INTRODUCTION INTO AYSEN CHILE OF PACIFIC SALMON

No. 13

Seasonal Change of Macroplankton Structure in the Surface of Aysén Fiord and Moraleda Channel, Southern Chile

By

Akira Zama

and

Eduardo Cárdenas G.

1984

SERVICIO NACIONAL DE PESCA
MINISTERIO DE ECONOMIA FOMENTO Y RECONSTRUCCION
REPUBLICA DE CHILE

JAPAN INTERNATIONAL COOPERATION AGENCY

All orders should be addressed to
SERVICIO NACIONAL DE PESCA
Teatinos 120. 8 - piso
Santiago de Chile

AUTHORS:

Akira Zama is assigned as an expert of the environmental investigation to the Project of Introduction into Aysén Chile of Pacific Salmon by the Japan International Cooperation Agency, Japan.

Eduardo Cárdenas G. is a fishery technologist in the Servicio Nacional de Pesca, Aysén Province, XI Region, Chile.

Address of the authors:
SERVICIO NACIONAL DE PESCA
Edificio Obras Públicas, 2º piso
Ribera Sur, Puerto Aysén
XI Región, CHILE

"INTRODUCTION INTO AYSEN CHILE OF PACIFIC SALMON"

CHILEAN COUNTERPART AUTHORITIES.

PROJECT DIRECTOR: SR. IVAN PETROWITSCH FUENTES	DIRECTOR DEL SERVICIO NACIONAL DE PESCA.
PROJECT COORDINATOR: SR. CARLOS CONLEY MILO	SUBDIRECTOR DEL SERVICIO NACIONAL DE PESCA.
PROGRAM MANAGER: SR. JUAN LOPEHANDIA PALMA	JEFE DEPARTAMENTO RECURSOS NATURALES DEL SERVICIO NACIONAL DE PESCA
OPERATION MASTER: SR. PABLO AGUILERA MARIN	DIRECTOR REGIONAL DEL SERVICIO NACIONAL DE PESCA XI REGION

CONTENTS

Seasonal Change of Macroplankton Structure in the Surface of Aysén Fiord and Moraleda Channel, Southern Chile.

Akira Zama and Eduardo Cárdenas G.

ABSTRACT

Seasonal change in abundance, biomass and animal group dominance of macroplankton were studied on material obtained from the surface of Aysén Fiord and Moraleda Channel between November 1980 and October 1981. A total of 45 samples contained organisms classified into 41 lower taxonomic categories in 19 animal groups. Brachyura larvae became the most numerous constituents from mid spring to summer,euphausiid larvae in autumn and arrow worms (Sagittidae) in winter. In spring there was a remarkable increase in number and wet weight of macroplankton represented by decapod larvae, while both abundance and biomass became impoverished in winter. The fiord area showed faunal poverty and lowest productivity of macroplankton, probably owing to low salinity of the surface layer. A sardine *Sprattus fuegensis* was the most dominant species in the fish larvae collected. It is suggested that as they grow decapod and sardine larvae are transported outward by a surface flow of Aysén Fiord.

INTRODUCTION

Juveniles of chum salmon (*Oncorhynchus keta*) and pink (*O. gorbuscha*) salmon run down into the sea from early spring to early summer during a period of increasing zooplankton biomass in shore waters (Kobayashi, 1977; Minoda, 1981). The juvenile salmon staying in inshore waters prey actively on crustaceans and fish larvae. They grow rapidly and then migrate to offshore waters with growth (Kobayashi, 1977; Ito, 1980).

The cooperative project between Chile and Japan has released the juveniles of Pacific salmon to Aysén Fiord mainly in spring between September and November in accordance with the season of their seaward migration in the northern Pacific region. However, no study is available of the production of natural food organisms for the released salmon in Aysén Fiord and adjacent waters. In order to determine a suitable period for the release of juvenile salmon, knowledge of zooplankton abundance as food is one of the most important subjects in the research of artificial salmon propagation. The effective utilization of natural foods by the released salmon must lead to an increase in their survival rates in the inshore waters. This study was made to clarify seasonal change of macroplankton structure in the surface waters of Aysén Fiord and Moraleda Channel.

MATERIAL AND METHODS

On five cruises between November 1980 and October 1981, a total of 45 surface horizontal Plankton tows were made seasonally with a larva net at 15 stations among the 16 ones

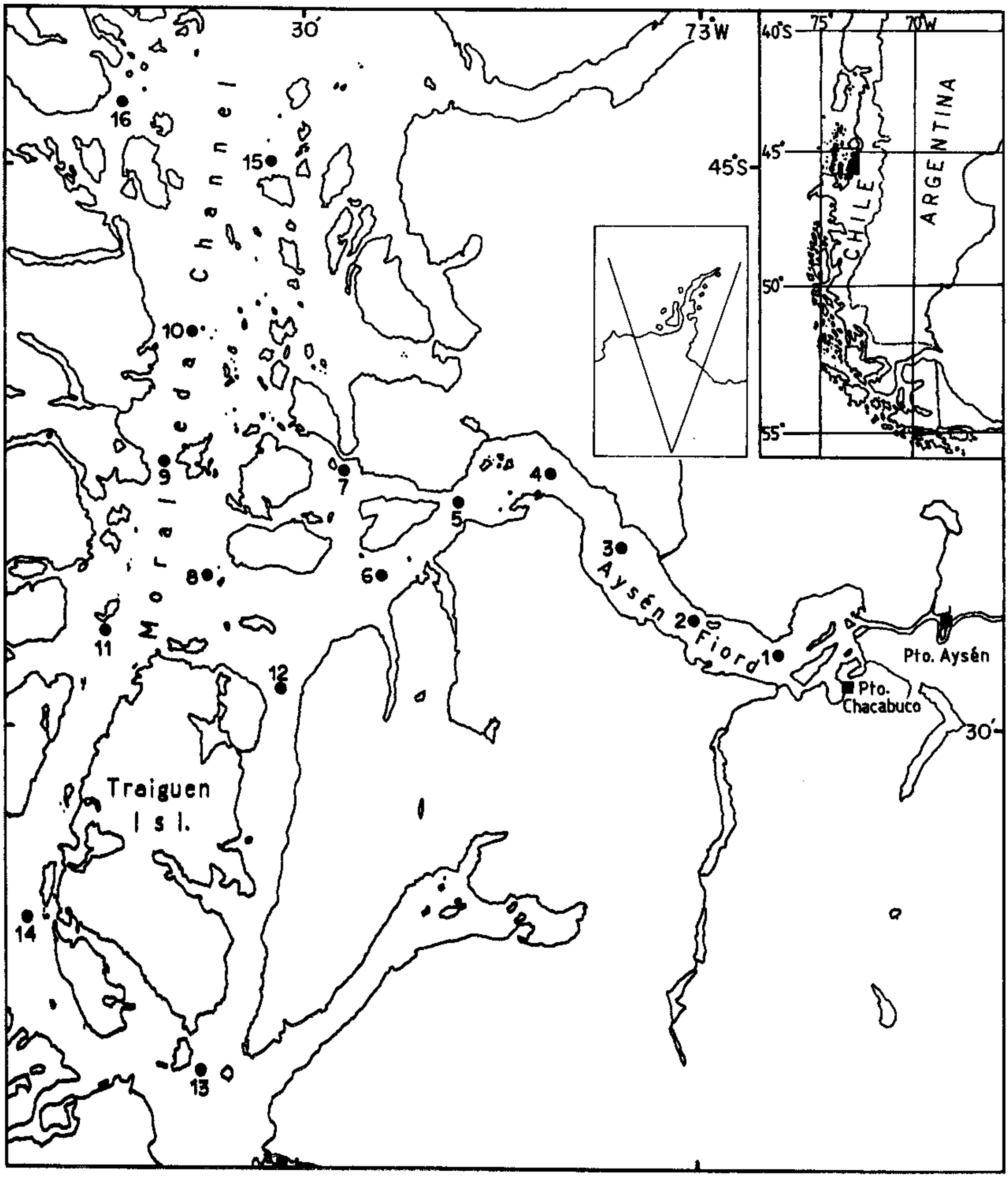


Fig. 1. Locations of the stations fixed in Aysén Fiord and Moraleda Channel. Inset map showing southern part of South America.

Table 1. Sampling tows (cross mark) with a larva net made at the stations fixed in Aysén Fiord and Moraleda Channel between November 1980 and October 1981. Months given in spring-winter order.

Area	Fiord				Transition				Channel							Total No.
Station	1	2	3	4	5	6	7	12	8	11	10	15	16	14	13	of tows
Oct. 9 to 11, 1981 (mid spring)		X		X		X			X		X		X	X	X	8
Nov. 7 to Dec. 4, 1980 (late spring)	X		X	X	X	X		X	X	X	X	X	X		X	12
Feb. 9 to 13, 1981 (summer)	X	X				X	X		X		X		X	X	X	9
May 13 to 17, 1981 (autumn)		X		X			X	X		X	X	X	X		X	9
Jul. 21 to 24, 1981 (winter)		X		X		X			X		X		X		X	7
	2	4	1	4	1	4	2	2	4	2	5	2	5	2	5	
Total number of tows	11				9				25							45

fixed for an oceanographic study of the salmon program in Aysén Fiord (Pl. I, B) and Moraleda Channel (Pl. I, C) (Fig. 1 and Table 1). The number of collections varied from 7 to 12 on each seasonal cruise and tows were not made regularly at the definite stations. The larva net used in this study was of conical form, 1.3 m mouth diameter and 4.5 m long, and had polyester fabric with mesh size of 1.5 x 1.5 mm (Pl. I, A). The net was towed from the stern of a small boat (12 to 15 m long) at each station for 20 minutes at a speed of about two knots per hour. The upper edge of the net ring was kept at the water surface. Almost all samplings were made in the daytime, but a few at sunset or within 30 minutes after sunset. Each sampling record is shown in App. Table 2.

All animal samples except for jellyfish were preserved at sea in 10% formalin. In each collection all the organisms were identified to lower taxonomic category, enumerated without subdividing the sample, and total wet weight was measured after the removal of surface water from specimens with filter paper. In the case of fish larvae specific determinations were attempted. The minimum and maximum total lengths of sardine (*Sprattus fuegensis*) larvae were taken for each collection. The material obtained in this study consisted of macroplankton larger than 2mm, including a small number of organisms, which had been forced to drift, and fish parasites (not plankton in a true sense).

Surface water temperature and specific gravity were measured at all the 16 stations (Fig. 1) on each cruise. The days on which the larva-net sampling and oceanographic observations were made at the same stations were not always quite coincident.

The specific gravity was converted into salinity. There is a probable error of ± 1.0°/oo for calculated values, particularly ± 2.0°/oo for the data taken on November-December cruise, due to the low precision of the specific gravimeter used. On the basis of the values of surface salinity, the study field can be divided into three areas as follows:

1. Fiord area (Sts. 1 to 4): Surface salinity is low, usually varying from 2 to 17°/oo under a strong influence of freshwater flows from rivers; a marked halocline was observed in the upper layer above 10 m deep.

2. Transitional area (Sts. 5 to 7 and 12): Transitional water from Aysén Fiord to Moraleda Channel, with the surface salinity usually ranging between 12 and 29°/oo.

3. Channel area (other stations): Surface salinity from 27 to 32°/oo, showing a small fluctuation through the year.

RESULTS

Surface water temperature and salinity

Surface water temperature and salinity taken at the 16 stations on each cruise are graphed in Fig. 2. The water temperature of the fiord area showed a greater seasonal fluctuation than that of the channel area. In summer (February) the water temperature was higher in the fiord

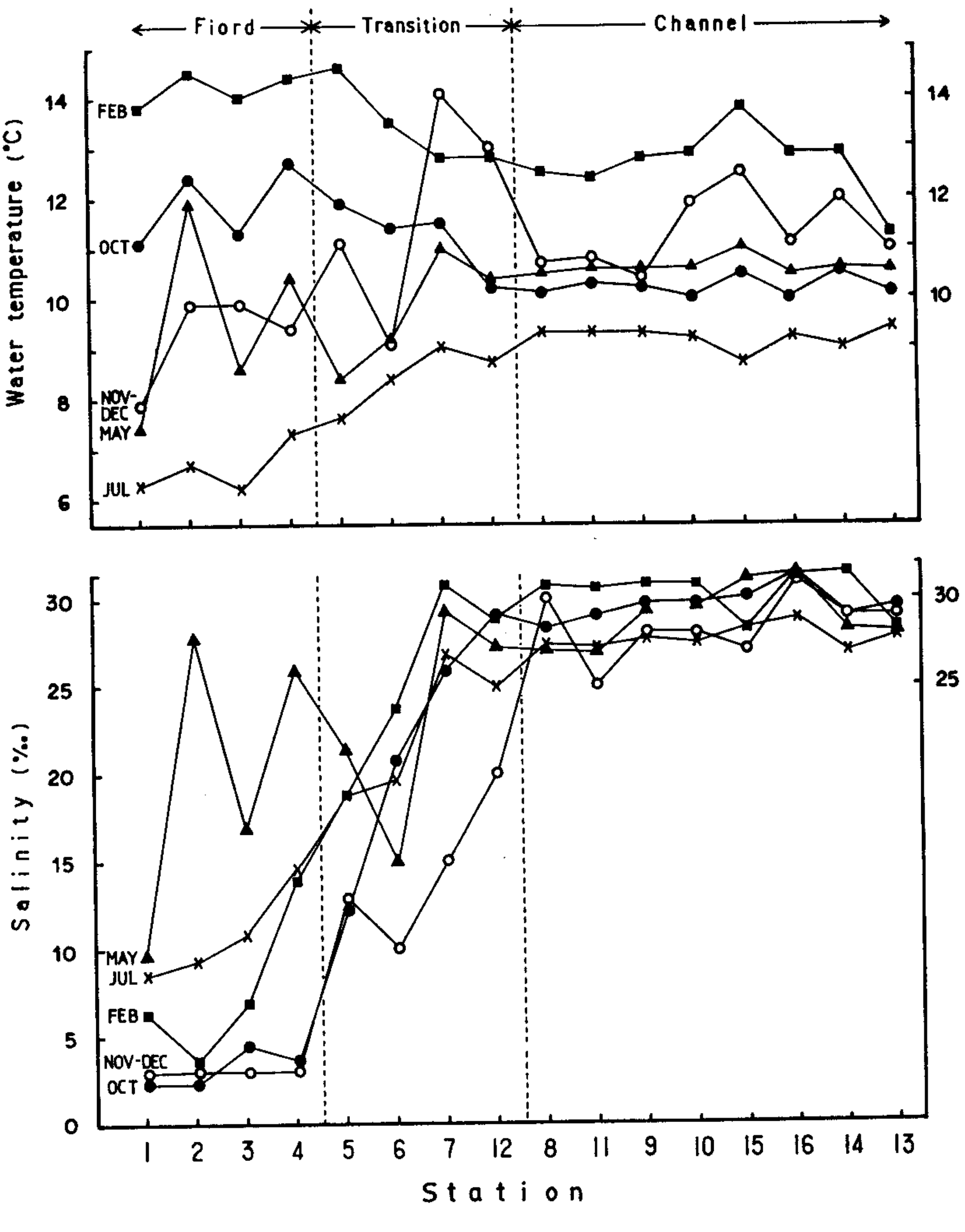


Fig. 2. Surface water temperatures and salinities at the stations in Aysén Fiord and Moraleda Channel on each cruise between November 1980 and October 1981. See App. Table 1 as to the detailed observation records.

Table 2. Average number (top figure) and wet weight (middle figure) per tow of organisms collected in the surface of Aysén Fiord and Moraleda Channel between November 1980 and October 1981. Bottom figure in parentheses showing the number of tows. Months given in spring-winter order.

Month	Area			Average or (total)
	Fiord	Transition	Channel	
Oct. 1981	2,453 3.51g (2)	5,292 9.79g (1)	4,160 14.06g (5)	3,875 10.89g (8)
Nov. - Dec. 1980	2 0.03g (3)	2,593 21.19g (3)	1,372 12.20g (6)	1,335 11.41g (12)
Feb. 1981	4 0.32g (2)	263 1.66g (2)	527 2.96g (5)	352 2.08g (9)
May. 1981	5 0.08g (2)	37 0.14g (2)	681 4.68g (5)	388 2.65g (9)
Jul. 1981	628 0.37g (2)	15 0.01g (1)	85 0.39g (4)	230 0.33g (7)
Average or (total)	562 0.78g (11)	1,521 8.55g (9)	1,416 7.33g (25)	1,229 6.00g (45)

Table 3. Number by animal group of organisms collected in the surface of Aysén Fiord and Moraleda Channel between November 1980 and October 1981. Asterisks showing animal groups which were made up of only larval or juvenile forms. Months given in spring-winter order.

Animal group	Oct. 1981	Nov. - Dec. 1980	Feb. 1981	May. 1981	Jul. 1981	TOTAL (%)
CNIDARIA						
1. Actiniaria*	–	1	7	–	–	8 (0.0)
2. NEMATODA (?)	–	–	–	5	–	5 (0.0)
MOLLUSCA						
3. Archaeogastropoda*	–	1	–	–	–	1 (0.0)
4. Dysodonta*	–	–	1	–	–	1 (0.0)
5. Octopoda*	2	–	–	–	–	2 (0.0)
ANNELIDA						
6. Errantia	–	–	1	5	2	8 (0.0)
ARTHROPODA						
7. Calanoida	480	82	18	188	120	888 (1.6)
8. Caligoida*	1	1	3	1	–	6 (0.0)
9. Thoracica*	–	–	1	–	–	1 (0.0)
10. Isopoda	1	1	–	–	–	2 (0.0)
11. Amphipoda	68	20	122	85	104	399 (0.7)
12. Euphausiidae*	35	916	65	2,027	113	3,156 (5.7)
13. Macrura*	3,394	181	928	717	–	5,220 (9.4)
14. Anomura*	7,973	408	296	58	–	8,735 (15.8)
15. Brachyura*	18,507	13,924	1,607	33	–	34,071 (61.6)
16. Squillidae*	162	27	3	177	7	376 (0.7)
17. Insecta	–	5	9	1	1	16 (0.0)
CHAETOGNATHA						
18. Sagittidae	195	65	29	173	1,263	1,725 (3.1)
VERTEBRATA						
19. Pisces*	181	388	76	18	–	663 (1.2)
Total no. of individuals	30,999	16,020	3,166	3,488	1,610	55,283 (100)
No. of animal groups	12	14	15	13	7	19
Total no. of tows	8	12	9	9	7	45

Table 4. Occurrence (cross mark) of animal groups by area in the surface of Aysén Fiord and Moraleda Channel between November 1980 and October 1981.

Animal group	Area		
	Fiord	Transition	Channel
1. Actiniaria		X	X
2. NEMATODA (?)			X
3. Archaeogastropoda		X	
4. Dysodonta		X	
5. Octopoda			X
6. Errantia	X		X
7. Calanoida		X	X
8. Caligoida		X	X
9. Thoracica		X	
10. Isopoda	X	X	
11. Amphipoda	X	X	X
12. Euphausiidae	X	X	X
13. Macrura	X	X	X
14. Anomura	X	X	X
15. Brachyura	X	X	X
16. Squillidae		X	X
17. Insecta	X	X	X
18. Sagittidae	X	X	X
19. Pisces	X	X	X
No. of animal groups	10	16	15
Total No. of tows	11	9	25

(13.8° to 14.5° C) than in the channel (11.3° to 13.8° C), while in winter (July) it was the reverse of the summer case, the temperature rising from 6.2° - 7.3° C to about 9° C toward the channel. The spring (October and November-December) and autumn (May) water temperatures of the whole area ranged approximately from 8° to 12° C, being more stable at 10° - 11° C in the channel.

Surface salinity was very low in the fiord area, usually less than 10°/oo and increased abruptly toward the channel (Fig. 2). The salinity of the fiord was higher in autumn and winter than in other seasons. In the channel the salinity was relatively stable, between 27 and 32°/oo through the year.

Abundance and biomass of macroplankton

Table 2 summarises the average number and wet weight per tow of organisms collected in each area on each cruise. In mid spring (October) the highest abundance (number) occurred in each area and then diminished toward summer. Biomass (wet weight) was very high in each area (except for the fiord in late spring, November-December) between mid spring and late spring, showing the highest values of all the areas in late spring. As a whole there was a slight increase in the abundance and biomass in autumn, but in winter both fell to the lowest levels.

Among the three areas the fiord revealed by far the lowest productivity both in abundance and in biomass in all seasons, except for winter (Table 2) when samples were composed of only arrow worms as mentioned below. In spring higher abundance occurred in the transitional area than in the channel, but was reversed in order from summer to winter. The biomass tended to increase from the fiord to the channel in each season.

Occurrence and numerical composition of macroplankton

The organisms obtained in this study were classified into 41 lower taxonomic categories which are assigned to 19 animal groups for convenience (App. Table 2 and Table 3). Brachyuran larvae were the most numerous constituents, occupying 61.6% of all individuals, followed by anomuran larvae (15.8%), macruran larvae (9.4%), euphausiid juveniles (5.7%), sagittids (3.1%), and so forth. The first three groups, i.e. decapod larvae, amounted to about 87%. In this study Calanoida, Amphipoda, Euphausiidae, Macrura, Anomura, Brachyura, Squillidae and Pisces are treated as principal animal groups owing to higher abundance and probable availavility as food for released salmon.

Table 4 presents the occurrence and number of animal groups in each area during the study. The fiord showed fewer animal groups than other areas. Apart from groups consisting of only a few individuals, calanoids, caligoids and squillids were not obtained from the fiord.

The total number of animal groups found in the whole area varied seasonally from 7 to 15 (Fig. 3). In winter the animal groups were remarkably fewer at 7 than in other seasons (at 12 to 15), showing the smallest number in each area. Between mid spring and summer the brachyurans were most dominant in number, comprising more than half of each seasonal total. In these seasons decapods made up more than about 90% of the total. However, they reduced to 23% in autumn and then disppeared in winter. Euphausiidae (58.1%) and Sagittidae (78.6%) were the dominant groups in autumn and winter, respectively.

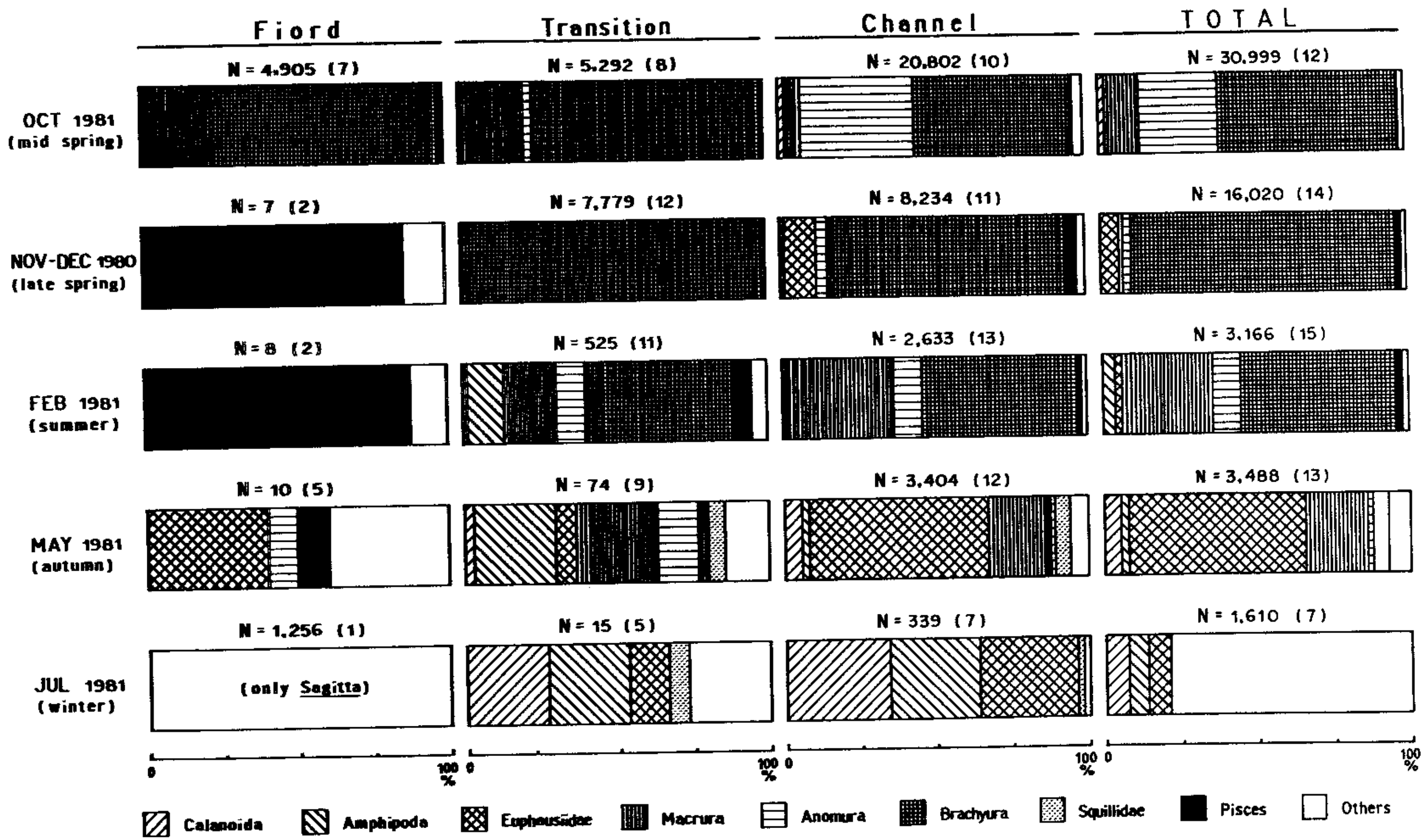


Fig. 3. Seasonal change in number composition of principal animal groups and total number of animal groups by area in the surface of Aysén Fiord and Moraleda Channel between November 1980 and October 1981. In each diagram the principal groups less than 1 o/o are included in "Others". Months given in spring-winter order.

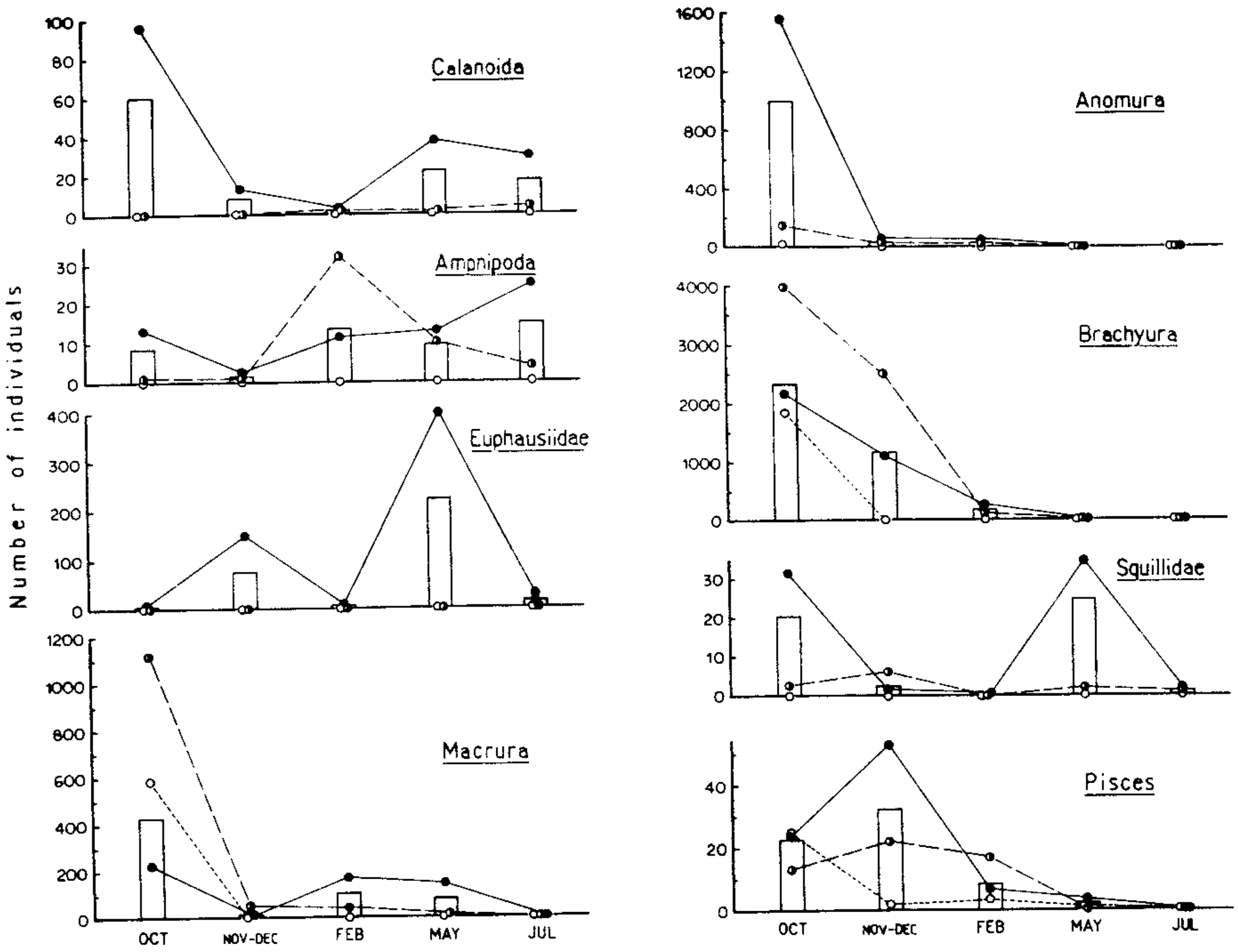


Fig. 4. Seasonal change of individuals per tow of principal animal groups by area in the surface of Aysén Fiord and Moraleda Channel during the same period as in Fig. 3. Histgrams showing average numbers per tow of all the areas. Open circle, fiord area; half-solid circle, transitional area; solid circle, channel area.

There was a similarity in numerical composition of the principal animal groups between the transitional and channel areas through the year (Fig. 3), but in this respect the fiord was much different from the other two except for in the case of mid spring. In late spring and summer samples from the fiord included only fish larvae and terrestrial insects, and a single group (Sagittidae) in winter.

To sum up results mentioned above, in spring there is a remarkable increase in abundance and biomass of macroplankton represented by decapod larvae in the surface of Aysén Fiord and Moraleda Channel, and both abundance and biomass become most impoverished in winter. The fiord area has a poor macroplankton fauna, showing much lower abundance and biomass than the transitional and channel areas. So far as the surface layer is concerned, the faunal poverty and low productivity of the macroplankton in the fiord are probably caused by low salinity.

Seasonality of abundance in principal animal group

The average numbers of individuals per tow of the eight principal animal groups in each season are graphed in Fig. 4. Among these groups, Calanoida, Macrura, Anomura and Brachyura showed peak abundances in mid spring and tended to fewer toward summer or autumn. There was an abrupt drop in abundance of the macrurans and anomurans from mid spring to late spring, while a comparatively gradual decrease of the brachyurans was found toward autumn. After late spring decapod larvae disappeared from the fiord area (except for an anomuran collected in May). In spring the transitional area embraced more numerous macrurans and brachyurans than the channel, but the channel exceded the former area after summer. In the fiord fish eggs and larvae were very few after late spring. As a whole Pisces increased in number from mid spring to late spring, and then decreased toward autumn.

Peak abundances of the remaining groups (Amphipoda, Euphausiidae and Squillidae) occurred in autumn or winter (Fig. 4). The euphausiids (juvenile) and squillids (larva) were collected in all seasons and had another minor peak of abundance in spring. Their occurrences were confined largely to the channel through the year.

Seasonal composition of zoeae and postlarvae of Anomura and Brachyura

No specific determinations of Anomura and Brachyura larvae were made in this study. However, the anomuran and brachyuran samples seemed to include at least 5 and 13 distinct species, respectively. The postlarval stage of Anomura is known as glaucothoe (including grimothea for Galatheidae in this analysis) and that of Brachyura as megalopa. Although a small number of anomurans and brachyurans advanced to a juvenile stage were also found in the samples, the present study includes these juveniles in each postlarval category for convenience.

In mid spring zoea larvae of Anomura and Brachyura occurred in all the areas, but the occurrence of glaucothoe and megalopa was almost confined to the channel area (Fig. 5), although surface water temperature was lower in the channel (Fig. 2). After late spring any larvae of thase decapods were not obtained from the fiord except an anomuran zoea collected in May. In late spring postlarvae of the decapods became higher in percentage in both the transitional and channel areas although glaucothoe larvae per tow were more numerous in mid spring than late spring. Percentages of the glaucothoe and magalopa in all the areas dropped to low in summer.

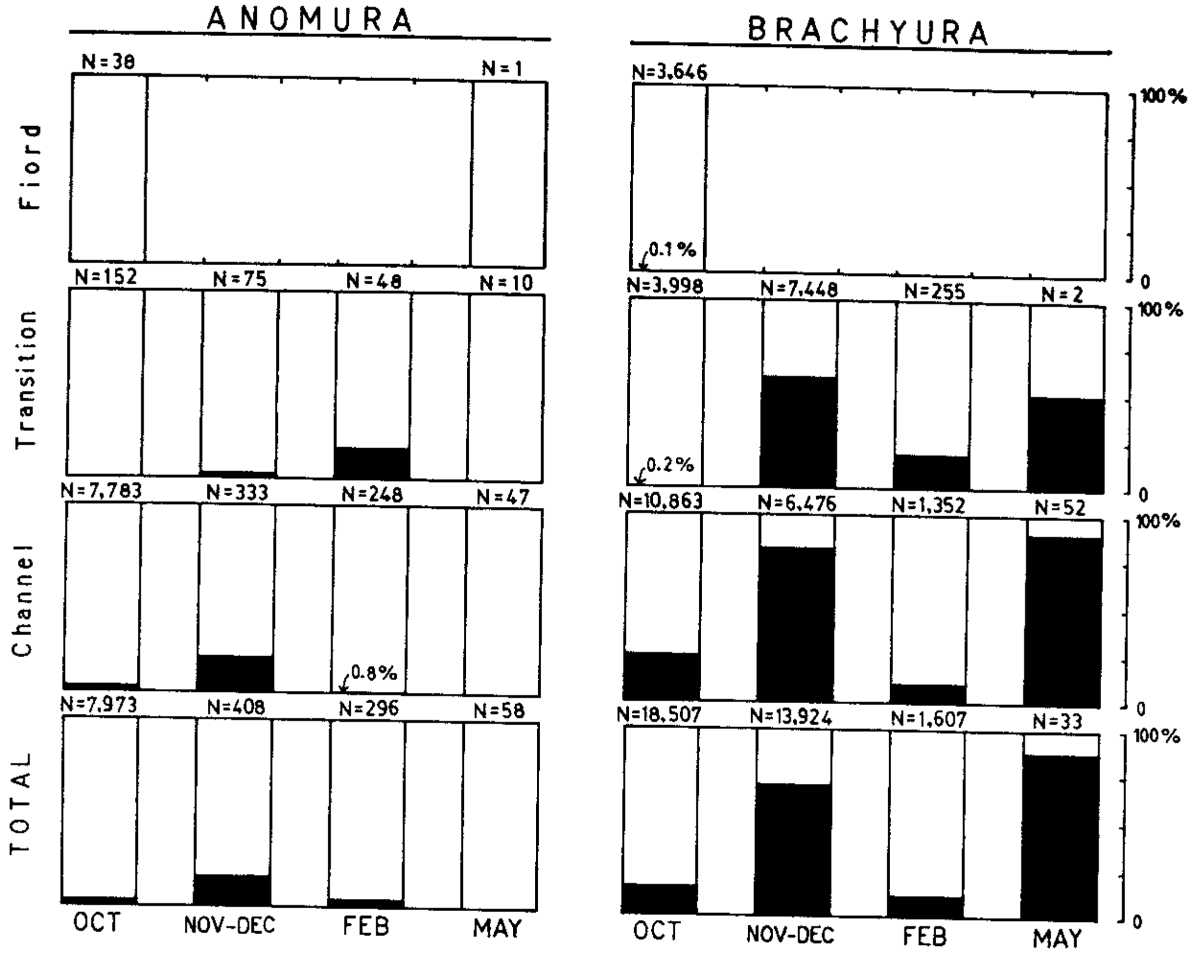


Fig. 5. Seasonal change in number composition of zoeae (open rectangle) and postlarvae (solid rectangle) of Anomura and Brachyura by area in the surface of Aysén Fiord and Moraleda Channel during the same period as in Fig. 3.

Table 5. Number of fish eggs and larvae in the surface of Aysén Fiord and Moraleda Channel between November 1980 and October 1981. The July-samplings are omitted from this analysis due to no collection of egg and larva. Months given in spring-autumn order. FI, fiord area; TR, transitional area; CH, channel area.

Species	Family	Oct. 1981			Nov. - Dec. 1980			Feb. 1981			May. 1981			Total by area			TOTAL	(%)
		FI	TR	CH	FI	TR	CH	FI	TR	CH	FI	TR	CH	FI	TR	CH		
EGG																		
1. *Maurolicus muelleri* (?)	Gonostomatidae	1	–	–	–	–	–	–	–	–	–	–	–	1	–	–	1	(0.2)
2. *Congiopodus peruvianus*	Congiopodidae	–	–	2	–	–	18	–	3	–	–	–	–	–	3	20	23	(3.5)
3. Undetermined sp.		–	–	19	–	–	1	–	–	–	–	–	–	–	–	20	20	(3.0)
LARVA																		
1. *Sprattus fuegensis*	Clupeidae	46	10	41	–	27	274	–	–	–	–	–	–	46	37	315	398	(60.0)
2. *Engraulis ringens*	Engraulidae	–	–	–	–	–	–	–	–	–	–	–	1	–	–	1	1	(0.2)
3. Aplochitonidae (?) sp.	Aplochitonidae (?)	–	–	–	5	1	–	1	–	–	–	–	–	6	1	–	7	(1.1)
4. *Galaxias maculatus*	Galaxiidae	–	–	–	–	–	–	–	9	16	–	–	4	–	9	20	29	(4.4)
5. *Salilota australis*	Moridae	–	–	6	–	4	5	–	–	–	–	–	–	–	4	11	15	(2.3)
6. *Macruronus magellanicus*	Merluccidae	–	–	17	–	12	1	–	–	–	–	–	–	–	12	18	30	(4.5)
7. *Merluccius australis*	Merlucciidae	–	–	–	–	3	–	–	–	–	–	–	–	–	3	–	3	(0.5)
8. *Genypterus* sp.	Ophidiidae	2	1	–	–	–	–	–	–	–	–	–	–	2	1	–	3	(0.5)
9. *Odontesthes smitti*	Atherinidae	–	–	–	–	–	–	4	1	3	–	–	–	4	1	3	8	(1.2)
10. *Leptonotus blainvilleanus*	Syngnathidae	–	1	2	–	2	–	–	1	6	1	–	8	1	4	16	21	(3.2)
11. *Sebastes oculatus*	Scorpaenidae	–	–	15	–	–	–	–	–	–	–	–	–	–	–	15	15	(2.3)
12. *Congiopodus peruvianus*	Congipodidae	–	–	1	–	–	–	–	–	–	–	–	–	–	–	1	1	(0.2)
13. *Normanichthys crockeri*	Normanichthyidae	–	–	–	–	–	–	–	–	1	–	–	–	–	–	1	1	(0.2)
14. *Agonopsis chiloensis*	Agonidae	–	–	1	–	–	–	–	–	–	–	–	–	–	–	1	1	(0.2)
15. *Prolatilus jugularis* (?)	Branchiostegidae	–	–	–	–	–	–	–	–	–	–	–	1	–	–	1	1	(0.2)
16. *Eleginops maclovinus*	Nototheniidae	–	1	14	1	1	–	2	–	–	–	–	–	3	2	14	19	(2.9)
17. Nototheniidae sp.	Nototheniidae	–	–	–	–	–	1	–	–	–	–	–	–	–	–	1	1	(0.2)
18. *Tripterygion* sp.	Tripterygiidae	1	–	–	–	1	6	–	16	5	–	–	3	1	17	14	32	(4.8)
19. *Hypsoblennius sordidus*	Blenniidae	–	–	–	–	1	2	–	4	3	–	–	–	–	5	5	10	(1.5)
20. *Stromateus stellatus*	Stromateidae	–	–	–	–	12	6	–	–	1	–	–	–	–	12	7	19	(2.9)
21. *Paralichthys microps*	Bothidae	–	–	–	–	1	2	–	–	–	–	–	–	–	1	2	3	(0.5)
22. Bothyidae sp.	Bothidae	–	–	–	–	1	–	–	–	–	–	–	–	–	1	–	1	(0.2)
Total number of individuals		50	13	118	6	66	316	7	34	35	1	0	17	64	113	486	663	
Total number of tows		2	1	5	3	3	6	2	2	5	2	2	5	9	8	21	38	
Average no. of individuals per tow			23			32			8			2		7	14	23	17	
No. of species occurred (egg + larva)			3 + 10			2 + 13			1 + 9			0 + 5		1 + 7	1 + 15	2 + 18	3 + 22	

There was a very small number of the decapod larvae collected in autumn: The anomurans comprised only zoeae and the brachyurans nearly composed of megalopae (of which most were advanced to the juvenile stage).

It can be said from the above data that the anomuran and brachyuran zoeae appear both in Aysén Fiord and in Moraleda Channel prior to mid spring, and the almost complete absence of these decapod larvae as well as macruran ones from the surface of the fiord area after late spring suggests that the decapod larvae are transported toward the channel by a surface flow

Species occurrence and abundance of fish eggs and larvae

A total of 44 fish eggs and 619 fish larvae were enumerated in this study (Table 5). The syngnathid fish (*Leptonotus blainvilleanus*) specimens collected were juveniles rather than larvae. Three species of egg and 22 of larva were recognizable although some species were not determined. Sardine (*Sprattus fuegensis*) larvae were most abundant, comprising 60% of all the eggs and larvae; other species of egg or larva occupied only less than 5%. Seasonality of species abundance corresponded with that of individual abundance, both showing peaks in late spring, decreasing toward autumn (Table 5 and Fig. 4). Among the fish larvae seven species appeared in the fiord area, 15 in the transition and 18 in the channel. The channel also showed the highest abundance of eggs and larvae.

The sardine larvae were collected only in spring. In mid spring they occurred in all the areas and were more abundant in the transitional and fiord areas than in the channel (Table 6). In late spring, however, the sardine larvae had disappeared from the fiord, being most abundant in the channel. Total lengths of the dardine increased from mid spring to late spring (Table 6). Apart from this study, we have observed that spawning schools of the sardine migrate into Aysén Fiord in a period between September and November each year. It is likely that the sardine larvae are transported by an outward surface flow with growth as was suggested for decapod larvae.

Table 6. Total length in mm and number (in parentheses) per tow of sardine (*Sprattus fuegensis*) larvae in the surface of Aysén Fiord and Moraleda Channel between November 1980 and October 1981. Months given in spring-winter order.

Month	Area			All areas
	Fiord	Transition	Channel	
Oct. 1981	5.0 ~ 18.0 (23)	5.0 ~ 10.5 (27)	8.0 ~ 15.0 (8)	5.0 ~ 18.0 (12)
Nov. - Dec. 1980	– (0)	8.0 ~ 24.0 (9)	8.0 ~ 20.0 (46)	8.0 ~ 24.0 (25)

DISCUSSION

The present study reveals that in mid spring there was the highest abundance of macroplankton in the surface of Aysén Fiord and Moraleda Channel. It is, therefore, recommended that juveniles of salmon should be released prior to mid spring, i.e. in September or early October. A swimming layer of the juvenile salmon is considered to be from the surface to 5 m deep or more (Sumi, 1979; Ito, 1981; Mayama et al., 1982). Salinity of Aysén Fiord abruptly increases to more than 20o/oo in lower layer below 3 m or 5 m deep according to our unpublished data. There must be a great difference of zooplankton structure between the surface and lower layers. In order to obtain more complete informations, further study is desirable on zooplankton abundance in both the surface and lower layers at least by month from winter to spring.

The present study also shows that the greatest abundance and biomass of macroplankton occurred in the transitional area. In the course of the study, we observed that an obvious current rip, which is formed by a low-salinity outward flow of Aysén Fiord and higher-salinity channel water, usually developed in the transitional area between Sts. 4 and 6. Planktonic organisms, derived from both the fiord and the channel, may be held in this area by tidal movements, even if temporarily.

It is known that estuarine decapod larvae, as well as other pelagic larvae of benthos, are transported passively by seaward surface currents (Sandifer, 1973 and 1975; Kikuchi, 1982), but they can avoid low-salinity water by a downward movement, to some extent choosing a swimming layer and altering the swimming layer in daily activities or through the course of ontogenetic development (Sato, 1958; Latz and Forward, 1977; Sulkin et al., 1980 Sulkin and Van Heukelem, 1982; Kikuchi, 1982). In this study the disappearance of decapod and sardine larvae from the fiord area after late spring might result from not only an outward transport by a surface flow, but an active vertical migration to lower layers.

Sandifer (1973) reported that in the York River estuary and lower Chesapeake Bay (U.S.A.) the number of decapod species (as meroplanktonic larvae) tends to decrease, in large part relating to the decreasing salinity upstream, and the decapod larvae are generally most abundant during summer when water temperature is higher than 20°C. In the water presently studied the surface water temperature was below 15°C through the year and the highest abundance of decapod larvae occurred in mid spring when the water temperature ranged from 10° to 13°C. Richardson and Pearcy (1977) noted that larvae of most brachyuran species occur between February and July with peak abundances in May and June off mid Oregon (U.S.A.).

As in the case of the present study, Ciechomski (1981) and Ciechomski et al. (1981) reported that a period of the major peak abundance of fish larvae in southern Argentine waters coincides with spring and early summer. Richardson and Pearcy (1977) also showed that there is a major peak abundance of fish larvae off Yaquina Bay (mid-Oregon) between May and July. Paralleling brachyuran larvae, Richardson and Pearcy (1977) suggested that offshore surface flow durig the uppwelling season (May to July) may provide a mechanism of the offshore transport of fish larvae, which are spawned in the coastal zone and spend at least part of their early life in surface waters. Ciechomski et al. (1975), Ciechomski et al. (1981) and Ciechomaski (1982) reported that water temperatures at which larvae of *S. fuegensis* occur in Argentine waters range from 6° to 13°C, more abundantly at 8° to 9°C.

With respect to feeding habits of juvenile salmon, crustaceans (such as copepods, mysids, amphipods and euphausiids), insects and fish larvae are generally regarded as important foods in inshore waters (Okada and Taniguchi, 1971; Iioka et al., 1977; Kobayashi, 1977; Yasunaga and Koshiishi, 1979; Morioka, 1979; Suzuki et al., 1980; Healey, 1980 cited by Takagi, 1980; Seki et al., 1981). In Aysén Fiord and Moraleda Channel squillid larvae may be also utilizable as food of the juvenile salmon in view of body size (5 to 20 mm long) and abundance (although not very high).

The present study shows that decapod larvae were most abundant during spring and summer. Okada and Taniguchi (1971), Iioka et al (1979 and 1980), Healey (1980, cited by Takagi, 1980) and Sakamoto et al. (1982) reported that decapod larvae form important foods for juvenile salmon staying in shore waters, while Kinase and sato (1980) and Seki et al. (1981 and 1982) showed that decapods are not utilized by the juvenile salmon in spite of their existence as zooplankton. Released juvenile salmon, which were recaptured in Aysén Fiord between September and November 1979 to 1982, preyed more abundantly on cladocerans, calanoids, balanid cypris, macruran larvae, terrestrial insects, and fish larvae (unpublished data). Brachyuran larvae may not become important foods for juvenile salmon in instance where there are other preferable preys.

ACKNOWLEDGMENTS

This study was made as part of the environmental investigation of the Project of Introduction into Aysén Chile of Pacific Salmon, which has been conducted by the Servicio Nacional de Pesca (SERNAP), Ministerio de Economía Fomento y Reconstrucción, Chile, and the Japan International Cooperation Agency (JICA).

We wish to thank Mr. Pablo Aguilera M., director of the SERNAP, XI Region, and Mr. Aliaky Nagasawa, leader of the Japanese expert team assigned to the project by the JICA, who have led the project program. Mr. Mario Puchi A., director of the SERNAP, Aysén Province Mr. Kosuke Shimazu, expert of salmon culture, and Mr. Delfin Vargas S., assistant of the Ensenada Baja Hatchery, kindly gave us various helps in carrying out field surveys. Our many thanks are due to Mr. Fernando Balbontín, Universidad de Valparaíso, Mr. Omar Rojas J., Instituto de Fomento Pesquero, Messers. Leonardo Guzmán M. and Italo Campodónico G., Instituto de la Patagonia, for their valuable informations on identifications of fish and decapod larvae. We are also grateful to the following persons for their courtesy in collecting literature: Messers. Jin Hattori and Kiyoshi Fujita, Tokyo University of Fisheries (Japan), Dr. Taiji Kikuchi, Kyushu University (Japan), Dr. Soichiro Shirahata, Hokkaido Regional Fisheries Research Laboratory (Japan), Dr. Kenji Takagi, Far Seas Fisheries Research Laboratory (Japan), Drs. Juana Y. D. de Cienchomski and Enrique E. Boschi, Instituto Nacional de Investigación y Desarrollo Pesquero (Argentina), Dr. Margaret M. Smith, Rhodes University (South Africa), Dr. Yasunobu Mastsuura, Universidade de Sâo Paulo (Brazil), etc. Finally, our sincere thanks are extended to Dr. Robert M. McDowall, Ministry of Agriculture and Fisheries (New Zealand), for improving our English of the manuscript.

REFERENCES

Literature marked with an asterisk is not cited directly in the present paper, but was available for identification of fish larvae.

*Aron, A. P. N. 1980. Taxonomía, distribución y abundancia de las larvas de peces en Bahía de Concepción (36° 40′ S; 63° 02′ W) Chile. Bachelor thesis, Dep. Ocanol., Univ. Concepción, 66 pp., 15 figs.

*Balbontín, F. and R. Pérez. 1979. Modalidad de postura, huevos y estados larvales de *Hypsoblennius sordidus* (Bennett) en la Bahía de Valparaíso (Blenniidae: Perciformes). Rev. Biol. Mar., Valparaíso, 16(3): 311 ~ 318, fig. 1.

*Balbontín, F. and R. Pérez. 1980. Descripción de los estados larvales de *Normanichthys crockeri* Clark (Perciformes: Normanichthyidae) del área de Valparaíso, Chile. Rev. Biol. Mar., Valparaíso, 17(1): 81 ~ 95, figs. 1 ~ 2.

*Brownell, C. L. 1979. Stages in the early development of 40 marine fish species with pelagic eggs from the Cape of Good Hope. Ichthyol. Bull. J. L. B. Smith Inst. Ichthyol., Rhodes Univ., (40): 1 ~ 84, figs. 1 ~ 186.

*Ciechomski, J. D. de. 1971. Estudio sobre los huevos y larvas de la sardina fuegina, *Sprattus fuegensis,* y de *Maurolicus mulleri,* hallados en aguas adyacentes al sector patagónico argentino. Physis, 30(81): 557 ~ 567, pls. 1 ~ 4.

*Ciechomski, J. D. de. 1975. Características y distribución de post-larvas del acorazado, *Agonopsis chiloensis* (Jenyns, 1842) Jordan y Evermann, 1898 y de *Tripterygion cunninghami* Smitt, 1898 en aguas del Atlántico frente a la Argentina (Pisces). Physis, secc. A, 34(89): 309 ~ 317, figs. 1 ~ 2, pls. 1 ~ 2.

Ciechomski, J. D. de. 1981. Ictioplancton. In Atlas del zooplancton del Atlántico sudoccidental y metodos de trabajo con el zooplancton marino (D. Boltovskov ed.). pp. 829 ~ 860, fig. 270.

Ciechomski, J. D. de. 1982. Investigations on ichthyoplankton in the Patagonian shelf off Argentina. Cybium, 6(1): 33 ~ 36.

*Ciechomski, J. D. de and C. I. Booman. 1981. Descripción de embriones y de areas de reproducción de los granderos *Macrourus whitsoni* y *Coelorhynchus fasciatus,* de la polaca *Micromesistius australis* y del bacalao austral *Salilota australis* en la zona patagónica y fuegina del Atlántico sudoccidental. Physis, secc. A, 40(98): 5 ~ 14, figs. 1 ~ 5.

Ciechomski, J. D. de, M. C. Cassia and G. Weiss. 1975. Distribución de huevos, larvas y juveniles de peces en los sectores surbonaerenses, patogónico y fuegino del mar epicontinental argentino, en relación con las condiciones ambientales, en noviembre 1973 - enero 1974. Ecosur, 24(4): 219 ~ 248, figs. 1 ~ 14.

Ciechomski, J. D. de, M. D. Ehrlich, C. A. Lasta and R. P. Sánchez. 1981. Distribución de huevos y larvas de peces en el mar argentino y evaluación de los efectivos de desovantes de anchoita y de merluza. Contrib. Inst. Nac. Invest. Des. Pesq. (383): 59 ~ 79, figs. 1 ~ 12.

*Ciechomski, J. D. de and G. Weiss. 1974. Características del desarrollo embrionario y larvas de las merluza *Merluccius merluccius hubbsi* y *Merluccius polylepis* (Pisces, Merlucciidae) Physis, secc. A, 33(87): 527 ~ 536, pls. 1 ~ 4.

*Ciechomski, J. D. de and G. Weiss. 1976. Desarrollo y distribución de postlarvas del robalo *Eleginops maclovinus* (Valenciennes, 1830) Dollo, 1904; de la merluza negra *Dissostichus eleginoides* Smitt, 1899 y de las nototenias *Notothenia* spp. Nototheniidae. Physis, secc. A, 35(91): 115 ~ 125, pls. 1 ~ 3.

*Fisher, W. K. 1959. Huevos, crías y prelarvas de la merluza (*Merluccius gayi*), Guichenot. Rev. Biol. Mar., Valparaíso, 9(13): 229 - 249, figs. 1 ~ 3, pls. 1 ~ 3.

*Hardy, J. D. Jr. 1978. Development of fishes of the mid-Atlantic bight. An atlas of egg, larval and juvenile stages. Vol. II. Fish and Wildlife Service, Washington, 458 pp., 245 figs.

*Hureau, J. C. (ed.). 1982. Methods for studying early life history stages of Antarctic fishes. Biomass hadbook no. 17, Group of specialist on living resources of the southern oceans, Paris, 32 pp., 4 + 36 figs.

Iioka, C., J. Terashima, K. Yamamoto et al. 1977. Report on developmental and experimental project of migratory important resources. –Experiment on releasing fry reared in sea water (during years 1973 to 1976)– Experiment Station of Iwate Prefecture (Japan), 33 pp.

Ito, J. 1980. Change in distribution, migration, growth and feeding habits of salmon with stage development. Progress rep. (1977 and 1979) on offshore ecological studies of salmon in young and homing periods. Far Seas Fish. Res. Lab., pp. 1 ~ 22, figs. 1 ~ 5.

Ito, J. 1981. Capture experiment on juvenile salmon in an early oceanic life by a purse seine (Hokkaido on the coast of the Okhotsk Sea in 1980). Progress rep. (1980) on offshore ecological studies of salmon in young and homing periods. Far Seas Fish. Res. Lab., pp. 45 ~ 62, figs. 1 ~ 7.

Kikuchi, T. 1982. Reproductive ecology and life history traits in the marine invertebrates - VIII. Larval dispersal (1). Aquabiology, 4(6): 444 - 449, figs. 1 ~ 3.

Kinase, M. and M. Sato. 1980. Studies on chum salmon in shore waters. Chum salmon juveniles and their food organisms. Progress rep. on stabilization and intensification of introducing effects of salmon. Japan Sea Reg. Fish. Res. Lab., pp. 51 ~ 57, figs. 1 ~ 3.

Kobayashi, T. 1977. Ecology of juvenile salmon in an inshore staying period. Bull. Japan. Soc. Fish. Oceanogr., (31): 39 ~ 44, figs. 1 ~ 11.

Latz, M. I. and R. B. Forward, Jr. 1977. The effect of salinity upon phototaxis and geotaxis in a larval crustacean. Biol. Bull., 153: 163 ~ 179, figs. 1 ~ 5.

Mayama, H., M. Kato, J. Seki et al. 1982. Studies on the chum salmon released in the Ishikari River System - I. On the seaward migration and inshore distributions of liberated fry in 1979. Sci. Rep. Hokkaido Salmon Hatch., (36): 1 ~ 17, figs. 1 ~ 14.

*McDowall, R. M. 1969. A juvenile of *Aplochiton* Jenyns. Copeia, 1969(3): 631 ~ 632, fig. 1.

Minoda, T. 1981. Feeding habits of juvenile salmon and zooplankton in shore waters - 4. Predatory behavior of juvenile salmon and biological environment in an inshore staying period. Rep. of study group on salmon in fluvial and inshore waters. Hokkaido Reg. Fish. Res. Lab., pp. 117 ~ 122, figs. 1 ~ 2.

*Mito, S. 1966. Illustrations of the marine plankton of Japan. Vol. 7. –Fish eggs and larvae– Soyo-sha, Tokyo, 74 pp., 26 pls.

Morioka, Y. 1979. Change in food demand of salmon with growth. Progress rep. on stabilization and intensification of introducing effects of salmon. Japan Sea Reg. Fish. Res. Lab., pp. 43 - 45.

*Moser, H. G., E. H. Ahlstrom and E. M. Sandknop. 1977. Guide to the identification of scorpionfish larvae (Family Scorpaenidae) in the eastern Pacific with comparative notes on species of *Sebastes* and *Helicolenus* from other oceans. NOAA Tech. Rep. NMFS CIRC-402, v + 71 pp., 40 figs.

Okada, S. and A. Taniguchi. 1971. Size relationship between salmon juveniles in shore waters and their prey animals. Bull. Fac. Fish., Hokkaido Univ., 22(1): 30 ~ 36, figs. 1 ~ 3.

*Orellana, M. C. and F. Balbontín. 1983. Estudio comparativo de las larvas de Clupeiformes de la costa de Chile. Rev. Biol. Mar., Valparaíso, 19(1): 1 ~ 46, figs. 1 ~ 9.

*Perez, R. M. 1979. Desarrollo postembrionario de *Tripterygion chilensis* Cancino 1955, en la Bahía de Valparaíso (Tripterygiidae; Perciformes). Rev. Biol. Mar., Valparaiso, 16(3): 319 ~ 329, figs. 1 ~ 2.

Richardson, S. L. and W. G. Pearcy. 1977. Coastal and oceanic fish larvae in an area of upwelling off Yaquina Bay, Oregon. Fish. Bull., 75(1): 125 ~ 145, figs. 1 ~ 8.

*Robertson, D.A. 1975. A key to the planktonic eggs of some New Zealand marine teleosts. Occ. Pub. Fish. Res. Div., Minist. Agri. Fish., New Zealand, (9): 1 ~ 19, figs. 1 ~ 9.

Sakamoto, S., H. Kondo, Y. Onoda et al. 1982. Physical environment conditions of the Soya coastal region and capture of juvenile salmon in 1977 to 1981. Rep. of study group on salmon in fluvial and inshore waters. Hokkaido Reg. Fish. Res. Lab., pp. 55 ~ 68, figs. 1 ~ 10.

Sadifer, P. A. 1973. Distribution and abundance of decapod crustacean larvae in the York River estuary and adjacent lower Chesapeake Bay, Virginia, 1968 - 1969. Chesapeake Sci., 14 (4): 235 ~ 257, fig. 1.

Sandifer, P. A. 1975. The role of pelagic larvae in recruitment to populations of adult decapod crustaceans in the York River estuary and adjacent lower Chesapeake Bay, Virginia. Estuar. Coast. Mar. Sci., 3: 269 ~ 279, figs. 1 ~ 6.

Sato, S. 1958. Studies on larval development and fishery biology of king crab, *Paralithodes camtschatica* (Tilesius). Bull. Hokkaido Reg. Fish. Res. Lab., (17): 1 ~ 102, figs. 1 ~ 32, pls. 1 ~ 10.

Seki, J., H. Mayama, I. Shimizu et al. 1981. Feeding habits of juvenile salmon and food organisms in shore waters. Stomach contents of juvenile salmon and food abundance in the shore of Ishikari Bay, 1980. Rep. of study group on salmon in fluvial and inshore waters. Hokkaido Reg. Fish. Res. Lab., pp. 123 ~ 131, figs. 1 ~ 4.

Seki, J., H. Mayama, I. Shimizu et al. 1982. Feeding habits of juvenile salmon and annual fluctuations of food organisms in the shore of Ishikari Bay. Rep. of study group on salmon in fluvial and shore waters. Hokkaido Reg. Fish. Res. Lab., pp. 129 ~ 144, figs. 1 ~ 8.

Sulkin, S. D. and W. Van Heukelem. 1982. Larval recruitment in the crab *Callinectes sapidus* Rathbun: An amendment to the concept of larval retention in estuaries. In Estuarine comparisons (V. S. Kennedy ed.). Academic Press, Inc., New York, 459 ~ 475 pp., 7 figs.

Sulkin, S. D., W. Van Heukelem, P. Kelly et al. 1980. The behavioral basis of larval recruitment in the crab *Callinectes sapidus* Rathbun: A laboratory investigation of ontogenetic changes in geotaxis and barokinesis. Biol. Bull., 159: 402 ~ 417, figs. 1 ~ 10.

Sumi, Y. 1979. Ecology of juvenile salmon in shore waters. Progress rep. on stabilization and intensification of introducing effects of salmon. Japan Sea Reg. Fish. Res. Lab., pp. 31 ~ 42, figs. 1 ~ 7.

Suzuki, U., H. Kondo, Y. Onoda et al. 1979. Analysis of physical environment conditions of the Soya coastal region. Rep. of study group on salmon in fluvial and inshore waters. Hokkaido Reg. Fish. Res. Lab., pp. 53 ~ 76, figs. 1 ~ 11.

Suzuki, U., H. Kondo, Y. Onoda et al. 1980. Analysis of physical environment conditions of the Soya coastal region (1979). Rep. of study group on salmon in fluvial and inshore waters. Hokkaido Reg. Fish. Res. Lab., pp. 55 ~ 70, figs. 1 ~ 7.

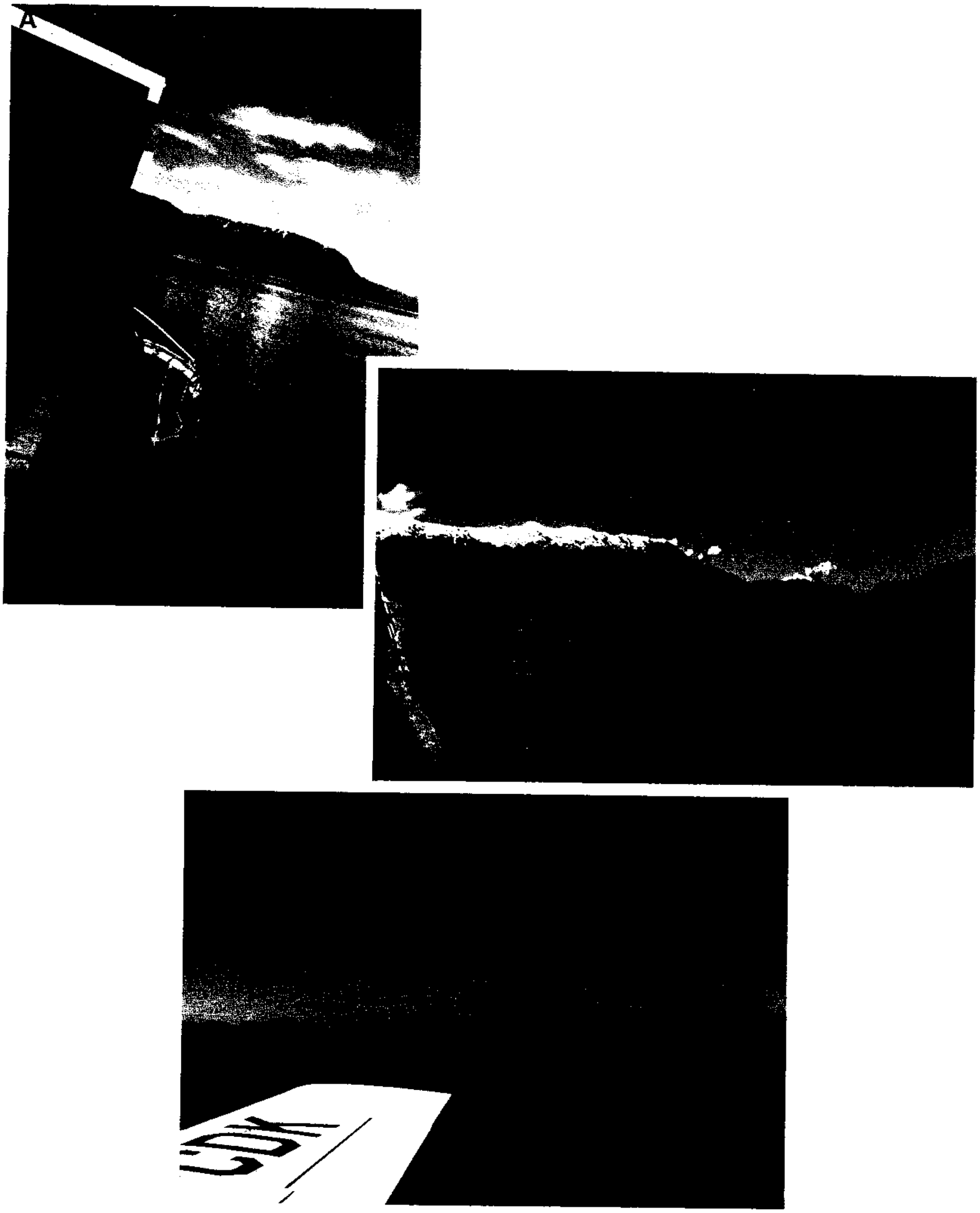
Takagi, K. 1980. Oceanic capacity of the north Pacific for retaining salmon. Progress rep. (1979) on offshore ecological studies of salmon in yound and homing periods. Far Seas Fish. Res. Lab., pp. 103 ~ 144, figs. 1 ~ 10.

*Uchida, K., S. Imai, S. Mito et al. 1958. Studies on the eggs, larvae and juvenile of Japanese fishes. Ser. I. 2nd Lab. Fish. Biol., Fish. Dep., Kyushu Univ., viii + 89 pp., 86 pls.

*Weiss, G. 1975. Hallazgo, descripción y distribución de las postarvas del bacalao criollo, *Salilota australis*, y del pez sabel, *Lepidopus caudatus*, en aguas de la plataforma argentina (Pisces). Physis, secc. A, 34(89): 319 ~ 325, fig. 1, pls. 1 ~ 3.

Yasunaga, Y. and Y. Koshiishi. 1979. Feeding and nutritive conditions of juvenile salmon staying in inshore waters. Progress rep. on stabilization and intensification of introducing effects of salmon. Japan Sea Reg. Fish. Res. Lab., pp. 111 ~ 116.

*Zama, A. and E. Cárdenas G. 1984. Illustrations of planktonic animals found in Aysén Fiord and Moraleda Channel, the XI Region, Chile. Inform. Brief Intro. Aysén Chile Pac. Salmon, (6): 1 ~ 20, figs. 1 ~ 81.



Explanation of Plate I:

A, the larvae net used, being taken aboard after sampling; **B**, Aysén Fiord midway from Sts. 2 to 3; **C**, Moraleda Channel southward from above St. 10.

Appendix Table 1. Surface water temperature (°C) and salinity (°/oo) measured at the stations in Aysén Fiord and Moraleda Channel between November 1980 and October 1981. Asterisks showing stations at which larva net samplings were made un each cruise. Months given in spring-winter order.

(A): October 1981

Station	1	2*	3	4*	5	6*	7	12	8*	11	9	10*	15	16*	14*	13*
Date	Oct. 9	Oct. 9	Oct. 9	Oct. 9	Oct. 9	Oct. 9	Oct. 9	Oct. 12	Oct. 11	Oct. 11	Oct. 11	Oct. 11	Oct. 11	Oct. 11	Oct. 11	Oct. 11
Time	10:40	11:30	13:00	13.50	15:20	16:30	17:25	14:25	13:10	15:20	12:05	10:45	18:20	08:25	17:15	19:15
Water temp. (C)	11.1	12.4	11.3	12.7	11.9	11.4	11.5	10.2	10.1	10.3	10.2	10.0	10.5	10.0	10.6	10.1
Salinity (%)	2.3	2.3	4.5	3.5	12.2	20.7	25.8	29.0	28.3	29.0	29.7	29.7	29.6	31.5	29.0	29.5

(B): Nov. - Dec. 1980

Station	1*	2	3*	4*	5*	6*	7	12*	8*	11*	9	10*	15*	16*	14	13*
Date	Nov. 7	Nov. 8	Nov. 8	Nov. 7	Nov. 7	Nov. 8	Nov. 20	Dec. 1	Nov. 18	Nov. 18	Nov. 18	Nov. 19	Dec. 4	Dec. 4	Dec. 2	Dec. 2
Time	10:15	15:15	13:20	13:25	17:45	07:50	14:25	20:45	11:10	12:40	09:10	13:15	11:00	14:00	13:20	10:30
Water temp. (C)	7.9	9.9	9.9	9.4	11.1	9.1	14.1	13.0	10.7	10.8	10.4	11.9	12.5	11.1	12.0	11.0
Salinity (%)	3.0	3.0	3.0	3.0	13.0	10.0	15.0	20.0	30.0	25.0	28.0	28.0	27.0	31.0	29.0	29.0

(C): February 1981

Station	1*	2*	3	4	5	6*	7*	12	8*	11	9	10*	15	16*	14*	13*
Date	Feb. 13	Feb. 9	Feb. 12	Feb. 9	Feb. 12	Feb. 12	Feb. 9	Feb. 12	Feb. 10	Feb. 11	Feb. 10	Feb. 10	Feb. 10	Feb. 10	Feb. 11	Feb. 12
Time	11:40	10:10	19:20	12:25	16:00	14:55	14:40	13:15	17:45	11:45	16:25	14:55	10:30	12:30	14:20	09:40
Water temp. (C)	13.8	14.5	14.0	14.4	14.6	13.5	12.8	12.8	12.5	12.4	12.8	12.9	13.8	12.9	12.9	11.3
Salinity (%)	6.2	3.5	6.8	13.9	18.7	23.7	30.7	28.8	30.7	30.5	30.7	30.7	28.1	31.4	31.4	28.1

(D): May. 1981

Station	1	2*	3	4*	5	6	7*	12*	8	11*	9	10*	15*	16*	14	13*
Date	May. 18	May. 13	May. 18	May. 13	May. 17	May. 17	May. 13	May. 17	May. 16	May. 16	May. 15	May. 15	May. 14	May. 14	May. 16	May. 17
Time	12:40	11:50	10:30	14:10	19:45	18:45	16:30	16:30	10:15	11:50	19:10	17:30	14:30	17:20	13:55	08:30
Water temp. (C)	7.4	11.9	8.6	10.4	8.4	9.2	11.0	10.4	10.5	10.6	10.6	10.6	11.0	10.4	10.5	10.6
Salinity (%)	9.7	27.8	16.9	26.0	21.4	14.9	29.2	27.2	27.0	26.8	29.2	29.4	31.0	31.0	28.2	27.9

(E): July 1981

Station	1	2*	3	4*	5	6*	7	12	8*	11	9	10*	15	16*	14	13*
Date	Jul. 25	Jul. 21	Jul. 21	Jul. 21	Jul. 21	Jul. 24	Jul. 21	Jul. 24	Jul. 23	Jul. 23	Jul. 22	Jul. 22	Jul. 22	Jul. 22	Jul. 23	Jul. 23
Time	11:15	11:35	13:05	14:00	15:15	13:00	16:25	10:45	09:05	10:20	17:10	15:30	11:15	12:50	13:10	15:15
Water temp. (C)	6.3	6.7	6.2	7.3	7.6	8.4	9.0	8.7	9.3	9.3	9.3	9.2	8.7	9.2	9.0	9.4
Salinity (%)	8.5	9.3	10.8	14.5	18.6	19.5	26.7	24.9	27.2	27.0	27.6	27.2	28.1	28.6	26.8	27.5

Appendix Table 2. Sampling records, number and total wet weight of organisms collected with a larvae net at each station in Aysén Fiord and Moraleda Channel between November 1980 and October 1981. Months given in spring-winter order. "n.d." showing no data. Weather codes: b, blue sky; bc, blue sky with detached clouds; c, cloudy or overcast; r, rain.

(A): October 1981

Station	2	4	6	8	10	16	14	13
Date	Oct. 9	Oct. 9	Oct. 9	Oct. 11	Oct. 11	Oct. 11	Oct. 11	Oct. 11
Time	11:50–12:10	14:00–14:20	15:55–16:15	13:25–13:45	11:00–11:20	08:45–09:05	17:20–17:40	19:15–19:35
Weather	b	c	c	r	c	r	c	c
Surface water temp. (°C)	12.4	12.7	11.4	10.1	10.0	10.0	10.6	10.1
Surface salinity (°/oo)	2.3	3.5	20.7	28.3	29.7	31.5	29.0	29.5
1. Actiniaria sp.								
2. NEMATODA (?) sp.								
Archaeogastropoda								
3. Acmaeidae sp.								
Dysodonta								
4. Mytilidae sp.								
5. Octopoda sp.	–	–	–	–	–	1	–	1
Errantia								
6. Syllidae spp.								
7. *Tomopteris* sp.								
Calanoida								
8. *Calanus* sp.	–	–	–	–	–	–	10	3
9. *Rhincalanus* sp.	–	–	–	3	3	395	1	–
10. *Euchaeta* spp.	–	–	–	2	–	–	–	–
11. *Centropages* sp.								
12. *Candacia* sp.	–	–	–	–	–	63	–	–
13. Caligoida spp.	–	–	1	–	–	–	–	–
Thoracica								
14. Balanidae sp.								
Isopoda								
15. Sphaeromidae spp.	1	–	–	–	–	–	–	–
Amphipoda								
16. Gammaridea spp.								
17. Hyperiidae spp.	–	1	1	5	11	14	30	6
Euphausiidae								
18. Euphausiidae sp.	–	–	–	30	1	3	1	–
Macrura								
19. *Betaeus* sp. (juv.)	–	–	–	–	–	1	–	–
20. Macrura spp. (mysis)	595	570	1,121	22	14	738	296	37
Anomura								
21. Lithodidae sp. (glau.)	–	–	–	–	–	–	–	1
22. *Munida* sp. (zoea)	–	35	121	47	26	5,962	1,222	24
23. *Munida* sp. (grimothea)	–	–	–	–	–	181	7	3
24. Albuneidae sp. (zoea)								
25. Callianassidae sp. (zoea)	–	–	–	–	–	–	51	–
26. Porcellanidae sp. (zoea)	–	3	31	61	40	107	51	–
27. Porcellanidae sp. (glau.)								
Brachyura								
28. Atelecyclidae sp. (zoea)	489	95	155	10	1	2	4	2
29. Brachyura spp. (zoea)	29	3,030	3,837	2,849	566	–	3,981	720
30. Brachyura spp. (megalopa)	–	3	6	3	1	2,700	6	18
Squillidae								
31. Squillidae sp. (alima)	–	–	3	11	4	105	33	6
Insecta								
32. Plecoptera sp.								
33. Mallophaga sp.								
34. Hemiptera sp.								
35. Trichoptera spp.								
36. Tipulidae spp.								
37. Diptera spp.								
38. Coleoptera spp.								
Sagittidae								
39. *Sagitta* sp.	2	2	3	2	11	168	–	7
Pisces								
40. Pisces spp. (egg)	1	–	–	1	–	16	2	2
41. Pisces spp. (larva)	41	8	13	3	1	32	60	1
Total no. of individuals	1,158	3,747	5,292	3,049	679	10,488	5,755	831
Total wet weight (g)	0.70	6.32	9.79	4.88	1.04	52.10	11.04	1.24

(continued)

(B): Nov. - Dec. 1980

Station	1	3	4	5	6	12	8	11	10	15	16	13
Date	Nov. 8	Nov. 8	Nov. 7	Nov. 7	Nov. 8	Dec. 1	Nov. 18	Nov. 18	Nov. 19	Dec. 4	Dec. 5	Dec. 2
Time	16:40–17:00	13:55–14:15	14:15–14:35	17:15–17:35	08:40–09:00	21:30–21:50	10:20–10:40	15:10–15:30	12:50–13:10	11:40 12:00–	08:20 08:40–	11:20 11:40–
Weather	c	c	b	b	c	c	c	c	bc	c	c	c
Surface water temp. (°C)	9.8	9.9	10.5	11.6	9.9	13.0	10.5	10.9	11.9	12.5	10.9	11.0
Surface salinity (°/oo)	n.d.	3.0	3.0	13.0	10.0	20.0	30.0	25.0	28.0	27.0	n.d.	30.0
1. Actiniaria sp.	–	–	–	–	–	–	–	–		–	–	1
2. NEMATODA (?) sp.												
Archaeogastropoda												
3. Acmaeidae sp.	–	–	–	–	–	1	–	–	–	–	–	–
Dysodonta												
4. Mytilidae sp.												
5. Octopoda sp.												
Errantia												
6. Syllidae spp.												
7. *Tomopteris* sp.												
Calanoida												
8. *Calanus* sp.												
9. *Rhincalanus* sp.	–	–	–	–	–	3	30	7	4	1	3	32
10. *Euchaeta* spp.	–	–	–	–	–	–	–	–	–	–	1	–
11. *Centropages* sp.												
12. *Candacia* sp.	–	–	–	–	–	–	–	–	–	–	1	–
13. Caligoida spp.	–	–	–	–	–	–	–	–	–	1	–	–
Thorencica												
14. Balanidae sp.												
Isopoda												
15. Sphaeromidae spp.	–	–	–	–	–	1	–	–	–	–	–	–
Amphipoda												
16. Gammaridea spp.	–	–	–	–	–	2	1	–	1	–	2	2
17. Hyperiidae spp.	–	–	–	–	1	–	–	1	4	–	6	–
Euphausiidae												
18. Euphausiidae sp	–	–	–	–	–	10	5	2	5	3	5	886
Macrura.												
19. *Betaeus* sp. (juv.)												
20. Macrura spp. (mysis)	–	–	–	–	3	144	3	4	5	4	4	14
Anomura												
21. Lithodidae sp. (glau.)												
22. *Munida* sp. (zoea)	–	–	–	–	–	1	–	–	–	–	–	–
23. Munida sp. (grimothea)	–	–	–	–	–	2	7	9	39	–	–	7
24. Albuneidae sp. (zoea)	–	–	–	–	–	–	–	–	–	1	1	–
25. Callianassidae sp. (zoea)												
26. Porcellanidae sp. (zoea)	–	–	–	–	3	69	–	14	103	73	42	36
27. Porcellanidae sp. (glau.)	–	–	–	–	–	–	–	–	1	–	–	–
Brachyura												
28. Atelecyclidae sp. (zoea)	–	–	–	–	8	24	–	–	–	–	–	7
29. Brachyura spp. (zoea)	–	–	–	–	2	3,048	112	42	732	6	2	247
30. Brachyura spp. (megalopa)	–	–	–	–	–	4,366	10	72	1,331	51	19	3,845
Squillidae												
31. Squillidae sp. (alima)	–	–	–	–	–	18	–	1	4	–	3	1
Insecta												
32. Plecoptera sp.	–	–	–	1	–	–	–	–	–	–	–	–
33. Mallophaga sp.												
34. Hemiptera sp.	–	–	–	–	–	1	–	–	–	–	–	–
35. Trichoptera spp.												
36. Tipulidae spp.	–	–	–	–	–	–	2	–	–	–	–	–
37. Diptera spp.	–	1	–	–	–	–	–	–	–	–	–	–
38. Coleoptera spp.												
Sagittidae												
39. *Sagitta* sp.	–	–	–	–	4	1	14	3	3	1	38	1
Pisces												
40. Pisces spp. (egg)	–	–	–	–	–	–	–	–	1	–	18	–
41. Pisces spp. (larva)	3	1	2	4	23	39	3	18	261	1	2	12
Total no. of. individuals	3	2	2	5	44	7,730	187	173	2,494	142	147	5,091
Total wet weight (g)	0.03	0.02	0.04	0.03	1.02	62.53	1.25	1.35	20.02	1.04	0.85	48.74

(continued)

(C): February 1981

Station	1	2	6	7	8	10	16	14	13
Date	Feb. 13	Feb. 9	Feb. 12	Feb. 9	Feb. 10	Feb. 10	Feb. 10	Feb. 11	Feb. 12
Time	11:55-12:15	10:25-10:45	14:00-14:20	14:05-14:25	17:25-17:45	15:10-15:30	12:00-12:20	13:30-13:50	09:15-09:35
Weather	bc	r	b	r	c	c	c	c	c
Surface water temp. (°C)	13.8	14.5	13.5	12.8	12.5	12.9	12.9	12.9	11.3
Surface salinity (o/oo)	6.2	3.5	23.7	30.7	30.7	30.7	31.4	31.4	28.1
1. Actiniaria sp.	–	–	–	7	–	–	–	–	–
2. NEMATODA (?) sp.									
Archaeogastropoda									
3. Acmaeidae sp.									
Dysodonta									
4. Mytilidae sp.	–	–	1	–	–	–	–	–	–
5. Octopoda sp.									
Errantia									
6. Syllidae spp.									
7. *Tomopteris* sp.	–	–	–	–	–	1	–	–	–
Calanoida									
8. *Calanus* sp.	–	–	–	–	–	3	–	–	–
9. *Rhincalanus* sp.	–	–	–	2	–	–	1	1	–
10. Euchaeta spp.	–	–	–	–	1	–	–	3	–
11. *Centropages* sp.	–	–	–	–	–	–	1	1	–
12. *Candacia* sp.	–	–	1	2	2	–	–	–	–
13. Caligoida spp.	–	–	–	–	2	–	–	–	1
Thoracica									
14. Balanidae sp.	–	–	1	–	–	–	–	–	–
Isopoda									
15. Sphaeromidae spp.									
Amphipoda									
16. Gammaridea spp.	–	–	59	1	22	1	3	–	1
17. Hyperiidae spp.	–	–	1	3	8	7	10	2	4
Euphausiidae									
18. Euphausiidae sp.	–	–	–	–	25	3	–	1	36
Macrura									
19. *Betaeus* sp. (juv.)									
20. Macrura spp. (mysis)	–	–	7	82	260	491	20	59	9
Anomura									
21. Lithodidae sp. (glau.)									
22. *Munida* sp. (zoea)	–	–	–	4	5	39	–	–	–
23. *Munida* sp. (grimothea)	–	–	–	2	–	–	1	–	–
24. Albuneidae sp. (zoea)									
25. Callianassidae sp. (zoea)									
26. Porcellanidae sp. (zoea)	–	–	3	33	60	96	23	17	6
27. Porcellanidae sp. (glau.)	–	–	4	2	–	–	1	–	–
Brachyura									
28. Atelecyclidae sp. (zoea)	–	–	1	1	7	–	–	–	–
29. Brachyura spp. (zoea)	–	–	29	179	587	381	46	116	74
30. Brachyura spp. (megalopa)	–	–	27	18	87	38	3	12	1
Squillidae									
31. Squillidae sp. (alima)	–	–	–	–	1	2	–	–	–
Insecta									
32. Plecoptera sp.									
33. Mallophaga sp.									
34. Hemiptera sp.									
35. Trichoptera spp.	–	1	–	–	–	–	–	–	–
36. Tipulidae spp.	–	–	–	–	–	–	1	–	1
37. Diptera spp.	–	–	4	–	–	–	–	–	–
38. Coleoptera spp.	–	–	1	–	–	–	–	–	1
Sagittidae									
39. *Sagitta* sp.	–	–	3	13	6	2	1	–	4
Pisces									
40. Pisces spp. (egg)	–	–	–	3	–	–	–	–	–
41. Pisces spp. (larva)	6	1	16	15	9	6	–	1	19
Total no. of individuals	6	2	158	367	1,082	1,070	111	213	157
Total wet weight (g)	0.54	0.10	0.92	2.39	5.29	6.85	0.31	0.62	1.71

(continued)

(D): May 1981

Station	2	4	7	12	11	10	15	16	13
Date	May 13	May 13	May 13	May 17	May 16	May 15	May 14	May 14	May 16
Time	12:35–12:55	14:30–14:50	16:50–17:10	16:45-17:05	10:10–10:30	17:55–18:15	14:55–15:15	17:30–17:50	10:10–10:30
Weather	r	r	c	c	r	bc	c	c	c
Surface water temp. (°C)	11.9	10.4	11.0	10.4	10.6	10.6	11.0	10.4	10.6
Surface salinity (o/oo)	27.8	26.0	29.2	27.2	26.8	29.4	31.0	31.0	n.d.
1. Actiniaria sp.									
2. NEMATODA (?) sp.	–	–	–	–	–	–	1	4	–
Archaeogastropoda									
3. Acmaeidae sp.									
Dysodonta									
4. Mytilidae sp.									
5. Octopoda sp.									
Errantia									
6. Syllidae spp.	–	–	–	–	–	1	–	–	–
7. Tomopteris sp.	1	–	–	–	–	–	–	2	1
Calanoida									
8. *Calanus* sp.	–	–	–	–	–	–	–	1	–
9. *Rhincalanus* sp.	–	–	–	2	–	2	1	30	152
10. *Euchaeta* spp.									
11. *Centropages* sp.									
12. *Candacia* sp.									
13. Caligoida spp.	–	–	–	–	–	1	–	–	–
Thoracica									
14. Balanidae sp.									
Isopoda									
15. Sphaeromidae spp.									
Amphipoda									
16. Gammaridea spp.	–	–	1	–	–	1	–	1	–
17. Hyperiidae spp.	–	–	5	14	27	15	1	14	6
Euphausiidae									
18. Euphausiidae sp.	2	2	–	5	3	843	8	74	1,090
Macrura									
19. *Betaeus* sp. (juv.)	–	–	–	–	–	1	–	–	–
20. Macrura spp. (mysis)	–	–	6	14	4	335	20	335	2
Anomura									
21. Lithodidae sp. (glau.)									
22. *Munida* sp. (zoea)	1	–	–	1	–	–	–	1	–
23. *Munida* sp. (grimpthea)									
24. Albuneidae sp. (zoea)	–	–	–	1	–	4	–	–	–
25. Callianassidae sp. (zoea)									
26. Porcellanidae sp. (zoea)	–	–	6	2	4	20	–	18	–
27. Porcellanidae sp. (glau.)									
Brachyura									
28. Atelecyclidae sp. (zoea)									
29. Brachyura spp. (zoea)	–	–	1	–	–	3	–	–	–
30. Brachyura spp. (megalopa)	–	–	–	1	–	20	–	8	–
Squillidae									
31. Squillidae sp. (alima)	–	–	–	4	7	161	–	5	–
Insecta									
32. Plecoptera sp.									
33. Mallophaga sp.	–	–	–	1	–	–	–	–	–
34. Hemiptera sp.									
35. Trichoptera spp.									
36. Tipulidae spp.									
37. Diptera spp.									
38. Coleoptera spp.									
Sagittidae									
39. *Sagitta* sp.	3	–	1	9	–	29	38	74	19
Pisces									
40. Pisces spp. (egg)									
41. Pisces spp. (larva)	1	–	–	–	–	9	–	4	4
Total no. of individuals	8	2	20	54	45	1,445	69	571	1,274
Total wet weight (g)	0.14	0.01	0.05	0.05	0.21	12.77	0.22	2.32	7.90

(continued)

(E): July 1981

Station	2	4	6	8	10	16	13
Date	Jul. 21	Jul. 21	Jul. 24	Jul. 23	Jul. 22	Jul. 22	Jul. 23
Time	11:55-12:15	14:15-14:35	13:15-13:35	08:40-09:00	15:45-16:05	13:10-13:30	14:50-15:10
Weather	bc	bc	c	c	c	bc	c
Surface water temp. (°C)	6.7	7.3	8.4	9.3	9.2	9.2	9.4
Surface salinity (o/oo)	9.3	14.5	19.5	27.2	27.2	28.6	27.5
1. Actiniaria sp.							
2. NEMATODA (?) sp.							
Archaeogastropoda							
3. Acmaeidae sp.							
Dysodonta							
4. Mytilidae sp.							
5. Octopoda sp.							
Errantia							
6. Syllidae supp.	–	–	–	2	–	–	–
7. *Tomopteris* sp.							
Calanoida							
8. *Calanus* sp.							
9. *Rhincalanus* sp	–	–	4	–	–	–	116
10. *Euchaeta* spp.							
11. *Centropages* sp.							
12. *Candacia* sp.							
13. Caligoida spp.							
Thoracica							
14. Balanidae sp.							
Isopoda							
15. Sphaeromidae spp.							
Amphipoda							
16. Gammaridea spp.	–	–	1	1	–	–	2
17. Hyperiidae spp.	–	–	3	–	24	54	19
Euphausiidae							
18. Euphausidae sp.	–	–	2	–	2	9	100
Macrura							
19. Betaeus sp. (juv.)							
20. Macrura spp. (mysis)							
Anomura							
21. Lithodidae sp. (glau.)							
22. *Munida* sp. (zoea)							
23. *Munida* sp. (grimothea)							
24. Albuneidae sp. (zoea)							
25. Callinassidae sp. (zoea)							
26. Porcellanidae sp. (zoea)							
27. Porcellanidae sp. (glau.)							
Brachyura							
28. Atelecyclidae sp. (zoea)							
29. Brachyura spp. (zoea)							
30. Brachyura spp. (megalopa)							
Squillidae							
31. Squillidae sp. (alima)	–	–	1	3	1	–	2
Insecta							
32. Plecoptera sp.							
33. Mallophaga sp.							
34. Hemiptera sp.							
35. Trichoptera spp.	–	–	–	–	–	1	–
36. Tipulidae spp.							
37. Diptera spp.							
38. Coleoptera spp.							
Sagittidae							
39 *Sagitta* sp.	152	1,104	4	–	–	–	3
Pisces							
40. Pisces spp. (egg)							
41. Pisces spp. (larva)							
Total no. of individuals	152	1,104	15	6	27	64	242
Total wet weight (g)	0.09	0.64	0.01	0.24	0.08	0.25	0.97