Difference of Frequency of Transfer Between Several Types of Fishes in Underwater Fence Net Model Experiment*

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INTRODUCTION

In the series of experiment, we have done and doing, to see the fish behavior toward various sorts of characters of fishing nets, scince these are a sort of model experiments in tank, we should select the fish species to use as to be small size proportional to that of the model net and as to alive actively through out the period of experiments.

Moreover, as the actual commercial fishing net is usually deviced so as to catch a certain kind of fish mainly, in model experiments we should select a minuature fish which can fairly represent the habit of it.

On the other hand, so various kinds of fish have so various peculiarities according to the range of living and habit of swimming, and about it also we are adding more knowlege in recent days by ultra sonic fish locater and others.

Set nets, including pound net and others, a group of fishing net kinds usually called "Teichi-ami" here, having long fence net or leader attached to the pocket or box, can catch any sort of fish which pass through the area where the net is set, though main turget is some particular fish.

In the course of studies on the screening effect of fence net, usually using "medaka", *Aplocheilus* (*Oryzias*) *latipes*, the common rice paddy minnow, as the minuature fish for model experiments, we became to anxious that if other fish species which has other sort of habit is used what result would be obtained. And we thought such a knowlege would adds some to the deductive interpretaion of the result of this sort of model experiment.

The fence net or leader of set nets is usually spread out from the bottom up to the surface of water, however the screening effect of it would differs according to the fish kind in various parts of the net, if it is considered to be devided according to the stratum in depth of water. Especially, in recent years, set net is deviced to sink below the water surface to avoid the rough wave of the surface caused by stormy weather, so fence net, as a part of it, also has possibility to be set underwater, having its float line or cork line beneath the water surface.

Therefore, in the following experiments in tank, as the under water fence net a

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nylon film (opaque) of various hights was set at the middle of the tank, and the passing rate was observed about several kinds of fish having different habit of living.

The first serries of the experiments was done by the hand of Keikichi KONDO, (Research student) and the latter part was done by Masakazu YAO (now a member of Tohoku Region Fisheries Research Institute) as a graduation thesis when he was a student, and the plan and the compilation was made by Yoshio HIYAMA.

DIFFERENCE BETWEEN SURFACE DWELLER, MIDDLE LAYER DWELLER AND BOTTOM DWELLER

The fish kinds selected for this first part of the experiment are (1) *Aplocheilus latipes*, the common rice pady minnow (Medaka), as a representative of the surface dwellers, (2) *Acheilognathus lanceolate* the common Japanese bitteling (Yari-tanago), as a representative of the middle layer dwellers, (3) *Misgurumus anguilicaudatus*, the common Japanese loach (Dojo , as a representative of the bottom dwellers. These all three are small fresh water fishes of strong living.

The tank we used through out these experiments are wooden, 22 cm deep, 72 cm long, and 52 cm wide, painted white inside.

At the middle of the length of the tank a septum made of white opaque nylon film of under mentioned heights is fitted in, and this was filled by water always 20 cm deep.

For each three species of fish, the height of the septum in the tank was deviced to very according to their swimming stratum. The height of the septum when the rice paddy minnow was used was 15 and 18cm; when the bitteling was used it was 14, 16, and 18 cm; when the loach was used, it was 5, 10, and 15 cm.

The passing rate, here we want to compare the difference of which with each other fish kind and with each height of the septum, was obtained as an accumulated total figure of the frequency that the fishes pass over the septum, in both directions eithr to and from the room where they originally liberated, throughout ten minutes, though it was counted and recorded at every minute. And, this figure was called as "frequency of the transfer" in this paper.

As the index which can express the degree of difficulty or easiness of the passing through the septum for fishes experimented, there were already several ways reported, to enumerate it from the records obtained by counting the frequency of passing in every minute. HIYAMA and MURATA (1948) compared the three different indications with each other, and OKA (1948) and HIYAMA (1952) used the another indication. These methods of indication should be selected considering the purpose of the experiment, and here the method we adopted is very near to "the frequency of transfer" that KUSAKA (1952) used.

The reason why we limited the duration of the time of this experiment within ten minutes is nothing but to avoid the change of value caused by the fact that the fish would tire or accustom to the special conditions of the experiment, as already known

through the preceding experiments reported.

As already stated in our preceding papers, the different values of passing rate would be obtained according to how and when the counting of the passing start in the experiment. We tried a comparison of several methods however, here just to see the difference of passing rate between three fish species and several heights of the septum, an uniform way is used throughout whole series of the experiment. That is:— taking ten indeviduals of fish from the reserve tank, liberate them quitely in to the experiment tank, where already the septum was prepared, and after two minutes passed since then, the counting of the number of fish passing the septum starts.

The series of the experiments were carried on from April 24th to July 1st of 1952 inside of our laboratory in Tokyo University by KONDO. During this period, as the room temperature getting high, that of water in experiment tank also varied from 18.4 to 25.6° C., and the activity of locomotion of the fish also gradually become higher in the end of the period. About the variation of the passing rate caused by the difference of the water temperature an analysis would be made in the later chapter. And here, just to see the difference of the passing rate against various height of the septum, no influence it has upon the analysis of the results, because for each set of experiment, numbered in Table 1., a combination of various heights of the septum was made, starting 0 cm high (i. e. no septum was fitted in).

The results obtained were tabulated in Table 1, here inserted.

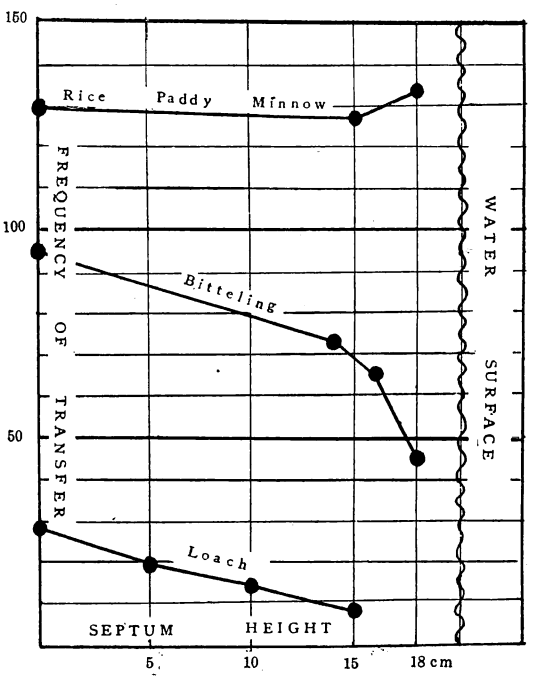

Fig. 1. Frequency of transfer of three fish species in presence of under water septum of various heights.

Table 1. Frequency of transfer of three fish species in presence of various heights of the septum.

Rice Paddy Minnow							Bitteling						Loach					
Septum height (cm)			0	14	16	18	Septum height (cm)			0	15	18	Septum height (cm)			0	5	10	15
Date	Time	Water temp.	Freq. Trans.				Date	Time	Water temp.	Freq. Trans.			Date	Time	Water temp.	Freq. Trans.			
V- 2	pm 2.00	18.7	85	77	70	55	VI- 3	am 9.30	18.6	60	55	88	VI-26	am 10.00	20.7	52	30	20	22
V- 1	pm 2.00	18.8	68	44	51	29	VI- 3	am 11.00	18.7	89	80	78	VI-26	pm 2.00	21.2	23	15	14	9
V- 2	am 10.00	19.0	103	80	46	32	VI- 2	pm 1.30	19.1	90	90	87	VI-27	am 10.00	22.5	30	9	3	5
V- 6	am 10.00	19.1	69	91	49	33	VI- 2	am 9.30	19.2	68	46	63	VI-27	pm 2.00	22.6	27	7	7	3
V- 7	am 10.00	19.2	74	72	68	49	VI- 4	am 9.30	19.6	48	78	51	VI-25	pm 2.00	22.8	21	24	23	19
V-10	am 11.20	19.4	109	90	106	58	VI- 5	am 9.30	20.6	99	73	109	VI-25	am 10.00	23.1	24	16	25	5
V- 9	pm 3.00	19.5	100	56	65	69	VI- 5	am 9.30	20.7	86	151	83	VI-23	am 10.00	23.2	26	24	21	5
V- 9	am 9.30	19.6	97	114	112	74	VI- 5	pm 1.30	20.8	185	143	144	VI-23	pm 2.00	23.2	14	13	9	1
V- 9	pm 3.00	19.6	100	56	65	69	VI- 9	pm 3.00	20.8	132	142	124	VI-21	am 10.00	23.2	40	28	15	10
V- 8	am 10.00	19.8	94	96	97	48	VI- 9	am 11.00	20.9	111	104	91	VI-21	pm 2.00	23.5	34	42	27	21
V-13	pm 4.00	19.8	67	48	26	17	VI- 9	am 9.30	21.0	63	76	191	VI-24	am 10.00	23.5	23	26	14	3
V-14	am 11.00	19.8	103	0	32	20	VI- 6	am 11.00	22.1	54	118	57	VI-20	am 10.00	23.6	7	3	12	4
V-14	pm 2.00	20.0	114	44	25	11	VI- 6	pm 1.30	22.3	233	198	182	VI-20	pm 2.00	23.8	14	24	4	1
V-13	am 10.00	20.5	144	142	105	67	VI- 6	pm 3.00	22.4	201	184	164	VI-28	am 10.00	24.4	25	7	6	3
							VI-12	pm 3.00	22.6	184	151	171	VII-1	am 10.00	25.6	61	13	13	14
							VI-18	pm 3.00	22.6	160	116	150	VII-1	pm 3.00	25.6	24	18	10	7
							VI-18	pm 1.30	22.7	111	121	145							
							VI-18	pm 3.00	22.8	164	139	171							
							VI-13	pm 3.00	23.1	232	236	280							
							VI-13	pm 1.30	23.3	179	203	194							
Average							Average						Average						

The average values of the rate of passing for these fish kinds and various heights of septum can be expressed as shown in Fig. 1.

It is obvious from the facts shown in Fig. 1 that the rice paddy minow, being a surface swimmer, got no disturbance by the presence of 15 cm high septum, but got some when it was 18 cm high. The bitteling, being a middle layer swimmer, got an apparent disturbance by the presence of 14 cm high septum, and it was more significant in the case of 16cm high and further more in 18 cm high. The loach, as it is a bottom creeper, even the septum of 5 cm high made them difficult to pass over it, and it was more significant in the cases that the septum was higher.

The comparisons of these average values were made by the statistical method, and the each neighbouring average figures has significant difference bellow 0.5% level of significance.

THE INFLUENCE OF WATER TEMPERATURE AND OTHERS

As the series of the experiments were done during 47 days, the water temperature, being influenced by the room temperature, changed remarkably from 18.6 to 25.6° C in the experiment tank during the course of the experiment. As according to the change of water temperature the locomotion activity is supposed to be influenced, Fig. 2 was made to see the relation of water temperature with the frequency of transfer here obtained. Though the frequency of transfer in the cases of the various heightsvaries

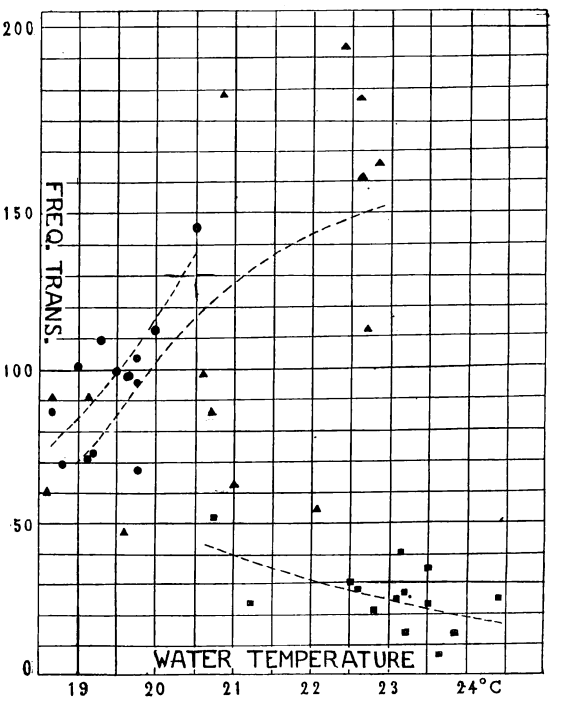

Fig. 2. Influence of water temperature to the frequency of transfer of three species of fish in the cases without the septum.

according to the water temperature, here only that of the cases without the septum (0 cm in Table 1) was graphed, so as to express the tendency clearly. Actually the same tendency was observed in the cases when the septum of various h ights exists.

The Fig. 2 tells that the influence of the water temperature is more remarkable about the rice paddy minnow and the bitteling, and less about the loach, within this extent of variation of temperature.

As already reported by KUSAKA (1952) about the rice paddy minnow that the time of day when the observation was done has some influence to the locomotion activity of fish being expressed as the frequency of transfer. So the following Table 2 was prepared to see the difference between the forenoon and the afternoon observations.

The result of the statistical analysis tells that only in the case of the rice paddy minow the difference is significant and not in other fish kinds. Its relation with time of day is shown in Fig. 3, merely about the rice paddy minnow.

DIFFERENCE BETWEEN FISH KINDS OF SIMILAR HABIT

Prior to the above mentioned experiments done by the hand of KONDO, YAO worked out the similar sort of experiments using the two kinds of fish, *Acheilognathus lanceolatus*, the common Japanese bitleling (Yari-tanago), and *Pseudolasbora parva*, the common Japanese minnow (Mo-

Table 2. Comparison of frequency of transfer concerning the time of day when experimented.

Septum height	Rice Paddy Minnow								Bitteling								Loach							
	am				pm				am				pm				am				pm			
	0	14	16	18	0	14	26	18		0	15	18	0	15	18			0	5	10	15	0	5	10	15
1	103	86	46	32	68	44	51	29	1	68	46	63	90	90	87	1		7	3	12	4	34	42	27	21
2	69	91	49	33	100	56	65	69	2	60	55	88	185	143	144	2		14	24	4	1	14	13	9	1
3	74	72	68	49	67	48	26	17	3	89	80	78	233	198	182	3		40	28	15	10	21	24	23	7
4	94	96	97	48	114	44	25	11	4	48	78	51	201	184	164	4		26	24	21	5	23	15	14	19
5	97	114	112	74	85	77	70	55	5	99	93	109	132	142	124	5		23	26	14	3	27	7	7	9
6	106	113	45	83					6	86	151	83	184	151	171	6		24	16	25	5	25	7	6	3
7	109	90	105	67					7	54	118	57	179	209	194	7		52	30	20	22	24	1	10	7
8	114	142	105	67					8	63	76	191	232	236	280	8		30	9	3	5				
9	103	0	32	20					9	111	104	91	111	121	145	9		61	13	13	14				
									10	160	116	150	164	139	171										
$\bar{x}$	97	89	73	52	87	54	47	36	$\bar{x}$	84	92	96	171	160	166	$\bar{x}$		31	19	14	8	24	18	14	9

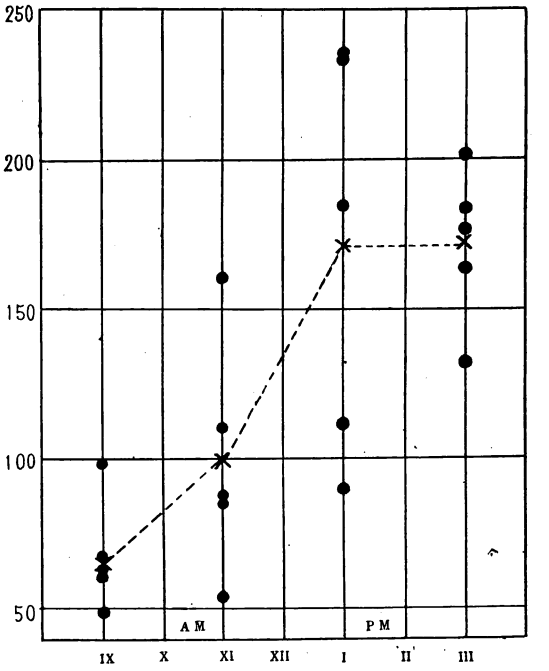

Fig. 3. Frequency of transfer of the rice paddy minnow in the cases without the septum in relation with the time of day when the experiment started. X is average value.

tsugo). The both fish kinds are commonly understood as to be the middle layer dwellers, so by comparing the figures of frequency of transfer in the existence of the septum of various heights with each other fish kind, we wanted to see if there is any sort of difference between the two species.

This series of the experiments were done in the same tank in the same laboratory, during January 21st to March 1st of 1952. And the method of the experiment is quite same as the one already mentioned.

Only the difference from the foregoing experiments is that the frequency of transfer was caluculated in the same way, from the records of observations but the comparisons were made between the rate of passing which was obtained by deviding the frequency of transfer by that of blank test (the case no septum was fitted in or expressed 0 cm in previous chapters), to avoid the influence of water temperature, which varies from 6.7 to 8.5° C during the experiment about the bitteling and from 5.7 to 12.7° C about the minnow.

The passing rates thus obtained were tabulated in Table 3. And, the average figures of these passing rates were expressed in a graph to compare as Fig. 4.

Fig. 4 shows the same tendency as that of the three species of fishes mentioned in previous chapter (Fig. 1). However, though it is unable to say that the difference of the average value of the passing rate for 14 cm high septum exist between both species, a remarkable difference is found in the case of 18 cm high septum between

Table 3. Passing rate of the bitteling and the minnow in presence of various height septum.

Bitteling				Minnow			
Septum height	14	16	18		10	14	18
1	84.7	82.4	11.8	1	49.0	40.2	31.4
2	55.2	46.3	16.4	2	75.7	67.5	48.6
3	32.3	29.1	21.0	3	95.8	76.9	32.6
4	96.3	70.3	63.0	4	79.5	75.7	60.3
5	79.4	48.6	16.2	5	87.6	78.5	43.1
6	37.5	25.0	3.3	6	58.8	70.6	39.7
7	67.0	50.9	21.7	7	63.3	57.0	31.6
8	81.2	61.2	38.8	8	68.2	77.3	40.9
9	108.4	84.3	62.7	9	83.3	62.5	20.7
10	48.0	18.8	14.6	10	74.0	62.0	38.0
11	72.4	50.0	27.6				
12	52.1	52.1	31.7				
13	80.0	57.5	43.8				
14	62.2	35.1	31.6				
$\bar{X}$	68.3	50.8	28.9	$\bar{X}$	73.5	66.8	38.7

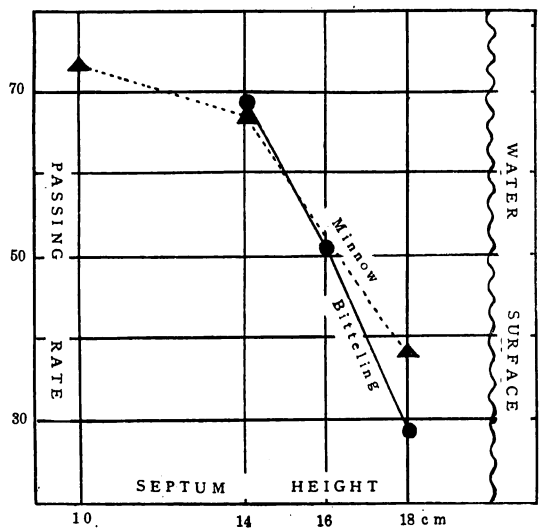

Fig. 4. Difference of passing rate between the minnow (▲) and the bitteling (●) in presence of under water septum of various heights.

the both species. And this difference is also proved by statistical comparison to be significant with in 0.05% level of significance.

This evidence can be understood that eventhough the both, the minnow and the

bitteling, are the fishes of the habit living always in middle layer equally, the minnow has less difficulty to pass over the high septum than the bitteling.

CONCLUSION

For the model experiment to see the fish behavior toward various types of fish net model, the minuature fish kind should fairly represent the swimming habit of the commercial fish kind to be caught by the actual fishing net. Roughly speaking about the classification of the habit of fish, the rice paddy minnow can represent the surface dwellers, the bitteling can do the middle layer dwellers, and the loach can do the bottom dwellers, seeing from the influences of various heights of under water septums upon the frequency of transfer to and from the part of the tank where they were liberated. And also the results of these experiments tells that the under water fence net or leader of the set nets can lead the more bottom dwellers than the surface swimmers, and to catch the latter effectively the more the fence should be the higher. Even though the both fishes, the minnow and the bitteling, are supposed to belong to the same category in the classification of the swimming habit, the different degree of influence of the existence of the septum was found between the each fish kind. This can be interpreted that each fish species has peculiarity of the habit of swimming. So exactly speaking, the representation of the commercial fish by the minuature fish can be done with some extent of exactness.

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