SEASONAL GROWTH OF THE TUI CHUB, *GILA BICOLOR*, IN PYRAMID LAKE, NEVADA

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Abstract.— Tui chubs collected from November 1975 through November 1977 from Pyramid Lake, Nevada, were analyzed for seasonal growth patterns. Major growth in length occurred during the fall and early winter, and major reproductive development occurred during the late spring and early summer.

The tui chub, *Gila bicolor*, is the most abundant fish in Pyramid Lake, Nevada, and is the major food source of the threatened Lahontan cutthroat trout, *Salmo clarki henshawi*. The tui chub is found in the drainage of western Nevada and eastern California from the San Joaquin system to southern Oregon and the Columbia River (LaRivers 1962).

The tui chub is an opportunistic feeder that utilizes algae, benthic invertebrates, zooplankton, and fish (Snyder 1917, Kimsey 1954, LaRivers 1962, Langden 1978). The tui chub spawns in late June or early July; during this time they are found in large numbers along the shore (Snyder 1917, Kucera 1978). Aerial surveys have shown that large schools of tui chub are also found in the open water during the spawning season.

Preliminary growth studies of the tui chub suggested that growth in length may not occur during the time of year when food and temperature are optimum. Although this is unusual, the timing of the reproductive cycle and the peak occurrence of some food items suggested the possibility of an atypical growth pattern.

Methods and Materials

From November 1975 through November 1977, 2,400 tui chubs were collected. All fish were measured to the nearest millimeter in fork length and weighed to the nearest gram in body weight.

Age was determined from scales obtained from the left side of the fish above the lateral line. Validity of the scale-based ages and calculations was established using criteria suggested by VanOosten (1979) and Hile (1941). The seasonal growth pattern was portrayed by plotting the length achieved at various intervals throughout the year against the date of scale collection. The length achieved from time of annulus formation was estimated by subtracting length at time of formation of the last annulus from the length at time of capture (Gerking 1966). The length at last annulus formation was determined by extrapolation of the body length–scale radius relationship.

The body-scale relationships and length-weight relationships were calculated according to Tesch (1971). Condition factors (K) were calculated according to Carlander (1969).

Results and Discussion

Seasonal Growth in Length

The Pyramid Lake tui chub population was composed of two morphological forms: coarse rakered with gill raker counts of 9 to 15 and a fine-rakered form with raker counts of 20 to 40. The coarse-rakered form was found inshore or on the bottom. The fine-rakered form was found in the upper 20 m, both offshore and inshore, but was not commonly found offshore on the bottom (Vigg 1978). Their food habits differed, but their growth rates and patterns were similar (Kucera et al. 1978).

The young fish showed almost continuous growth throughout their first two years of life. The fish collected inshore and offshore on the bottom had a slight decrease in

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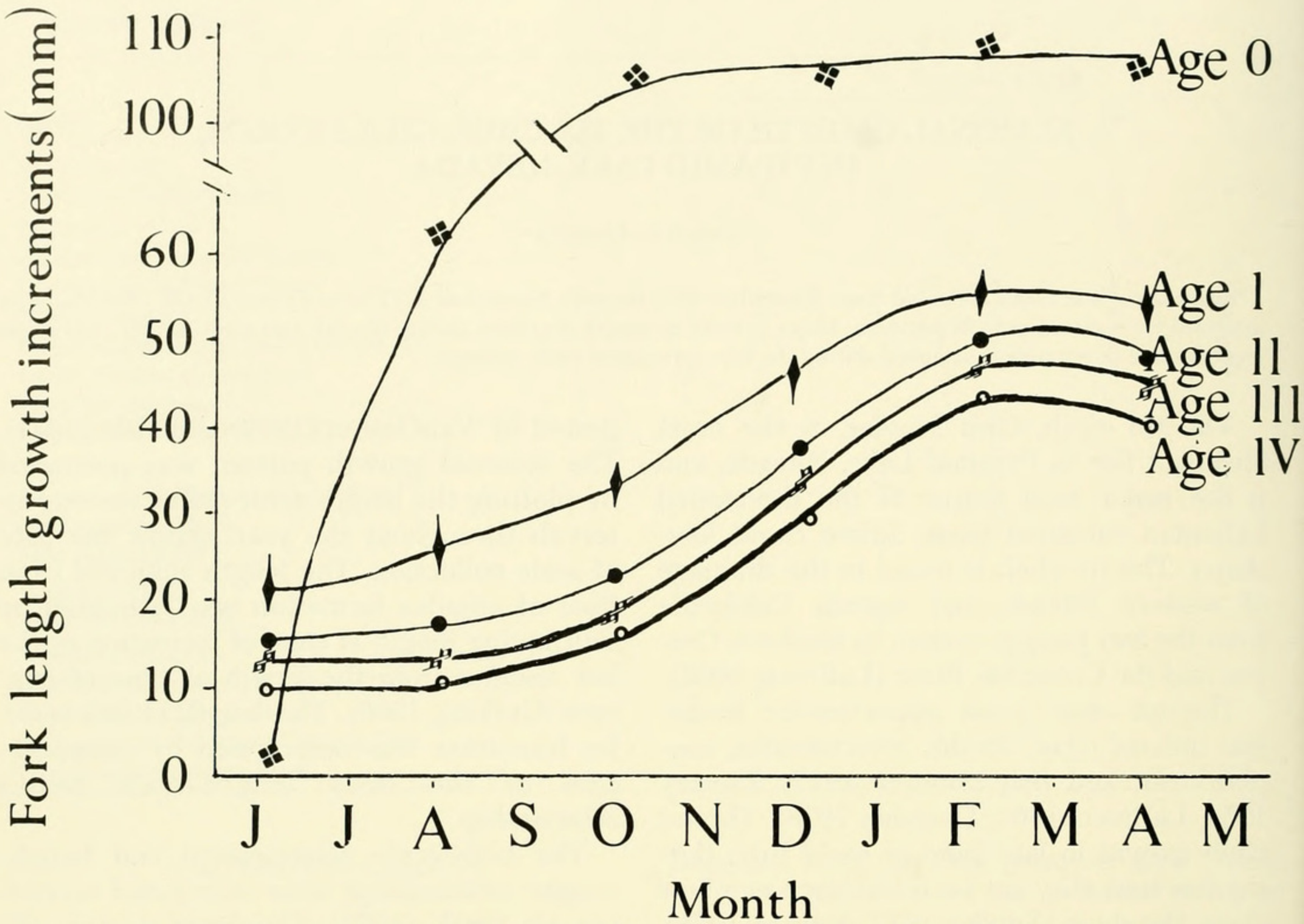

Fig. Seasonal growth curves for tui chub age-groups O through IV, collected in Pyramid Lake, Nevada.

growth in late April and May, but the pelagic chubs collected at the station did not have an interruption in growth until their second year (171 mm FL).

Age-groups II through IV showed the same general pattern of growth, with peaks in the fall and winter and a seasonal low during the late spring and early summer. These age groups never experienced a period of rapid growth in length but had a long, continuous growing season that lasted from late summer through the winter. The peak growth for age-groups II through IV was in late fall–early winter (Figure 1). The young-of-the-year fish achieved most of their growth in length during the first summer of life. This 0 age-group attained a length of 48.5 mm in July and 98.5 mm by September. Total group growth for the first year was 121.9 mm. Annulus formation by II through V began in May, but some did not form an annulus and resume growth until as late as August. The beginning of growth occurred after the major portion of the energy required for reproductive tissue development had been expended, and relatively late in the summer from the standpoint of optimal environmental conditions. The growth curves for all age-groups, other than 0 and 1, showed growth during the time of year when the water temperature was cooling or at a stable, cold temperature (6 C) and little growth in lengths during the spring and summer when warmer temperatures occurred.

Annulus formation also reflected the different growth patterns for young and adult fish. The coarse-rakered young-of-the-year fish formed their annulus/check mark in late April and May. This interruption in scale growth was very narrow and formed in a very short period of time. It also did not have the characteristic crowding of circuli that normally accompanied annulus formation. The fine-rakered chubs did not have an interruption in scale growth during the first year. The adult fish (older than II) formed their annulus from late June through August. The annulus was more diffuse, had the characteristic crowding of circuli, and occurred over a longer time period. This was the case for both the fine-rakered form and the coarse-rakered form. The later annulus formation and the lack of growth in length during the summer months is explained by the timing of the reproductive cycle and probably intense competition from young-of-the-year fish.

The tui chub began to accumulate reproductive tissue during March and April with a major increase in May and June (Kucera 1978). This was followed by spawning in July. The peak in reproductive tissue, indicated by the gonadal somatic index, coincided with the formation of the annulus. Interestingly, the annulus formed by adult fish was actually a combination of an annulus and reproductive check marks. The annulus/check mark formed by the young-of-the-year coarse-rakered group occurred when the lake was rapidly warming. The rapidly changing water temperature and the accompanying change in seasonal distribution pattern probably combined to stress the young fish and induce annulus formation.

Following spawning, the adults began to grow, but the expected rapid growth period did not occur. The onset of adult growth in length coincided with the seasonal low of macroinvertebrates and periphyton (Robertson 1978). Also, the spring peaks of zooplankton had started to decline, possibly from the feeding pressure exerted by the young-of-the-year chubs (Kennedy et al. 1977). But total zooplankton, dominated by *Diaptomus sicilis*, still numbered 18 to 41 organisms per liter during this time (Lider and Langden 1978). This density of zooplankton was equal to or greater than that which Noble (1975) found during peak growth periods for yellow perch.

The growth rates continued to increase throughout the fall and winter, and peaked when periphyton and macroinvertebrates peaked. Growth during the winter months has also been reported for bluegills (Gerking 1966, Krumholz 1948), but I have not found reports of fish species having major growth periods during the winter months. Pyramid Lake may also be unique with the peak abundance of macroinvertebrates and periphyton occurring during the winter. In addition, the total zooplankton numbers are still relatively high during the winter months (Lider and Langden 1978).

The young-of-the-year and the one-year-old fish grew during the warmer summer months, when the adults did not grow in length, and continued to grow during the fall and winter, pausing only briefly during early spring. The much longer growth period of the younger fish was also reflected in the larger increments of growth by the younger fish (I, 123 mm; II, 48 mm; III, 43 mm; IV, 37 mm; V, 35 mm; and VI, 47 mm).

Seasonal Growth in Weight

As with growth in length, the adults and young fish had different patterns of seasonal growth. The young fish (O, I) increased in weight throughout the year in much the same pattern as growth in length. For adults (some II and all older fish) growth in weight included both somatic and reproductive tissue and must be examined with this in mind. The adult fish increased in weight from August after spawning through the following June. There was a significant decrease in weight following spawning, as would be expected. Close examination of the data showed that the mean weight following spawning was higher than the mean weight preceding the rapid increase in reproductive tissue (March), and this probably represents a slight amount of somatic growth that occurred during the spawning season.

Summary

The tui chub shows remarkably synchrony with its environment. The species has evolved to utilize the food available during the fall and winter for much of its somatic growth and to utilize the abundant zooplankton populations in spring and summer for reproductive tissue and growth by young fish. The differential utilization of food allows this species to maximize the energy going into the population and minimize the competition between size or age groups. This adaptation to the particular environment stresses the importance of not introducing exotic species that might compete with the chub or disrupt the timing of their seasonal growth or reproductive cycles.

Acknowledgments

The Pyramid Lake Painted Tribe initiated the ecological study of Pyramid Lake from