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INCONSISTENCIES IN LOCATING THE FIRST ANNULUS OF PACIFIC SARDINES[1]

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A special scale reading session designed to bring together old and new scale readers to compare the criteria for estimating the first annulus in sardine scales (L_1), examined scales collected from the 1941 through 1962 sardine landings. Estimates of L_1 by the original readers were consistently lower than those of the newer readers. The reported increase in Pacific sardine length at the formation of first annulus appears to be due to a change in the older reader's criteria for the position of the first annulus. In addition, there was a gradual replacement of the older readers by newer ones who consistently read higher and thus overestimated L_1. Hence, it appears that there was no real change in sardine growth rates during these years.

INTRODUCTION

Walford and Mosher (1943a, 1943b) validated the use of scales for estimating the age of the Pacific sardine and set criteria for the scale annulus. In 1960, I suspected the sardine scale readers were not strictly following the criteria in locating the first or innermost annulus. The radius of this annulus is used to estimate the L_1 (defined as (i)) the calculated length of the fish at the end of the first year of life (Marr 1960), or (ii) the calculated length of the fish at the time of formation of the ring in the first year of life (Phillips 1948a). From information obtained on the time of annulus formation on known-age sardine (Kimura and Sakagawa 1972) the second definition is recommended.

The L_1 is one of the basic measurements for estimating growth (Phillips 1948b). It has also been used as a parameter to separate subpopulations (Felin 1954), and to support certain hypothesis about the population (Marr 1960). The importance of the parameter warranted that a study be made to determine if scale readers were changing L_1 estimates by mislocation of the first annulus.

Preliminary analysis of the scale-age data and rereads of a random number of scales for the 1941–42 through 1961–62 seasons indicated that the only conclusive way to settle the matter was by direct comparison of scale reading between the original scale readers and the readers then in tenure. This report describes the results of the comparative scale reading.

MATERIALS AND METHODS

On March 25–29, 1963, the three original scale readers and the circa 1963 scale readers met at Hopkins Marine Station, Monterey, California, to determine whether the latter readers were following the original

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readers' criteria in reading Pacific sardine scales. Since the three original readers had been away from such work for so long, certain steps were taken to ensure their ability to read scales in the same way as they did during their tenure. For practice they were sent, 4 months before the formal meeting, 100 scale slides which each had read and recorded during his tenure. They also practiced as a group prior to the formal meeting, and a test was carried out for consistency in aging with 60 slides selected from the 1941–42 through 1943–44 season. They agreed about 88% of the time, which compared favorably to the 80–90% agreement when they were in tenure. The 1963 readers did not practice but were told to read in the same manner as they were doing.

At the formal meeting each reader read independently the same pre-selected scales from 105 scale samples of fish taken in the San Pedro, California, fishery. The pre-selected scales were those selected originally by the historical scale readers (as recorded on scale cards) and were distinguished from the others for the present test by encircling with a glass-marking pen. The remaining scales on the slide were left in view to aid each reader in his evaluation of the annulus.

Other test scale readings included individual readings on the same slides but each individual selecting a scale of his choosing, two-separate group readings on the same slides, and a final reading whereby all seven readers together read a series of slides. All showed the same trend as is described for the test in the present report.

After viewing the scale on a scale projector, the reader recorded the radii of all annuli, and also the margin of the scale on a scale card. The reader went through the same procedure for each of the 105 slides; five slides for each of the 21 seasons from 1941–42 through 1961–62, the same method used and described by Felin and Phillips (1948). The back-calculated lengths of the fish at various annuli were obtained with a nomograph by the method of Phillips (1948a).

The average L_1 values were calculated for the original and the 1963 readers, respectively, and the results compared. The average L_1's from the historical data used to prepare the age and length reports for the Pacific sardine reported by Wolf (1961) were also calculated for comparison.

RESULTS

A graphic comparison of L_1 estimations by seasons for both groups of readers and the historical readers shows that the L_1 estimates of the original readers were consistently lower than those of the 1963 readers (Figure 1). The historical average L_1 had a positive trend with time but the other two did not.

DISCUSSION

A comparison of the scale readings shows that the 1963 scale readers were not following the criteria of the original readers. Therefore, the average L_1 values which were used as a basic measurement for estimating growth, to separate subpopulations, and to support certain hypothesis about the population needed to be reexamined. For example, Marr (1960) found a positive trend with time in the L_1 values for the year-classes 1934 through 1955 for the fishery at San Pedro. He assumed that the increase in length of L_1 was caused by biological or

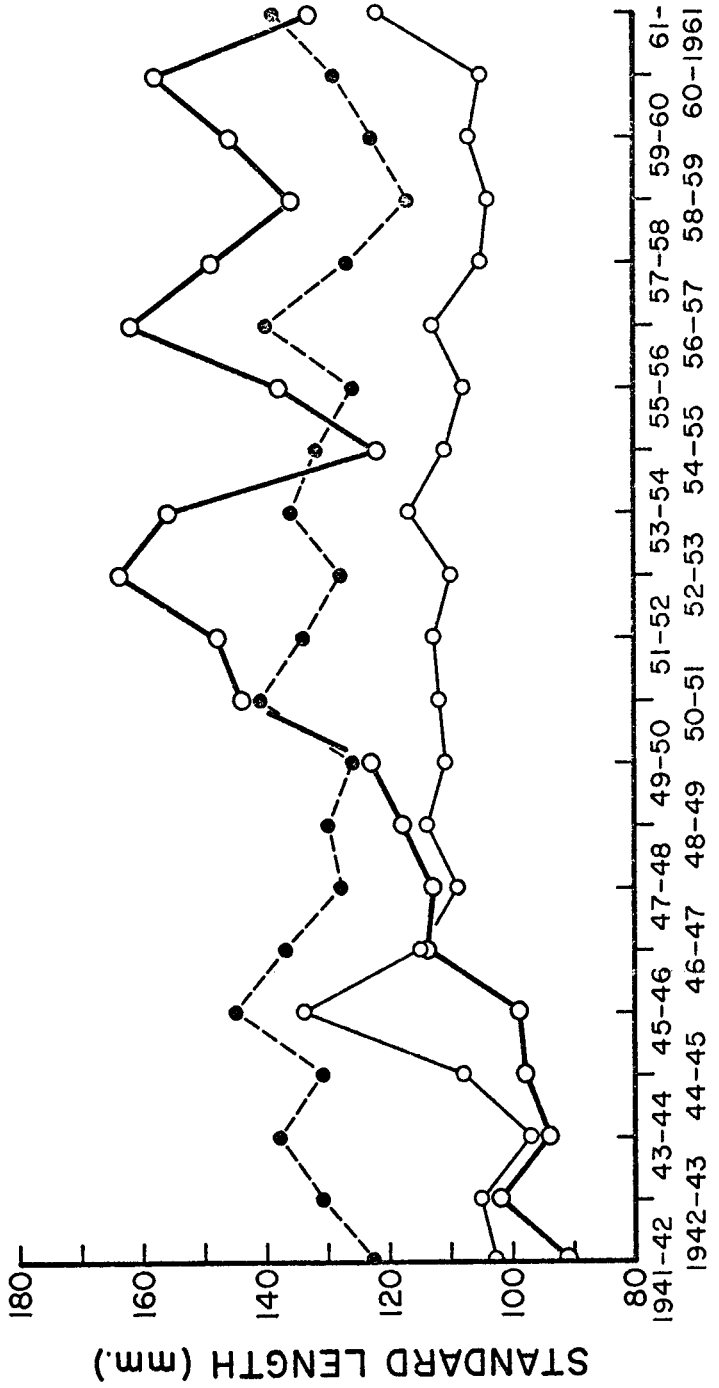

FIGURE 1. Comparison of calculated sardine lengths in mm at first scale annulus (L_1)-in time. The heavy line connects averages of L_1's from scales of five fish in each season as they were historically read. The light line connects the averages of L_1's of the three original scale readers and the dashed line connects the L_1's of the four 1963 readers.

environmental factors which affected the Pacific sardine; but, this study indicates the change in L_1 was the result of scale reader bias.

The consensus of opinions among scale workers is that consistency among a group of readers, or the presence of experienced readers guarantee results comparable to past results. However, there were two experienced readers present at the time the historical L_1 estimation began its abrupt increase in the mid-1940's. The present study indicates that while the 1963 readers were consistent among themselves, their criteria were inconsistent with those of the original readers. Kimura and Sakagawa (1972) concluded on the basis of a comparison of L_1 of known age sardine with the average L_1 of fish aged by the early and recent scale readers that the early readers' L_1 estimations were closer to that obtained from the known age fish.

The results obtained here indicate a need for some kind of standard or length-by-age values to serve as a reference to the readers in obtaining back-calculated length measurements. A suggested standard is a series of random, stratified-by-age scales, i.e., O-, I-, II-, III-, . . . n-year-old fish scales, preferably selected from the time period when the validators of the scale (otolith and any other bony structures used in aging) method were in tenure, or were used by the validators as the basis of their study. For the sake of simplifying comparative readings and as assurance that the same scale will be read at all times, the initial readers of the standard series of slides should circle the selected scale with a marking pen. Similarly, the slides read routinely during a season should also be circled by the initial reader so that both a reader and the checker can be certain to have examined the same scales.

The presence of such a set of standard slides probably would (i) assure continuity in the manner of the scale interpretation by the original validators of the scale or any other method used in estimating fish age, (ii) counteract and monitor the effect of dominance of any individual scale reader, and (iii) deter the occurrence of similarly costly mistakes as illustrated in this study.

CONCLUSIONS

The circa 1963 scale readers have not been reading like the original readers and, apparently, have not been following the same criteria in estimating the L_1. The L_1 value change in time resulted from scale-reader subjectivity and was not caused by biological or environmental factors.

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