held in 1979 at Lake Arrowhead, California. The content and relevance of these unpublished proceedings were reviewed briefly. The relationship between stock structure and what is referred to as the breeding structure of a resource was discussed, as were various methods for studying this important problem in fisheries management. The importance of harmonizing fisheries management tactics with the breeding structure, or evolutionary strategy of a species, was stressed, as was the need for an investigative approach which can provide the data required to frame the required tactics. Some possible breeding structures were illustrated, and the limitations of various approaches used in the past to study this problem were discussed. Methods that can be used to assess the rate of immigration and emigration of individuals into and out of specific fisheries, while unable to assess the degree of genetic isolation between individuals from different geographic areas, can in fact provide useful management data.

The proposition that niche and habitat variation within the range of a species is expected to result in detectable variation

in the chemical composition of tuna-like species, and that these differences in turn can be used as a form of natural tag was put forth. A method of encoding these natural tags or "chemical fingerprints" was described, as were the results of some recent studies carried out on juvenile and adult Bluefin tuna (*Thunnus thynnus*) collected in different geographic areas.

A proton beam of 3 million electron volts from a particle accelerator was focused upon a small (.8 mm) cross-section of the centrum of vertebrae from the caudal region. X-rays in turn are emitted by the sample during irradiation, and are characteristic of the chemical composition of the bone and its matrix. The method whereby data are obtained and the results visualized was described briefly.

Studies carried out on vertebrae from 2- and 3-year-old bluefin tuna collected in the western Atlantic (off Virginia) and in the eastern Atlantic (Bay of Biscay) revealed the presence of characteristic differences in X-ray spectra-- differences which are both seasonal and geographic in nature. A number of non-overlapping analyses were carried out on the same vertebrae at 9-mm intervals beginning at the focus of the centrum and extending to the outer edge. Fish of different sizes and from different geographic areas were compared. Pattern recognition (multivariate analyses) as well as

"spectrum stripping" techniques were used. The results suggest that cyclic variation in the ratio of specific concentrations of chemical elements can be used to determine the fish's age and age-specific growth rates.

While seasonal variations exist, geographic differences were found to be greater in magnitude, especially in that portion of the vertebrae formed during the first winter of life. Two different sets of 2- and 3-year-old bluefin from the eastern and western Atlantic were compared, and consistent geographic differences were found using (1) visual methods, that is, comparing spectra by making overlays, (2) by calculating ratios of elements such as chlorine/strontium and by carrying out simple statistical tests (t-tests), and by (3) multivariate techniques, i.e., factor analysis, discriminant function analysis, and cluster analysis. Geographic differences were found not only in the area formed during the first winter, but in other areas along the vertebrae.

The results from a pilot study of 42 giant bluefin vertebrae collected in the eastern and western Atlantic were presented. As with the juveniles, line transects were carried out beginning at the center of the vertebrae and extending to its outer edge. The interval between analyses was 2.2 mm. Using criteria defined during the study of juveniles, samples were classified as having originated either in the eastern or western Atlantic. Twenty-one fish from each side of the Atlantic were used in this pilot study. Of these 42 samples, 26-28% of the western Atlantic sample was classified as having originated in the eastern Atlantic. The 95 percent confidence limits for this

estimate is 11-54%. Of the giants taken in the eastern Atlantic and Mediterranean, 14% were classified as having originated in the western Atlantic: the 95% confidence limits are 3-37%.

The estimates are based upon small sample sizes and the requirement for larger sample sizes was discussed, as was evidence for additional complexity in the breeding structure of bluefin tuna.