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Larval Distribution of Walleye Pollock, *Theragra chalcogramma* (Pallas), in the Bering Sea, with Special Reference to Morphological Changes*

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Abstract

The distribution and morphology of walleye pollock [*Theragra chalcogramma* (Pallas)] larvae collected in surface larva net tows and mid-water trawls in the Bering Sea during June to August, 1970–1974, were studied. Pollock larvae were widely found over the Bering Sea, but were most abundant on the shelf region of the southeastern Bering Sea along the continental slope from Unimak Island to Cape Navarin. The larvae ranged in size from 5.1 mm to 97.1 mm long. The mean length was 16.3 mm in June and 18.9 mm in July. The July group had a wider deviation. Length-weight relationships were established. The data shows an inflection point at 7–8 mm size. The formulas are $\log W = 6.3694 \log BL - 5.3227$ for the size range of 5–8 mm fish and $\log W = 3.3512 \log BL - 2.6283$ for the size of the 8–39 mm fish. The inflection point corresponds with the appearance of the caudal fin rays. Pollock larvae were assigned to postlarval, juvenile and young stages primarily based upon the development of the fin rays. The fin rays reached the full number at about 22 mm in length, indicating a transition from postlarval stage to juvenile stage. In the southern part of the Bering Sea pollock larvae of late postlarval stage through juvenile stage were common, whereas in the northern part of the sea the larvae of early postlarval stage were predominant.

Introduction

In the eastern Bering Sea the spawning grounds of walleye pollock extend from Unimak Island to 170°W longitude between the 50 m and 300 m isobaths. The pollock begins to spawn at the end of February and mass spawning lasts from late March to the middle of June.[1)2)] The most intense spawning takes place from mid-April until the end of May.[3)] In the northwestern Bering Sea pollock eggs were collected in the Gulf of Anadyr and Olyutorskii Bay between June and September.[4)5)6)] Moiseev[7)] indicated that the spawning ground was on the continental slope south of Cape Navarin.

Ichthyoplankton surveys have provided information on the distribution of pollock larvae in the Bering Sea. Musienko[5)] and Kashkina[6)] indicated that

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during March to September pollock larvae occurred on the shelf region adjacent to the continental slope. According to Waldron and Favorite[8] and Waldron and Vinter[9] pollock larvae were concentrated on the continental slope and outer shelf regions in the southeastern Bering Sea in late April and May. Kobayashi[10] and Maeda and Hirakawa[11] reported the occurrence of pollock larvae in the basin area of the Bering Sea. Despite the knowledges on regional distribution, seasonal distribution and abundance have not been clearly documented.

There is little information about the morphological changes of pollock larvae during development. Yamamoto and Hamashima[12] and Yusa[13] have elucidated morphological characteristics of pollock larvae from experimental observations. Hamai et al.[14] reared hatched larvae and examined the effects of temperatures on the development of the larvae. These studies were made on the larvae for only a relatively period after hatching. Takeuchi[15] described the morphological differences of the alimentary canal of 7.7, 17.5 and 42.0 mm larvae taken from the ocean, but did not deal with the relationship between this and other morphological features.

The development of organisms can be divided into several and separate stages. According to Nikolsky[16], every developmental stage of fish is species specific, and morphological and physiological natures of each developmental stage possess its own adaptational meanings to the surrounding environment. Gorbunova[4] analized the process of the development of pollock from larval to young stages and clarified the morphological characters. However, information on morphological aspects of pollock, especially from postlarval through young stages, is still insufficient.

The purpose of the present paper is to profile seasonal distribution and relative abundance of pollock larvae at the surface layer of the Bering Sea. To make clear the seasonal changes, data on the larvae collected in the Bering Sea during the summer[17] were analized. It is also the purpose of this paper to discern the developmental stages of larval pollock relating to the geographical distribution.

Materials and Methods

Ichthyoplankton surveys were made in the Bering Sea during the period between June and August, 1970–1974. The sampling was conducted during the cruises of the *T/S Oshoro Maru*, Hokkaido University, and the *R/V No.* **21** *Habomai Maru* of the Fishery Agency of Japan. These surveys were aimed at obtaining information on the distribution of ichthyoplankton. Published data[17] on fish larvae collection made from 1965 to 1969 were also used. Fish larvae collection were carried out in different areas of the Bering Sea each year. Although the sampling data and survey area varied each year, comparison of seasonal and geographical distribution of the pollock larvae was possible.

Samples were taken using a larva net with a 130 cm mouth diameter and 450 cm in length. The mesh size of this net was 2 mm in the frontal 300 cm and 0.333 mm in the latter 150 cm. Horizontal surface tows were carried out for 10 minutes at a speed of about 2 knots one hour after sunset. During June to July, 1974 mid-water tows were made with a 6-foot Isaacs-Kidd Mid-water Trawl net having a 2 mm mesh in the cod end 250 cm. The depth of these tows was from 20 m to 50 m for 15 to 20 minutes at about 4 knots.

A total of 238 stations consisting of 118 stations in June, 105 stations in July and 15 stations in August were occupied for five years (Table 1). The survey area covered almost the entire Bering Sea (Fig. 1, 2). Collections were made more intensively in the eastern Bering Sea than in the central and western areas. Very few collections were made north of St. Lawrence Island, Nunivak Island, or Norton Sound.

The samples of ichthyoplankton taken were immediately preserved in a 5–10% formaldehyde solution. Pollock larvae were sorted from the samples in the laboratory. The collections contained 15,252 fish larvae with only 1.6% of these pollock larvae. A total of 61 larvae were collected by surface tows (Table 2). Twenty four larvae were caught in June, 36 in July, and only one in August. The number of larvae collected in mid-water trawls accounted for 75% of the total. The body length of the larvae was measured from the end of the snout to the posterior tip of the notochord or the end of the hypural bone. The larvae were weighed to an accuracy of 0.1 mg. The alimentary canal was not removed from the body.

Table 1. *The number of stations occupied for ichthyoplankton collections in the Bering Sea during June to August, 1970–1974. Numbers in parentheses denote sampling locations occupied by mid-water trawls in June-July, 1974.*

Year	Number of stations			
	June	July	August	Total
1970	14	2	8	24
1971	14	10	-	24
1972	28	28	5	61
1973	27	27	2	66
1974	32	33	-	65
	(3)	(5)	-	(8)

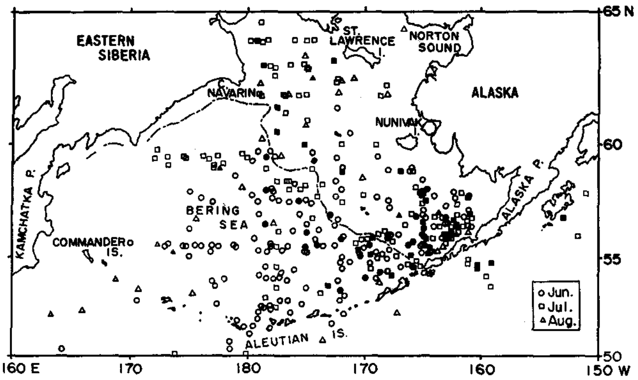

Fig. 1. Locations of larva net surface tows for ichthyoplankton collections in the Bering Sea during June to August, 1963–1974. Closed circles, squares and triangles denote the stations where walleye pollock larvae were obtained in June, July and August, respectively.

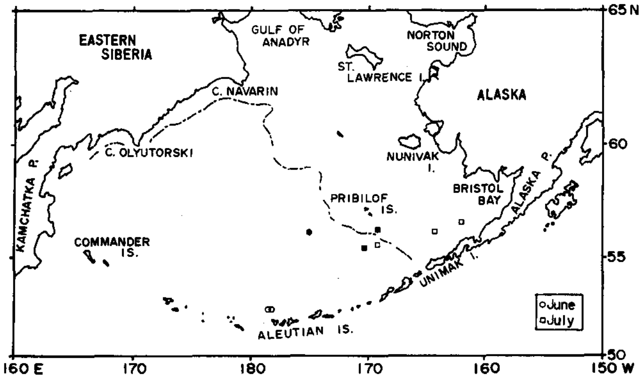

Fig. 2. Locations of mid-water trawls for ichthyoplankton collections in the Bering Sea during June to July, 1974. Closed circle and squares denote the stations where walleye pollock larvae were obtained in June and July, respectively.

Table 2. *The number of walleye pollock larvae collected in surface larva net tows in the Bering Sea during June to August, 1970–1974. Numbers in parentheses denote larvae caught in mid-water trawls in June-July, 1974.*

Year	No. of fish larvae			
	June	July	August	Total
1970	7	0	1	8
1971	0	5	-	5
1972	3	6	0	9
1973	9	5	0	14
1974	5	20	-	25
	(111)	(69)	-	(180)
Total	135	105	1	241

The identification of pollock larvae was made referring to the studies of Schultz and Welander[18], Matsubara[19] and Okada and Kobayashi[20] for the specimens possessing completely developed meristic characters, and of Kobayashi[10], Yamamoto and Hamashima[12], Yusa[13] and Musienko[21] for ones possessing rudimentary meristic characters. A total of 236 larvae were stained in a solution of alizarin[22] to count the number of fin rays.

The developmental stages of the larvae were classified into one of the four stages, i.e. prelarval stage, postlarval stage, juvenile stage and young stage. The postlarval stage was subdivided into five stages in this study. The terminology and definition of the developmental stages was based on Uchida and Dotsu[23] and Watanabe and Hattori[24].

Results

Distribution and relative abundance

Walleye pollock larvae occurred in almost the entire study area (Fig. 1).

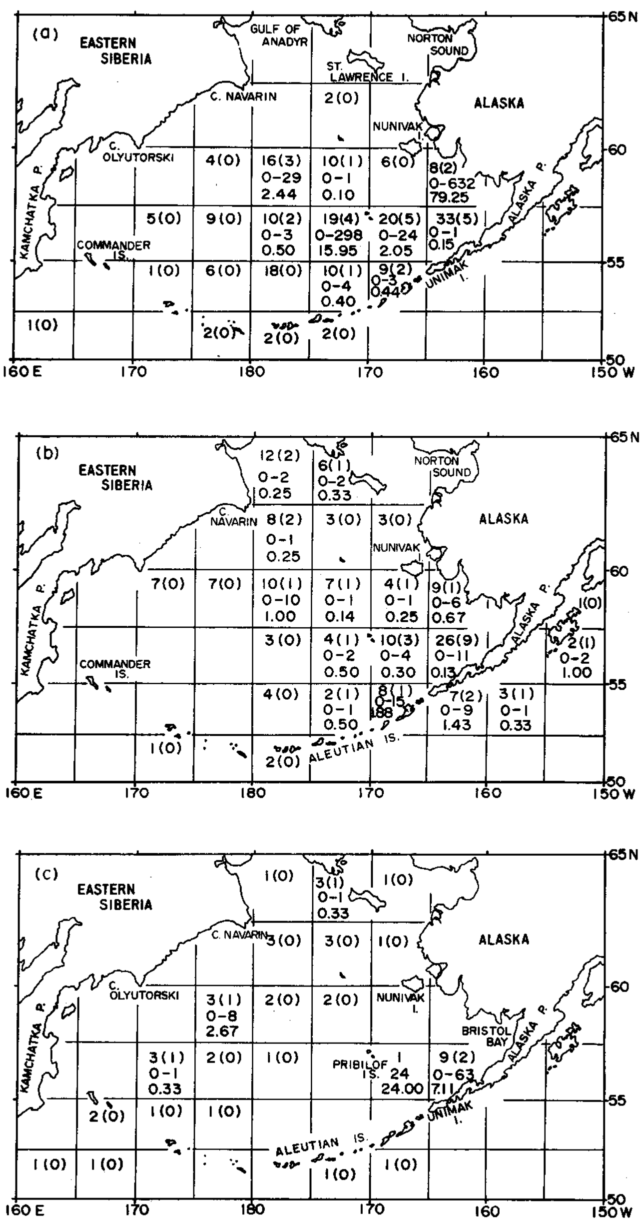

Fig. 3. Relative abundance of walleye pollock larvae in the Bering Sea by 2.5°×5° quadrangles in 1963–1974: (a)-June; (b)-July; (c)-August. The figures in each quadrangle denote the number of hauls (the number of occurrence of pollock larvae), range of the number of pollock larvae collected and the number of pollock larvae per one haul from top to bottom respectively.

The occurrence was most frequent on the shelf region east of the Pribilof Islands near 170°W longitude, and were distributed widely along the continental slope from Unimak Island to Cape Navarin. Very few pollock larvae occurred near the Aleutian Islands. The larvae were also taken in the northern North Pacific Ocean south of the Alaska Peninsula and Kodiak Island.

Determination of the relative abundance was made by dividing the study area into quadrangles of 2.5° latitude by 5° longitude. Figure 3a shows that in June pollock larvae were most abundant in the western part of Bristol Bay and southwest of the Pribilof Islands, and were comparatively abundant in the southeastern parts of the Pribilof Islands and Cape Navarin. Only a few larvae occurred in the other areas. No pollock larvae were taken from the western side of the Bering Sea in June. The north to south distribution in July shows that relatively few pollock larvae were encountered in the eastern Bering Sea (Fig. 3b). Relatively high numbers were found in the southeastern part of Cape Navarin and the western parts of Bristol Bay and Unimak Island. In August the abundance was still high in the north of Unimak Island (Fig. 3c). The larvae also occurred in the western Bering Sea during August where they were absent in June and July. Although pollock larvae were captured in the south of the Alaska Peninsula and Kodiak Island in July, information on the June distribution in these areas was unavailable due to a lack of sampling.

Size composition

Figure 4 shows the size distribution of pollock larvae collected in June and July. The length ranged from 5 mm to 23 mm in June and from 5 mm to 36 mm in July. It is apparent that the median is different between these two months. The mean length was 16.3 mm in June and 18.9 mm in July. The July samples also have a wider deviation. The difference of the means was statistically significant at 0.05 probability level.

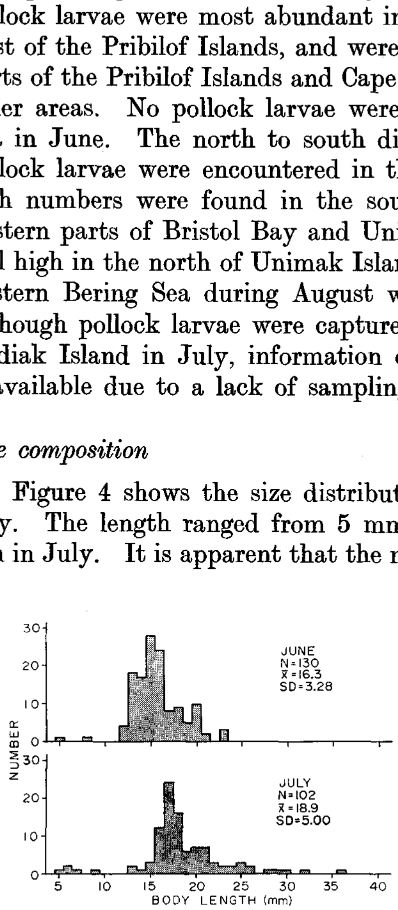

Fig. 4. Size distribution of walleye pollock larvae in the Bering Sea in June and July, 1970–1974.

Length-weight relationship

The log length-log weight relation for pollock larvae is given in Figure 5. From the figure, it is assumed that there is an inflection point at 7–8 mm size. Therefore two curves can be fit for the two size groups. The formula log W= 6.3694 log BL–5.3227 (N=5, r_1=0.9305) is computed for the size range of 5–8 mm and log W=3.3512 log BL–2.6283 (N=101, r_2=0.9782) for the size range of 8–39 mm.

It must be mentioned that in this calculation the gut of the larvae was not removed from the body. It is also well known that length and weight of fish larvae is reduced due to formalin fixation and preservation. The shrinkage of length and the weight loss has been reported to be 1–10% and about 20% respectively in 4% formalin.[25)26)27)] However, in this study these features were not taken into consideration.

Larval stage

The morphological changes during the development of pollock larvae examined in this study were the appearance and the change in the number of fin rays and the presence of a primordial marginal fin. Russell[28)] states that in larval, and especially postlarval stages, the disposition of the melanophores is one of the chief diagnostic characters for identification of species. He also indicates that in the earliest postlarval stage a species specific pigmentation pattern is present which generally persists until the postlarva is assuming meristic characters. Pearcy et al.[29)] report that the developmental stages of flatfish larvae can be separated on the basis of pigment patterns which correspond with eye migration. In the present

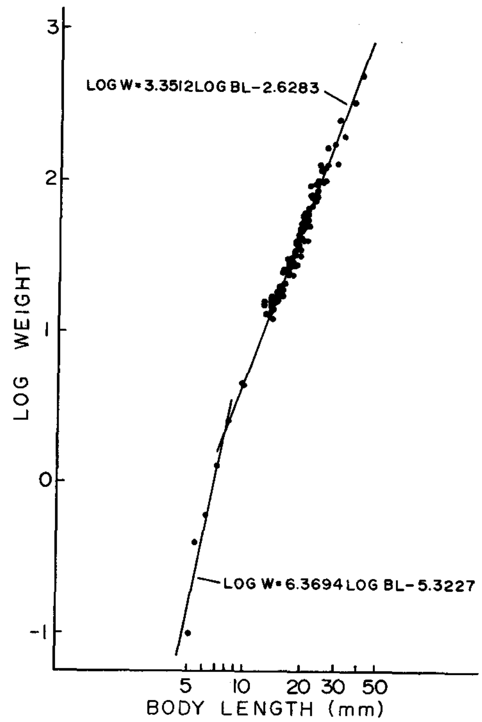

Fig. 5. Log length-log weight relation for walleye pollock larvae caught in the Bering Sea during June to August, 1970–1974.

Table 3. *Range of body length and numbers of the fin rays by developmental stage in walleye pollock larvae. Numbers in parentheses denote mean value.*

Developmental stage	No. of larvae	Body length (mm)	Number of fin rays						
			1st Dorsal	2nd Dorsal	3rd Dorsal	1st Anal	2nd Anal	Pectoral	Pelvic
Postlarval P_1	13	5.1–13.1 (8.4)	0	0	0	0	0	0	0
P_2	17	12.4–14.2 (13.4)	0	5–10 (6.4)	6–12 (9.3)	9–14 (12.0)	8–14 (10.5)	0	0
P_3	36	12.2–18.0 (14.8)	0–5 (1.4)	5–12 (8.9)	7–15 (12.5)	12–17 (14.8)	9–17 (14.1)	0	2–4 (3.3)
P_4	84	14.6–21.5 (17.0)	2–10 (5.7)	7–17 (12.1)	10–21 (16.6)	13–23 (18.0)	14–22 (17.9)	3–17 (9.1)	3–6 (4.3)
P_5	70	16.4–23.4 (19.3)	5–11 (8.4)	14–18 (15.4)	17–22 (19.6)	19–25 (21.5)	18–23 (20.6)	6–17 (13.8)	4–6 (5.2)
Juvenile J	15	21.7–39.5 (27.7)	12–14 (12.6)	15–18 (15.8)	19–23 (20.8)	19–25 (21.9)	19–25 (22.1)	18–20 (18.8)	6
Young Y	1	97.1	13	17	20	22	21	20	6

study, however, the pigmentation pattern was not employed for assigning the developmental stage, because this pattern does not always correspond with the development of meristic characters in pollock (personal observation).

Pollock larvae were divided into the following developmental stages (Table 3, Fig. 6).

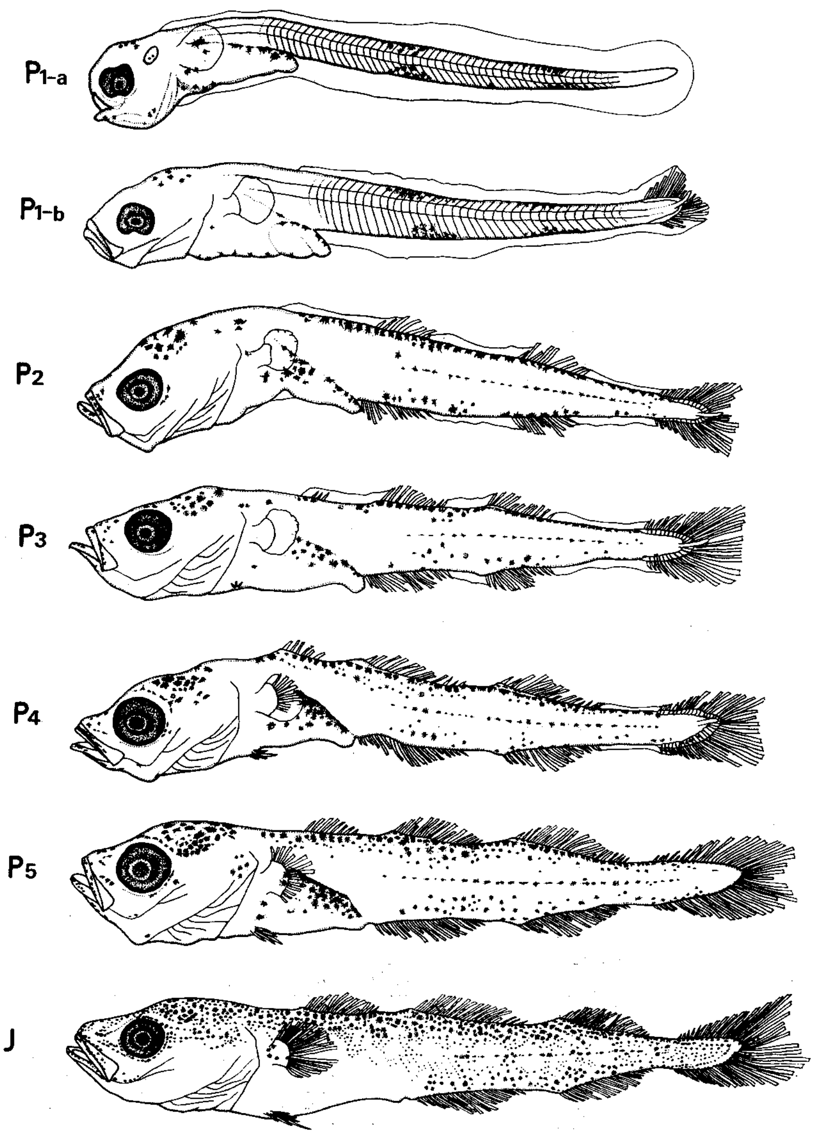

Fig. 6. Postlarval stage to juvenile stage of *Theragra chalcogramma*. Postlarval stages, P_1-a: BL 6.1 mm, P_1-b: 9.6 mm, P_2: 13.9 mm, P_3: 15.2 mm, P_4: 18.3 mm, P_5: 21.6 mm, Juvenile stage, J: 39.5 mm.

1. *Postlarval stage*: Yolk sac is completely absorbed. The development of fin rays is incomplete. The fin rays do not exhibit the consistent number for the species. The postlarval stage can be subdivided into the following five stages.

Stage P_1: The body is surrounded by the primordial marginal fin. The fin rays occur only in the caudal area, and are undeveloped in other areas. Two pigment bands are found along the upper and lower edges of the posterior part of the body.

Stage P_2: Rays are present in the second and third dorsal fins and first and second anal fins. The rays in the first dorsal, pectoral and pelvic fins are not developed.

Stage P_3: The rays in the first, second and third dorsal, first and second anal, and pelvic fins are present, but the development of the first dorsal fin rays differs between individuals. The pectoral fin rays have not developed.

Stage P_4: The primordial marginal fin connecting each fin begins to disappear and each fin becomes independant. Rays are present in all fins.

Stage P_5: The rays in the second and third dorsal and first and second anal fins reach the consistent number for the species. The first dorsal, pectoral and pelvic fins are incomplete.

2. *Juvenile stage*: The rays in every fin reach the full number of the adult. The number of fin rays has been reported to be *D* 11–16, 11–19, 15–21; *A* 17–23, 16–22; *Pect.* 18–21; *Pelvic* 6–7.[18)20)30)31)32)] External appearance is nearly the same as the adult form.

3. *Young stage*: The general form of the body presents all the species characteristics. The proportion of various parts of the body becomes closer to that of adult. The range of the number of the fin rays could not be determined due to lack of specimens.

An increase in size was apparent from stage P_1 to juvenile stage. The length of each developmental stage overlapped. This means that the developmental rate of larvae differs by individual. The development of fin rays corresponds to an increase in size. The number of fin rays completed at about 22 mm in length. This size may be used as an indicator to divide postlarval and juvenile stages. The sample size was not sufficient to determine if juvenile and young stages could be separated by length.

Percentage composition of developmental stages

The percentage occurrence of pollock larvae by stage is given in Table 4. In June 69% of the larvae belonged to stages P_3 and P_4. In July stage P_5 was predominant. The combined proportion of stages P_4 and P_5 was 76%. The

Table 4. *Percentage composition of developmental stages of walleye pollock larvae by month.*

Month	No. of larvae	Developmental stage						
		P_1	P_2	P_3	P_4	P_5	J	Y
June	132	4.5	10.6	27.3	41.7	15.1	0.8	0
July	104	6.7	2.9	0	27.9	48.1	13.4	1.0

juvenile stage considerably increased in July. An increase of stage P_1 and the bimodal distribution in this month suggests the occurrence of newly hatched larvae. Consequently it is indicated that the growth of pollock larvae takes place as the season proceeded from June to July, and that newly hatched individuals appeared.

Geographical distribution by developmental stage

The geographical distribution of pollock larvae by developmental stage is illustrated in Figure 7. In June the larvae of postlarval stages P_3 to P_5 were predominant along the continental slope from Unimak Island to the southeastern part of Cape Navarin, except the southwestern area of the Pribilof Islands (Fig. 7a). No juvenile or young stages were found. In July the occurrence of larvae was different between the southern and northern part of the Bering Sea (Fig. 7b).

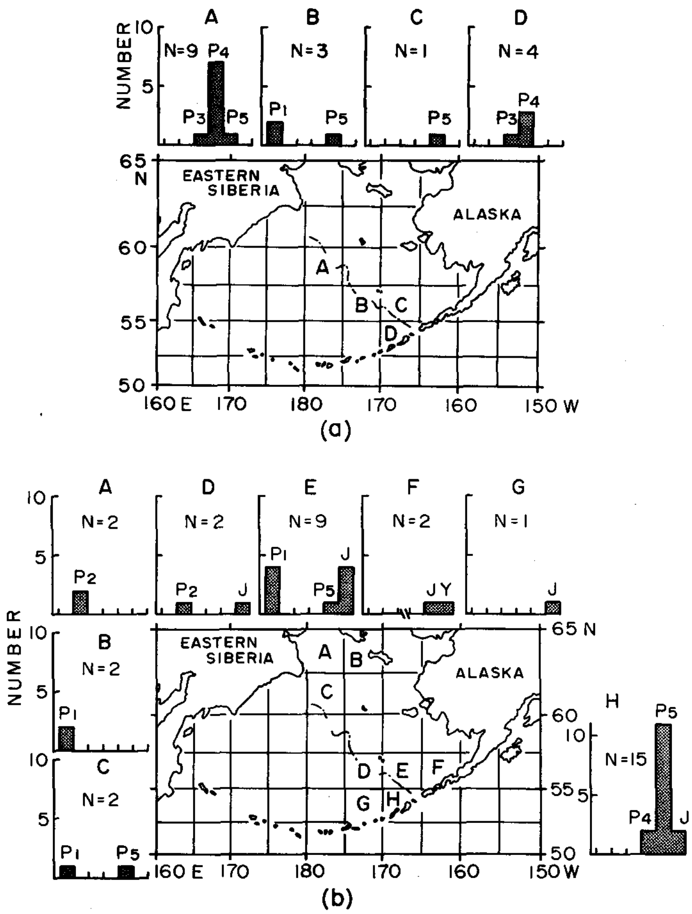

Fig. 7. Frequency distribution of developmental stages of walleye pollock larvae caught in surface tows by 2.5°×5° quadrangle in 1970–1974: (a)-June; (b)-July.

Stage P_5 larvae and juvenile were commonly found in the southeastern Bering Sea. In the southernmost, postlarval stages P_1 and P_2 did not occur. No pollock larvae of stage P_3 were caught, but a few stage P_4 larvae were found. In the northern part of the Bering Sea stages P_1 and P_2 were predominant. One stage P_5 larva was found in the south of Cape Navarin.

Thus, the occurrence of pollock larvae of stages P_4 to juvenile was common in the southern part of the Bering Sea, whereas the larvae of stages P_1 and P_2 were predominant in the northern part of the Bering Sea. An increase in the number of larvae belonging to late postlarval stages (P_4-P_5) and advanced stages was apparent in the southern Bering Sea with the progression of the season from June to July. Concurrently, early postlarval stages (P_1-P_2) occurred.

Discussion

From the present study it is revealed that the distribution of walleye pollock larvae is mainly concentrated along the continental slope from Unimak Island to Cape Navarin. It is also found that pollock larvae are sparsely distributed over the basin area of the Bering Sea. It has been reported that the spawning grounds of walleye pollock are formed along the continental slope and shelf area.[1)11)33)34)] Thus it is apparent that the larval distribution coincides with the spawning grounds.

It has been generally accepted that pelagic fish eggs and planktonic fish larvae are carried by currents from the spawning grounds to other regions.[35)36)37)] Hydrologically the major spawning areas can be included in the Transvers Current and the West Alaska Current.[38)39)40)41)] A question arises whether the currents carry pollock eggs and consequently determine the distribution of pollock larvae in the Bering Sea. Assuming that the Transverse Current moves along the continental slope at a highest speed of 26–30 cm/sec[1)39)40)] for 30 days during the period from fertilization to hatching[14)], pollock eggs could be expected to be transported for 350–420 nautical miles distance. Drifting period of planktonic larvae must be added. Therefore, a great part of pollock larvae born in the southeastern part of the Bering Sea might be expected to be found near Cape Navarin. It seems improbable, however, that the larvae reach Cape Navarin. It has been reported that high densities of pollock eggs were found separately in the northwestern and southeastern parts of the Pribilof Islands.[1)5)11)] Pollock eggs and larvae were coincidently found in the regions adjacent to the spawning ground. The evidence found in this study that the advanced stage of the larvae did not predominate in the northern area may support the minor role of current in carrying eggs and larvae of walleye pollock in the eastern Bering Sea.

A number of pollock larvae were also found in the basin area away from the shelf region. Although it has been reported that walleye pollock spawn in deeper layers[4)], it has not been confirmed that the spawning takes place in the central Bering Sea. Maeda and Hirakawa[11)] noted that pollock larvae encountered in the basin area were not carried by the current from the spawning ground in the southeastern Bering Sea, but originated there. They stated that in the basin area spawners were present and larvae were abundant. However, Suzuki[42)], Okada[43)] and Yoshida[44)] observed that the gonads of walleye pollock caught in the basin area were all in post spawning condition. There is no evidence that the pollock in post spawning condition released eggs in the basin area. It is therefore possible to suppose that the occurrence of pollock larvae in the basin area is the result of active movement and short transportation by the current from the individual spawning grounds along the slope area.

A difference of abundance in walleye pollock between horizontal tows and oblique tows was observed. This suggests differences in distributional patterns and inhabiting layers. Pollock larvae accounted for only 1.6% of fish larvae collected in surface tows and were less abundant in the surface layer than in the mid-layer. Kobayashi[10] suggested that postlarval fish moved to mid-layer and made diurnal vertical migrations. It has also been suggested that the larvae inhabit the mid-layer rather than the surface layer and perform diurnal vertical migrations in search of food.[15][21][37][45] It is therefore conceivable that this species is essentially meso-pelagic during larval stages, and that the movement to deeper layers resulted in the low abundance of the larvae at the surface. Further, as was noted by Kobayashi[10] it is reasonable to consider that a decrease of abundance of pollock larvae with the progression on the season might be caused by the net avoidance with the growth and the natural mortality of pollock.

The development of organisms is recognized by qualitative and quantitative changes in the characteristics of the body and is divided into separate stages. A number of scientists have noted general developmental stages in fish.[16][23][24][46][47][48] Specific changes have been described by Sette[49] for Atlantic mackerel, Gorbunova[4] for walleye pollock and Watanabe[50] for the Japanese common mackerel. Since the descriptive terminology differs between investigators, standardization is needed.

Watanabe and Hattori[24] defined developmental stages of fish in relation to morphology, physiology and ecology. These authors conclude that morphological changes truly correspond with physiological and ecological changes. In this study, pollock larvae were assigned to postlarval, juvenile and young stages chiefly according to the development of the fin rays. The present author considers that the formation of skeletal rays are closely related to survival of fish larvae, as the improved speed in accordance with the formation of the fins will enable them to escape from predators and also to catch more food.[4][51]

Pollock larvae take different food as the development progresses. The larvae at the stage of initial feeding utilize copepod nauplii and eggs, and larger food such as copepods as the larvae size increases.[15][45][52] The analysis of the length-weight relation reveals an inflection point between 7 to 8 mm long. The 7–8 mm length apparently correspond with the size at which caudal fin rays appear. It appears that this morphological change causes behavioral changes in swimming movement and feeding behavior as was indicated by Gorbunova[4]. Vilela and Zijlstra[53] showed that the condition factor of herring larvae obtained from dry weight/length^3 initially decreased after yolk-sac absorption between 6 and 8 mm and after that it remained constant up to a length of 15 mm.

The rays in the unpaired and paired fins appeared at stage P_4, 15 to 22 mm long. When the larvae reached about 22 mm long, the rays of every fin had reached the full adult number. These larvae are considered to belong to the juvenile stage. According to Gorbunova[4], the rays in the unpaired and paired fins of pollock larvae appear during the third step of the larvae phase, 15–20 mm long, and they are completely developed during the first step of the fingerling phase of 35–50 mm in length. This phase is regarded as the end of the morphogenesis period.

Late postlarval and juvenile stages were frequently found in the southern Bering Sea, whereas only early postlarval stages were encountered in the northern part of the sea. As Gorbunova[4] indicated, the spawning in the northern part of the Bering Sea shifted to the summer. Serobaba[54] stated that hydrological conditions differed in the individual microregions on the entire area of the spawning grounds and this lead to uneven development of the spawners and eggs. It therefore appears that geographical differences in the developmental stages of pollock larvae are caused by variation in spawning periods due to the different hydrological and environmental conditions specific to each of the studied habitats.

Summary

1. Walleye pollock larvae were collected with a larva net and Isaacs-Kidd Mid-water Trawl net in the Bering Sea during June to August, 1970–1974. The size ranged from 5.1 mm to 97.1 mm. Data record of walleye pollock larvae taken in surface tows with the larva net made in the Bering Sea during the summer, 1963–1969, was analized.

2. The pollock larvae occurred widely all over the Bering Sea. The larvae were abundant along the continental slope from Unimak Island to Cape Navarin in the eastern Bering Sea. Pollock larvae were most abundant on the shelf region of the southeastern Bering Sea. A relative abundance tended to decrease in the vicinity of the spawning grounds with progress of the season from June to July.

3. The mean length of pollock larvae was 16.3 mm in June and 18.9 mm in July. The length (BL)-weight (W) relationship is empirically established for the two size groups. An inflection point was found in 7–8 mm in length. The equation $\log W = 6.3694 \log BL - 5.3227$ is fitted for the 5–8 mm length group and $\log W = 3.3512 \log BL - 2.6283$ for the 8–39 mm length group.

4. Pollock larvae were assigned to postlarval, juvenile and young stages primarily according to the development of the fin rays. The postlarval stage was divided into five substages. The fin rays of the larvae reached the full number for the adult at about 22 mm in length, indicating a transition from postlarval stage to juvenile stage. The consistent number of the fin rays was *D* 12–14 (mean, 12.6), 15–18 (15.8), 19–23 (20.8); *A* 19–25 (21.9), 19–25 (22.1); *Pect.* 18–20 (18.8); *Pelvic* 6.

5. In June 69% of the larvae belonged to stages P_3 and P_4. In July the predominance of stage P_4 shifted to stage P_5 and the combined proportion of the stages P_4 and P_5 accounted for 76% of the larvae found. An increase in stage P_1 resulted in a bimodal distribution of frequency in this month.

6. Regional differences of developmental stages were recognized. In the southern part of the Bering Sea pollock larvae of stage P_4 to juvenile stage were common, whereas in the northern part of the sea stage P_1 and P_2 larvae prevailed. The larvae transfered to more advanced stage in the southern Bering Sea as the season proceeded.

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