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Witch flounder
Glyptocephalus cynoglossus

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Witch flounder, or grey sole, is a small-mouthed, right-sided pleuronectid distributed in deep, cold waters from Labrador to North Carolina. Although numerous stocks of witch flounder have been delineated in Canadian waters (Fairbairn 1981, Bowering and Misra 1982), no stock-identification studies have been conducted for our region. Witch flounder in the Gulf of Maine-Georges Bank region are considered to be a unit stock for assessment purposes. Witch flounder are sedentary and do not undertake seasonal migrations (Bigelow and Schroeder 1953). Most commercial catches occur at depths of 90-270 m over mud bottom at temperatures ranging from 2°C in winter to 9°C during summer (Burnett and Clark 1983).

Relative to other flatfish in the region, the witch flounder can be characterized as a slow-growing, late-maturing, long-lived species. Maximum observed length and age for the Gulf of Maine-Georges Bank region are 72 cm total length and 30 years, respectively. Median age at sexual maturity for male witch flounder is 4 years; for females, 6.5 years. Spawning occurs over a protracted season with a peak occurring during May and June. The pelagic larval stage is lengthy compared with other flounders, lasting from 4-6 months (Bigelow and Schroeder 1953) to a year (Evseenko and Nevinsky 1973).

The first study of witch flounder age was conducted by Huntsman (1918), who used scales as the ageing structure. Molander (1925) and Bowers (1960) both employed whole otoliths for witch flounder from the eastern Atlantic, but did not validate their methodology. Powles and Kennedy (1967) polished whole otoliths from Scotian Shelf samples, validating their interpretation of hyaline zones as annuli by using modal analysis of back-calculated mean lengths-at-age of younger fish. Burnett (1987) examined thin-sectioned otoliths from the Gulf of Maine-Georges Bank collections. Validation techniques in this study consisted of comparing ages obtained from scales with otolith-based ages of individual fish and examining the seasonal progression of otolith edge type.

At Woods Hole, thin-sectioned otoliths are examined with the following exceptions: 1) Whole otoliths are used when possible for younger fish to save preparation time, and 2) scales are used for commercial samples when dealers do not allow otolith extraction by National Marine Fisheries Service port samplers. (However, scales cannot be aged accurately beyond 10 years-of-age due to compression of annuli on the scale edge). Upon removal from the fish, otoliths are stored dry.

Although either otolith is a suitable structure, the ventral otolith (easily distinguished in larger fish by its greater length and lesser height) generally provides better interpretations in older fish due to minimal dorsolateral compression within the sacculus. A low-speed macrotome saw is used for thin-sectioning otoliths to thicknesses of 0.178 ± 0.051 mm (0.007 ± 0.002 inches); the most successful orientation of the section is transversely through the nucleus along the dorsolateral axis. The resulting section allows tracing of hyaline zones from the sulcus area into the otolith body.

Sections are immersed in ethyl alcohol and viewed against a dark background at magnifications of 25-50× with reflected lighting. Age determinations are based on the number of hyaline zones present. Figure 1 shows a section from an otolith taken from a 54-cm female witch flounder assigned an age of 17 years. Features of interest include: A) poorly defined first annulus; B) broad, well-defined opaque and hyaline zones present through ages 2-9; C) a check between annuli 6 and 7, possibly associated with initial reproductive efforts; D) narrowing of both zones subsequent to age 5; and E) splitting of opaque zones which can be mistaken for annuli in the outer fields. The section from an 11-cm male illustrates both a settling check within the nucleus associated with metamorphosis and settling to a benthic habitat and the lack of a well-defined first annulus (Fig. 2); this fish, captured in July, was assigned an age of 1+. Figure 3 represents a typical intermediate-aged fish, in this instance, a 34-cm female captured in April. Again, the first annulus is poorly defined; however, the settling check and annuli 2-4 are prominent in this age-5 interpretation. For older fish, both lateral fields must be utilized: earlier annuli, more distinct and less subject to zone-splitting in the ventral field, can be traced around to the dorsal field. This generally affords better interpretation of later annuli. Later annuli may also be more accurately evaluated within the sulcus, providing a point of reference has been established in the otolith body. Care must be taken in evaluating the outer annuli of older fish and in categorizing the type and width of edge material; often increasing magnifications and the examination of the otolith halves are necessary in both instances.

An important clue in the age-determination process is also provided by the spacing of opaque and hyaline zones. Annual incremental growth of witch flounder diminishes sharply after age 12 and remains fairly uniform thereafter; often decisions between true annuli and splits within opaque zones can be made by examining the spacing of otolith events.

To summarize, thin-sectioning of otoliths is a reliable method for witch flounder. Sectioning increases the preparation time, but the resulting improvement in accuracy of age determinations justifies the approach. Reliable age determinations beyond age 10 or so will be an important prerequisite for analytical assessments of this species.

Figure 1
Otolith section from a 54-cm age-17 female witch flounder collected in November showing a poorly defined first annulus; broad, well defined zones present through ages 2-9; a check between annuli 6 and 7, possibly associated with initial reproductive efforts; narrowing of zones subsequent to age 5; and splitting of opaque zones in the outer fields. (This section is not cut exactly at the nucleus.)

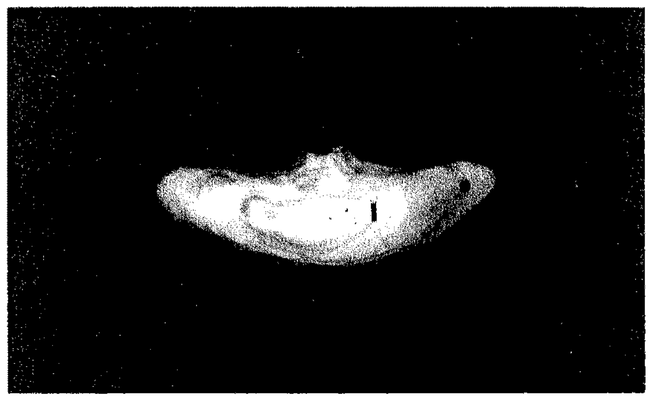

Figure 2
Otolith section from an 11-cm age 1+ male witch flounder collected in July showing a settling check and poorly defined first annulus.

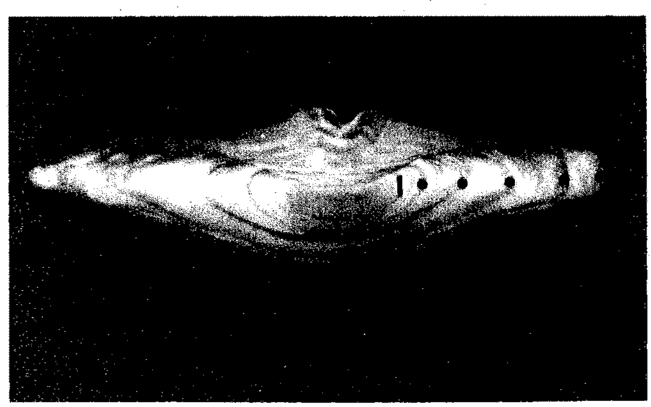

Figure 3
Otolith section from a 34-cm age-5 female witch flounder collected in April showing a prominent settling check, poorly defined first annulus, and well defined annuli 2-4.

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