Sexual Maturity, Fecundity, Spawning, and Early Life History of Sablefish (*Anoplopoma fimbria*) off the Pacific Coast of Canada

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Analysis of ichthyoplankton surveys and maturity states showed that sablefish (*Anoplopoma fimbria*) spawn along the entire Pacific coast of Canada from January through April with peak spawning occurring in February. Spawning took place at depths greater than 300 m all along the continental slope and did not entail a noticeable spawning migration. Fifty percent of females and males spawned for the first time at an age of approximately 5 yr. Length at 50% maturity was approximately 58 cm for females and 52 cm for males. The adult male to female ratio during the spawning seasons of 1980 and 1981 was approximately 1:3 and was 1:1.5 during all other sampling periods. The sex ratio of juveniles was 1:1. Fecundity estimates are described by the equation $F = 1.11987\text{FL}^{2.8244}$. After hatching in March and April, postlarvae moved into the surface waters and were found >180 km offshore in late March. Juveniles were found in inside waters in July and August, attaining a length of 9 cm by early August. Juveniles may remain in inside waters until maturity when they return to the spawning areas.

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Une analyse des relevés de l'ichtyoplancton et de l'état de la maturité démontre que la morue charbonnière (*Anoplopoma fimbria*) fraye tout le long de la côte du Pacifique du Canada de janvier à avril, avec sommet en février. La fraie a lieu à des profondeurs de plus de 300 m tout le long de la pente continentale et ne comporte pas de migration importante. Cinquante pour cent des femelles et des mâles frayent pour la première fois à l'âge d'environ 5 ans. La longueur à laquelle 50 % des sujets sont matures est d'environ 58 cm chez les femelles et 52 cm chez les mâles. La proportion des mâles et des femelles adultes pendant les saisons de ponte de 1980 et 1981 a été approximativement de 1:3 et elle a été de 1:1,5 pendant toutes les autres périodes d'échantillonnage. La proportion des sexes des juvéniles était de 1:1. On peut décrire les estimations de fécondité à l'aide de l'équation $F = 1{,}11987\text{LF}^{2{,}8244}$. Après l'éclosion en mars et avril, les postlarves montent à la surface, et on les trouve à >180 km au large, fin mars. Les juvéniles se trouvent dans les eaux intérieures en juillet et août, atteignant une longueur de 9 cm au début août. Ils peuvent y demeurer jusqu'au moment de la maturité, alors qu'ils retournent sur les lieux de fraie.

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LITTLE is known about the spawning habits of sablefish (*Anoplopoma fimbria*). Fragmentary observations (Thompson 1941; Shubnikov 1963; Heyamoto 1962; Kodolov 1968, 1976; Bell and Gharrett 1945; Phillips and Imamura 1954) suggest that throughout the North Pacific Ocean sablefish may spawn from late fall to early spring. Thompson (1941) felt that spawning probably commenced in February off the Queen Charlotte Islands in northern British Columbia, based on description of eggs taken from a single ripe female and the presence of like eggs in plankton catches. Bell and Gharrett (1945) concluded that spawning occurred late in the year off Cape Flattery, based on accounts of ovarian states furnished by fishing captains. Phillips and Imamura (1954) stated that the spawning period off California was December through April with peak spawning occurring in January and February. In the Bering Sea, peak spawning was reported to be restricted to February (Shubnikov 1963) or to occur in the fall (Kodolov 1976). Larvae, postlarvae, and juvenile sablefish

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(11.3–30.2 mm TL) were taken off the Aleutian Islands (163°W to 175°E) in July and August by Kobayashi (1957). From the small size of some of these larvae, spawning in the general area may extend into late May.

The reported sizes and age ranges at 50% maturity vary and estimates often have not been recorded separately for each sex. Heyamoto (1962) indicated that 50% of a sample were mature at 48 cm and the males and females were mature at 56.0 and 67.5 cm, respectively. Age at 50% maturity was 5–7 yr. Kodolov (1976) reported a length range at 50% maturity of 60–64 cm and an age of 4–7 yr.

The Canadian fishery for sablefish developed rapidly over the past 5 yr, relative to traditional levels, and currently has the highest landed value in the groundfish fisheries of the Canadian Pacific coast, including that for Pacific halibut (*Hippoglossus stenolepis*).

Development of an effective management strategy for this important commercial species is dependent on reliable knowledge of age and size at maturity, timing, location, and relative magnitude of spawning, fecundity, and associated migratory behavior. These biological concerns are preliminary to elucidation of the stock recruitment mechanisms as they may relate to environment. Because available information was poorly documented and fragmentary, particularly off the North American coast, and there was no previous comprehensive study of reproductive biology, such a study was undertaken in 1979 and 1980 and included preliminary information on the early life history of sablefish referenced to environment.

Materials and Methods

Sablefish were examined for sex and state of maturity and were measured for fork length to the nearest centimetre. Pairs of otoliths were collected for age determination from subsamples of the total catch and stored in a 50% glycerin solution. The size of each subsample varied, but in all cases a portion of the total catch was sampled without selection. The method of age determination was described and partially validated by Beamish and Chilton (1982). Samples were collected from 18 cruises conducted between the period September 1979–May 1980 and a further cruise from 16 November to 20 December 1981. Data from two cruises conducted during the same period in 1978 have also been included in the analysis. Approximately 12 000 fish were measured, sexed, and examined for maturity states and 2684 of these fish were sampled for otoliths.

Two approaches were used to ensure that the timing and location of spawning were identified. Gonadal development was monitored from commercial catches at a number of locations along Canada's west coast, coincident with a late winter–spring series of egg and larval surveys throughout all commercially fished areas.

The gonad of immature females appeared as a thin, lobed thread of bubbly texture. The immature male gonad was similar but with no bubbly texture. Maturing and mature ovaries contained white, opaque eggs visible to the eye. Eggs became hydrated and translucent just prior to spawning. Maturing or mature males developed folds or lobes in the gonad of whitish coloration, and as the male matured, the number and size of the folds increased. Spawning females produced a stream of translucent eggs from the vent following slight external pressure on the body wall. The ovary from a spawned (or spent) female was flaccid, of purplish red color, and contained a few residual mature eggs. Males in spawning condition released sperm from the vent following slight external pressure on the body wall.

Lengths were grouped in 1-cm intervals and ages in 1-yr intervals. The median length and age at 50% maturity were identified using probit analysis (Leslie et al. 1945). Although this procedure provided median ages in fractional years, the median first spawning age is only meaningful biologically when recorded in whole years.

For determination of fecundity, ovaries of 220 females 58–110 cm FL were collected at sea from catches made during the 1st wk of February 1981. Fish were taken in Korean-type traps fished off the northwest coast of Vancouver Island and the west coasts of the Queen Charlotte Islands. Maturity state ranged from resting to spent ovaries, although most ovaries were ripe. Fifty-five ripe females were selected so that no more than three were in any centimetre interval. Fresh ovaries were preserved in 10% formaldehyde solution. In the laboratory, the preserved ovaries were transferred to Gilson's fluid, as modified by Simpson (1951), for 4 mo before extracting the eggs, to allow breakdown of connective tissue.

Ovaries were washed thoroughly in cold water over a series of stainless steel screens and gently broken up by hand to separate the hardened eggs from the ovarian tissue. The cleaned eggs were stored in 5% formaldehyde solution.

Eggs from a single ovary were transferred to a 20-L glass reservoir filled to either 10 or 15 L and stirred vigorously with a wooden paddle. A volumetric subsample of 25–50 eggs in 1–2 mL was extracted using Stempel pipettes. Fifty subsamples were transferred to petri dishes while stirring continued. Under the dissecting microscope at 50× magnification, all eggs were sized and counted in 20-μm-diameter intervals in five subsamples. These results were then combined to construct a size frequency histogram describing the ovary. The eggs larger than 500 μm in diameter were then counted in the remaining 45 subsamples to provide 50 subsample volumetric counts of large eggs. Without exception, all ovaries examined contained a bimodal distribution of egg size with peaks occurring at 100 and 1000–1200 μm. No difficulty was encountered in distinguishing between ripening, well-yolked eggs (large) and small eggs containing scant or no yolk material, and the two size-classes of eggs were separated by a consistent size gap of some 500 μm between 300 and 800 μm egg diameter.

The total number of large eggs was calculated from the product of mean subsample count of large eggs per millilitre and the reservoir volume prior to subsampling. From 1/300 to 1/100 of the total eggs in an ovary were actually counted.

Four monthly cruises were conducted from January to April 1980 to examine the distribution of sablefish eggs and larvae. The survey covered 77 stations located on 18 equidistant transect lines, which terminated seaward adjacent to the 500-fathom isobath (1 fathom = 1.83 m). Approximately 45 stations were situated on the 30-, 50-, 100- and 500-fathom isobaths of the outer continental shelf and slope.

At each station an oblique tow was made using 0.25-m^2

Bongo samplers (McGowan and Brown 1966) after the general sampling procedure described by Smith and Richardson (1977) with the following exceptions: all sampling components were black; nets were 351-μm Nitex and of modified SCOR design; codends were made of PVC with 351-μm stainless steel mesh windows; a mine sweeper depressor of approximately 100 kg was employed on the January cruise but replaced by a cylindrical weight (75 kg) on subsequent cruises. Along the outer shelf at tow depths exceeding 300 m, filtration volumes ranged from 400 to 800 m^3. Catches of eggs and larvae were standardized to number per 10 m^2 by applying a standard haul factor to the raw catches derived from the following equation:

$$SHF = \frac{\text{max. tow depth (m)}}{\text{volume filtered (m}^3\text{)}} \times 10.$$

Vertical profiles of salinity and temperature were obtained using a Bissett–Berman STD system, standardized from Nansen casts. Ichthyoplankton and hydrography data compilations are to be found in reports by Mason et al. (1981a, 1981b, 1981c, 1981d, 1981e, 1981f, 1981g).

Sablefish eggs are pelagic, 1.8–2.2 mm in diameter, and have a smooth, nondescript chorion. They are isolecithal with no oil globules, have a narrow perivitelline space, and the embryo remains unpigmented until the later stages (J. C. Mason, unpublished). The larvae were described by Kobayashi (1957).

Results and Discussion

Distribution and Timing of Reproduction

Male sablefish were found in spawning condition from late in the year until early spring. This ability of males to remain in prolonged spawning condition is common in fishes, rendering males unsuitable for defining the spawning period. In contrast, females were in spawning condition over a shorter time period, allowing recognition of a peak spawning period as a meaningful biological characteristic.

Intermittent weekly observations of female maturity state from a number of locations off the west coast of Canada (Fig. 1) indicated that females were in spawning condition from January through March with peak spawning occurring in mid-February (Fig. 2). Although it was logistically impossible to make daily observations simultaneously in all three major areas, the available daily samples (drawn predominantly from the Queen Charlotte Islands area) show that 50% of the females examined spawned by February 12 (Fig. 3). This date is accepted as being generally appropriate for all the major areas, suggesting no significant latitudinal effect. The small percentage of females reported in spawning condition in August, September, and November (Fig. 2) are of questionable significance and probably due to some naive observers incorrectly identifying ovaries as spent. Infrequently, however, fishermen have reported catching sexually mature sablefish at times outside the January to March spawning period so a few fish or some minor stocks may spawn outside the major spawning period.

Highest individual catches of sablefish eggs were taken in ichthyoplankton hauls made in January and February

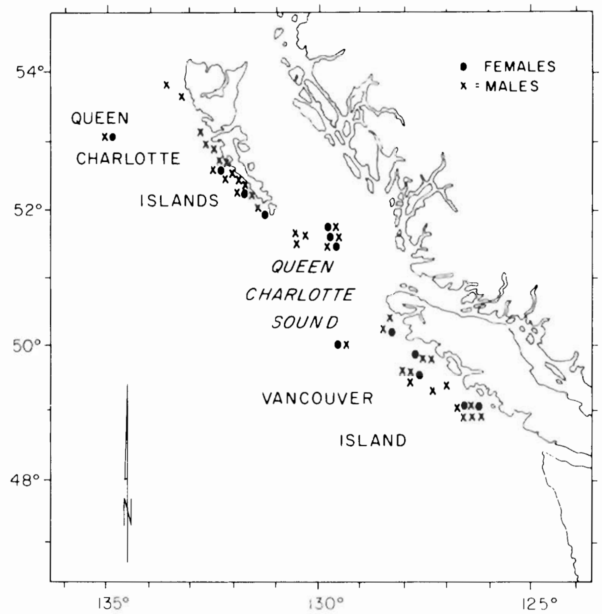

FIG. 1 Capture locations for spawning sablefish.

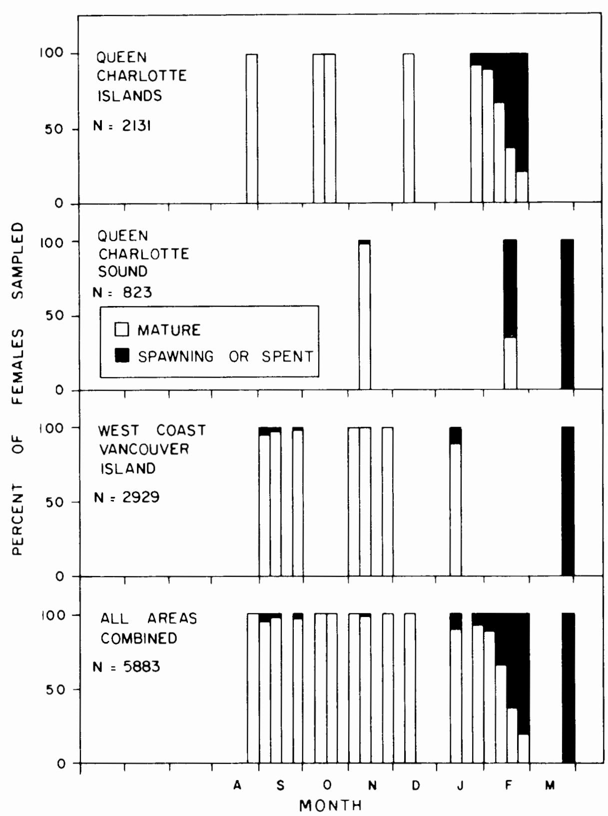

FIG. 2. Time of spawning in the Queen Charlotte Islands, Queen Charlotte Sound, Vancouver Island, and all areas combined.

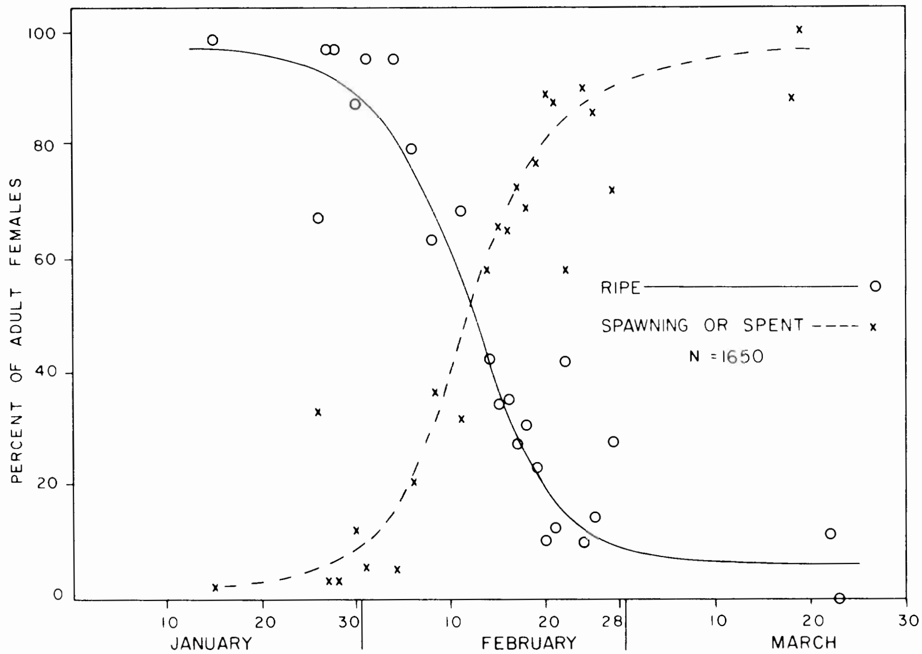

FIG. 3. Maturity states for female sablefish sampled daily between January and March on the British Columbia coast.

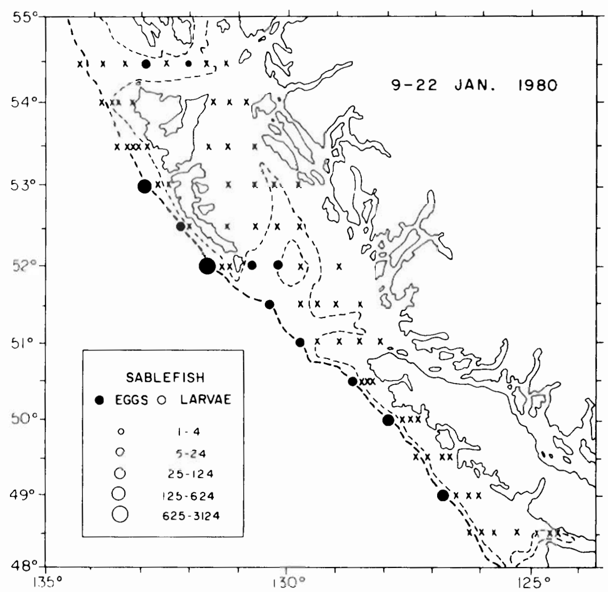

FIG. 4. Distribution and abundance (No./10 m^2) of sablefish eggs along the Pacific coast of Canada, January 1980. The 200- and 500-m isobaths are indicated by broken lines; × = zero catches.

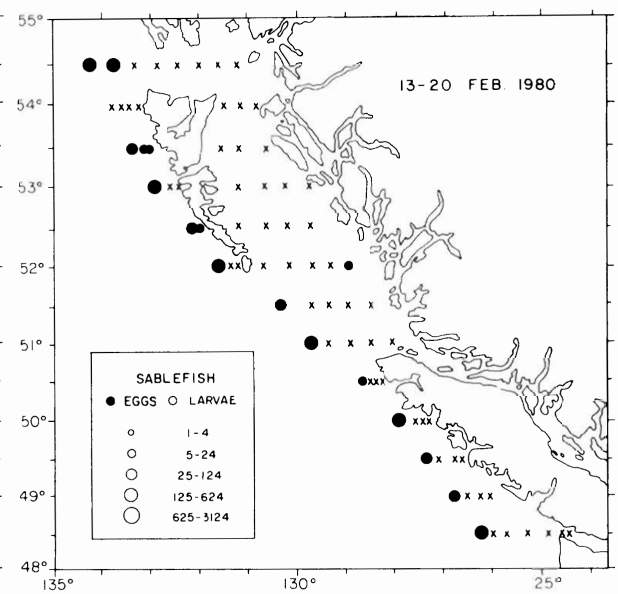

FIG. 5. Distribution and abundance (No./10 m^2) of sablefish eggs along the Pacific coast of Canada, February 1980. Symbols as in Fig. 4.

(Fig. 4–7) but eggs were taken in all four monthly cruises. The geometric mean catches (back-transformed means of the $\log_{10}$ catches) by cruise (Table 1) indicated peak spawning activity in February. The number of positive stations for larvae was greatest in April, suggesting a period of embryological development exceeding several weeks. The ichthyoplankton survey and the maturity survey both showed that spawning occurs almost simultaneously all along the coast (Fig. 2, 5). From the greater abundance of eggs in mid-February, the ichthyoplankton surveys (Table 1) indicate

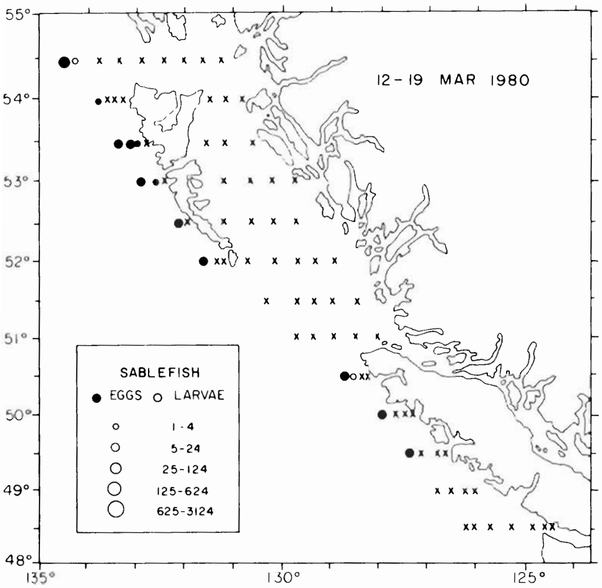

FIG. 6. Distribution and abundance (No./10 m^2) of sablefish eggs and larvae along the Pacific coast of Canada, March 1980. Symbols as in Fig. 4.

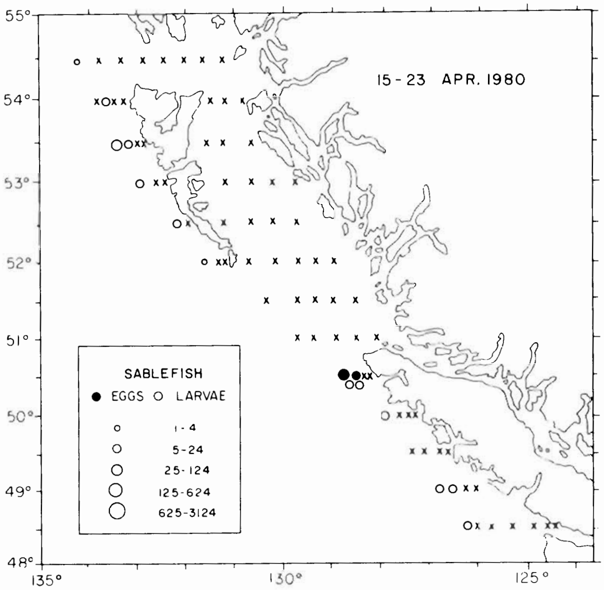

FIG. 7. Distribution and abundance (No./10 m^2) of sablefish eggs and larvae along the Pacific coast of Canada, April 1980. Symbols as in Fig. 4.

more spawning activity in late January than was indicated from the maturity observations. Since maturity observations were made on trapped fish, one might argue that such observations are biased toward feeding fish. However, our present data preclude effective testing of this hypothesis and we conclude that most spawning occurred during January and February with peak spawning occurring in February.

Our documentation of the seasonal timing of ovarian maturation and released egg production is similar to that reported by Phillips and Imamura (1954) for California stocks, suggesting the absence of a wide-scale latitudinal trend in reproductive timing although collection of larvae in the Aleutian Islands area in July and August (Kobayashi 1957) may reflect spawning activity there extending well into May.

The samples of spawning fish were obtained at depths ranging from 175 to 1450 m but most fish were caught at approximately 700 m, as this is an average fishing depth for commercial fishermen. The largest catches of both eggs and larvae were taken at stations where tow depth exceeded 400 m. Of 27 catches exceeding 25 eggs/10 m^2, 23 catches (85%) were taken at sampling depths exceeding 400 m. Similarly, the six highest catches of larvae were taken in tows deeper than 400 m, and 11 of 15 catches (73%) were made at tow depths exceeding 400 m.

Although the largest catches of eggs and larvae were taken west of the Queen Charlotte Islands, the small number of positive stations there (12 of 43 in all) does not allow the interpretation that spawning was more intensive (greater spawning stock) off these islands.

Almost all eggs were found at stations over or adjacent to the continental slope (Fig. 4–6). There was no indication of major spawning areas in Johnstone Strait, Hecate Strait, or Queen Charlotte Sound. Whereas fishermen have reported that small stocks of sablefish spawn in some mainland inlets,

TABLE 1. Geometric mean catches (No./10 m^2) of sablefish eggs and larvae from the Canadian Pacific Ichthyoplankton Survey, 1980. Values in parentheses indicate number of positive stations.

Sampling period	No. of stations occupied	Eggs	Larvae
9–19 January	72	31.1(12)	0(0)
12–17 February	77	78.9(17)	0(0)
11–16 March	77	43.6(12)	6.0(2)
15–20 April	77	20.3(2)	10.8(13)

there remains little doubt that the major spawning area is along the continental slope.

Because of the coastwide distribution of spawning activity, we suggest an absence of spawning migration, an interpretation that is supported by our tagging study. A total of 127 tagged sablefish were recovered during the maturity study (Table 2). These fish were tagged from February to September, 1977–80, as part of a program to identify sablefish stocks in the Canadian zone (Beamish and McFarlane 1983). Of 127 tags recovered, 90% were taken within 200 km and 81% within 100 km of the tagging location (Table 2) indicating that there is no extensive annual spawning migration, although localized movements of one or both sexes may occur.

All of the eggs captured were in the early or middle stages of embryological development. All 55 larvae taken were at least several days old, and 25 measurable larvae ranged in FL from 6 to 9 mm, the majority being 7–8 mm long. The noticeable absence of eggs in the later stages of development and a preponderance of newly hatched larvae (5–6 mm) are interpreted as evidence for an egg descent into waters exceeding 400–500 m (maximum depth of sampling) prior to hatching and maintenance of position at such depths at least

TABLE 2. Tagged sablefish recaptured from January to March 1980. Recoveries are segregated by distance from tagging sites.

Release period	Midpoint of release area	No. tagged	No. (%) of recoveries		
			<100 km	100–200 km	>200 km
July 1977	52°55′ 132°30′	5 159	10	1	1
September 1977	43°30′ 126°20′	5 506	12	—	—
May 1978	53°00′ 132°35′	5 287	9	1	3
June 1978	51°20′ 130°05′ 50°15′ 128°20′	5 465	16	—	—
May 1979	48°40′ 126°30′	8 993	26	2	8
June 1979	53°00′ 132°35′	6 300	26	7	1
August 1979	52°42′ 132°11′	281	2	—	—
February 1980	53°00′ 132°31′	1 538	2	—	—
Total		38 529	103(81%)	11(9%)	13(10%)

until hatching.

The lack of discrete-depth sampling gear disallowed any opportunity to document the actual vertical positions of eggs and larvae in the water column. Therefore, the actual depths of spawning, relative to the sea floor, equilibrium depths of egg stages, and the probable descent of eggs during development and ascent of larvae following hatching paralleling that suggested for the Pacific halibut by Thompson and Van Cleve (1936), must await further research.

AGE AND SIZE AT MATURITY

Mean lengths at 50% maturity were calculated for samples collected from four cruises from January to March 1980. The mean size of males varied very little among localities (Table 3). On the average, females were larger than males (56.8 and 52.5 cm, respectively). Mean ages at maturity were 4.8 for males and 5.1 for females indicating that 50% of males and females spawned for the first time at age 5. The second survey, conducted during November–December 1981, produced larger mean lengths for females at 50% maturity and sexual maturity for both sexes at a somewhat younger age.

The discrepancies in size and age at maturity between the two studies and among sampling areas probably reflect real variation and sampling error both in the field and in the ageing laboratory. For example, we know that sablefish grow very slowly in a particular area off the west coast of Vancouver Island (Beamish and Chilton 1982) and generally that faster growing marine fish tend to mature at younger ages (Beacham 1982, 1983). The method of age determination is difficult (Beamish and Chilton 1982) and ageing errors cannot be discounted. In 1981, larger members of the 1977 year-class matured and were recruited into the fishable stock. The inclusion of these fish in the 1981 sample tends to reduce average age at maturity and, since they were larger than 60 cm, to increase the average size at maturity. Thus, we have combined the 1980 and 1981 samples, resulting in average length and age at 50% maturity of 58.3 cm and 5.2 yr for females and 52.4 cm and 4.8 yr for males.

At present, a larger year-class (1977) is being recruited into the fishery. Approximately 50 000 of these fish were tagged and released as juveniles. The recovery of tagged fish from 1981 to 1983 may reveal any tendency for fish to mature at larger sizes in northern latitudes and any variation in age at maturity associated with area of residency.

SEX RATIO

The male to female ratio of sablefish collected during prespawning and spawning periods in 1980 and 1981 (mid-November to mid-March) was 1:3. During all other sampling periods, the male to female ratio was 1:1.5.

Individual samples were quite variable. For example, in June 1980, of 1138 fish sampled off the Queen Charlotte Islands, 64% were male, whereas in June 1981 at the same location, a sample of 300 fish was 66% female. Of 412 sablefish collected during November and December 1981 from Queen Charlotte Islands, Queen Charlotte Sound, and Vancouver Island, females composed 64, 78, and 81% of samples, respectively.

Adult females dominate the commercial catch; however, it is doubtful that there are many more females than males in the population. Research samples of 412 and 200 juvenile sablefish collected in inside waters during September 1980 and August 1981 were composed of 50% males and females. Unless there is a differential mortality acting on adult fish

TABLE 3. Mean fork length[a] and age at 50% maturity of sablefish from (a) four cruises in January–March 1980, (b) one cruise bridging November–December 1981, and (c) combined data. Value in parentheses following mean value indicates sample size.

		Mean fork length (cm)		Mean age (yr)	
		♂ (N)	♀ (N)	♂ (N)	♀ (N)
Queen Charlotte Is. (52°N–U.S. border)	(a)	52.8(396)	56.6(1035)	4.5(248)	4.8(774)[b]
	(b)	51.6(240)	61.2(393)	4.2(163)[b]	5.6(276)[b]
	(c)	52.6(636)	56.6(1428)	4.6(411)	5.1(1050)
Queen Charlotte Sd. (50°50′N–52°N)	(a)	51.3(226)	57.5(349)	5.8(81)	6.0(158)[b]
	(b)	54.6(99)	63.4(702)	4.9(60)[b]	4.7(493)[b]
	(c)	51.9(325)	60.4(1051)	5.6(141)[b]	5.6(651)[b]
Vancouver Is. (N) (49°30′N–50°50′N)	(a)	55.6(164)[b]	62.0(95)[b]	6.5(36)[b]	6.0(52)[b]
	(b)	53.1(92)	61.7(415)	3.8(48)	4.6(234)
	(c)	53.1(156)	61.4(510)	3.5(84)	4.5(286)
Vancouver Is. (S) (U.S. border–49°30′N)	(a)	52.3(233)	56.0(609)	4.0(65)	5.3(187)[b]
	(b)	—	—	—	—
	(c)	52.3(233)	56.0(604)	4.0(65)	5.3(187)
Weighted mean	(a)	52.5(919)	56.8(2083)	4.8(430)	5.1(1171)
	(b)	52.6(431)	62.4(1510)	4.3(271)	4.9(1003)
	(c)	52.4(1350)	58.3(3593)	4.8(701)	5.2(2173)
Mean	(a)	53.0(4)	58.0(4)	5.2(4)	5.5(4)
	(b)	53.1(3)	62.1(3)	4.3(3)	5.0(4)
	(c)	52.5(4)	58.6(4)	4.5(4)	5.1(4)

[a]To correct fork length to weight use the regression $W_g = 1.4 \times 10^{-6} \times FL^{3.5025}$ (Beamish et al. 1980) or $W_{kg} = 0.1923 \times 10^{-2} \times FL^{3.4638}$ (Kodolov 1976).
[b]Not determined by probit analysis.

after maturity, it is probable that the male to female ratio of the stock is equal and that the bias towards females encountered in commercial samples reflects selective trapping: relatively higher feeding or congregating activity of females, preferences of fishermen to catch larger fish, which are mostly females, etc.

FECUNDITY

Standard errors of the mean egg counts for fecundity estimates ranged between 0.6 and 4.0% of the means and were less than 2.5% in nearly 85% of the 55 counts. The variability of the enumeration technique compares favorably with that reported for Wiborg's whorling vessel (Wiborg 1951) as evaluated by Pitt (1963) for mature eggs of the American plaice (*Hippoglossoides platessoides*), which averaged 0.8 mm in diameter in Gilson's fluid. Pitt's test was applied to eggs from a single female and his standard error amounted to 2.2% of the general mean count drawn from 24 subsamples.

The fecundity estimates were regressed against fork length and increased with fork length where FL = fork length in centimetres according to the equation $F = 1.11987FL^{2.8244}$. The correlation coefficient (r) for the regression was 0.78. The smallest and largest females (57.9 and 115.0 cm) gave minimum and maximum fecundities of 58 200 ± 931 and 977 000 ± 16 400 maturing eggs. The average-sized female in the commercial fishery (70 cm) (R. J. Beamish, unpublished data) thus produces some 195 000 ripe eggs during the spawning season.

Although the scant information on fecundity reported in the literature cannot be compared extensively with our results, due in part to the lack of described quantitative methods, it is of some interest to consider it. Reported fecundities are higher than those presented here. The fecundity of three females taken in the Bering Sea by Kodolov (1968) is some 40–60% higher than for average females of equivalent size in this study. Females <80 cm in this study contained no more than 285 000 large eggs although two of Kodolov's fish (72.5 and 74 cm) had fecundities of 438 000 and 468 000 eggs, respectively. His third fish (82.5 cm) contained 503 000 eggs whereas the most fecund female <83 cm from Canadian waters contained only 485 000 eggs. Similarly, Kodolov (1976) reported a fecundity of 330 000 and 400 000 eggs for 70-cm females taken in the Gulf of Alaska and off Oregon–Washington, respectively, compared with 195 000 eggs (present study). Phillips and Imamura (1954) gave representative fecundities for California females of 100 000 and 1 million eggs for 21-in. (53.3 cm) and 40-in. (101.6 cm) lengths. The estimate for the smaller fish compares favorably with that derived from the present fecundity equation (90 303 eggs) but the larger fish, like Kodolov's, is some 55% more fecund than the average Canadian female of that size, as projected from the equation (641 416 eggs). However, the available data preclude an accurate comparison of larger fish due to their scarcity in the present study as well as in the existing literature. Only three females >90 cm FL were available in the sample.

EARLY LIFE HISTORY

Our findings suggest that most sablefish spawn along the slope at depths generally exceeding 300 m. Egg descent during embryological development appears probable with hatching occurring predominantly at depths exceeding 400 m.

From January to late April 1980, average hydrographic conditions at depths from 300 to 750 m included temperatures ranging from 6.5 to 3.8°C and decreasing northward (a trend discernible despite local events occurring at depth), salinities ranging from 33.7 to 34.4‰, and sigma-*t* values ranging from 26.6 to 27.1, the last two parameters showing no latitudinal trends. Therefore, spawning, embryological development, hatching, and early posthatching life history stages take place below the relatively more dynamic upper waters, at temperatures and salinities generally below 6°C and above 34.0‰. Considering the minor hydrographic changes at depths exceeding 500–600 m with latitude, it is not surprising that a noticeable latitudinal trend in reproductive timing from California to Canada is absent.

After hatching, the young stages move into the surface waters and may be transported offshore or to shallow inshore regions. Four juveniles ranging from 21 to 35 mm were taken at the surface in late May, some 370 km seaward of Cascade Head, OR, by Brock (1940). Four larvae (9–10 mm) were captured in surface tows using a modified neuston sampler after Sameoto and Jaroszynski (1969) at two Line "P" stations some 70 and 175 km offshore in late March 1982 (J. C. Mason, unpublished data).

Juvenile sablefish have been observed recently in inside waters of British Columbia. On July 9, 1981, a series of surface tows using the neuston sampler caught nine juvenile sablefish in the entrance to Queen Charlotte Sound (51°37′N, 130°2′W). These juveniles ranged from 39 to 72 mm with an average length of 53 mm. Beamish and Chilton (1982) observed juveniles (5–9 cm) in Queen Charlotte Sound early in August. Despite the absence of major inshore surface currents during the summer months due to prevailing northwest winds producing offshore transport, passive onshore movement could occur in a countercurrent flow at the bottom of the mixed layer (100–150 m).

The 1977 age-class was found in great abundance that summer in Queen Charlotte Sound, Hecate Strait, and the mainland inlets (Beamish et al. 1980), indicating that large-scale onshore movement may occur subsequent to movement of the postlarvae into the surface waters.

These observations indicate that after hatching in March and April in British Columbia waters, sablefish larvae ascend to the surface and may be found as postlarvae at considerable distances offshore, well beyond the seaward boundaries of the spawning grounds (<55 km offshore). As juveniles, they can be found in inshore or inside waters at least by midsummer, possibly earlier, as some of the larvae captured on the outer shelf in April were taken shoreward of the egg distribution. The juveniles may remain inshore and in great abundance until they mature several years later. Preliminary observations (tag returns) of the movements of the abundant 1977 age-class indicate a return to the spawning grounds as adults.

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