COLLECTION, STORAGE, TRANSPORT, AND ACCLIMATION OF MILKFISH FRY AND FINGERLINGS

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The present methods of collecting fry and fingerlings involve filtration by mobile or stationary devices. The bottom topography of the fry ground, wind direction, and tidal fluctuations are the most important considerations in the design and construction of fry and fingerling catching gear. The behavior of young milkfish in the different environments where they are exploited determines the catching methods to be employed. Collection, handling, storage, and transport activities expose the fish to undue stress, which contributes to poor survival. The simple method of lowering the salinity of the water medium considerably reduces mortality. Prior acclimation history has significant effects on subsequent survival and adaptation. Although it appears that milkfish fry are more hardy than the fingerlings, both have the same capability for resisting subsequent environmental stress provided sufficient time is given for the fish to recover from previous stress.

INTRODUCTION

The unavailability of seed stock is the main bottleneck in milkfish aquaculture. Even when hatchery-bred fry become commercially available in the future, the natural fry and fingerling fishery will remain an important and decisive factor in the culture of milkfish.

Methods and practices of collection, storage, transport, and acclimation of milkfish fry and fingerlings in the Philippines, Indonesia, Taiwan, and Sri Lanka are presented, and the probable factors affecting catch and survival are discussed in the light of recent findings about the ecology, behavior, and physiology of the fry and fingerlings.

COLLECTION METHODS AND GEAR

Bottom topography, wind and water current patterns, and tidal fluctuations in the fry grounds are the most important considerations in the design and construction of gear for catching milkfish fry and fingerlings. The behavior of the fish determines the collection methods to be employed in specific areas. The various methods and gear currently being used to catch milkfish fry and fingerlings in the Philippines (Kumagai et al 1980, Villaluz et al 1982b), Indonesia (Noor-Hamid and Mardjono 1976, Noor-Hamid et al 1977), Taiwan (Lin 1969), and Sri Lanka (Villaluz et al 1982a) are presented below. Illustrations of the gear used in the Philippines are found in Kumagai et al (1980) and Villaluz et al (1982b).

Fry Barriers or Fences

These are devices to which fry are attracted or on which they are concentrated by favorable wind and tidal currents. The gear is usually set perpendicular to the shore, extending 10-50 m into the water. Shallow intertidal areas along a narrow pass or tidal flats with a muddy or coralline substrate are suitable locations for this gear. Fry barriers are also set halfway across tidal creeks. Actual catching of fry is by skimming nets or double stick nets. This method and gear are employed in the Philippines and Indonesia.

In Indonesia, gear made of grass or dried banana leaves strung into a garland-like rope is used to drive milkfish fry in shallow water. The 20-m rope is laid in a wide circle and the diameter of the enclosed area is reduced gradually by pulling one end of the rope, the other being fastened to a stake. The fry are caught by a skimming net in the small central space of the closed ring.

Filter Bag Nets

Skimming net. This is usually used in mangrove areas, along fishpond dikes and canals, and in tidal flats with a muddy or coralline substrate. Women and children prefer it due to its light weight and ease of operation. It is used in the Philippines, Taiwan, and Indonesia.

Tidal set net. This consists of a catching chamber with fixed wings, usually constructed across the mouth of a river or tidal creek, and occasionally along the shore facing favorable wind and tidal currents. A series of two to four tidal set nets may be placed across the mouth of a relatively large river. The gear is generally operated by two to five men during flood tide. Although this gear has been introduced in Indonesia, its use for commercial collection of milkfish fry is limited to the Philippines.

Floating tidal set net. This is set against longshore currents and is particularly suited to coastal promontories with relatively shallow coralline platforms. In certain areas, several units may be set about 10-15 m apart, one in front of the other. The gear is usually operated during flood tide by one man. It is found only in the Philippines.

Push net. This is usually operated along the shore or river bank by two people, one pushing the gear and scooping the fry from the bagnet, the other taking charge of shuttling and sorting the fry. In some areas, the push net has bigger dimensions and is provided with a platform for basins and pails; in this case, one person pushes the gear while the other pulls it with a rope from the shore. The push net is also used in a stationary position along the shore or river mouth and is operated like a tidal set net. During stormy days, push nets are set against the surf. The push net has been motorized in some areas in Taiwan and the Philippines. In the latter, it is modified and attached to one side of a pumpboat with a 10-16 hp engine and operated in the deeper portions of the fry grounds. The push net has been demonstrated in Indonesia but there is no report whether it has been adopted by local fry collectors.

Push net with bamboo raft. This gear is usually operated in fry grounds with very extensive shallow intertidal waters up to 5 m deep. Two persons are required; one pushes the gear by means of a bamboo pole, while the other scoops and sorts the fry. Operation is usually undertaken at night until early morning (2100-0400 h), a lamp being used to facilitate catching and sorting of fry. At times, this gear is set along the river bank and is operated like a tidal set net. This method and gear have been reported only on Panay Island, Philippines. However, a motorized push net with a bamboo raft is common in Taiwan.

Tow net with bamboo floats. This is towed along the shore by two persons, one at the end of each wing. When one of the operators takes the fry to shore, the other continues towing by holding both ends of the wings. This gear is also used in rivers or creeks, either mobile or operated like a tidal set net. It has been reported only in southern Luzon, Philippines.

Tow net. The tow net is used in areas with steep shore profiles, high waves, and strong winds. Two persons operate it, each pulling on the bamboo pole at the end of one wing. The filtered fry are concentrated at the cod-end; the string at the cod-end is untied and the fry are poured into a plastic bag. The tow net can also be operated like a tidal set net in places where a sandbar has formed parallel to the shore. This gear and method have been reported only in the Philippines.

Seine Nets

Double stick net. This is towed by two persons along the shore or at the river mouth. It has undergone various modifications due to the cost of materials, prevailing local conditions, and mode of operation, including use of fine mesh nylon netting at the wings while retaining *sinamay* (abaca cloth) in the central portion where the fry are concentrated and scooped. In fry grounds with moderately steep shore profiles, the bamboo poles at one or both ends are replaced with rope loops, which allow the collectors to swim with the net. A smaller version of the double stick net is used by children mostly in shallow rivers or creeks. This type of gear is used in the Philippines, Sri Lanka, and Indonesia.

Fry seine. The fry seine is operated like a beach seine. Two persons operate it, one staying on the shore holding one end of the towline while the other casts the gear 50-100 m from the shore with the use of a small boat. The fry are concentrated and scooped at the shore. This gear has been modified to have a bag net at the center similar to the tow net with bamboo floats. The wings are longer and made entirely of fine mesh nylon netting. Four persons are required to operate this gear, which is used only in Antique Province, Philippines.

FACTORS INFLUENCING CATCH

The milkfish fry season occurs at different times of the year in different parts of its geographic range. In regions affected by monsoon or trade winds, peak fry seasons typically coincide with one or both of the twice-yearly wind shifts. These seasonal peaks are more or less predictable, but fry abundance may vary from year to year. The milkfish fry occurrence and peak seasons in the Philippines, Indonesia, Taiwan, and Sri Lanka are shown in Table 1.

More milkfish fry are caught 1-2 days before and up to 3 days after the new moon and full moon periods than at other times (Kuronuma and Yamashita 1962, Kumagai et al 1976, Noor-Hamid et al 1977). It is also observed that the catch increases when the direction of the wind is toward the shore. Schmittou (1977) suggested that this could be partially due to the increase in volume of surface water reaching the shore.

Milkfish fry generally utilize the tidal current as a passive means of transport, but they may actively enter coastal wetlands even during receding tides (Villaluz et al 1982, Buri and Kawamura 1983). However, most of the fry remain far from shore after high tides of spring tide periods. This makes the fry inaccessible to most of the gear currently being used. The fry seine used in Antique, Philippines, not only catches the fry in its path but probably also attracts other fry toward the shore, enabling them to be caught by other types of gear. Motorization of the push net also makes possible the exploitation of the deeper portions of the fry grounds.

Kawamura et al (1980) concluded from behavioral observations that the fry are not caught by filtering but by driving. They suggested that the fine mesh net of the wings of fry gear be replaced with a highly visible (black colored), larger mesh net. However, the fry collectors claim that, although this modification made the operation of the gear easier, it drastically reduced the catch. Hemings (1966), in his study of visibility of nettings in different sea conditions, found that illumination and turbidity of the water are significant factors in herding fish. The poor catch from modified gear with wings made of larger mesh net is probably due to the cancellation of the driving effect of nets on the fry in relatively turbid water near the shore during the fry season.

Current developments and modifications of milkfish fry gear are directed to areas farther from the shore. Encina and Gatus (1977) reported that milkfish fry congregate close to fish shelters located offshore and can be caught in sizable quantities in deeper coralline areas. In such a situation, where the water is clear, fry collection gear that effectively utilizes the driving effect and the optomotor response of the fish may be adopted.

The demand for milkfish fry also affects the catch. Smith (1981) attributed the steady increase in the nationwide catch of milkfish fry in the Philippines to higher prices elicited by increased demand. In Indonesia, fry are sometimes not gathered during the second season due to the absence of buyers (Noor-Hamid et al 1977).

Table 1. Milkfish fry occurrence and peak seasons in the Philippines, Indonesia, Taiwan, and Sri Lanka.

Location	Occurrence	Peak seasons		Source
		Major	Minor	
Philippines	Jan.-Dec.			
North	Mar.-Aug.	May-July	—	Villaluz et al 1982b
Central	Mar.-Jan.	Apr.-June	November	
South	Jan.-Dec.	Mar.-May	—	
Indonesia	Jan.-Dec.			
North	Apr. -Nov.	Apr.-May	—	Noor-Hamid et al 1977
Central	Mar.-Dec.	Aug.-Oct.	Apr.-June	
South	Dec.-Feb.	—	—	
Taiwan	Apr. - Aug.	May	—	Lin 1969
Sri Lanka	Apr.-Nov.	May	November	Ramanathan 1969

STORAGE OF FRY

The general practice of handling and storage of milkfish fry is similar in Indonesia (Noor-Hamid et al 1977, Noor-Hamid and Mardjono 1976), Taiwan (Lin 1969), and the Philippines (Villaluz et al 1982b), as described below.

Milkfish fry, together with fry of other fish and crustacean species, are brought to shore after capture. The whole catch is then transferred to an earthen jar, a plastic basin, or a water-tight bamboo basket. Counting and sorting are done with a small cup, bowl, or shell. The counted fry are placed in one container while dead fry and unwanted species are discarded. In the Philippines, a cylindrical device made of nylon netting is utilized for sorting fry if numerous undesirable organisms are present.

The fry are counted each time they are transferred from one container to another and also before and after being sold. An actual head count is done when the fry are few, but when the catch runs into several thousands, counting is done with the aid of pebbles, shells, or any suitable markers. One small pebble or shell represents 1 fry, while a bigger one would represent 100 fry. Another method of counting is by visual estimation; the density of fry in one container is compared to the density of fry in another container in which the exact number has been previously determined.

The day's catch is stored overnight in the fisherman's house or in a storage facility provided by the fry concessionaire or dealer. The fry are not fed at this time. The storage water is generally diluted with fresh water; in the Philippines, the ratio of dilution is 3 parts seawater to 1 part fresh water. The fry next pass through a fry dealer and are again counted and sorted before acceptance. They are then brought to the main warehouse of the dealer in oxygenated plastic bags, earthen jars, or bamboo baskets, and a longer-term storage follows. The water in the storage container is again diluted at ratios of 1 part seawater to 1 part fresh water in the Philippines and 1 part seawater to 4 parts fresh water in Indonesia. Another method of obtaining the desired water medium for storage of fry in Indonesia is by mixing salt with fresh water to obtain a salinity of 10 ppt.

The yolk of hard boiled eggs, pulverized rice, or wheat flour is given to the fry daily or every other day. The storage containers are inspected and cleaned of excess food, dead fry, and debris every morning and afternoon. Storage water is either completely or partially replaced with new water premixed at the desired salinity level every day or every other day.

Fry stored for more than 15 days are as a rule weak; very low survival is obtained when these are stocked in the nursery pond. The condition of the fry may be determined by the following procedures:

1. Observe the fry closely. Strong and healthy fry move continuously in the same direction along the wall of the container. If the fry display this behavior only occasionally, or when swimming is slackened, they are already weak.
2. Swirl the water. Healthy fry swim vigorously against the current.
3. Tap the container or move a hand over it. Fry which react with a quick diving avoidance movement are in good condition.

Some dealers keep fry alive and in reasonable condition for 1 month or longer by storing them in earthen jars and reducing the stocking density to a few hundred per container.

Milkfish fry storage practices in the Philippines, Indonesia, and Taiwan are summarized in Table 2.

FACTORS AFFECTING SURVIVAL DURING STORAGE

Milkfish fry are subjected to a number of stress factors during collection which, if not alleviated, cause immediate death or else have a deleterious effect on subsequent survival. Reduction of salinity to 20-25 ppt during storage enhances survival of fry by reducing osmotic stress. Tissue fluid osmolarity of milkfish fry collected from the shore has an osmotic pressure equivalent to a salinity of 13.67 ppt (Almendras 1982), and dilution with fresh water brings the salinity of the medium close to that of their body fluids. An increase in the activity of the fry often accompanies sudden changes of salinity; these may eventually be harmful if often repeated over short periods.

More fry can be stocked in plastic basins (300-500 fry/liter) than in earthen jars (100-200 fry/liter) because of the greater surface/volume ratio in the former. For long-term storage (>15 days), earthen jars are more appropriate. The cooler and darker environment of the jar decreases fry activity and energy expenditure. The lower temperature (<27°C), in combination with low stocking density (25 fry/liter) and high salinity (28-30 ppt), reduces stress and enables the fry to conserve energy while in storage.

TRANSPORT OF FRY AND FINGERLINGS

In Indonesia (Schuster 1952, Noor-Hamid et al 1977) and the Philippines (Villaluz et al 1982b) the fry are not fed before transport. Storage containers are cleaned and water is completely replaced. The fish are transferred to smaller containers and their number determined by actual count or visual estimation. Fresh water is sometimes added to reduce the salinity. In the Philippines, the ratio is 1-2 parts fresh water to 2 parts storage water, while in Indonesia, 9 parts fresh water to 1 part

Table 2. Milkfish fry storage in the Philippines, Indonesia, and Taiwan.

Conditions	Fry storage practices		
	Philippines	Indonesia	Taiwan
1. Container	1. a. plastic basin b. earthen jars	1. a. earthen jars b. bamboo basket	1. a. plastic basin b. bamboo basket
2. Water volume (liter)	2. a. 15-23 b. 10-20	2. a. 2 b. 30	2. no report
3. Salinity (ppt)	3. 10-25	3. 10-25	3. <20
4. Feeds and feeding	4. egg yolk or wheat flour every day or every other day	4. rice flour, dried wheat, or egg yolk	4. no report
5. Water management	5. complete change or 1/2 of total volume change every day or every other day.	5. complete change	5. no report
6. Stocking rate (fry/container)	6. a. 3000-8000 b. 2000-3000	6. a. 1000 b. 15 000	6. no report
7. Stocking density (fry/liter)	7. a. 150-500 b. 100-300	7. 500	7. np report
8, Days of storage	8. 1-7	8. 10-20	8. no report
9. Mortality (%)	9. 2-10	9. 5-10	9. <2
10. Source	10. Villaluz et al 1982b	10. Noor-Hamid et al 1977	10. Lin 1969

seawater is common. Water is removed with a shell, cup, or small bowl over a scoop net or nylon netting that excludes the fry. The fry are poured into double plastic bags. Oxygen is added at a volume equal to that of the water in the bag. The plastic bags are then placed inside palm bags or cardboard boxes if they are to be transported by land, or inside styrofoam boxes or jerricans in the case of air transport. Transport by boat using earthen jars or bamboo baskets as fry containers is practised in Indonesia. Since it usually takes 3 days to about 1 week for the fry to reach their destination, water in the container is changed daily.

In Sri Lanka, the fry are placed directly into double cylindrical plastic bags after capture. One part lagoon water is diluted with 1-3 parts fresh water before the bag is filled with oxygen. One bag contains about 4-6 liters of water and 8-12 liters of oxygen. The bags are not placed in cardboard boxes or similar containers as in other countries; they are simply arranged vertically inside a jeep or van (Villaluz et al 1982a).

Very little is known about the method utilized to transport fry in Taiwan. Lin (1969) reported that as a general rule the transport route is short and the fishermen take good care of the fry. Mortality during this phase of operation is negligible.

Methods of milkfish fry transport in the Philippines, Indonesia, and Sri Lanka are presented in Table 3.

Table 3. Methods of milkfish. fry transport in the Philippines, Indonesia, and Sri Lanka.

Conditions	Fry transport practices		
	Philippines	Indonesia	Sri Lanka
1. Container	1. plastic bag	1. a. plastic bag b. earthen jar/bamboo basket	1. plastic bag
2. Mode of transport	2. a. land b. air	2. a. air b. land or water	2. land
3. Transport time (h)	3. a. 2-14 b. 3-6	3. a. 12 b. 4-7 days	3. 5-10
4- Water volume (liter)	4. a. 8-10 b. 3-5	4. a. 10 b. 2 c. 30	4. 4-6
5. Salinity (ppt)	5. 12-22	5. 10-15	5. 10-30
6. Stocking rate (fry/container)	6. a. 4000-6000 b. 4000-8000	6. a. 10 000-20 000 b. 1000 c. 15 000-40 000	6. 1500-2000
7. Stocking density (fry/liter)	7. a. 400-750 b. 800-2000	7. a. 1000-2000 b. 500 c. 500-1300	7. 375-500
8. Mortality (%)	8. 2-6	8. a. 5 b. 20	8. 2-20
9. Sources	9. Villaluz et al 1982b	9. Schuster 1952, Noor-Hamid et al 1977, Noor-Hamid and Mardjono 1976	9. Villaluz et al 1982a

Transport of milkfish fingerlings has been reported only in the Philippines (Villaluz et al 1982b) and Sri Lanka (Villaluz et al 1982a). Both countries use plastic bags and oxygen. Similar procedures as in the transport of milkfish fry are followed. Dilution of transport water with fresh water, however, is not practised in the Philippines.

Another method of fingerling transport in the Philippines is by means of a "live boat." The boat has a flat bottom used as the fingerling compartment and provided with one to three holes for free entrance of water. A water pump is used to change the water in the compartment continuously. When passing muddy or polluted water, the holes are closed and the pump recirculates the water inside. Upon reaching the destination, the fingerlings are caught with a fine mesh seine and transferred by pails directly to fishponds or pens.

The methods of transporting milkfish fingerlings in the Philippines and Sri Lanka are summarized in Table 4.

FACTORS AFFECTING SURVIVAL DURING TRANSPORT

In the transport of fry and fingerlings, temperature is the most critical factor because of its effect on metabolic rate. Oxygen consumption of fry (5-8 mg body

Table 4. Methods of milkfish fingerling transport in the Philippines and Sri Lanka.

Conditions	Fingerling transport practices	
	Philippines	Sri Lanka
1. Container	1. a. plastic bag b. "live boat"	1. plastic bag
2. Mode of transport	2. a. land b. water	2. land
3. Transport time (h)	3. a. 3-6 b. 4-5	3. 5-10
4. Water volume (liter)	4. a. 10-15 b. 6-8 m^3	4. 4-6
5. Salinity (ppt)	5. a. 10-35 b. initial (20-30ppt), final depends on where fish are stocked (0-30ppt)	5. 10-50
6. Stocking rate	6. a. 500-600 (fish 3-4 cm TL) b. 200-300 (5-10 cm) c. 80 000-120 000 (3-5 cm) d. 50 000-60 000 (6-10 cm)	6. a. 600-800 (fish 2.5-3.5 cm FL) b. 200-400 (4.0-8.6 cm)
7. Stocking density (fish/liter)	7. a. 33-60 (fish 3-4 cm TL) b. 15-30 (5-10 cm) c. 20-30 (3-5 cm) d. 10-12 (6-10 cm)	7. a. 100-160 (fish 2.5-3.5 cm FL) b. 40-80 (4.0-8.6 cm)
8. Mortality (%)	8. a. no report b. 0.05-2	8. 2-100
9. Source	9. Villaluz et al 1982b	9. Villaluz et al 1982a

weight) increases from about 0.011 mg O_2/h per fry at 20°C to 0.056 mg O_2/h per fry when the temperature is elevated to 32°C. If the number and/or size of fish are small, the oxygen content of the water does not become a limiting factor. In a crowded situation, however, an increase in temperature can result in severe stress and high if not mass mortality. This indicates that the fry stocking density may be higher and the time of transport may be longer if the water temperature is lower.

Under the stressful situation of transport, water and ionic balance (Eddy 1981) and resistance to diseases (Wedemeyer and McLeay 1981) may be impaired, and fungal infestation and mass mortality may still occur a few hours or days after stocking of fry or fingerlings even in environments with optimal conditions. Physical injuries also cause mortality during transport because milkfish fry have the tendency to concentrate at the two bottom corners of the plastic bag, which become death traps during transport.

ACCLIMATION OF FRY AND FINGERLINGS

Milkfish fry are stocked in the nursery pond in the early hours of the morning or late in the afternoon after a period of acclimation to the quality of pond water. If the fry are to be stocked directly in the pond upon arrival, the fry containers are made to float in the pond for about 6-10 minutes. The water in the containers is then diluted with pond water, and the fish are released into the pond after 10-20 minutes. Survival after 1 day of stocking is from 20 to 100% (Schuster 1952, Villaluz et al 1982a, 1982b). If the fry are stocked in plastic basins prior to release into the pond, the water in the basin is either replaced or diluted about 25% with pond water 4-6 h after arrival. This is repeated every 2-4 h until the salinity more or less equals that of the pond. Most fish farmers transfer fry directly from basin to pond, while others let the basins float in the pond for about 10-15 minutes to further reduce temperature differences. Survival rate is 95-100% after 1 day of stocking (Villaluz et al 1982b).

Milkfish fingerlings transported inside plastic bags are acclimated directly in the pond upon arrival. If the "live boat" method of transport is used, acclimation to fresh water is done by gradual but continuous replacement of water in the fingerling compartment at 0.15-0.25% per minute. A mortality rate of 20-30% in the first week of stocking in Laguna de Bay, Philippines has been reported (Villaluz et al 1982b).

FACTORS INFLUENCING SURVIVAL DURING AND AFTER STOCKING

Improper acclimation has been blamed by most fish farmers as the cause for as much as 80% mortality of milkfish fry and fingerlings upon or shortly after stocking. Such mortality can be attributed to acute or chronic stress experienced by the fish from the time of capture up to stocking in grow-out ponds or pens. Stressed fish are also more vulnerable to predation.

Young milkfish can tolerate transient exposure to high temperatures up to 42°C (Pannikar et al 1953), but daily exposure to temperatures that increase from 25° to 34°C at 1°C/h might be lethal (Villaluz and Unggui, unpubl.). This means that the duration of exposure to thermal stress may be more critical to survival than the magnitude of the temperature change.

Milkfish fry initially exposed to low salinity (20-25 ppt) had higher survival rates (Quinitio and Juario 1980) when stored at different salinity levels (0, 8,16, 20, and 32 ppt) than those that were not previously acclimated. Mass mortality occurs if newly-caught fry are transferred to fresh water without proper acclimation. A gradual but continuous replacement of the original water with fresh water over a 12-h period was shown to be the best procedure in acclimating the fry to fresh water (Santiago et al 1982). Water and ionic balance of the fry generally stabilize 24 h after transfer to different salinity levels (Almendras 1982). On the other hand, newly-caught wild or pond-reared (pond salinity 28-50 ppt) fingerlings can be transferred directly to fresh water and vice versa without any ill effects (Villaluz et al 1982a). However, if these fingerlings undergo transport before direct transfer to fresh water, mass mortality may occur. Water and ionic balance of the fingerlings stabilize 60 h after transfer to different salinity levels (Almendras 1982). Since the fry recover from osmotic stress faster than the fingerlings, the former would seem more hardy than the latter. However, both fry and fingerlings have the same capability to resist subsequent environmental stress if given sufficient time to recover from previous stress.

CONCLUSION

Socio-economic and ecological conditions which would optimize milkfish fry catch vs. energy and labor while not depleting the natural supply should be examined and considered in the development of new collection methods and gear and/or the improvement of existing ones. The objectives should be not only to increase the supply of fry and fingerlings but also to give satisfying and remunerative employment to many. In order to increase the catch in a particular fry ground, appropriate fishing gear and methods should be utilized at different times of the day and at different locations. Offshore exploitation with the use of floating objects and chemical attractants to aggregate the fry should, be looked into so that search time is minimized and catch per unit of effort is maximized.

The different methods and practices from collection to stocking of milkfish fry and fingerlings have been established mostly by trial and error, which is sound enough as a basis in practical application. However, the various activities subject the fish to stress, which lowers their future performance and survival. Research is needed to minimize and/or alleviate such stress encountered by the fish in artificial environments and during handling.

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