

A Fundamental Study on the Behaviour of Milkfish Fry for Improving the Efficiency of Traditional Fry Collecting Gear in the Philippines*¹

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and

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Abstract

The reaction of milkfish fry to moving and stationary nets of different meshes and colors in an experimental tank was determined. The underwater visibility of the nets was measured and the water filtration in a fry-sweeper was observed.

Milkfish fry were both driven well by the moving nets and retained well by the stationary nets, with the fine-meshed black net most effective in both cases. The white and blue nets were found to be quite invisible to the fry in the blue-painted tank, particularly under contour lighting conditions; the black net was found to be very visible to the fry under both surface and contour light. The underwater visibility of the nets was found to vary with the sea conditions and the light direction. Water filtration in the fry-sweeper was found to be almost perfect.

From the results, it was concluded that milkfish fry are caught by the moving fry collecting gear through driving and not by filtering. Since fry collection grounds are usually turbid, it was recommended that dark-colored materials be used for effective driving. It is also deemed much better to use larger mesh nets in the wings of the fry gear to minimize net resistance in the water and facilitate operation.

INTRODUCTION

The milkfish, *Chanos chanos* (FORSSKÅL), is widely distributed in the tropical and sub-tropical Indo-Pacific, and is an important food fish in the Philippines, Taiwan, and Indonesia, where its culture has been practiced for centuries. The seed (fry) for the culture is collected from shore waters, river mouths and tidal creeks, only during the spawning seasons. The culture industry is alleged to suffer from inadequate fry supply. The induced spawning of milkfish has been attempted in the Philippines, Taiwan, and Hawaii, and has so far been successful at the SEAFDEC Aquaculture Department in the

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Philippines (VANSTONE *et al.*, 1977; CHAUDRI *et al.*, 1977; Liao *et al.*, 1979). Nevertheless, the artificial seed production of milkfish is still only on the laboratory scale and the culture industry will remain dependent on the natural seed supply for still a long time.

In the Philippines, local fishermen employ various fry collecting gears, among them the so-called "saplad", "sudsud", and "sagyap". In principle, they operate by filtration, in the same manner as the plankton net and larval net. The optomotor reaction of the milkfish fry has been clarified (KAWAMURA and HARA, 1980a), and it has been shown that vision is developed foremost among the senses (KAWAMURA and HARA, 1980b). The fry could thus be expected to respond to the gears by vision. This study was conducted to obtain a fundamental knowledge on the behaviour of milkfish fry for improving the catching efficiency of the traditional gear. In this paper, the authors report on the response of the fry to moving and stationary nets of different meshes and colors, as well as on the underwater visibility of the nets and the water filtration in a fry-sweeper.

MATERIALS AND METHODS

The experiments were carried out at the SEAFDEC Aquaculture Department, Tigbauan, Iloilo, Philippines, during the second fry collection season, October 1979. The milkfish fry used were collected from the shore of Guimbal, an adjacent town.

The experimental procedure basically followed that of KUSAKA (1957).

The experimental wooden tank (240 × 60 × 60 cm) was painted blue on the inside and was put in a shed (Fig. 1). While diffused light from the translucent roof illuminated the shed, the light distribution in the tank was not homogeneous because one side of the shed was unwallled. During the experiments, the tank was filled with seawater to a depth of 20 cm.

Black nylon twine of 0.53 mm diameter was stretched vertically on a blue-painted wooden frame at intervals of 5, 10, and 20 mm; and white nylon twine of the same diameter, at 5 and 20 mm. In the following discussion, these will be referred to as black 0.5, black 1, black 2, white 0.5, and white 2. In addition, nylon monofilament white, blue and black mosquito net, with filament diameter of 0.24 mm and mesh of 0.8, 0.8, and 1.4 mm respectively, were also used, attached to the wooden frame.

Each time, one pair of nets of two colors or two mesh sizes was presented to the milkfish fry in the tank. In each observed pair of nets (moving net and stationary net) 200 fry were used. For the observation of fry response to the stationary net, the fry were driven to one end of the experimental tank and were blocked by the net set 60 cm from the wall. The number of fry which passed through the mesh was counted. For the observation of fry response to the moving net, the fry were driven to one end of the tank where the net had been set beforehand next to the wall. The net was then moved at 3.5-4.0 cm/s toward the opposite wall. The number of fry which passed through the mesh or that were filtered by the net were counted; the distance between the net and the fry was noted. As it was found very difficult to count the fry escaping the net when they exceeded 15, the approximate number was recorded in such case. All observations were recorded on tape and were analyzed after the runs. As the experimental control, the wooden frame without the net was also moved and stationed at turns and fry reaction also observed. Water temperatures in the tank ranged from

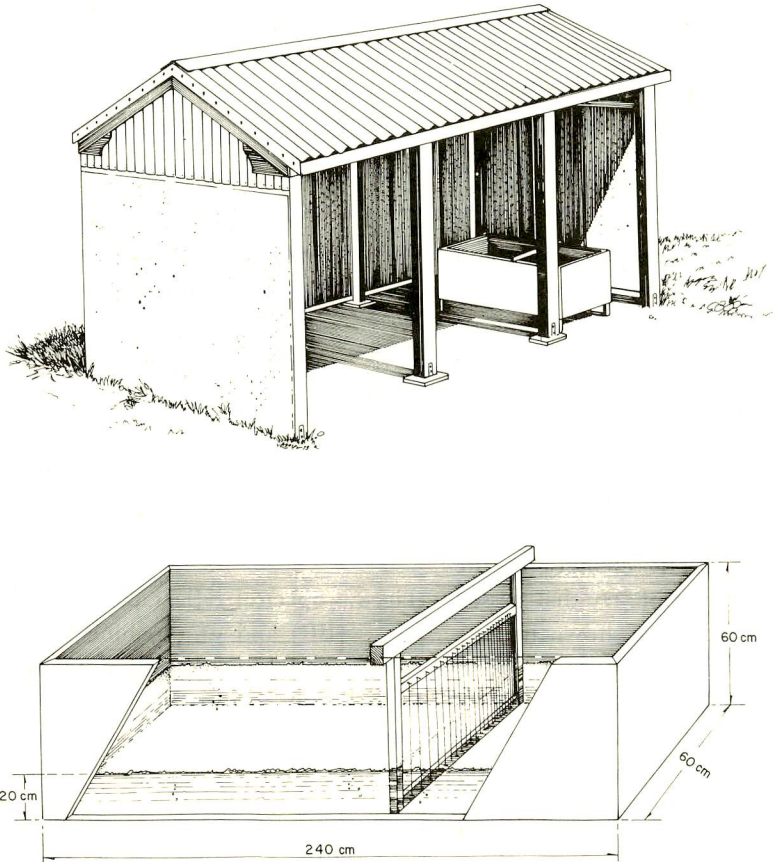


Fig. 1. Illustrations of the shed wherein the experiments were done (top) and of the experimental tank (bottom). Top shows the light condition in the shed in the early morning. The experiments were done from late morning to afternoon when the shadow covered the experimental tank (drawn by P. O. LEGASPI, Jr.).

28.6 to 30.6 °C.

To estimate the filtering efficiency of the fry-sweeper, the stream-line in the gear was observed by pouring milk in front of the one operated on shore.

The underwater visibility of the mosquito nets was also measured.

The spectral reflectances of the blue paint and of the white, black and blue mosquito nets used were measured in Kagoshima University and are shown in Fig. 2. Each net material was placed on a blue-painted plate. From the curves, the contrasts against the blue background could be seen (BLAXTER, 1970).

RESULTS AND DISCUSSION

When the fry were introduced into the experimental tank, they swam continuously, forming one or two schools, and showed no preference for any particular area in the tank. They could easily be driven by shaking a hand in the air. When the fry were blocked by the stationary frame without the net, all passed through the frame at once and no response to the frame could be recognized. But when the frame was moved,

the fry were driven sometimes up to the opposite side. The driving was almost perfect when the fry were distributed at the bottom, and imperfect when they were in the midlayer or surface of the water.

When the fry driven to one end of the tank were blocked by a stationary net, they rotated forming one or two schools in the compartment inside the net. When a school approached the net, a small part of the school escaped through the black 0.5 mesh, and a much greater part through black 1 and black 2, and through white 0.5 and white 2. The changes in the cumulative number of fry that passed through the mesh are shown in Figs. 3-6 for the different pairs of mesh and/or color. It is immediately evident that black and white twine had different effects on fry: the fry readily and very quickly escaped through the white twine, but were retained for a much longer time in the black (Fig. 3). In the pairs black 0.5-black 1 and black 0.5-black 2, the tendency of change for either and both of black 1 and black 2 is greater than for black 0.5 (Figs. 4 and 5). There was no remarkable difference between black 1 and black 2 (Figs. 4 and 5); nor between white 0.5 and white 2 (Fig. 6). From these results, it can be concluded that milkfish fry easily escape through the mesh of white twine and through mesh larger than 1 cm of black twine. The retaining efficiency of the twine and mesh used could be arranged in descending order as follows: black 0.5, black 1 and black 2, white 0.5 and white 2.

The response of the milkfish fry to the moving net varied slightly with the mesh and color of the twine. The fry swam forward in a relatively dense school keeping a distance of about

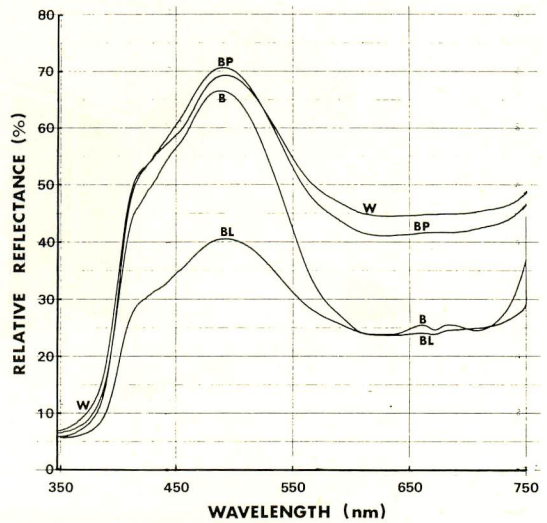


Fig. 2. Spectral reflectances of the blue paint (BP) and of the blue (B), black (BL), and white (W) mosquito nets placed on a blue-painted plate.

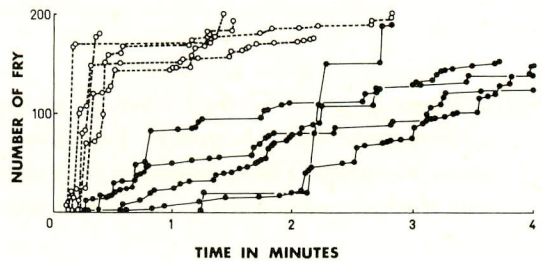


Fig. 3. Change in the cumulative number of fry that escaped through the stationary black 0.5 (closed circle) and white 0.5 (open circle) with time.

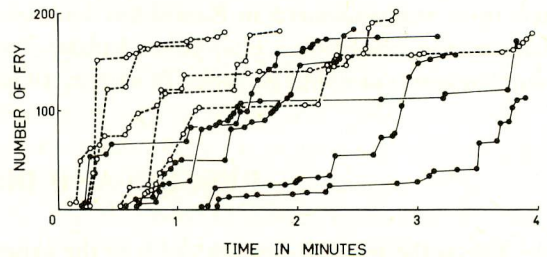


Fig. 4. Change in the cumulative number of fry that escaped through the stationary black 0.5 (closed circle) and black 1 (open circle) with time.

10-45 cm from the moving black twine; they formed a loose school keeping a distance of 3-45 cm from the moving white twine. The number of fry that passed through the net at different points in the tank are given in Table 1. Remarkable differences in the number of the fry that escaped, according to mesh and/or color, could be seen at the 30 cm and 15 cm positions from the opposite side; so also in the number of fry finally retained. In the first pair, all fry were retained by black 0.5 in three of five trials, whereas they escaped early through, with less than half retained, white 0.5. Both black 0.5 and black 2 (second pair) effectively drove the fry, but no fry was finally retained by black 2 in four of five trials. In the third pair, the fry escaped through both black 0.5 and black 1 at positions close to the staring point, although more fry were retained by the former. This seems to be caused not by the direct response of the fry to the net but by some other unknown factor. In the fourth pair, white 0.5 retained more than half of the fry while white 2 retained none or only a few. The driving efficiency of these nets could be arranged in descending order as: black 0.5, black 1, black 2, white 0.5, white 2.

The response of milkfish fry to the moving mosquito net is indicated as the distance between the net and the last member of the school moving forward away from the net (Fig. 7). When the fry was pressed to the net by water pressure, the distance was recorded as zero. The response was remarkably different depending on the direction of the net. When the fry encountered the net moved against the light, they turned about and generally kept quite a good distance ahead of it. On the other hand, when they encountered the net moved in the same direction as the incoming light, they were easily pressed against it; this was most noticeable with the white net in pair III which was conducted on a rather cloudy day, and with the blue net in pair II. These results indicate that the underwater visibility of the nets probably varies with the nature of lighting: surface lighting when the net was moved against the incoming light, and contour, when moved in the same direction. This speculation is partly supported by the observation that when the lighting condition switched from surface to contour, the underwater visibility of the nets for the human eyes decreased by 19% for the white net, 9% for the blue, and 2% for the black (Table 2).

The white mosquito net (and the white twine) appears to be quite invisible to the fry, particularly under the contour lighting condition (Fig. 7). The blue net appears to

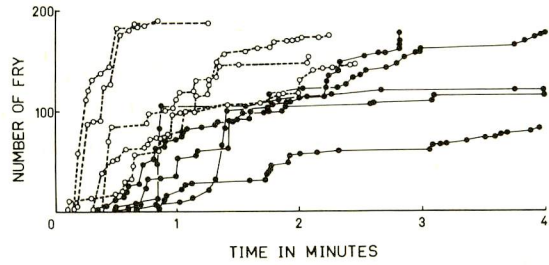


Fig. 5. Change in the cumulative number of fry that escaped through the stationary black 0.5 (closed circle) and black 2 (open circle) with time.

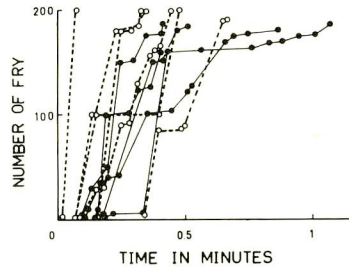


Fig. 6. Change in the cumulative number of fry that escaped through the stationary white 0.5 (closed circle) and white 2 (open circle) with time.

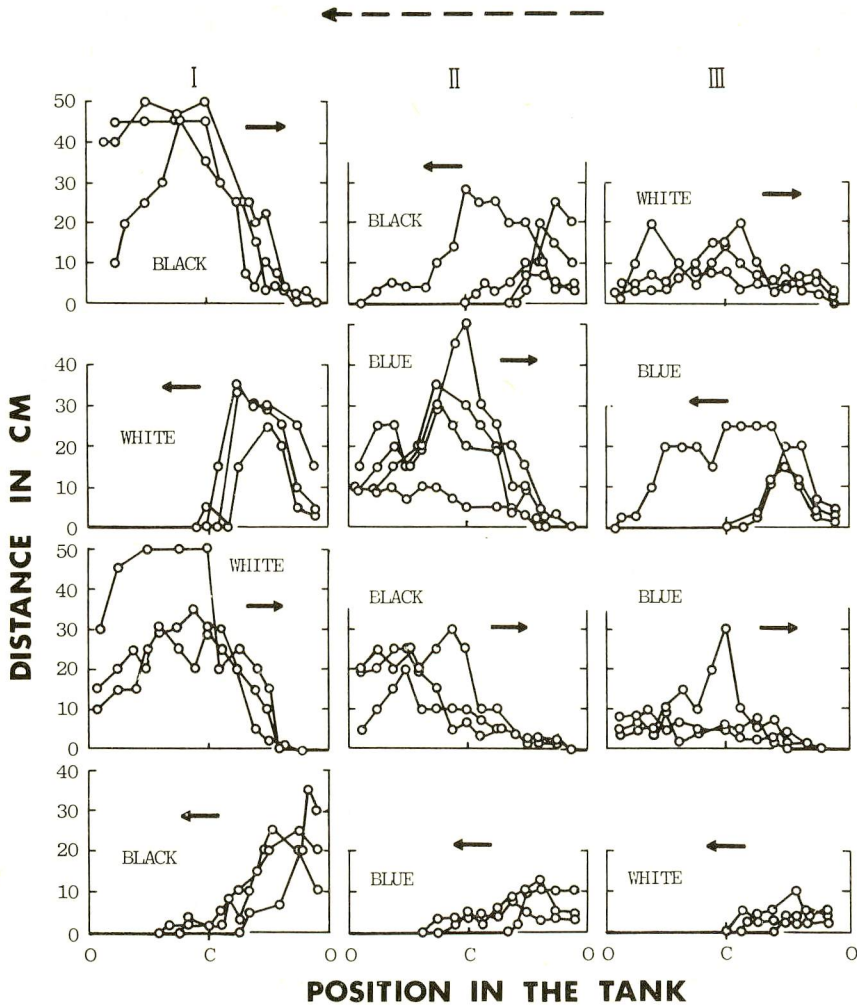


Fig. 7. Response of the milkfish fry to the mosquito net at different positions in the tank: C, central; O, starting and/or final. Ordinate shows the distance between the moving net and the last member of a school swimming forward away from it. The short arrows show the direction of movement of the nets. The uppermost arrow shows the direction of the incoming light.

be just as invisible to the fry as the white net; the black one seems to be very visible to the fry under both surface and contour lighting. The near-invisibility of the white and blue nets may also be due in part to their weak contrasts against the blue background of the experimental tank. While juvenile milkfish is known to have color sense (KAWAMURA and NISHIMURA, 1980), the fry has not yet been studied. Nevertheless, it can be concluded from the results that invisible materials do not have a good fry driving effect.

The waters in the fry collection grounds are relatively turbid because of the repeated operations of many fry collectors, if not for the rough sea conditions themselves. The underwater visibility measured at noon in Table 2 may be regarded as the representative value for the fry collection grounds. It can be said that the fry respond feebly to a

white net operated in a turbid collection ground, and that a white net does not have a good fry driving effect under such condition.

Whether the fry collecting gear operates by filtration or by driving, the water filtering efficiency of the moving net is a very important factor in efficient capture. The fry-sweeper is constructed of bamboo for frame and of mosquito net commonly

Table 2. Underwater visibility of the mosquito net in a fry collection ground measured under different conditions.

Color of net	Condition		
	Noontime, windy, sea rough	Morning, calm, sea smooth	
		Contour light	Surface light
Blue	209 cm	238 cm	262 cm
Black	170	277	282
White	157	263	324

of blue and/or white color. The underwater depth of the wing is about 15 cm and that of the belly less than 40 cm. The probable stream-line in the net and just behind it is shown in Fig. 8. It was observed that the water smoothly passed through the wings and that very little moved along the net. The water was smoothly filtered in the cone and slightly retained at the cone end, while a little moved along the belly and side. The stream-line drawn by the milk was disturbed behind the wing and cone; the disturbance followed the net for a long distance and was most noticeable behind the cone end.

From these observations, it can be said that filtration in the fry-sweeper is almost perfect. However, since the gear is moved slowly and since the fry are good swimmers, they can not be caught on the mesh. During the operation of the fry-sweeper to determine its stream-line, the behaviour of an undetermined species of juvenile fish was incidentally observed. These juveniles swam forward forming a school in the direction of the gear and associated with the net in the cone. Now and then, they went out to the space between the wings, and came back to the cone. They did not go away from the inside of the sweeper. Milkfish fry may exhibit such a similar behaviour in the fry-sweeper, for they have optomotor reaction (KAWAMURA and HARA, 1980). It can be concluded that the fry are not caught by filtering but driving.



Fig. 8. Probable stream-line in the operating fry-sweeper.

It is well known that small fishes can be driven by nets of large mesh. Japanese fishermen catch anchovy fry from coastal fishing ground by means of a boat seine which has wings of more than 2 m mesh. It can be inferred from the experimental results that milkfish fry could also be driven by nets of larger mesh than those presently used. Larger mesh decreases the net resistance in the water; the collectors could more easily move the gear. The net at the wings and at the mouth of the belly of the fry-sweeper should be replaced with larger mesh that should be of dark color, preferably black, for effective driving. However, white mosquito net is best for the cone, especially the cone end because the fry are more easily visible on a white background to the collectors during scooping. The wings of the other fry collecting gears should also be replaced by nets of larger mesh, for the same reasons as in the fry-sweeper. If the fishermen/collectors could not acquire or make nets of larger mesh, they should use other available materials such as coconut leaves or grass straws. The present fry-sweeper sweeps in limited surface water and only the fry distributed at the surface could be collected with it. Once the vertical distribution of fry in the collection grounds is known, it may be possible to decide on a reasonable depth of net or operation of the fry-collecting gear.

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REFERENCES

- BLAXTER, J. H., 1970, in "Marine Ecology" vol. 1, Environmental Factors (ed. by KINNE, O.), part 1, pp. 278-280, Wiley-Interscience, London.
- CHAUDHURI, H., JUARIO, J., PRIMAVERA, J. H., MATEO, R., SAMSON, R., CRUZ, E., JARABEJO, E., and CANTO, J. Jr., 1977, Artificial fertilization of eggs and early development of the milkfish *Chanos chanos* (Forsk.). *Technical Rep.*, no. 3, *Aquaculture Department, SEAFDEC*, p. 21-38.
- KAWAMURA, G. and HARA, S., 1980a, The optomotor reaction of milkfish larvae and juveniles. *Bull. Japan. Soc. Sci. Fish.*, v. 46, p. 929-932.
- _____ and _____, 1980b, On the visual feeding of milkfish larvae and juveniles in captivity. *Ibid.*, v. 46, p. 1297-1300
- _____ and NISHIMURA, W., 1980, S-potential from the retina of milkfish, *Chanos chanos* (FORSSKAL). *Ibid.*, v. 46, p. 1421.
- KUSAKA, S., 1957, Experiments to see the effect of color on nets by the centralizing method and the driving to one side method. *Ibid.*, v. 22, p. 668-673.
- LIAO, I. C., JUARIO, J. V., KUMAGAI, S., NAKAJIMA, H., NATIVIDAD, M. and BURI, P., 1979, On the induced spawning and larval rearing of milkfish, *Chanos chanos* (Forsk.). *Aquaculture*, v. 18, p. 75-93.

VANSTONE, W. E., TIRO, L. B. Jr., VILLALUZ, A. C., RAMSINGH, D. C., KUMAGAI, S., DULDUCO, P. J., BARNES, M. M. L. and DUENAS, C. E., 1977, Breeding and larval rearing of the milkfish *Chanos chanos* (Pisces: Chanidae). *Technical Rep.*, no. 3, *Aquaculture Department, SEAFDEC*, p. 3-17.