The age, growth and food habits of the marine cottid Leptocottus armatus
by Edward Frederick Weiss

A thesis submitted to the Graduate Faculty in partial fulfillment of the requirements for the degree of MASTER OF SCIENCE in Fish and Wildlife Management
Montana State University


Abstract:
A study was made on the age, growth and food habits of the Pacific staghorn sculpin (Leptocottus armatus) in the vicinity of Friday Harbor, Washington. The study was conducted during the summer of 1961. Otoliths were removed from 295 sculpins for the age and growth study. The otoliths are generally elliptical in appearance with a moderately crenated outline. The otolith radius to total length relationship for 272 sculpins was expressed by the equation Y = -16.9 + .642X and a correlation coefficient of 0.974 After elimination of the 20 largest fish the relationship was expressed by the equation Y = -10.0 + .601X and a correlation coefficient of 0.980. The average calculated lengths for 262 sculpins at the end of each succeeding year of life for ten years were 34, 55, 80, 101, 122, l48, 174, 200, 222, 228 mm., respectively. Calculated growth rate at the end of each year of life, except for the ninth and tenth, is greater in older fish. Length-frequency data generally agreed with growth data. The growth increment was determined to be uniform throughout the life of the sculpins sampled. A total of 182 stomachs was analysed for the food habits study. Amphipods were the most numerous items taken by the sculpins and comprised the largest volume of material in stomachs of small specimens. Fish made up the largest volume of food in stomachs from large sculpins.

THE AGE, GROWTH AND FOOD HABITS OF THE MARINE COTTID
*LEPTOCOTTUS ARMATUS*

by

EDWARD FREDRICK WEISS JR.

A thesis submitted to the Graduate Faculty in partial
fulfillment of the requirements for the degree

of

MASTER OF SCIENCE

in

Fish and Wildlife Management

Approved:

Head, Major Department

Chairman, Examining Committee

Dean, Graduate Division

MONTANA STATE COLLEGE
Bozeman, Montana

June, 1962

Acknowledgements

The author wishes to extend thanks to those who assisted in this study. Dr. C. J. D. Brown suggested and directed the investigation, and assisted in the preparation of the manuscript. Mrs. Evangeline Brown, Mr. John Campbell and several graduate students assisted with the collections. The University of Washington Friday Harbor Laboratories provided laboratory space and furnished the equipment for making collections.

Table of Contents

## List of Figures

Abstract

A study was made on the age, growth and food habits of the Pacific staghorn sculpin (Leptocottus armatus) in the vicinity of Friday Harbor, Washington. The study was conducted during the summer of 1961. Otoliths were removed from 295 sculpins for the age and growth study. The otoliths are generally elliptical in appearance with a moderately crenated outline. The otolith radius to total length relationship for 272 sculpins was expressed by the equation Y = -16.9 + .642X and a correlation coefficient of 0.974. After elimination of the 20 largest fish the relationship was expressed by the equation Y = -10.0 + .601X and a correlation coefficient of 0.980. The average calculated lengths for 262 sculpins at the end of each succeeding year of life for ten years were 34, 55, 80, 101, 122, 148, 174, 200, 222, 228 mm., respectively. Calculated growth rate at the end of each year of life, except for the ninth and tenth, is greater in older fish. Length-frequency data generally agreed with growth data. The growth increment was determined to be uniform throughout the life of the sculpins sampled. A total of 182 stomachs was analysed for the food habits study. Amphipods were the most numerous items taken by the sculpins and comprised the largest volume of material in stomachs of small specimens. Fish made up the largest volume of food in stomachs from large sculpins.

## Introduction

The age, growth and food habits of the Pacific staghorn sculpin (Leptocottus armatus Girard) were investigated from June to September, 1961. This study was carried out at the University of Washington Friday Harbor Laboratories located on San Juan Island, Washington. All collections were made along the shores of this island, which provides suitable habitat for this species.

No age growth investigations and only one stomach analysis study of marine sculpins have been found in the literature. Mitchell (1953) analyzed the stomach contents of three species of tidepool sculpins in California. Several investigations have been made concerning age, growth and food habits of the freshwater sculpin Cottus bairdi. Bailey (1952) investigated the age, growth and food habits of this species in Montana and Zarbock (1951) made a similar study in Utah. Koster (1937) and Daiber (1956) reported its food habits in New York while Dineen (1951) investigated this species in Minnesota. Northcote (1954) compared the food habits of Cottus asper and Cottus rhotheus in British Columbia.

## Description of the Sampling Areas

The Pacific staghorn sculpin was most abundant on clean sandy areas of the intertidal zone. The collecting areas on San Juan Island were: False Bay, on the southwestern side, which is generally protected from direct wave action, and North Bay, on the eastern side, which is exposed to constant wave action. Bottom materials in the collecting areas were primarily sand and gravel. Sea lettuce (Ulva) and eelgrass (Zostera) were the most abundant aquatic plants present in these areas. The Pacific staghorn sculpin, when disturbed, utilized the aquatic plants for concealment, but preferred the open, sandy areas at other times. While it was the most abundant fish collected in the sampling areas, the shiner perch (Cymatogaster aggregata) and starry flounder (Platichthys stellatus) were also abundant. A considerable number of other species was taken less frequently.

## Collection and Preservation of Samples

Most sculpins less than 150 mm. in total length were collected with a 15 foot "common sense" seine. Larger sculpins evaded this seine, and were captured with a 30 foot bag seine moved rapidly parallel to shore, with the operator at the outer end remaining about ten feet in advance of the other. Many sculpins of all sizes were also collected by applying rotenone to small areas near eelgrass beds.

Sculpins from which otoliths were taken and those used for stomach analysis were measured while fresh. Those used for length-frequency study were preserved in 10% formalin. The relationship between total lengths of fresh and preserved sculpins was determined for 50 specimens under 100 mm. in total length and 75 over 100 mm. Conversion from fresh total length (Y) to preserved total lengths did not exceed .984 Y and therefore no corrections were applied to preserved fish.

## Age and Growth

Otoliths were studied from 295 specimens. These were removed by making an oblique cut from immediately posterior to the orbits to the beginning of the vertebral column. The top of the skull was then raised and the two exposed otoliths of the sacculus were removed with a forceps. These were the only otoliths used in this study.

The otoliths of the Pacific staghorn sculpin are generally elliptical in outline with the ventral edge more flattened than the dorsal (Fig. 1). Smaller otoliths have narrower and more pointed anterior projections than the larger ones. The lateral surface of the otolith is slightly concave, while the mesial surface is convex with the sulces acusticus along its longitudinal axis. The margin of the otolith is moderately crenated. Otoliths ranged from 1.5 to 11.2 mm. in length and 1.0 to 5.5 mm. in width. Growth of the structures appears to be uniform (Fig. 2).

Generally, the core of most otoliths consisted of a small, opaque center, surrounded by a translucent band. The core of larger otoliths was usually composed of an enlarged translucent area with an opaque band immediately outside the core.

The otoliths have translucent rings that alternate with opaque zones outside the core (Fig. 1). The translucent rings are narrower than the opaque ones and occur near the edge of otoliths collected during June. These are interpreted to represent winter growth or annuli while the opaque zones are summer growth.

Otoliths were gently rubbed between the thumb and forefinger to remove adhering tissues, and then stored in vials. The majority of otoliths were preserved in 50% glycerin and water to which a few crystals of thymol were

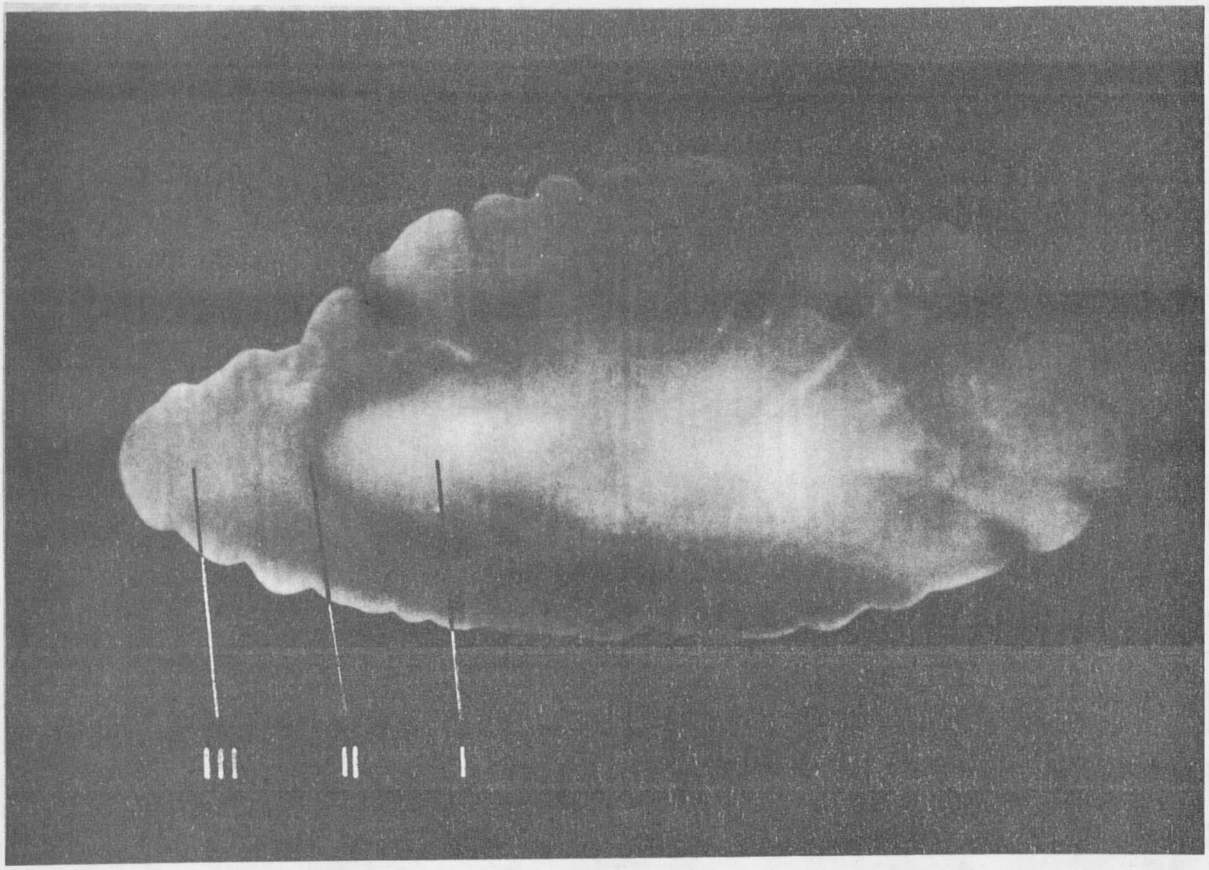


Fig. 1. Otolith from a Pacific staghorn sculpin of 87 mm. total length showing three annuli.

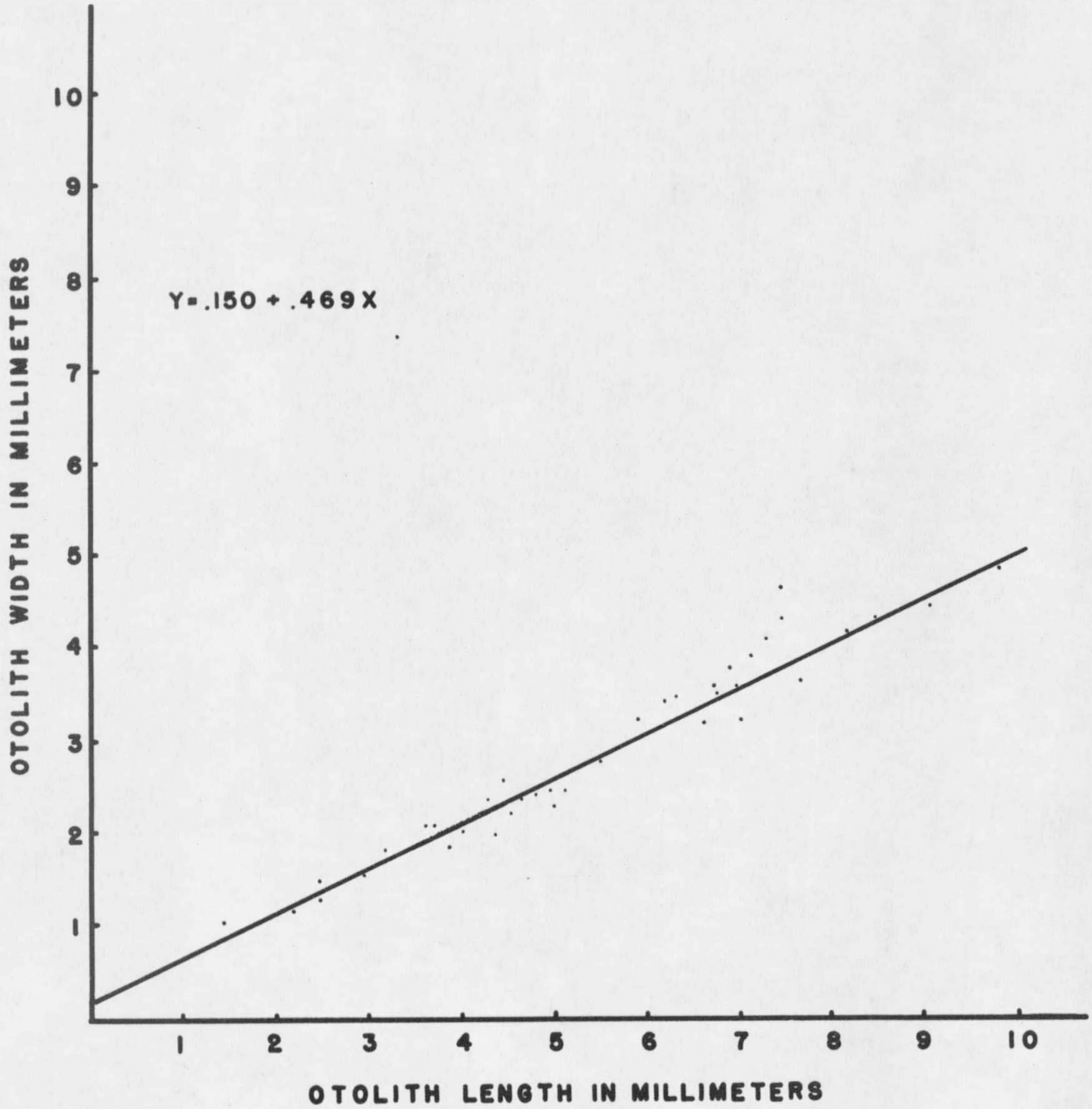


Fig. 2. Relationship between otolith length and otolith width for Pacific staghorn sculpins collected near Friday Harbor, Washington, 1961.

added. However, some were stored in xylene. No major difference was noted in otoliths stored in two media at the end of five months. Preserved otoliths, with their concave surfaces directed upwards, were placed in a blackened dish and immersed in glycerin. A Cyclospot illuminator was positioned to allow the light to strike the otolith perpendicular to the concave surface. Magnification ranged from 15 to 45X. A translucent band was considered to represent a true annulus only if it were continuous, or nearly so, around the entire otolith. The first annulus was often incomplete and narrower than other annuli. Annuli were sometimes difficult to distinguish due to increased thickness and opacity in otoliths from larger sculpins. Large otoliths were cleared by immersion in pure creosote for a period of from 12-24 hours. Otoliths that were crystalline or partially so, or those exhibiting "multiple rings" of the type described by Frost (1945) were discarded. The paired otoliths from each sculpin showed 95% agreement in ages.

<u>Total Body Length-Otolith Relationship</u>: Otolith measurements were made in millimeters by use of an ocular micrometer while the otolith was positioned as described above. Measurements were made from the center of the core of each otolith, along the longitudinal axis to the anterior edge, and the distances to each successive annuli and to the anterior edge of the otolith were recorded. The distance from the core of an otolith to its anterior edge is hereafter referred to as otolith radius. Variations in the number of fish used in the tables resulted from discarding otoliths which could not be read and measured with confidence.

The otolith radii in millimeters were plotted against the corresponding total lengths in millimeters and a line fitted to the data by the method of least squares. This line was found to intercept the Y axis at -16.9 mm. (Fig. 3). The regression coefficient for the data was calculated to be 0.974.

Inclusion of the small sample of sculpins over 200 mm. in total length (20 fish comprising 7.4% of the total number used in the calculations) was thought to cause the intercept value to be low. A new regression line was calculated from the data after elimination of larger sculpins and was found to intercept the Y axis at -10.0 mm. The new regression coefficient was calculated to be 0.980. This compares favorably with the value of 0.969 determined by Sneed (1950) for catfish spines.

The low intercept value for the data including the larger sculpins was apparently caused by an inadequate number of large fish in the sample and/or by a differential sexual mortality causing a change in sex ratio at the greater lengths. These data could also represent a true curvilinear relationship rather than the assumed rectilinear as described above.

Rate of Growth: The age was assessed and growth rates were determined for 262 Pacific staghorn sculpins. Calculations to determine lengths at the end of each year of life were made with the aid of a nomograph similar to that described by Carlander and Smith (1944). These calculations were based on a rectilinear relationship between otolith radius and body length and included a correction factor of -10 mm. (Fig. 3). Calculated lengths have been expressed for each age group and as grand averages for all groups.