Seasonal Occurrence of Deep-sea Bathylagid Fishes in Sagami Bay, Central Japan, with Notes on Their Reproduction

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Abstract One hundred and thirty-four deep-sea oblique-haul samples in Sagami Bay, central Japan, between 1968 and 1988, yielded 441 specimens of bathylagid fishes, mostly larvae, of the following five species: *Bathylagus ochotensis*, *B. pacificus*, *B. milleri*, *B. bericoides*, and *Leuroglossus schmidti*. Of these, *B. ochotensis* ($n=372$) was the most numerically dominant, followed by *B. pacificus* ($n=35$), *B. milleri* ($n=18$), *L. schmidti* ($n=14$) and *B. bericoides* ($n=2$). Larval occurrences of these species exhibited clear seasonality, with *B. ochotensis* being most abundant during November-April; in the other four species, such occurrences were restricted to several months, *viz.* February-May in *B. pacificus*, November-March in *B. milleri*, December-January in *L. schmidti* and March in *B. bericoides*, the data apparently reflecting annual synchronous reproduction. Sexually mature males and females were found only in two bathypelagic species (*B. pacificus* and *B. milleri*), although their occurrences, which were restricted to several months between July and December, barely overlapped those of their respective larvae (November-May overall). Furthermore, no immature adults of the latter two species, intermediate between the juvenile and mature adult size ranges (27-48 and 134-207 mm standard length [SL], respectively), were collected, suggesting that they undergo ontogenetic migrations, either below the capture depths ($>$1,200-1,300 m) or to more oceanic waters outside the bay (or both), until they attain sexual maturity.

Deep-sea fishes of the family Bathylagidae are one of the more common components of oceanic or slope midwater fish assemblages. The family currently comprises some 20 or more species (Kobylyanskiy, 1985, 1990; Kobyliansky, 1986; Olivar et al., 1993) that are widely distributed in meso- and bathypelagic depths from subarctic/antarctic waters to equatorial latitudes, although there has been no consensus regarding their generic arrangement to date (see contrasting view points by Dunn, 1983; Ahlstrom et al., 1984; Kobyliansky, 1986). Despite their ubiquity and relative importance in midwater fish assemblages, biological information is restricted to scattered observations, except for those on a few, shallow-living, "light" colored species, such as *Leuroglossus schmidti* in the Strait of Georgia, British Columbia, Canada (Mason and Phillips, 1985) and *Bathylagus ochotensis* in Sagami Bay, central Japan (Miya, 1994).

During the study of *Bathylagus ochotensis* biology in Sagami Bay (Miya, 1994), several tens of other bathylagid specimens were collected in 90 deep-sea, oblique-haul samples. Examination of these specimens plus material from an additional 44 oblique-haul samples from the bay, revealed that a further four bathylagid species occurred seasonally in Sagami Bay, apparently indicating their annual synchronous reproduction.

This paper describes and compares seasonal occurrences of the five bathylagid species (*Bathylagus ochotensis*, *B. pacificus*, *B. milleri*, *B. bericoides*, and *Leuroglossus schmidti*) in Sagami Bay. Some reproductive aspects, such as sexual maturity, fecundity and egg diameter, are also noted for the two bathypelagic species (*B. pacificus* and *B. milleri*). A total of 441 specimens of the five species, collected by 134 deep-sea, oblique hauls over two decades (1968-1988) from a fixed station and adjacent waters in Sagami Bay, formed the basis of the study.

Materials and Methods

Study site.—All samples were collected at a fixed station near the center of Sagami Bay (35°00′N, 139°20′E, ca. 1,500 m depth, see fig. 1 in Miya, 1994) or in adjacent waters within the bay. Sagami Bay, located about mid-way along the length of

Japan, opens to the Pacific Ocean through the Oshima-West and East channels. Descriptions of oceanographic features and seasonal changes in water temperature at the station are given in Miya and Nemoto (1991).

Monthly samplings.—A total of 104 oblique hauls were made during 31 cruises from January 1968 to August 1984, using a large conical plankton net (ORI net: mesh size, 0.33–1.0 mm; mouth diameter, 160 cm; Omori, 1965) (for details, see Table 1 and table 2 in Miya and Nemoto, 1986). Wire (1,000–2,000 m) was paid out at a speed of 0.8–1.0 m s^{-1} and retrieved at the same speed. The ship speed was 2.0–2.5 knots while the net was sinking and 1.0–1.5 knots

Table 1. Oblique-haul sampling data from Sagami Bay. Data listed in Miya (1994) and Miya and Nemoto (1986, 1987, 1991) are excluded

Cruise	Date	Latitude/Longitude	Gear	Time	Sampling depth (m)
KT-68-1	20 Jan. 1968	35°00.9′N, 139°21.4′E	ORI-100	1826–1936	0–780
KT-68-6	14 Apr. 1968	35°00.3′N, 139°19.5′E	ORI-100	1428–1500	0–310
KT-71-1	19–20 Jan. 1971	34°59.3′N, 139°14.7′E	ORI-33	2340–0108	0–800
KT-71-6	26 May 1971	35°10.5′N, 139°20.2′E	ORI-33	0513–0655	——
KT-71-6	27 May 1971	34°58.4′N, 139°22.7′E	ORI-33	0313–0435	0–1480
KT-71-12	17 Aug. 1971	35°02.6′N, 139°17.6′E	ORI-33	1415–1543	0–800
KT-71-12	18 Aug. 1971	34°50.5′N, 139°29.8′E	ORI-33	1011–1130	0–1000
KT-71-17	12 Nov. 1971	34°49.0′N, 139°30.8′E	ORI-33	1843–2010	0–1500
KT-71-17	12–13 Nov. 1971	35°01.2′N, 139°20.1′E	ORI-33	2213–0034	0–1050
KT-71-17	15 Nov. 1971	34°54.7′N, 139°39.0′E	ORI-100	0915–1030	0–1200
KT-72-16	30 Oct. 1972	35°02.5′N, 139°21.3′E	ORI-100	2157–2304	——
KT-73-6	9–10 June 1973	34°49.4′N, 139°30.0′E	ORI-33	2255–0035	0–1300
KT-75-14	25 Sept. 1975	35°14.8′N, 139°19.1′E	ORI-100	2030–2108	0–1320
KT-75-14	26 Sept. 1975	35°00.9′N, 139°21.0′E	ORI-100	0055–0219	0–600
KT-77-13	14 Sept. 1977	35°12.0′N, 139°19.1′E	ORI-100	1633–1733	0–850
KT-77-13	15 Sept. 1977	34°59.8′N, 139°17.7′E	ORI-100	2055–2206	0–850
KT-78-16	31 Oct. 1978	34°52.5′N, 139°31.0′E	ORI-100	2018–2150	0–800
KT-78-16	31 Oct. 1978	34°46.2′N, 139°31.7′E	ORI-100	2245–2358	0–450
KT-78-16	4 Nov. 1978	35°12.9′N, 139°20.1′E	ORI-100	2133–2243	0–820
KT-78-16	4–5 Nov. 1978	35°19.5′N, 139°17.8′E	ORI-100	2320–0043	0–800
KT-78-16	5 Nov. 1978	35°03.4′N, 139°20.0′E	ORI-100	0140–0250	0–900
KT-78-16	5 Nov. 1978	34°59.8′N, 139°23.6′E	ORI-100	0325–0439	0–750
KT-80-2	20 Feb. 1980	35°13.9′N, 139°20.0′E	ORI-69	2144–2230	0–466
KT-80-2	20 Feb. 1980	35°09.3′N, 139°19.8′E	ORI-69	2322–2359	0–499
KT-80-2	21 Feb. 1980	35°04.3′N, 139°19.7′E	ORI-69	0057–0134	0–466
KT-80-2	21 Feb. 1980	34°59.9′N, 139°21.1′E	ORI-69	0230–0307	0–466
KT-80-2	21 Feb. 1980	34°54.5′N, 139°24.7′E	ORI-69	0423–0505	0–576
KT-80-2	24 Feb. 1980	35°09.4′N, 139°28.7′E	ORI-69	2305–2345	0–410
KT-80-2	25 Feb. 1980	35°12.2′N, 139°15.1′E	ORI-69	0126–0205	0–583
KT-80-4	15 Mar. 1980	35°10.0′N, 139°19.1′E	ORI-100	1331–1406	0–434
KT-80-4	15 Mar. 1980	35°10.0′N, 139°19.1′E	ORI-69	1331–1406	0–434
KT-80-4	15 Mar. 1980	35°14.3′N, 139°19.9′E	ORI-69	1938–2020	0–506
KT-80-4	15–16 Mar. 1980	35°10.1′N, 139°22.3′E	ORI-69	2331–0006	0–583
KT-80-4	16 Mar. 1980	35°00.2′N, 139°21.1′E	ORI-69	0238–0254	0–415
KT-80-5	18 Apr. 1980	35°01.1′N, 139°20.1′E	ORI-69	1926–2011	0–437
KT-80-5	18 Apr. 1980	35°10.9′N, 139°19.9′E	ORI-69	2130–2216	0–377
KT-80-5	18 Apr. 1980	35°14.7′N, 139°20.4′E	ORI-69	2310–2356	0–379
KT-80-11	6 July 1980	35°02.4′N, 139°21.1′E	ORI-100	1616–1823	0–1500
KT-80-11	6 July 1980	35°10.6′N, 139°20.2′E	ORI-69	2036–2117	0–580
KT-80-11	6 July 1980	35°14.4′N, 139°19.8′E	ORI-69	2230–2310	0–525
KT-80-11	7 July 1980	34°59.5′N, 139°20.3′E	ORI-69	0134–0220	0–558
KT-80-11	7 July 1980	35°11.0′N, 139°21.5′E	ORI-69	1437–1545	0–830
KT-82-7	23 June 1980	35°04.8′N, 139°22.1′E	ORI-100	0055–0125	0–500
KT-82-7	23 June 1980	35°05.1′N, 139°21.7′E	ORI-69	0551–0723	0–700

during retrieval. The volume of water filtered, monitored by a flowmeter mounted within the mouth, ranged from 2,900 to 16,700 m^3, with a mean volume of 8,160 m^3. The maximum depths fished by the nets were estimated from the records of the Time-Depth meter, or, if such were unavailable, from the wire angle during towing. The maximum depth varied from 310 to 1,500 m, with an average depth of 930 m.

A total of 30 oblique hauls were made during eight cruises, from December 1984 to July 1988, alternatively using an Isaacs-Kidd plankton trawl (IKPT; Loeb, 1979) with a mouth area of 7.32 m^2 and a mesh opening of 0.5 mm (for details, see Miya and Nemoto, 1986, 1987, 1991; Miya, 1994). The IKPT was towed obliquely from the surface to 730–1,410 m (average depth, 1,110 m) from two to eight times during each cruise. Each tow was monitored with a Time-Depth meter equipped with a temperature sensor (Tsurumi Seiki Co., Ltd., Yokohama, 2000-m model). The towing method was as used for the ORI net, except for the length of wire paid out; 2,000 to 3,000 m in the IKPT tows. The volume of water filtered ranged from 20,500 to 44,800 m^3, with a mean volume of 37,280 m^3.

Sample processing.—The samples were fixed in 5–10% buffered formalin seawater immediately after collection, later transferred to 70% ethanol for preservation and eventually deposited at the Natural History Museum and Institute, Chiba, Japan. All bathylagid specimens were separated from the plankton samples, but no attempt was made to sort the eggs. The larval specimens were identified to species using diagnostic features given by Okiyama (1988) and Matarese et al. (1989). They were counted and standard length (SL) measured to the nearest 0.1 mm. Possible shrinkage after preservation with ethanol was not taken into account. Larvae were divided into the following five stages according to the general criteria given by Kendall et al. (1984): yolk-sac, preflexion, flexion, postflexion, and transformation stages. The transformation stage was defined as the period from the onset of loss of the eye-stalks to the completion of peritoneum pigmentation. Sexually indeterminate individuals completing the transformation stage were arbitrarily defined as juveniles. When fully mature females (just prior to hydration) were available, fecundity was estimated by counting the total number of eggs in the largest size class and measuring diameters (largest axis) to the nearest 0.01 mm of at least 30 ova using an ocular micrometer.

Results

All data were pooled for respective months in order to examine seasonality of occurrences, although bathylagid abundance was not standardized because of the scarcity of specimens. Instead, total volumes of water filtered by the nets and the number of tows in each month provided rough guides to sampling efforts, which differed considerably between month (see Tables 2–5).

In the following species accounts, the generic arrangement advocated by Ahlstrom (1969) and Borodulina (1969), later upheld by Dunn (1983), in which two distinct genera (*Bathylagus and Leuroglossus*) are recognized within the family, was followed.

Bathylagus ochotensis (Table 2; $n = 372$)

A total of 277 larvae, 79 juveniles, seven males and nine females were collected. Larval occurrence was restricted to October–June, with abundance peaking somewhere between November and April. Miya (1994) showed monthly changes of standardized abundances of *Bathylagus ochotensis* for each larval stage and found that preflexion and flexion larvae tended to occur a little earlier (mainly October–February) than postflexion and transformation larvae (mainly November–March) in Sagami Bay. There was no indication of seasonality in occurrences of juvenile and adult *B. ochotensis.*

Bathylagus pacificus (Table 3; $n = 35$)

A total of 15 larvae (all preflexion), six juveniles, three males and 11 females were collected. Larval occurrence was restricted to February–May. There was no indication of seasonality in juvenile occurrence, although males and females were collected only from July to March. All males and females taken during August–December had attained sexual maturity, indicated by milt-filled testes and ovaries with yolked ova (mean diameter >0.61 mm); four spent, but recovering females taken during February–March had somewhat flaccid ovaries containing numerous developing ova. Total fecundity counts based on three females (150–168 mm SL) ranged from 2,051 to 4,933 with mean diameters of 0.91–1.04 mm (Table 6). One female (156 mm SL) collected in December had ovaries with approximately two hundred fully hydrated ova with a mean diameter of 1.57±0.06 SD (mm). It seemed likely that this female was caught during spawning because of relatively low number of ovarian eggs. Since there were no smaller-sized ova in this specimen, multiple spawnings within a single year seem unlikely. Sexual size dimorphism was evidenced by the smaller males (134–143 mm SL) and larger females (150–207 mm SL).

Bathylagus milleri (Table 4; $n=18$)

A total of 10 larvae (all preflexion), one juvenile,

Table 2. Pooled monthly catch data of *Bathylagus ochotensis.* Numerals indicate numbers

	Jan.	Feb.	Mar.	Apr.	May	June
Total VWF*	49,287	49,538	89,413	41,645	176,966	185,487
No. of tows	5	10	12	7	13	14
Larvae	34 (6.1–15)	31 (7.1–16)	19 (7.0–19)	6 (9.3–19)	7 (15–19)	1 (17)
Juveniles	2 (20–21)	11 (20–54)	13 (20–67)	12 (20–25)	3 (20–28)	5 (21–35)
Adults (♂)	——	1 (60)	——	1 (98)	——	——
Adults (♀)	1 (86)	——	——	——	——	1 (97)

* Total volume of water filtered by oblique tows (m^3).

Table 3. Pooled monthly catch data of *Bathylagus pacificus.* Numberals indicate numbers

	Jan.	Feb.	Mar.	Apr.	May	June
Total VWF*	49,287	49,538	89,413	41,645	176,966	185,487
No. of tows	5	10	12	7	13	14
Larvae	——	3 (5.7–7.2)	8 (5.4–8.4)	3 (6.1–8.1)	1 (7.0)	——
Juveniles	——	1 (29)	——	——	——	——
Adults (♀)	——	——	——	——	——	——
Adults (♂)	——	1 (207)	3 (161–176)	——	——	——

* Total volume of water filtered by oblique tows (m^3).

Table 4. Pooled monthly catch data of *Bathylagus milleri.* Numerals indicate numbers

	Jan.	Feb.	Mar.	Apr.	May	June
Total VWF*	49,287	49,538	89,413	41,645	176,966	185,487
No. of tows	5	10	12	7	13	14
Larvae	——	1 (9.2)	2 (9.1–9.2)	——	——	——
Juveniles	——	——	——	——	1 (27)	——
Audlts (♀)	——	——	——	——	——	——
Adults (♂)	——	——	——	——	——	——

* Total volume of water filtered by oblique tows (m^3).

Table 5. Pooled monthly catch data of *Leuroglossus schmidti* (upper) and *Bathylagus bericoides* (lower). Numerals

	Jan.	Feb.	Mar.	Apr.	May	June
Total VWF*	49,287	49,538	89,413	41,645	176,966	185,487
No. of tows	5	10	12	7	13	14
Larvae	2 (8.5–11.5)	——	——	——	——	——
Juveniles	——	——	——	1 (51)	——	——
Larvae	——	——	2 (9.0–9.1)	——	——	——

* Total volume of water filtered by oblique tows (m^3).

three males and two females were collected, larval occurrence being restricted to several months between November and March, except for January when sampling effort was relatively low. Male and female occurrence barely overlapped that of larvae, being restricted to July–November, except for September. All males and females had attained sexual maturity. Total fecundity counts based on three females ranged from 1,058 to 2,244 (167–195 mm SL) with mean ova diameters of 1.22–1.49 mm (Table 6). There were no hydrated ova in these specimens. Sexual size dimorphism, as in *B. paci-*

of individuals collected in respective months. Size ranges (mm SL) given in parentheses

July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
237,502	145,895	170,999	79,030	557,596	00,346	
11	16	8	7	26	5	
——	——	——	1 (7.8)	151 (4.8–19)	27 (7.9–21)	277 (4.8–21)
16 (27–60)	7 (21–29)	2 (27–61)	1 (24)	2 (32–43)	5 (29–35)	79 (20–67)
2 (64–73)	2 (59–79)	——	——	1 (76)	——	7 (60–98)
——	3 (56–105)	——	——	2 (68–101)	2 (61–83)	9 (56–105)

of individuals collected in respective months. Size ranges (mm SL) given in parentheses

July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
237,502	145,895	170,999	79,030	557,596	100,346	
11	16	8	7	26	5	
——	——	——	——	——	——	15 (5.4–8.1)
——	3 (32–48)	——	——	2 (30–39)	——	6 (29–48)
——	1 (136)	1 (143)	——	1 (134)	——	3 (136–143)
2 (169–190)	1 (150)	——	——	3 (159–168)	1 (156)	11 (150–207)

of individuals collected in respective months. Size ranges (mm SL) given in parentheses

July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
237,502	145,895	170,999	79,030	557,596	100,346	
11	16	8	7	26	5	
——	——	——	——	1 (7.8)	6 (6.3–8.8)	10 (6.3–9.2)
——	——	——	——	——	——	1 (27)
1 (147)	——	——	1 (143)	1 (144)	——	3 (143–147)
——	4 (167–195)	——	——	——	——	4 (167–195)

indicate numbers of individuals collected in respective months. Size ranges (mm SL) given in parentheses

July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
237,502	145,895	170,999	79,030	557,596	100,346	
11	16	8	7	26	5	
——	——	——	——	——	2 (11.7–12.1)	4 (8.5–12.1)
——	6 (29–43)	——	1 (31)	1 (32)	1 (31)	10 (29–51)
——	——	——	——	——	——	2 (9.0–9.1)

ficus, was evidenced by the smaller males (143–147 mm SL) and larger females (167–195 mm SL).

Leuroglossus schmidti (Table 5; $n=14$)

An overall total of four larvae (all postflexion) and 10 juveniles were collected. Although few specimens were available, larval occurrence was restricted to December–January. There was no clear evidence of seasonality in juvenile occurrence.

Bathylagus bericoides (Table 5; $n=2$)

Two larvae were collected, in March, both at the preflexion stage.

Discussion

Six bathylagid species (*Bathylagus ochotensis*, *B. pacificus*, *B. milleri*, *B. bericoides*, *B. longirostris*, and *Leuroglossus schmidti*) occur in Japanese waters (Uyeno, 1984), five of which, mostly represented by larvae, were collected during the present study. *Bathylagus bericoides*, the least abundant species in Sagami Bay, has previously been recorded only east of the Ogasawara Islands in Japanese waters (Uyeno, 1984), the present two specimens therefore representing the second record from Japan. The other four species are commonly encountered in deep-sea, midwater fish collections from Japanese waters.

Seasonality of larval occurrence was clearly evident in the five species: *B. ochotensis* was most abundant during November–April; in the other, less abundant species, larval occurrences were restricted to several months, during February–May in *B. pacificus*, November–March in *B. milleri*, December–January in *L. schmidti*, and March in *B. bericoides*, all of these periods falling between late autumn and late spring. Seasonality in larval occurrence is likely to occur for shallow-living, "light" colored species, such as *B. ochotensis* and *L. schmidti*, as previously shown by Miya (1994) and Mason and Phillips (1985), respectively, although such was unexpected for the deep-living, "dark" colored species (*B. pacificus*, *B. milleri*, and *B. bericoides*) because of the inconsequential effects of surface seasonal phenomena in deeper waters. No factors responsible for such seasonality in the three bathypelagic species were apparent. Nevertheless, clear evidence supports the existence of annual synchronous reproduction in *B. milleri* and some other bathypelagic species off Southern California (Childress et al., 1980) and in lower meso- and bathypelagic species, such as *Cyclothone atraria* (Miya and Nemoto, 1987, 1991). Small differences in the periods of larval occurrence among the five Sagami Bay species probably reflect differences in the spawning seasons.

Perhaps significantly, not only did larval occurrences of the two bathypelagic species exhibit marked seasonality, but also occurrences of their respective, sexually mature adults were restricted to several months (between July and December in *Bathylagus pacificus* and between July and November in *B. milleri*), which barely overlapped those of the larvae. Four recovering-spent female *B. pacificus* were also taken during February–March, indicating that all of the adults had attained sexual maturity. Also of interest were the absence from the samples of immature adult specimens of size intermediate between juveniles (27–48 mm SL), and mature adults (134–207 mm SL), in the two bathypelagic species. In their growth analyses of *B. milleri* from basins off Southern California, Childress et al. (1980) similarly found no intermediate-sized individuals (between ca. 30 mm SL [$n=1$] and 140–170 mm SL [$n=33$]), despite extensive collections. Their growth curve, however, derived from otolith rings, indicated that

Table 6. Total fecundity counts and egg diameters of *Bathylagus pacificus* (upper) and *B. milleri* (lower)

SL (mm)	Right ovary	Left ovary	Total	Egg diameter (mm)*
150	874	1177	2051	0.91±0.06
165	—	—	2509	0.93±0.03
168	2436	2497	4933	1.04±0.19
167	—	—	1360	1.25±0.10
183	—	—	1058	1.22±0.05
195	—	—	2244	1.49±0.04

* Mean±SD.

ages of 1 and 2 year could be assigned to ca. 70 mm SL and 115 mm SL, respectively, the size intervals corresponding closely to the present "intermediate" size ranges in both *B. milleri* and *B. pacificus*. Therefore it was improbable that growth rates in these bathypelagic species was so rapid between the juvenile and sexually mature stages that it generated an "apparent" absence of intermediate-sized individuals. On the contrary, the absence of intermediate-sized individuals suggests that *B. pacificus* and *B. milleri* undergo ontogenetic migration below the capture depths (mostly >1,200–1,300 m) or to more oceanic waters outside the bay (or both), until they attain sexual maturation.

Some contrary evidence, however, was provided by Berry and Perkins (1966) and Willis and Pearcy (1982). The former found several intermediate-sized individuals of *B. pacificus* (65.5–92.2 mm SL) among smaller (30–57 mm SL) and larger individuals (127–149 mm SL), although there were no such *B. milleri* individuals (37.5–45.5 vs. 86–179 mm SL), off Southern California. Willis and Pearcy (1982) collected numerous intermediate-sized individuals of *B. milleri* and less numerous, but still substantial, numbers of similar *B. pacificus* off Oregon, while using exceptionally large, midwater trawls (mouth area, $50\,m^2$). Verification of whether or not these contrasting data reflect local differences or simply sampling biases requires further sampling effort at bathypelagic depths throughout the year. It should also be noted that despite the species predominance over the other four bathylagid species in Sagami Bay, relatively few adult specimens of *Bathylagus ochotensis* were found in the present samples. Miya (1994) suggested that the main spawning ground of this species is located along the coastal area of the bay.

Miya (1994) noted that larval *Bathylagus ochotensis* did not occur in the upper 200-m layer in Sagami Bay, instead remaining in the upper mesopelagic zone (ca. 300–600 m) during both day and night. No comparable data exists for the other four species, although preflexion larvae of *B. pacificus* and *B. milleri* were collected from depths of 525–585 m (at night) and 842–921 m (during the day), respectively, in February 1983 (Miya, unpublished data). Since there is no evidence for the epipelagic occurrence of larvae in these two species (the shallowest catch was an oblique haul with a maximum depth of 392 m), their larvae apparently occur in the mesopelagic zone in Sagami Bay as in *B. ochotensis*. However, such phenomena are likely to be regional in nature, rather than representing consistent features of these bathylagid species, since for *B. ochotensis* at least much contradictory evidence is available (Miya, 1994).

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相模湾における中・深層性ソコイワシ科魚類の季節的出現とその生殖に関する二，三の知見

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1968 年から 1988 年にかけて相模湾で行われた 134 回の中・深層傾斜曳き採集により，計 441 個体の主として仔魚からなる 5 種のソコイワシ科魚類（*Bathylagus ochotensis*, *B. pacificus*, *B. milleri*, *B. bericoides* および *Leuroglossus schmidti*）が採集された．これらのうち，*B. ochotensis* が最も卓越し（$n=372$），*B. pacificus*（$n=35$），*B. milleri*（$n=18$），*L. schmidti*（$n=14$），*B. bericoides*（$n=2$）がそれに続いた．いずれの種においても仔魚の出現の季節性は明瞭で，*B. ochotensis* では 11 月から 4 月にかけて比較的個体数が多く，他の 4 種でも *B. pacificus* では 2–5 月に，*B. milleri* では 11–3 月に，*L. schmidti* では 12–1 月に，また *B. bericoides* では 3 月に出現が限られていた．このような仔魚の季節的出現パターンは，それぞれの種の生殖周期を反映したものと考えられた．2 種の深層種（*B. pacificus* と *B. milleri*）では，仔魚とともに成魚も採集されたが，その成熟個体の出現時期（7–12 月）は仔魚の出現時期（11–5 月）とほとんど重複せず，またこれら 2 種の稚魚（27–48 mm SL）と成魚（134–207 mm SL）のあいだの未成魚はまったく採集されなかった．この成熟個体の出現の顕著な季節性ならびに幼魚と成魚のあいだの大きなサイズのギャップは，これら 2 種が成熟するまでの過程で，ネットの届かない深海（>1,200–1,300 m）か，あるいは湾外への移動のような，なんらかの個体発生的回遊を行っているために生じることが示唆された．

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