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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The proper transportation and handling of fish eggs and fry is a vital part of any fish production system. Careful planning is important. The first thing to decide is the type of container to be used to hold the fish. There are buckets and barrels of many sizes and designs, each with different characteristics. A second consideration is the density to which the fry should be packed in the container. This must be as dense as possible to save space and money, but not so dense as to kill the fish. The two most important factors in determining

the maximum allowable density are water temperature and dissolved oxygen levels. Fish fry and eggs are shipped by three major means: by land, by water, and by air. This involves either trucks, trains, boats, airplanes, or human labor. Each method has advantages for different situations. During any form of transportation, water maintenance is necessary. If some sort of method for replenishing dissolved oxygen is used, replacement of water can be put off, but still not avoided. The source of fresh water must be inspected carefully before it is used. Clean pond water appears to be best. Any temperature difference between old and new water should be minimized. In more recent years, cultivation of mullet species has become prominent, moving in with the more traditional species, the carps and the bigheads.

Most of the techniques used for the transportation of all species, including mullet, apply to their eggs.

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# Fish Production in China

## TRANSPORTATION OF FISH EGGS, FRY, AND YOUNG

Pretransportation preparation and transporting utensils

1. Preparation work. Before fish fry are transported, proper planning ~~is~~ essential to success. Utensils must be selected and inspected. Agreements must be entered with transportation agencies beforehand. A survey must be made of the water source and water quality on the transporting route, and stations must be established where water change will take place.

2. Transporting utensils

(1) Fish basket. This is made of bamboo splints. The inside wall is coated with tissue paper and persimmon oil so that it is water proof. It has a round mouth and a square bottom. The size varies somewhat from place to place. Although the basket is cheap to make, it is not durable, generally lasting only one season. Figure 1.

(2) Canvas bucket. Cylindrical in shape, the bucket measures 1m in diameter and 1.6m in height. Inside the mouth, there is a 13 cm wide collar to stop the water from slushing out. The canvas is supported by a metal frame. The bucket can be dissembled and is therefore convenient to use. Figure 2.

(3) Wooden barrel. The barrel is 100 cm high, has a bottom diameter of 90 cm, and an opening diameter of 70 cm. A lid is provided. In the center of the lid is an opening with a diameter of 35 cm. This opening is for the stirring

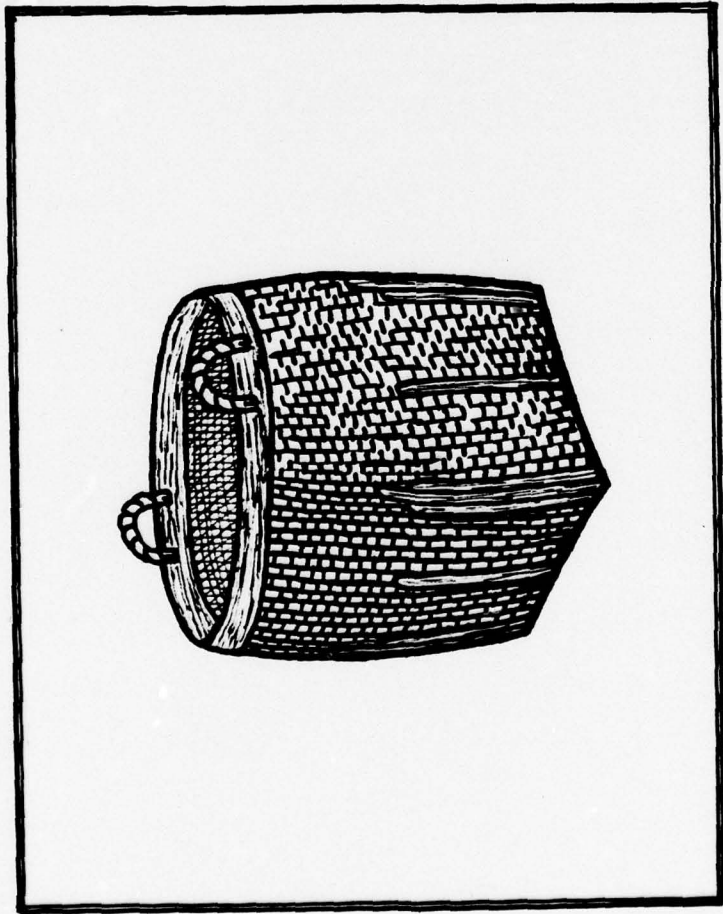


Figure 1. Fish Basket for Transport of Fry

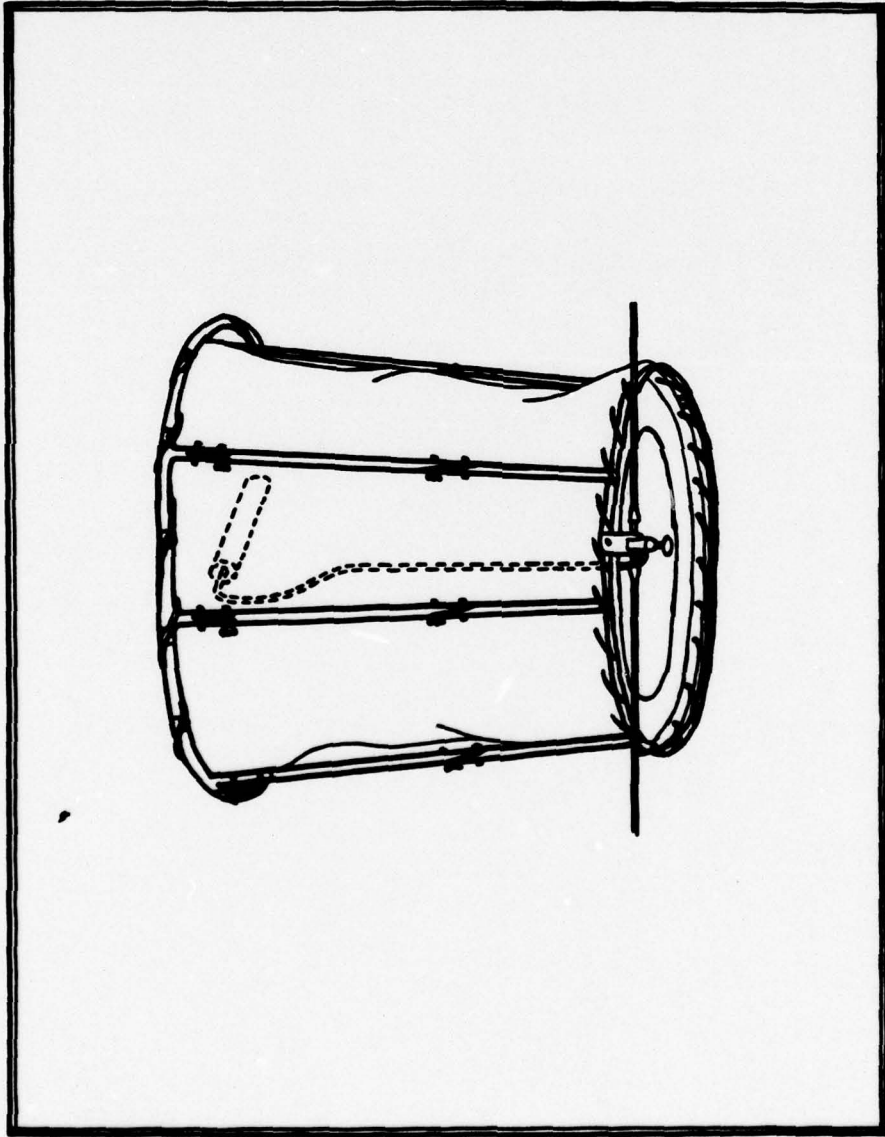


Figure 2. Canvas Basket for Transport of Fry

rod. Thirteen (13) cm from the bottom is a hole with a cork stopper. The advantage of the wooden barrel lies in its sturdiness and its good insulating qualities. Figure 3

(4) Carrying basket. This basket is for transporting fry by carrying with a pole over the shoulder. It usually has a round mouth and a square bottom. Figure 4.

(5) Suction tube. This is used to suck out dead fish and debris from the bottom. It is a cylinder, 1m high and 0.3m in diameter. Figure 4.

(6) Volume measure.

(7) Water bailer. This is made of split bamboo and is wrapped on the outside with oil skin.

In addition to the above utensils, other items must also be prepared; such as small basins, spot light, hand light, thermometers, etc.

#### Transporting density

Fry density during transportation often determines success or failure. The proper density varies according to species, fry size, condition of the fish, water temperature, distance to be traveled, and whether there would be any transference in transporting means.

1. Transporting density of fry. When transporting is via ship, generally from 200,000 to 300,000 fry can be placed in a basket that contains approx. 200 liters of water (water

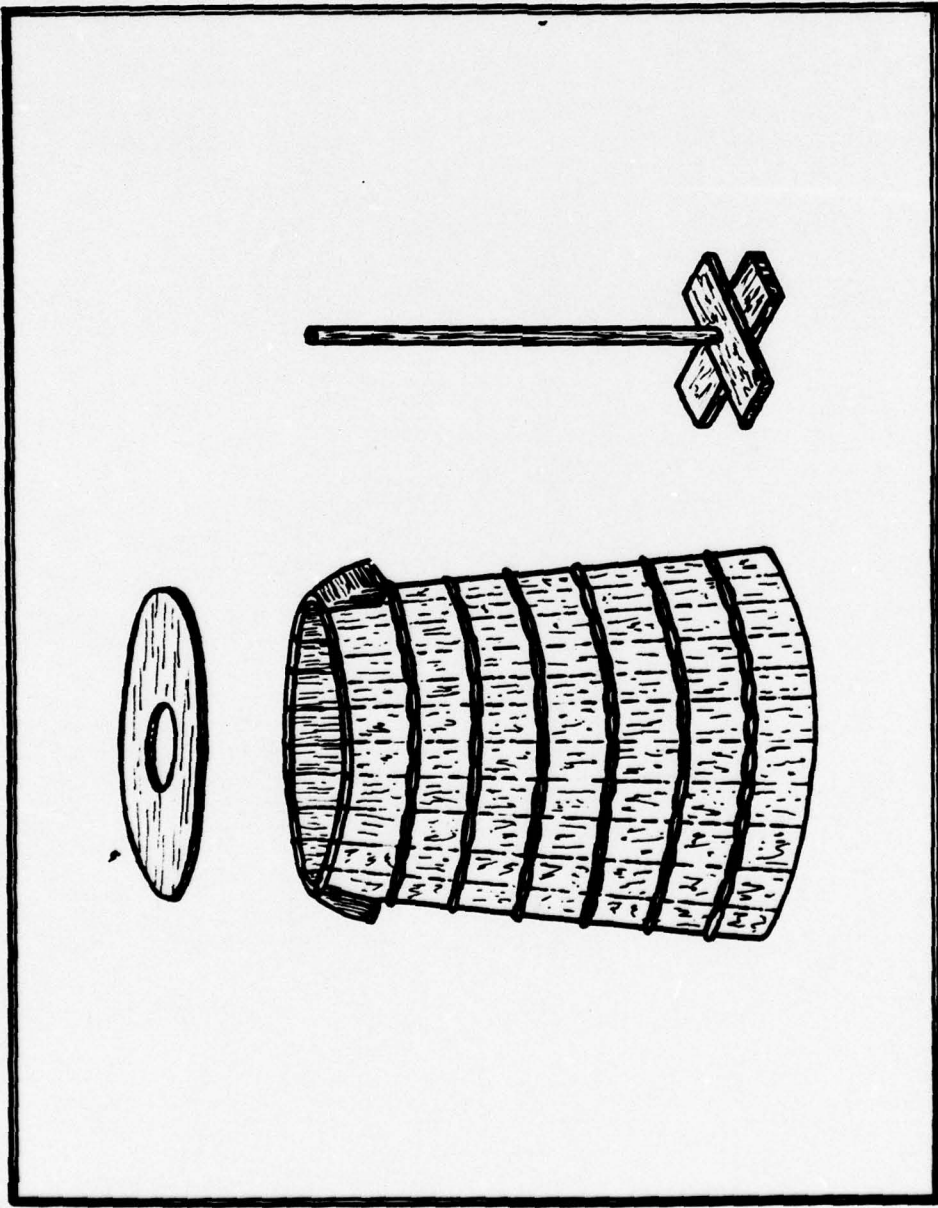


Figure 3. Wooden Barrel for Transport of Fry

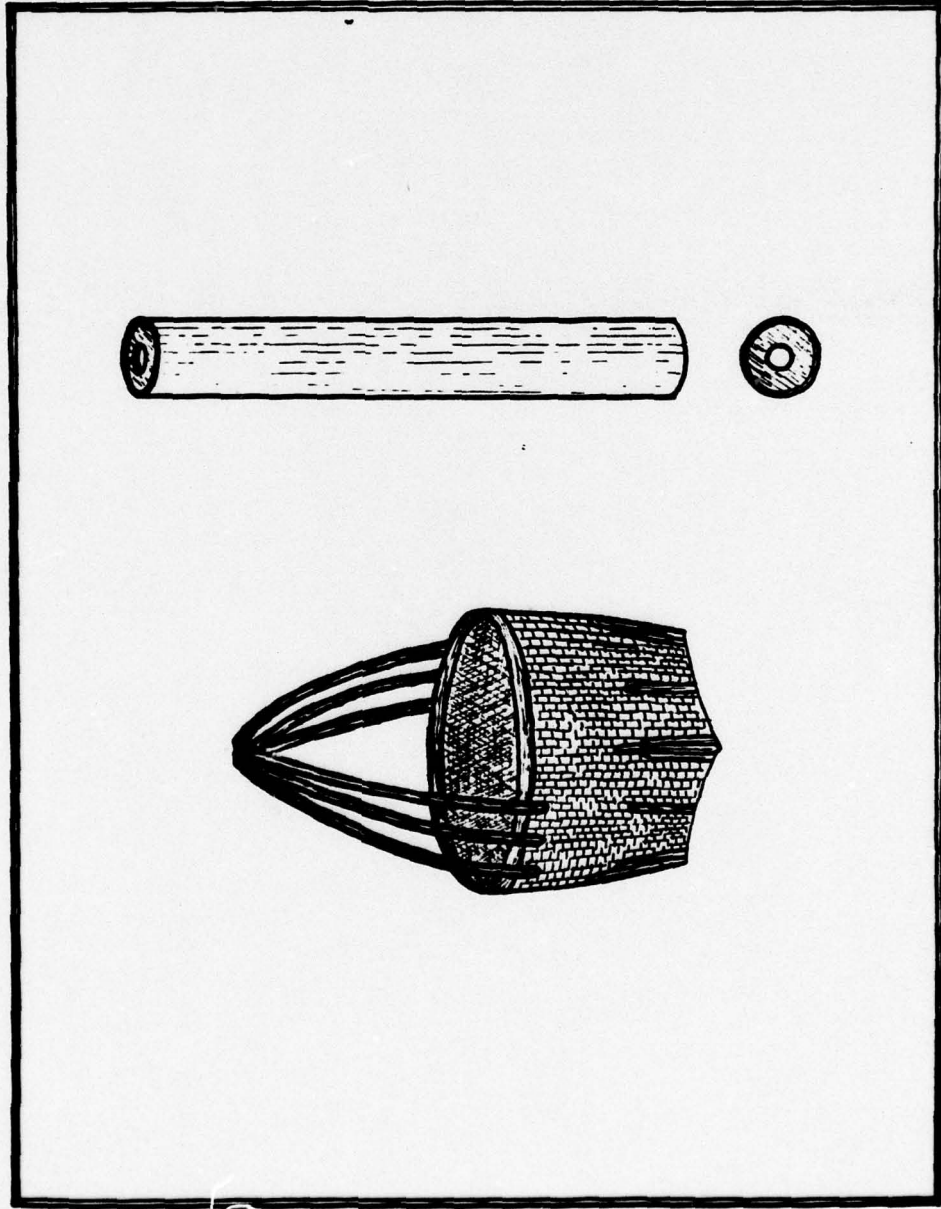


Figure 4. Carrying Basket for Transport of Fry and Suction Tube to Remove Dead Fish and Debris

temperature 15-25 C). In the case of the black roach or relatively older fry, the number should be less.

When transporting by hand carrying, the number of fry will have to depend upon the distance to be traveled, the weather condition, and the fish condition. The skill of the carrier and the condition of the road also have some bearing. Generally, if the carrying takes 1-2 days, 50,000-60,000 fry less than 1.3 cm long can be placed in each 20-25 pint container of water. If the fry are 1.5-2.0 cm long, 8,000-12,000 should be allowed; if 2.5 cm long, only 5,000-6,000 fry.

In truck transport (3-4 ton truck), six baskets, each two-thirds filled with water, can be loaded at a time. In the spring when the weather is not hot, each load can take 3,600,000 fry if the destination is within one day's travel; 2,400,000 fry if the destination is within 2 days' travel. When the weather gets hotter, the number of fry should be reduced to between 300,000 and 200,000. The two rear buckets will be subjected to the heaviest shaking and therefore a smaller amount of fry should be placed in them.

A 15-ton rail car can take 22-24 baskets and transport 4 to 5 million fry. Past experience shows a great deal of variability in survival rate of fry in rail transport. It varied from 20% to 98%. Much of this variation was probably due to fry density, whether, water quality, and other factors.

A medium sized airplane can take 5 baskets; a large plane can take 10 baskets. Each basket can take 400,000-500,000 fry.

2. Transporting density of summer "seed". When fry are reared to summer seed stage, the weight is increased many times - as many as more than 100 times. The transporting density of summer seed must therefore be greatly reduced.

When shipping via boat with constant change of water, at water temperature of 20-24 C, from 30,000 to 38,000 fish may be put in each ton of water for fish of 2 cm in length and the distance is within one of reach. For larger fish, the number should be reduced.

3. Transporting density of "spring seed." Spring seed fish are usually shipped during the period from December to February when water temperature is not more than 10 C. For shipping via boat, about 10,000 fish of 4 cm long (bigheads) may be placed in each ton of water. 8,000 for 6 cm fish; 5,000-6,000 for 5 cm fish. Maintain the same density for the black roach. The density for grass carp may be increased 20 to 25%, since oxygen consumption in grass carp is lower.

The amount of dissolved oxygen in water is an important consideration of fish density in transportation. The maximum amount of fish that can be transported under certain temperature and oxygen conditions can be calculated according to the following formula:

$$o - b \frac{o - o'}{a} = o''$$

$$\text{or, } b = a \cdot \frac{o - o''}{o - o'}$$

where  $o$  - DO before fish are put in;  $a$  - number of fish in container;  $o'$  - DO after fish are put in (usually 1/2 to 1 hour);  $o''$  - minimum requirement of DO for fish's survival;  $b$  - maximum possible number of fish to be shipped.

The minimum DO requirement for the four domestic carps is 2.0-2.5 mg/l for the fry stage; 1.5-2.0 mg/l for the seed stage.

#### Means of transportation

Fish fry and seed are shipped by one of three major means: by water, by land, and by air.

1. Water transportation. This involves various sizes of ships and boats. Some take the advantage of regular passenger boats; others use specially constructed fish transporting boats. One of the special boats is the "live water" boat, in which water intake openings are provided on the bottom or sides of the boat so that fresh water constantly enters into the tanks as the boat is traveling. Excess water is passed through a screen and is pumped out.

2. Land transportation. This involves carrying, truck, or train. Carrying by human labor is the most primitive method of transporting fish fry, but it is useful in certain areas that are not accessible by other means. However, fish mortality rate is high, sometimes 100%.

Transporting fry by truck has made some improvements in the past few years, but specially built trucks for fish carrying are yet to be developed in China.

Rail shipping is good for long-distance and large quantity shipments. The cost is also the lowest. In recent years, due to artificial aeration and water change on the way, the survival rate of fish fry has been vastly improved.

3. Air transport. The advantage of transporting fish fry via airplane lies in speed of reaching destination. The density of fry can be higher than in other means of transportation, and the survival rate is high. In 1959, fish fry were sent to the Soviet Union in sealed nylon bags via airplane with good success. The survival rate was over 90%.

#### Maintenance During Transportation

##### 1. Replenishment of DO in water

(1) Water change. Regardless of transportation means, change of water is important. Generally, the time for water change is when the fish start to surface and gulp for air. In May, 1959 when the Fisheries Research Institute of Academia Sinica undertook the transporting experiment, water quality data were obtained. The results are seen in Table 2.

It can be seen that pH varied between 7.2 and 7.6, and it did not have any adverse effect on the fish. Water temperature was 19-21 C; each basket contained 360,000 - 400,000

fry. In freshly changed water, DO was 5.92-7.36 mg/l. After 4-5 hours, it dropped to 3.04-4.72 mg/l, a decrease of 2.56-3.20 mg/l. At this time many fish start to surface and show discomfort.

Table 1. Change of DO before and after change of water during fry transportation.

Basket	Density	Date	Time	Air C	T Water C	T pH	DO Fresh water mg/l	DO When fish surface	Drop in DO mg/l
1	360,000 in 400 l water	May 22-23	1430	21.0	20	7.5	5.92	----	----
			1800	21.5	20	7.3	----	2.88	3.04
			1930	21.5	20	7.6	6.24	----	----
			2345	19.0	20	7.4	----	2.62	3.62
			0012	20.0	21	7.6	6.72	----	----
			0500	20.0	19	7.4	----	3.04	3.68
2	380,000 in 400 l water	May 22-23	0600	19.0	20.5	7.6	6.24	----	----
			1430	21.0	20	7.5	6.08	----	----
			1800	21.5	20	7.3	----	3.04	3.04
			1930	21.5	20	7.6	6.40	---	----
			2345	19.0	20	7.4	----	2.56	3.84
			0012	20.0	21	7.6	6.24	----	----
			0500	20.0	19	7.4	---	3.20	3.04
			0600	19.0	20.5	7.6	6.24	----	----

Table 1. CONT'D

Basket	Density	Date	Time	Air C	T Water C	T pH	DO Fresh water mg/l	DO when fish surface	Drop in DO mg/l
			1430	21.0	20	7.5	6.08	----	----
			1800	21.5	20	7.3	----	2.88	3.20
			1930	21.5	20	7.6	5.92	----	----
3	440,000 in 600 l water	May 22-23	2345	19.0	20	7.2	----	2.88	3.04
			0012	20.0	21	7.6	7.36	----	----
			0500	20.0	19	7.4	----	2.62	4.72
			0600	19.0	20.5	7.6	7.04	----	----

The source of water must be carefully inspected before the water is used for changing. Water coming from a mine, water from an overly fertile pond or salty water are all to be avoided. Tap water contains chlorine which is harmful to fish. It has been proven that when water contains chlorides to 0.2-0.6%, all cyprinid fry will die. Wherever possible, it is best not to use tap water entirely. A mixture of tap water and pond water has yielded good results. Temperature differential between water in the basket and fresh water must be minimized; a sudden change of water temperature may kill the fish. In any change of water, no more than two-thirds of water is replaced.

(2) Stirring. Stirring water to increase DO is a crude method and is very labor consuming. The effect is also

minimal. In manipulating the stirring action, the stirrer should be kept under water, and should be operated rather gently.

(3) Aeration. This is done either by an electric pump or by a hand pump. Rubber tubing is used to send air into fish baskets, and at the end of the tubing a sand stone is connected. The stones should be placed near the center of the bottom of the baskets. Air pressure is regulated by valves. Even when electric pumps are used, some spare hand pumps should be provided just in case the electric pumps fail to function.

(4) Running water spray and aeration. A system of running water spray and another system of forced air are installed in a railway boxcar.

In each box car are installed 16, 0.8 cubic meter fish tanks. A water storage tank of the same size is also installed, and is connected to the fish tanks with a screen partition between them.

Water is drawn off the bottom of fish tanks and is recirculated to overhanging water tanks, which release water back to fish tanks through overhead sprayers.

Air is supplied to the fish tanks through rubber tubing and sand stones by air compressing pumps.

(5) Oxygenation in a sealed container. This method has been used in recent years. The container is three-fourth filled with water. It is then filled with highly compressed

oxygen and sealed tight. In a series of experiments conducted in 1958, the survival rate was found to be 96.6% after five hours in the air in a density of 2,000 fry per liter of water. After 6 hours, the survival rate was 94%.

In another large scale experiment, a cylindrical metal container with a diameter of 20 cm and a height of 80 cm was used. When two-thirds full, it contains 50 liters of water and may take 197,000 fry. With an air temperature of 36 C and water temperature of 28 C, and after 6 hours of transportation, the survival rate was over 90%. Compared with transporting by truck, this method can transport 5 times the volume at 2-3 times the survival rate. The only drawback is that it requires pure oxygen, which imposes a definite limitation to widespread adoption of the method.

Most recently nylon sacs have been used in the place of metal containers, and they have yielded good results.

2. Avoid sudden change of water temperature. Fish species are adapted to special temperature regimen beyond which they will suffer mortality. Fry and seed are more delicate than adult fish, and their temperature tolerance is much smaller. In transporting fish fry, it is therefore important that sudden temperature changes be avoided. Within the temperature regime, it is best to keep the temperature as low as possible. Sudden change of water temperature usually occurs when water is changed. It is a good practice to let the fresh water sit for a while before replacing the old water.

Fish fry can adapt better from high to low temperatures than from low to high temperatures.

The optimum temperature range for fishes is between 15-25 C. Fish activity fluctuates according to temperature. Under high temperature, the metabolic rate is high; breathing rate is fast, and oxygen consumption is large. In transporting fish during the summer, it is best to cool the water by using ice.

3. Maintaining water quality. During long transport, fish fry should be fed; but feeding should be slight, or water quality will deteriorate. Egg yolk should be ground into fine granules so that it would remain suspended in the water for a longer time, thereby giving the fish more opportunity to feed on it. In transporting summer fry there is no need to feed if the destination can be reached in one or two days. In transporting spring fry, feeding is not necessary regardless of the length of time in transport. There are two reasons for this.

When feeding is necessary in long distance transport, it is better not to feed in the basket, but instead, use the method of "pond lodging." This is to transfer fry into a live cage in a preselected pond and let the fish rest for a period of time (not too long). This has proved to be quite effective in increasing the survival rate of the fry.

Dead fish and excrement in the basket should be removed promptly. In warm water, these materials decay easily and produce toxic material.

Before feeding and cleaning it is necessary to change water. Water should be changed again 5 or 6 hours after feeding. Another occasion that calls for water change is at dawn when fry usually surface to gulp for air. The frequency of water change depends upon water quality. If water change is accompanied by aeration, then once a day is usually sufficient.

Chemicals can be added to water to prevent bacterial activity, and thereby to lessen decomposition of decaying matter. When antibiotics are used in experiments, the effect was especially pronounced where changing water was not feasible. Many chemicals have been used. When copper sulphate (0.7 ppm) was used, the mortality rate was only 5.4% after 5 days. When 0.5% salt solution was used, mortality rate was 5.8% after 4 days. A new development is in the use of tranquilizers, such as sodium amytal, to reduce the metabolic rate and decrease the consumption of oxygen by the fish.

#### Transportation of mullet fry and seed

The mullets have long been cultivated in China. But rearing these fish in freshwater has not progressed rapidly in the past due to difficulties in transportation. In more recent years, however, there has been some success in transporting these fish, and freshwater culture of mullets has had some outstanding results.

1. Elimination of other species. When mullets are collected in the field, there are usually mixed in the collection some other species, including large amounts of labrids. These are especially harmful to the mullets, and therefore must be removed first. They can be removed by (1) sieves, since they are smaller; (2) selective scooping, since the labrids are in the lower layer and mullets are in the upper layer; and (3) hand picking.

2. Acclimation. In the vicinity of mullet fry collecting sites, just above high tide mark, dig several small ponds about three feet deep, and provide with an intake and an outlet. From 200,000 to 300,000 mullet fry can be placed in each pond to acclimate. Acclimation takes four steps: first, 75% sea water and 25% freshwater; second, half and half; third, 25% sea water and 75% freshwater; fourth, all freshwater. Fish should be left in each step for 2-3 days. Because the density in the acclimation pond is high and natural food becomes insufficient, fish must be fed. At the end of acclimation period, which usually takes around 10 days, the fish can be transported.

The mullets are truly euryhaline. Recent experiments have shown that mullets survived sudden transfer from 14.9-24.0 o/oo to 2.79 o/oo salinity.

3. Transportation of mullet fry. Mulletts are easily excited. Before transporting, they should be kept in dense schools for several days to clear them of excrements. The best time to transport is in the early morning or evening when temperature is relatively low. Transport should be avoided during days when atmospheric pressure is low.

At the present, the transportation of mulletts is mostly confined to short distances- the longest not over two days. Generally, in one liter of water, can be placed to 140 1 cm fry; 50 2.5 cm fry; 20 4 cm; 10 5 cm fry; 3-4 6.5 cm fry. Water should be changed every hour. If necessary, the entire carrying basket can be immersed in water in a pond to rescue fry that start to surface.

In long distance transport, survival rate seldom surpasses 70% in the summer. In one experiment conducted by Nankai University when mullet fry were sent from Mukden to Inner Mongolia, the survival rate reached 97% in three days of transport and when the temperature was 14-22.8 C. Each basket had 8,550-9,450 fry.

Based on many experiments conducted in Hopei Province, it is certain that the most important single factor affecting the survival rate of mullet fry during transportation is that the temperature be kept under 16 C. Mulletts can tolerate dissolved oxygen content down to 0.9 ppm. Although survival rate of mullet fingerlings is higher, it is still more practical to

transport fry, because the number of fingerlings transported must necessarily be low and the per unit cost high.

#### Transportation of fish eggs

Egg transportation in fish culture does not play an important role. This is because the hatching time of most culture species (grass carp, black roach, the bigheads) is too short to be of any practical use for transportation. The major species for which egg transportation applies is the common carp. But even here the application is quite limited because carp can breed in various kinds of still water.

The important considerations in carp egg transportation are to maintain proper temperature, humidity, and air circulation, so that normal development is not hampered but at the same time development is retarded enough so that hatching will not take place en route.

1. Preparation work prior to transporting. A proper container should be selected. The best container is a wooden box. This can be of any shape, but small holes should be provided on the bottom as well as on the sides. The box is multilayered; each layer being 10-15 cm deep. Items at hand for transportation should include water sprayer, water storage vessel, thermometer, and a thermos jug with ice.

2. Methods of egg transportation

- (1) Dry method. The advantages of the dry method are: Saprolegnia does not grow; high hatching rate; easy handling.

i. Generally, it is better to transport eggs before their eye stage. At this time, oxygen demand of the eggs is low. If transportation does not take more than two days, it can be started 4-10 hours after fertilization.

ii. Dead (white, opaque) eggs should be removed and only good eggs (transparent and slightly yellowish) selected for transportation. Two to three million eggs can be placed in a cubic meter tank. Egg nests should be placed in a criss-cross fashion and not too thick. The important point is to provide good ventilation. Direct sunshine and wind should be avoided.

iii. It is important to maintain proper humidity in the egg container. Generally additional water should be added by spraying every 30-60 minutes. En route, the temperature must be strictly controlled; sudden changes must be avoided. In hot weather, ice can be added. For best result, water temperature should be maintained at 13-14 C.

It is also important that mechanical damage be avoided. This can be done by cushioning the containers.

(2) Wet method. When eyed eggs are to be transported, the wet method should be used. This is simply to immerse eggs in water-filled container. Water should be changed in the morning and in the evening. The wet method is relatively safe in that water temperature is not subject to sudden changes. However, it occupies a lot of space and is difficult to handle. Therefore, it is not used as often.

When fish eggs reach destination, dead eggs should be removed, and the egg nests lifted gently and transferred to hatching pond. To increase the hatching rate, the eggs can be immersed in 0.2-0.4% saline solution for 5-10 minutes. If, by this time, eggs still are not eyed, they should be kept in dark room to continue development until the eyed stage is reached.