

入,脱かごと入り口高さとの関係

| | |
|-------|------------------|
| 誌名 | 日本水産學會誌 |
| ISSN | 00215392 |
| 著者 | 山根, 猛 飯高, 勇之助 |
| 巻/号 | 53巻12号 |
| 掲載ページ | p. 2145-2150 |
| 発行年月 | 1987年12月 |

Relation between Ingress, Escape and Height of Pot Entrance*1

Takeshi Yamane*2 and Yunosuke Iitaka*2

(Accepted July 4, 1987)

In this paper, attention is focused on the relation between the ingress and escape behaviour of prawns and height of pot entrance for the purpose of applying these data to investigate the catching mechanism of a small shrimp pot. The experiments were performed in a tank using six model pots without bait. The behaviour of prawns near the entrance funnel was recorded using video camera for a duration of 3 hours per experiment. In each case, the variation in the number of individuals in a pot was well defined by the model equation. The relative catching efficiency was at maximum value near 8 cm height of pot entrance.

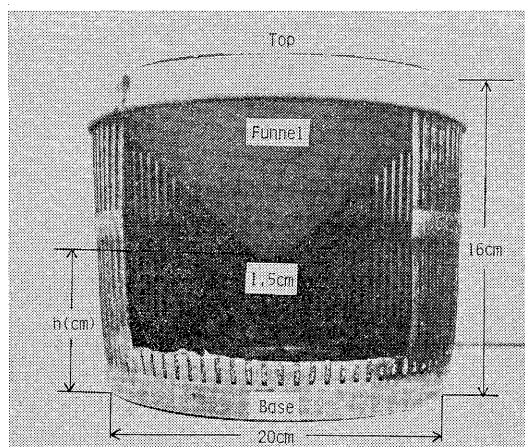
Many types of pots are used widely in the pot fishery throughout the world. Pots are simple gears and their basic concept is the same in almost all cases. Commonly, the pots are constructed in such a way that the aquatic animals can go into and out through one or more entrance freely. However, this function complicates the catching mechanism of pots. Many factors affect the escape and ingress behaviour of aquatic animals, for example, pot construction, attractiveness of a bait and the condition of the interior of a pot. In the previous papers,^{1,2)} the ingress and escape behaviour of aquatic animals was discussed separately. Recently, some basic informations from field observations³⁻⁷⁾ using actual pots and model experiments were obtained. However, there are number of unclarified points regarding the catching mechanism and analytical approaches to such problems which were not sufficiently covered in the previous studies. In designing an effective pot, it is therefore important that the relation between ingress, escape and pot construction be evaluated. If the catch ability of pot through the model experiment in a tank is evaluated, the results may be useful in designing an effective pot.

The present report therefore aims at representing basic data to evaluate the catch ability of pots in laboratory conditions. Attention is focused on the relation between the escape and ingress behaviour of striped prawn *Palaemon paucidens* and height of entrance of pot for the purpose of

investigating the catching mechanism of a pot.

Method

Six models were constructed using plastic basket having the same size of the actual commercial pot (Fig. 1). Six entrance funnels with 1.5 cm in diameter entrance were made using polyvinyl chloride 0.3 mm thick. The height of a pot entrance above the base was varied in six heights (Fig. 1). The experiments were performed with-



Height of a pot neck, h (cm)
h 2 4 8 10 13 16

Fig. 1. Experimental pot.

*1 Model Experiment on the Catching Mechanism of a Small Shrimp Pot III (えびかごの漁獲機構に関する実験的研究 III).

*1 Presented at the Annual Meeting of the Japanese Society of Scientific Fisheries, Kochi, Japan, October 1986.

*2 Department of Fisheries, Faculty of Agriculture, Kinki University, Higashiosaka, Osaka 577, Japan (山根 猛, 飯高勇之助: 近畿大学農学部水産学科).

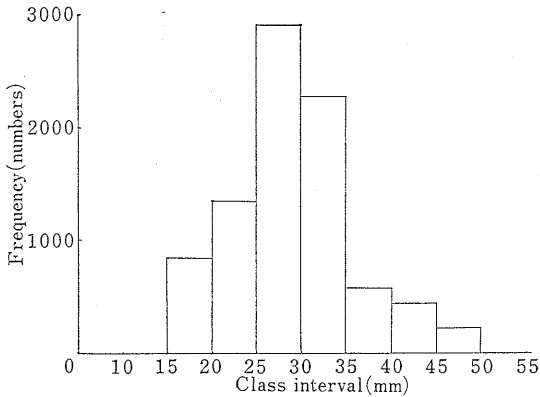


Fig. 2. The length frequency distribution of prawns used.

out bait in a tank 1 m diameter by 40 cm high with 30 cm water depth. Striped prawns (15–50 mm in body length) (Fig. 2) caught by bamboo screen and commercial pot were utilized. The number of prawns used in both ingress and escape experiments were varied in five densities; 50, 100, 150, 200 and 250 individuals. In both experiments, activities of striped prawn near the entrance funnel were recorded by video camera for a duration of 3 hours per experiment. The water temperature was maintained at $20^{\circ}\text{C} \pm 2^{\circ}$ during experimental period. The light condition was controlled at 300 lux on water surface.

Results

In the previous paper,²⁾ we proposed the measuring method of the degree of prevention of escape from a pot through the value of a .^{*} It was shown that the escape behaviour of aquatic animals from a pot was controlled by the height of an entrance above the base. Let us now consider some application of the moving ratio (a) to evaluate the catching efficiency of a pot. The data obtained for each pot are arranged through mean value.

The rigorous evaluation of the effect caused by the population pressure on the ingress and escape behaviour of aquatic animals in a given space is a very difficult problem. As first step, the variation in the value of $a(h_i, N_{0j})/a(h_i, N_{0, min})$, (P_r) is presented as a function of the value of number of individuals in a given space/volume of a given space (N_i) (Fig. 3). Here, h_i is the height of an

entrance above the base, N_{0j} is the initial number of individuals in a given space at j -th experiment and $N_{0, min}$ is the minimum number of individuals in a given space. Actually, the value of a obtained in the case of $N_{0j}=50$ individuals was used as the value of $N_{0, min}$ in the calculation. In the determination of practical (P_r) values of the ratio of a , the following expression is used;

$$P_r = \left\{ \sum_{j=1}^n a(h_i, N_{0j}) / a(h_i, N_{0, min}) \right\} / n \quad (1)$$

where, (n) shows the number of trials done. Although the plots in the graph for each case are slightly scattered, as a whole, the value of P_r assumes a constant value. The values of moving ratios used in the calculation are given in Table 1.

Many factors affect the catching efficiency of a pot. Here, the main focus is in the height of entrance of pot. The value of C_r is defined as the relative catching efficiency as first approximation.

$$C_r = \left\{ \sum_{j=1}^n a_{in}(h_i, N_{0j}) / a_{es}(h_i, N_{0j}) \right\} / n \quad (2)$$

Here, a_{in} is the moving ratio for ingress experiment and a_{es} is the moving ratio of escape experiment. In Fig. 4, the value of C_r are plotted as a function of the height of a pot neck. As may be seen from Fig. 4, C_r can be represented as a function of the height of an entrance of pot above the base (h). From Fig. 4, the curve has a peak. It seems that the apparent catching efficiency was at maximum value near $h_i=8$ cm.

When considering the catching efficiency of a pot, it also becomes necessary to evaluate the

Table 1. Mean moving ratio used in the calculations.

| Numbers | Height of a pot entrance (cm) | | | | | | |
|---------|-------------------------------|-----|------|------|------|------|------|
| | 2 | 4 | 8 | 10 | 13 | 16 | |
| 50 | A | 5.9 | 3.7 | 6.7 | 7.0 | 5.6 | 1.7 |
| | B | 1.1 | 2.2 | 1.1 | 2.7 | 3.3 | 3.0 |
| 100 | A | 5.3 | 7.6 | 8.3 | 3.7 | 4.6 | 3.7 |
| | B | 1.1 | 5.6 | 1.1 | 1.4 | 1.3 | 4.1 |
| 150 | A | 5.7 | 3.1 | 4.3 | 4.4 | 5.1 | 1.1 |
| | B | 1.0 | 0.86 | 1.1 | 0.62 | 0.37 | 2.5 |
| 200 | A | 5.4 | 4.3 | 7.2 | 9.6 | 1.9 | 0.56 |
| | B | 1.2 | 0.74 | 0.74 | 1.4 | 0.69 | 2.6 |
| 250 | A | 3.8 | 2.7 | 5.5 | 2.0 | 1.3 | 0.67 |
| | B | 1.4 | 0.74 | 0.96 | 0.44 | 0.89 | 4.2 |

$\times 10^{-3}$

A; the results for ingress experiment.

B; the results for escape experiment.

* $-(N(t+1)-N(t))/N(t)=a$; $N(t)$ is the number of individuals in a given space at time t , t is the elapsed time, a is moving ratio.

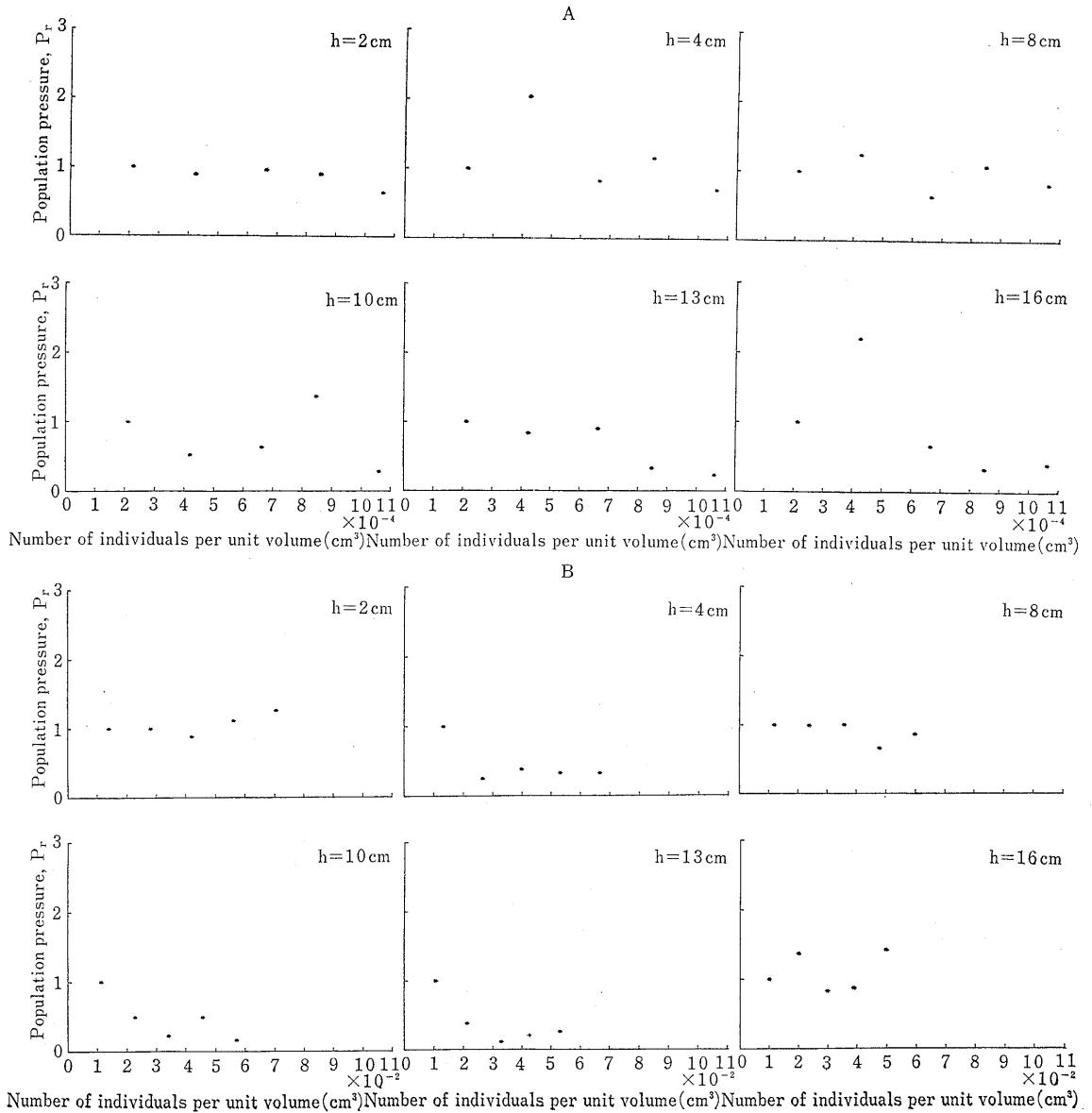


Fig. 3. Relation between population pressure, P_r and number of individuals per unit volume (cm^3) N_s .

A; the results for ingress experiment.
 B; the results for escape experiment.

ingress and escape behaviour of target species since these behaviour explain catching mechanism of the pot. Naturally, an effective pot is that which ingress exceeds escape. However, it is very difficult to observe the ingress and escape of individual in the actual fishing conditions. In this study, as first step, to investigate the ingress and

escape behaviour of aquatic animals, the probability of return* of aquatic animals escaped (r_p) is used in escape experiment. Although in ingress experiment, it was observed that the escape of individual entered was very low. In calculation of the probability of return therefore, the value obtained from ingress experiment is not con-

* The mean value of the ratio of the total return to the total escape was obtained from the data collected and arranged for a duration of 3 hours.

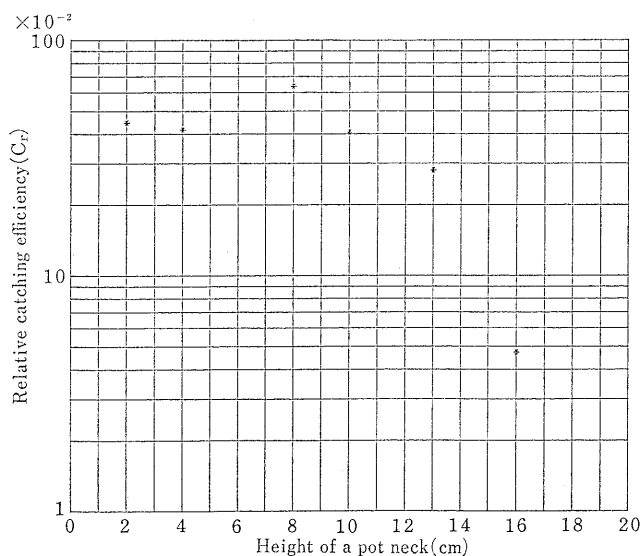


Fig. 4. Relation between relative catching efficiency, C_r and height of pot entrance (cm).

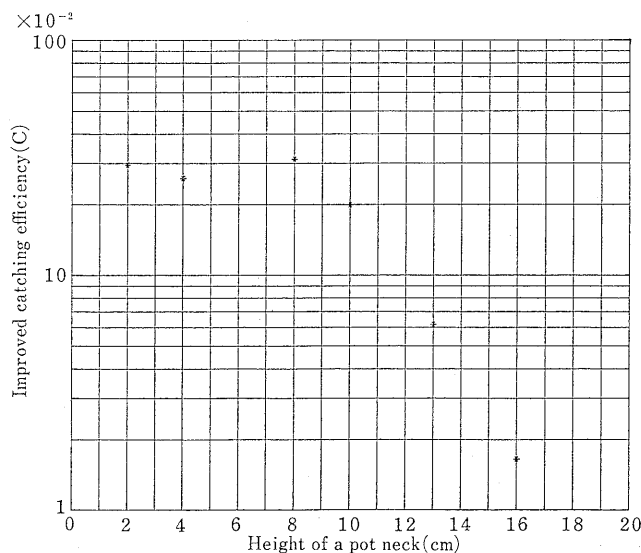


Fig. 5. Relation between improved catching efficiency, C and height of pot entrance (cm).

Table 2. Probability of return of aquatic animals (r_p).

| | Height of a pot entrance (cm) | | | | | |
|-------|-------------------------------|------|------|------|------|------|
| | 2 | 4 | 8 | 10 | 13 | 16 |
| r_p | 0.66 | 0.62 | 0.49 | 0.49 | 0.22 | 0.35 |

sidered. The data obtained for a duration of 3 hours were arranged through the mean value of the ratio of the total return to the total escape.

The results are given in Table 2. The probability of return becomes large due to decrease in the height of a pot entrance.

Discussion

Spatial behaviour of aquatic animals is one of the important problems when considering the catching mechanism. But in actual fishing conditions, to observe the behaviour of aquatic animals near a pot is very difficult. Although separate measurement of the degree of dispersion of individuals and the degree of enticement of a pot is impossible, the effect on the ingress of individuals as roughly caused by the population pressure through the value of P_r can be considered.

In case of ingress behaviour of individuals, the

value of P_r is generally constant for each case with only a few exception. Although there are differences in the number of aquatic animals that entered due to different pot construction, it is presumed that the ingress behaviour of individuals will be accelerated with increase in the number of aquatic animals in a given space (effective area around the pot). On the other hand, the increase in the number of aquatic animals distributed near the pot would increase the population pressure basically. However, in the case of a pot with $h=16$ cm (Table 1), the value of moving ratio is very low compared with other cases. This means that the pot construction, with reference to height of entrance, seriously controlled the ingress of aquatic animals into a pot. In this study, the change in the height of a pot entrance is equal to the change in the angle of slope of cone funnel.

In case of escape experiment, the value of P_r generally constant value for each pot (Fig. 3). It is presumed that the escape of aquatic animals is accelerated by the increase in the population pressure inside the pot. The moving ratio obtained will be arranged as a function of the height of a pot entrance, but the aspect of variations in the value of moving ratios differed compared with the results obtained for ingress. In case of escape, the change in the moving ratio is significant only at $h=16$ cm. On the other hand, in case of ingress, the value of moving ratio decrease gradually from $h=10$ cm to $h=16$ cm. Although it is not conclusive because of insufficient number of data, at least it is safe to say that in case of a pot with flat top where an entrance is made, the ingress is difficult, on the other hand, the escape is easy for aquatic animals that entered as observed in this experiment.

Next, the catching efficiency of a pot through the moving ratio is considered. The catching efficiency of a pot is closely related to the amount of catch. Commonly, the pots are constructed mainly based on experience through actual fishing operation with little or no reference to the behaviour of target species. If there are some informations for the effective pot construction through the results obtained in the laboratory tests, such information becomes useful in designing a pot. However, there are many factors affecting the catching efficiency. Here, as first step, the relation between the change in height of a pot entrance and moving ratio is focused. As mentioned before, the relative catching efficiency, C_r , was well arranged as a function of h (Fig. 4).

Now, a more detailed evaluation on the results obtained through some useful data is tried synthetically.

When we observed in more detail the behaviour of aquatic animals near entrance, the probability of return (r_p) obtained in escape experiment varied due to the change in the h . Therefore, the value of C_r was improved taking into account the value of r_p as follow;

$$C = C_r \times r_p \quad (3)$$

Here, C is improved catching efficiency. The results are shown in Fig. 5. As can be seen clearly from this figure, the plots in the graph are well arranged as a function of h . In the graph, the variations at near peak become gradual. On the other hand, at $h=10, 13$ and 16 cm, the value of C decrease considerably compared with the results before improvement (Fig. 4). When considering the ingress and escape of aquatic animals, it became clear from these facts that the catching efficiency of a pot with relatively high entrance will become very low.

When comparing the results obtained from different experimental conditions such as in the field tests and laboratory tests, it is important that there is similarity of the data obtained in both experimental conditions. In actual field condition, a space is considered as an infinite quantity. However, for simplification the problem now, is only confined to a given space which aquatic animals gather around the pot or the effective area of a pot. As pointed out in previous papers,^{2,7} the variations in the number of individuals in a pot is well defined by the model equation. And the height of a pot entrance applied in actual fishing condition is about the same as the height of a pot entrance with high catching efficiency in laboratory condition.

From these facts, although there is still room for future study, as first approximation, at least it can be deduced that the value of moving ratio (a) is very useful in examining the catching mechanism of a pot within the limits of this experiment.

Acknowledgements

The authors are grateful to Miss. K. Kinoshita of Kinki University for her excellent assistance. The authors are also thankful to Prof. E. E. C. Flores of the University of the Philippines in the Visayas for a critical reading and improving of the manuscript.

References

- 1) T. Yamane and Y. Iitaka: *Nippon Suisan Gakkaishi*, **51**, 881-888 (1985).
- 2) T. Yamane and Y. Iitaka: *Mem. Fac. Agr. Kinki Univ.*, **19**, 17-21 (1986) (in Japanese).
- 3) J. L. Munro: *J. Cons. Int. Explor. Mer.*, **35**, 337-350 (1974).
- 4) A. Koike, M. Ogura, and S. Takenouchi: *Nippon Suisan Gakkaishi*, **47**, 457-461 (1981) (in Japanese).
- 5) R. G. J. Shelton and W. B. Hall: *Fisheries Research*, **1**, 45-53 (1981).
- 6) P. Gros and L. Santarelli: *Oceanologica Acta*, **9**, 81-87 (1986) (in French).
- 7) T. Yamane, Y. Iitaka, and K. Tomita: *Nippon Suisan Gakkaishi*, **53**, 1399-1405 (1987).