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Winter flounder *Pseudopleuronectes americanus*

BRENDA FIELDS
Woods Hole Laboratory
Northeast Fisheries Center
National Marine Fisheries Service, NOAA
Woods Hole, MA 02543

Winter flounder is distributed in the Northwest Atlantic from lower Labrador southward to Georgia, and is most abundant from the Gulf of St. Lawrence to Chesapeake Bay. For descriptive purposes, the winter flounder resource and fishery have been divided into four major geographic groups: Gulf of Maine, Georges Bank, Southern New England, and Mid-Atlantic. Migrations of winter flounder are not extensive. The fish appear to be broken up into local subpopulations that are relatively stationary. Movements north of Cape Cod are relatively localized and confined to inshore waters, whereas south of Cape Cod, flounder disperse seasonally in relation to water temperature. Little mixing occurs between Georges Bank and inshore areas (Howe and Coates 1975). Lux (1973) observed that winter flounder on Georges Bank grow faster than fish from inshore areas.

Winter flounder are relatively long-lived, reaching a maximum age of about 15 years and a length of 58 cm. The growth rate up to age 2 is the same for both sexes, but thereafter females grow faster and live longer than males (Lux 1973). Both males and females mature sexually at age 2, although males mature at a smaller size than females. Winter flounder spawn from January through May with spawning beginning earlier in southern portions of its range.

Because interpretation of winter flounder growth in inshore areas has not been validated, this section deals only with age determination for Georges Bank fish. Recent research employing daily growth increments as an age-validation tool for inshore winter flounder has shown promise, but such studies are as yet incomplete.

Early investigators (Lobell 1939, Perlmutter 1940) chose scales as the preferred structure; later investigators based age determinations on otoliths (Berry at al. 1965, Pearcy 1962). At the Woods Hole Laboratory, scales are used as the primary structure, although otoliths are used quite frequently for a corroboration of age determination.

Scales are taken from the lateral line area a few centimeters anterior to the caudal peduncle for dry storage. Impressions of the dried scales are made in laminated plastic using a roller press and viewed on a microprojector at a magnification of 40×. Regenerated scales are discarded.

The scales are ctenoid, with radial grooves extending from the focus to the forward margin of the scale. Otoliths from young-of-the-year fish may be covered with Kodak Photo-Flo 200 solution for viewing whole by a binocular microscope at a magnification of 25×, under reflected light. Otoliths from older fish are thin-sectioned by a low-speed macrotome saw (Nichy 1977). The sections are covered with Photo-Flo, and examined under a binocular microscope against a dark field with transmitted light at a magnification of 25-50×.

By convention, a 1 January birthdate is used. Annular zones on winter flounder scales appear as changes in the circuli pattern. Zones of fast and slow growth are reflected by wide or narrow spacing, respectively, of circuli, made up of individual platelets on the sculptured upper surface of the scale.

When using either whole or sectioned otoliths, a year's growth consists of a white opaque zone, representing fast summer growth, followed by a dark hyaline zone, representing slow winter growth. The annulus, by definition, is the hyaline zone marking the end of a year of growth, i.e., the winter growth zone.

On winter flounder scales and otoliths, the first winter zone representative of the first annulus is well defined for slow-growing fish but not for fast-growing fish. The scale winter zone appears on the edge approximately coincident with the hyaline edge on

otoliths. Studies have demonstrated close agreement between scale and otolith readings from the same fish through age 4.

The first annulus on a scale is identified by a dense mass of winter growth (closely spaced circuli) near the focus; the end of the annulus is considered to be the outermost of these circuli. Sometimes, pigmentation on the scale will cover the first annulus almost completely. The first annulus on many scales is barely discernible and is usually estimated by slight changes in the formation of the circuli (Fig. 1). For all succeeding years, spring and summer growth are characterized by widely spaced circuli (rapid length accretion) and fall and winter growth by closely spaced circuli (slow length accretion). The outer edge of the zone of closely spaced circuli is considered to be the end of the annulus. Slight checks in growth consisting of only a few closely spaced circuli on the scale are considered to be checks and may be ignored in assigning age (Fig. 2).

On scales from older fish the identity of checks is more obvious because of the relative spacing of annuli and the contrast of checks with the more strongly formed annuli (Fig. 3 and 4). After formation of the third annulus, age interpretation may be complicated by irregular spacing of annuli (Fig. 5). The growth increment between the second and third annuli is generally wide, with decreasing growth increments between later annuli (Figs. 6 and 7).

Contrast between winter and summer zones tends to deteriorate toward the outer edge of scales of older winter flounder. After the fourth winter zone, summer growth appears to merge with the slow winter growth and the narrow growth increments may make interpretation difficult (Fig. 8).

Citations

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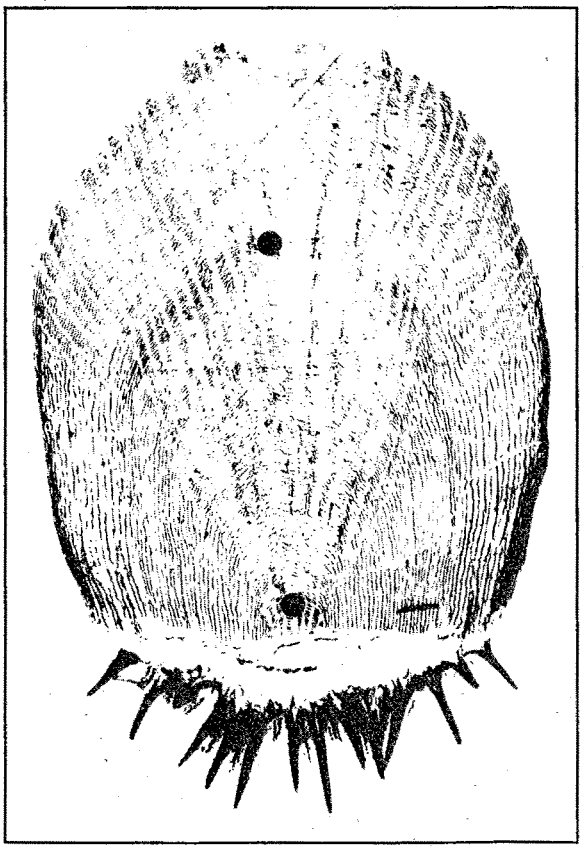

Figure 1
Scale impression of a 36-cm age-2 female winter flounder collected in the fall from Georges Bank showing a small first annulus with good growth in the second year.

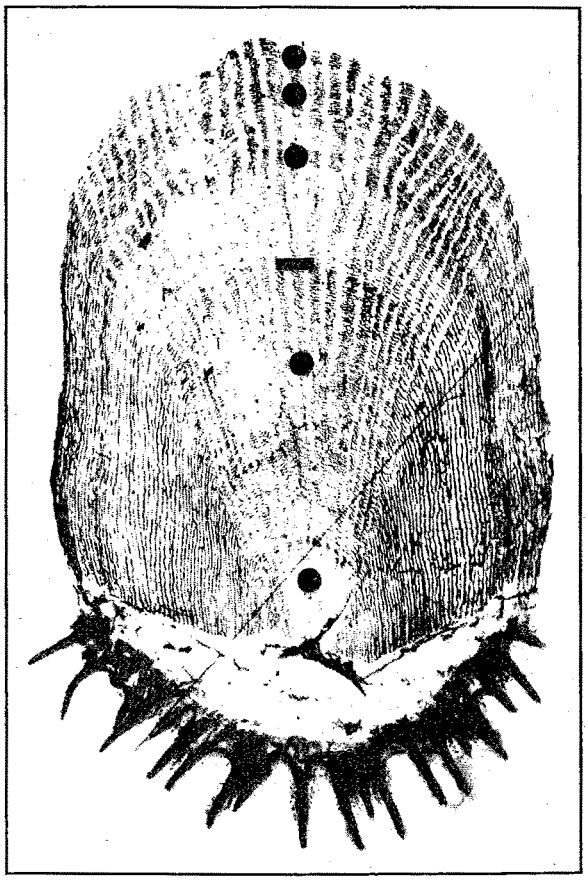

Figure 2
Scale impression of a 46-cm age-5 male winter flounder collected in the spring from Georges Bank showing a fairly strong check after the second annulus.

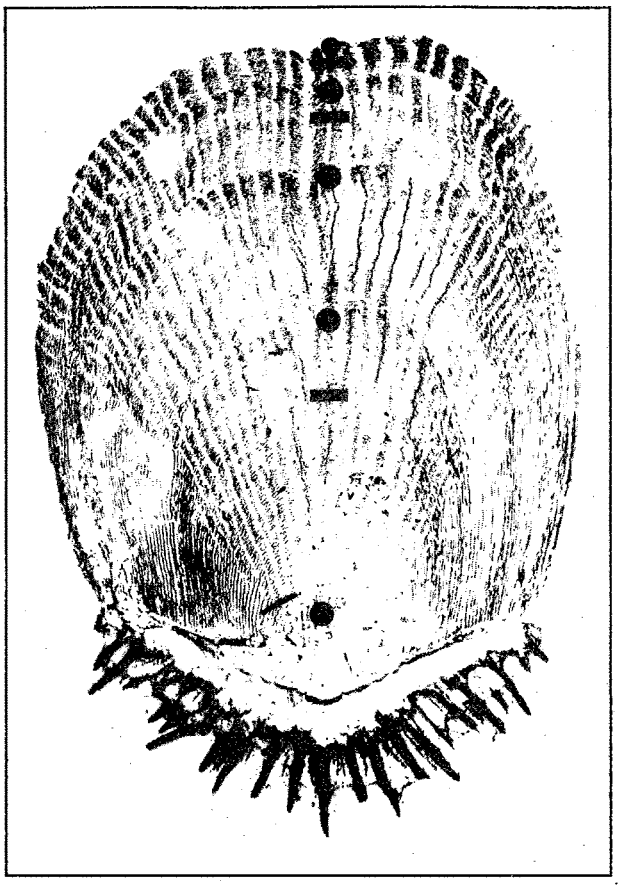

Figure 3
Scale impression of a 54-cm age-5? female winter flounder collected in the spring from Georges Bank showing a check before the second annulus with split fourth and fifth annuli.

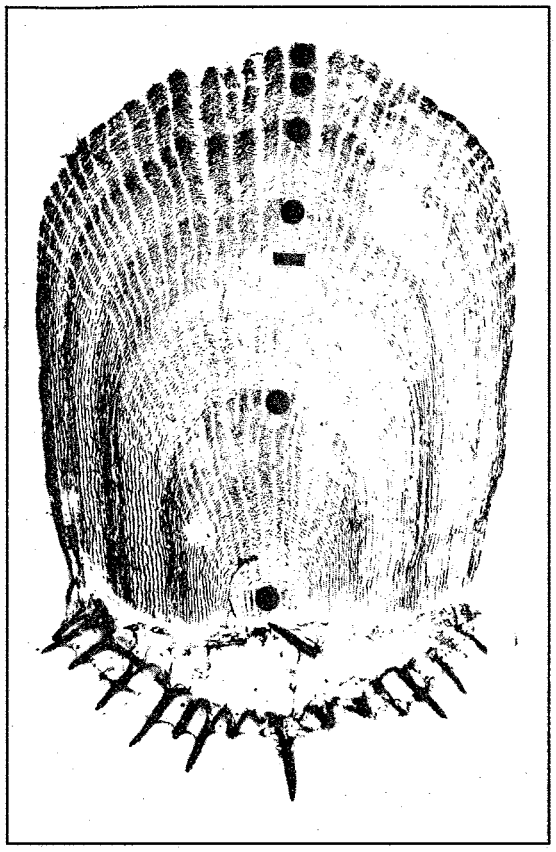

Figure 4
Scale impression of a 47-cm age-6 male winter flounder collected in the spring from Georges Bank showing a split third annulus.

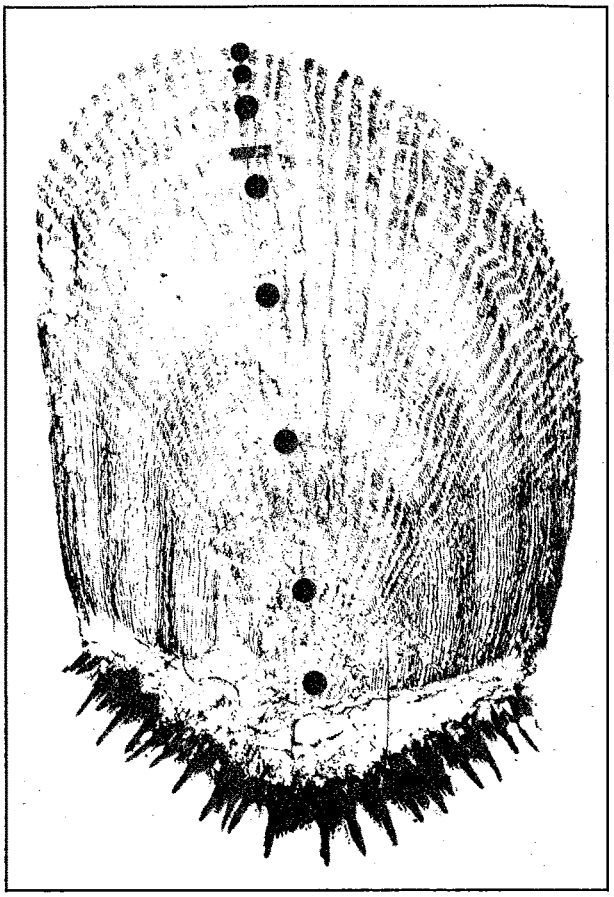

Figure 5
Scale impression of a 49-cm age-8 female winter flounder collected in the spring from Georges Bank showing fairly small first, second, and third annuli. There is also a check or damage evident between the fifth and sixth annuli.

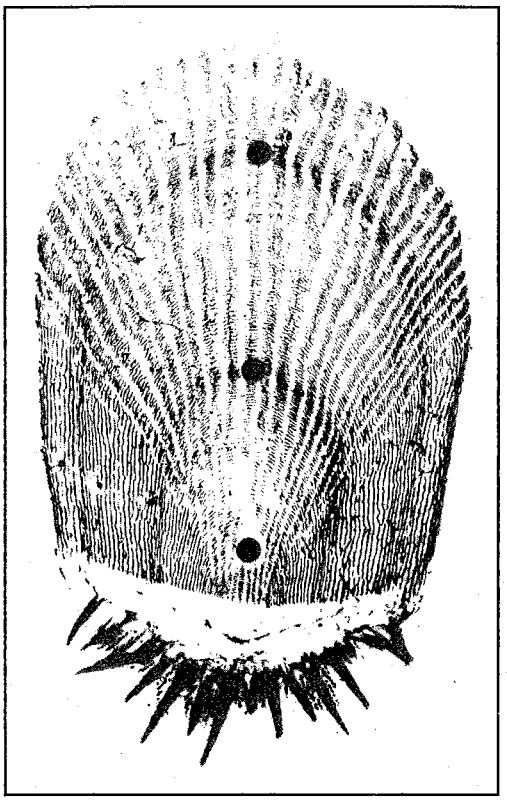

Figure 6
Scale impression of a 46-cm age-3 female winter flounder collected in the fall from Georges Bank showing a fairly small second annulus with good growth in the third year.

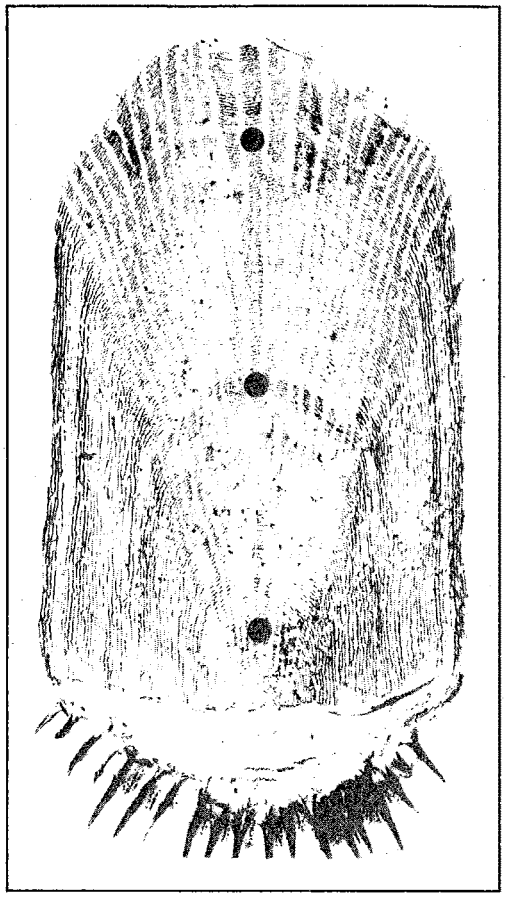

Figure 7
Scale impression of a 40-cm age-3 female winter flounder collected in the fall from Georges Bank showing moderate growth in the second year with good growth in the third.

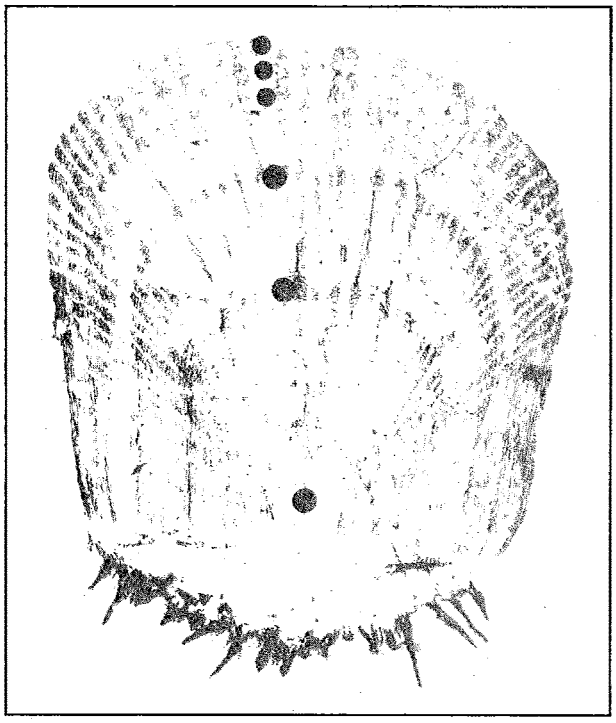

Figure 8
Scale impression of a 51-cm age-6 female winter flounder collected in the spring from Georges Bank showing close fourth, fifth, and sixth annuli.