Oecological Studies on the Japanese Fresh-water Shrimp,

Palaemon nipponensis.1. Seasonal Migration and Monthly Size-composition
with Special Reference to the Growth and Age.

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On the oecology of the common shrimp, *Palaemon nipponensis* DE HAAN, some valuable contributions have been done by Kitahara (1895), Fisheries Experimental Station of Ibaraki Prefecture (1912), Ichô (1912) and Kubo (1937). But much is left to be desired in this line of research. The present writer has undertaken a scrutiny of this item during one year starting from June, 1946.

Before proceeding any further, the writer wishes to express his sincer thanks to Mr. J. HANAEI, who has given his support in every possible way in collection of the material, on which the present article is based, and to Miss SATSUKE HAMADA, by whom a part of measurement has been done. Acknowledgment is also made to the "Suisan kenkyu Kai", by which the expense of the present investigation was partly defraed.

Material and method: The material dealt with obtained monthly from Kihara standing on west coast of the Kake Kasumigaura by a collector made up a bundle of tree-branches about 1.5m long. The collectors lowered to bottom at 4 station, I~IV, which locate on a straight line running offshore. The characteristics of each the station are given in the following table (Table 1).

Table 1.

Ttation	Distance from the coast (m)	Depth (m)	Bottom matter
I	30	0.35~0.85	Sand
II	200	2.20~2.70	Sandy mud
III	250	3.15~3.65	Mud
IV	300	3.48~3.98	Mud

At Shrimping the collector is pulled up gently and the Shrimps raised with it are scooped up by a kind of dip-net (1.63×1.35×0.47m in size) with meshes about 5 mm when it comes near water-surface.

The monthly average water-temperature given in the Table 2 is based on the data measured daily at 10 O' clock at Tsuchiura by the Fisheries Experimental Station of Ibaraki Prefecture during 7 years from 1928~'34. Tsuchiura, which is located on the coast of the lake, stands north 12 km from Kihara.

Table 2. Monthly average water-temperature ($^{\circ}\text{C}$) measured daily at 10 O' clock at Tsuchiura.

Month	Year							Range	Average
	1928	'29	'30	'31	'32	'33	'34		
1	5.2	4.1	5.3	4.7	5.2	4.7	3.0	3.0~5.3	4.6
2	5.5	5.5	7.2	4.2	4.8	5.8	5.0	4.2~5.8	5.4
3	10.5	9.0	11.4	10.3	9.5	8.1	7.9	8.1~10.5	9.5
4	13.7	15.3	14.5	15.9	14.7	14.5	14.0	13.7~15.9	14.7
5	20.6	17.9	21.7	20.4	20.1	20.4	20.4	17.9~20.6	20.2
6	22.9	22.8	24.4	22.0	25.5	24.4	23.9	22.0~25.5	23.7
7	26.8	28.6	29.6	23.2	27.6	29.2	25.5	23.2~29.6	27.2
8	27.6	27.3	30.3	28.2	28.2	29.8	27.9	27.3~30.3	28.4
9	27.0	23.2	24.2	24.7	23.6	24.9	23.3	23.2~27.0	24.4
10	19.9	20.2	19.0	18.9	19.5	18.4	16.3	16.3~20.2	18.9
11	13.6	14.2	12.3	12.9	11.4	12.3	12.2	11.4~14.2	12.7
12	8.0	11.5	6.5	8.0	7.4	6.7	6.1	6.1~11.5	9.2

Seasonal migration: The stock or population of the *Palaemon* seems to be distributed somewhat more densely, irrespective of sex, in shallower water, namely stations I~III, than in deeper one in summer months from June to September (Fig. 1, I~L). During this period, the water-temperature ranges 22.0~30.3 $^{\circ}\text{C}$ (25.9 $^{\circ}\text{C}$ on average). But it appears to move offshore in October as the water-temperature becomes lower. The peak of the population exists at station III (Fig. 1, H). In November the catch of the shrimp suddenly increases. The distribution of the stock of this month is similar to that of October as shown in Fig. 1, G. In the next month, the most part of the population seems to move for deeper water than in the case of November, since the population at the station IV much raised in number. Yet the peak of the stock occurs at station III (Fig. 1, F). As going to January, in which the water-temperature is lowest: 3.0~5.3 $^{\circ}\text{C}$ (4.6 $^{\circ}\text{C}$ on average), throughout year, the population becomes most at the deepest station (IV), and is scarce at stations I and II (Fig. 1, E). In February, the peak of the population comes to station III again.

The population at the stations I and II is still little. At spring, March and April, the population undergoes onshore migration as the water-temperature becomes warmer. The peak of the population, although it is still laying at the station III, becomes lower in April than in March (Fig. 1, C and B). In May, the majority of the population occurs at the stations I~III forming summer-type of the stock-distribution (Fig. 1, A).

It may be seen through the monthly data given above that the population of this

Tabld 3. Monthly caught individuals at each station by a collector.

Month	Male					Female					Total
	I	II	III	IV	Total	I	II	III	IV	Total	
5	23	29	36	14	102	33	34	38	13	118	220
4	57	70	127	70	324	44	86	138	91	359	683
3	8	40	233	73	354	20	50	246	82	398	752
2	14	21	87	51	173	21	19	104	75	219	392
1	58	25	149	173	405	52	53	175	199	479	884
12	9	118	325	207	659	9	190	393	320	912	1,571
11	10	229	269	109	617	24	318	375	184	901	1,518
10	—	12	23	7	42	—	25	30	9	64	106
9	8	9	17	4	38	18	27	19	7	71	109
8	10	5	10	9	34	21	20	12	12	65	99
7	16	24	2	4	46	23	51	14	19	107	153
6	10	5	5	1	21	15	5	6	0	26	47
Total	223	587	1,283	722	2,815	280	878	1,550	1,011	3,719	6,534

Fig. 1 (left). Monthly catches obtained by a collector. Abscissa, number of stations. Ordinate, number of individuals (numerals within brackets showing number of female). A, May; B, April; C, March; D, February; E, January; F, December; G, November; H, October; I, September; J, August; K, July; L, June. Solid marks, female; soft ones, male.

Fig. 2 (right). Monthly size-composition. Abscissa, body-length (mm) without rostrum. Ordinate, number of individuals. A~E, August~December; F~L, January~July. Solid marks, female; soft ones, male.

Fig. 3. Seasonal catches. Abscissa, number of station. Ordinate, number of individuals. a, Spring (March and April); b, summer (June-September); c, Autumn (November and December); d, Winter (January and February). Solid marks, female; soft ones, male.

Table 4. Frequency table for individuals taken monthly by a collector.

Items	Sex	Month	Body-length (mm)																							
			9	12	15	18	21	24	27	30	33	36	39	42	45	48	51	54	57	60	63	66	69	72	75	
			12	15	18	21	24	27	30	33	36	39	42	45	48	51	54	57	60	63	66	69	72	75	78	
Frequency	Male	8	1	4	8	3	4		1	3	5	2	2							1						
		9		2	7	4	5	5	2	1	4	1		3	1			1	1						1	
		10		3	6	4	4	3	2	3	1	1	1	1	3	5		2	2	1						
		11		3	51	97	153	121	94	41	24	11	8	4	4	4	2									
		12		8	70	141	184	98	67	41	13	10	10	4	1	1	8	1	2							
		1		14	55	65	82	69	39	24	14	14	14	7	2	1	3	2								
		2		26	38	24	32	17	8	10	4	6		2	2	3	1									
		3		31	50	68	54	61	29	23	12	9	4	5		2	5		1							
		4	2	56	84	41	33	17	21	18	11	13	9	6	4	4	2	1	2							
		5		2	8	11	11	12	13	6	5	9	9		5	4	4	1	2							
		6					7	5	2		1	1	1	2			1				1					
		7						3	11	11	8	5					1	1	2	1	1	1		1		
		Frequency	Female	8	2	10	14	6	1	1	2	2			4	10	8	2	1	1		1				
				9	1	1	8	10	10	9	4	1	1	2	2	6	7	3	3	2	1					
10				8	13	11	11	3	4	7	2	1		1	2		4		1			1				
11				7	79	136	183	191	149	86	33	8	3	3	11	7	5									
12				3	96	251	210	163	98	49	10	6	5	4	5	5	5	1		1						
1				14	78	93	98	88	52	26	12	5	3	1	5	2	2									
2	1			29	41	47	30	37	19	7	3	2		1		1	1									
3	5			22	92	79	64	56	52	9	9	4		1	2		3									
4	4			65	88	65	37	32	27	19	9	6		2	4				1							
5				1	6	9	11	12	13	22	17	11	4	3	1	3	3	2								
6								5	6	4	3	2	2			2		2								
7										2	2	22	26	33	9	2	2	5	3			1				

shrimp is subject to onshore migration in spring and offshore one in autumn. These seasonal migrations are, however, more evidently figured out by seasonally summing up the monthly catches. As plainly shown in Fig. 2, the population is thickest at the station III in spring, in which the water-temperature warms up to $8.1\sim 15.9^{\circ}\text{C}$ (12.1°C on average). As it becomes in summer (June~September), the population scatters almost uniformly through the area with depths running at least $0.35\sim 3.98\text{m}$. As the water-temperature gradually decreases to $6.1\sim 14.2^{\circ}\text{C}$ (10.9°C on average) in Autumn (November and Desember), the shrimp-population moves offshore and assembles to the stations II-IV, thickest at the station III as is the case with spring. In winter (January and February)— $3.5\sim 5.8^{\circ}\text{C}$ (5°C on average) in watertemperature—, most of the population is found at the stations III and IV.

Monthly size-composition: The shrimp-population, which appears at KIHARA, is at least referable to three groups (a~c). The group-a, that is composed of the shrimps newly hatched in about July, appears firstly in the material taken in August. This group grows to the group-b until the following July. The group-c is of shrimps over 55mm in body-length.

The group-a found in August ranges from $9\sim 24\text{mm}$ in body-length having a mode at $15\sim 18\text{mm}$ for both sexes. This group becomes large and grows gradually with advance of month, but it seems that the growth is not so remarkable until the following April as shown in Fig. 3, B~I. In May—just before breeding season—this group, however, appears to undergo very rapid growth, attains in mode of the body-length to $27\sim 30\text{mm}$ for male and $30\sim 33\text{mm}$ for female respectively. The growth during June and early July seems to be much faster in female than in male, since the mode of the body-length of the July-material captured on July 12 is $42\sim 45\text{mm}$ in female against $27\sim 33\text{mm}$ in male. The group-b occurs continuously until October, showing gradual growth. The mode of the body-length appears at $33\sim 36\text{mm}$ in both August and September and $48\sim 51\text{mm}$ in September, and $51\sim 54\text{mm}$ in October for female respectively. But this group suddenly becomes scarce after October. Consequently it may be mentioned that most of the animals in question die shortly after spawning and a small number of them survives as the member of the group-c. Therefore the duration of life of this animal in most cases is of 14~15 months.

The description given above may be concluded as follows. The fresh-water shrimp, *Palaemon nipponensis* grows to $30\sim 40\text{mm}$ in body-length except rostrum in male, to $36\sim 54\text{mm}$ in female during one year after its development. This result is largely in keeping with that given by KITAHARA⁴⁾. The age of the crustacea is short. It appears to be about one year (14~15 months) in most cases, although that of those, which survive as the group-c, is unknown. In this connection it should be mentioned that the conclusion that the age of this shrimp is of about one year corresponds to those reached by many investigator as to the following natantia: American common prawn, *Penaeus setiferus*⁵⁾; Californian shrimps, *Crango nigricauda* and *C. franciscorum*¹⁾; *Penaeus orientalis*; *Leander paucidentis*²⁾; and *Paratya compressa improvisa*³⁾.

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