

## NOTES ON FISH FRY INDUSTRY OF CHINA

by S. Y. Lin

## INTRODUCTION

The history of Pond Culture in China is very old. Fan Li, (范蠡) in his "Classic of Fish Culture", said to have been written in 475 B.C., related: "There are five ways to procure wealth; one of which is aquatic culture. What I mean by aquatic culture is fish ponds. A pond of 6 mows (about 1 1/5 acres) is built and partitioned into 9 sections. Plenty of aquatic plants are introduced and arranged in some zig-zag manner. Twenty full-grown and egg bearing carp (common carp, *Cyprinus carpio* Linn.) of 3 ft. long each and 4 males of 3 ft. long are then introduced in the second moon (March). By maintaining the water undisturbed the fish will spawn."

Although Fan did not mention the practice of collecting fish fry from the rivers and rearing of them in ponds as it is done today, yet a few centuries later Shi Ma Tsen (司馬遷) in the period between 140 B.C. to 88 B.C. definitely referred to this profitable enterprise of pond culture and strongly recommended it to the Emperor Wu Ti (武帝). He said that a thousand *shik* of fish could be harvested from a pond after one year's rearing. Actual records of fish fry collecting and transportation were made by Chow Mit (周蜜) in 1243 and Hsu Kwang Ch'ih (徐光啟) in 1639.

In recent centuries the practices of fish fry collecting in the West River and Yangtze River and of pond culture have been highly developed into one of the most important industries in the rural economy of China. It is estimated that from the two main rivers and tributaries 11,000,000,000 newly hatched carp fry and eggs are collected and distributed annually to different provinces of China, Siam, Singapore and Malaya. If only 5% of the fry collected should survive and grow to attain an average weight of one catty each, we should have a total annual harvest of 5,500,000 piculs (327,000 tons). The actual production may be bigger, which nurserymen usually expect, but there are no accurate statistics available at the moment.

As shown in the map, the West River and Yangtze River, with its origin in the Kun Lun Mountains (崑崙山脈), running through 8 provinces of China, covers a course of 3,400 miles. The South-East monsoon starts annually in April and brings

heavy rain to the interior of China until September. Consequently the rivers rise in early summer and the temperature of the water is also slightly increased. Such changes of environment constitute important factors hastening the spawning of the mature fish inhabiting the rivers. The fertilized ova drift with the rapid current (travelling at 2 or 3 miles per hour,) and hatch usually overnight. Traps in the form of bag nets or troughs are set up along the embankment to collect them. Fry and eggs of many kinds of fishes enter the traps, but only those of the following species are selected and used:

1. Grass carp ( 鯪 )  
*Ctenopharyngodon idellus* (C. & V.)
2. Big head ( 鱮 )  
*Aristichthys nobilis* (Richardson)
3. Silver carp ( 鯪 )  
*Hypophthalmichthys molitrix* (C. & V.)
4. Mud carp ( 鯪 )  
*Cirrhina molitorella* (C. & V.)
5. Black carp ( 青魚黑鯪 )  
*Mylopharyngodon piceus* (Richardson).

The work of the Fish Fry industry can be divided into 4 main sections, namely, (1) Organization and Administration at the headquarters; (2) Collection of Fry; (3) Management of the Nursery, and (4) Transportation of Fry.

The following discussions are based mainly on personal observations made by the writer in the West River regions and pictures taken at Shiu Hing (肇慶) by Mr. Yu Yat Sam, Research Assistant of Hong Kong Fisheries Research Station.

ORGANIZATION AND ADMINISTRATION  
AT THE HEADQUARTERS

Each year the nurserymen start, in December or January, to organize a company or companies to handle the fry business. Firstly they set up headquarters, for administrative work; secondly the staff is selected and assigned to various posts in the Company; preparations for collection, rearing and distribution of the fry are then made. The headquarters establishment is housed in a big mat shed covering

an area of about 5,000 sq. ft.; it consists of a meeting room, an office, storage for tools, staff's quarters, kitchen and bathrooms. Guests and customers coming from different parts of the country (300 to 500 in number) are accommodated in separate quarters nearby. The central meeting room has a big shrine at the inner and farther end and people use this room to discuss business. There is an accounting room where payment is received on sale of fry. The Fish Fry company provides 2 meals free to all the staff members and workmen and for customers who come to the company and wait for fry. The dining hall is a busy rendezvous at meal time.

Pre-war there were 46 independent companies in Shiu Hing (肇慶); each employed 1 chief fry expert, 1 assistant expert and 6 to 10 workers. Post-war circumstances obliged them to combine into one single organization and to monopolize the fry business of that district. The new company employs practically all the best fry experts; the capital is about 50,000 dollars Hong Kong Currency in 1948, and is raised by shares, the holders of which are confined to the old 46 companies only. In 1948 only 36 joined the main company.

The company operates 16 fry collecting stations along the River in the Shiu Hing district, (prewar there were 72 stations). It is staffed by a manager who is an old fry expert himself, 4 assistant fry experts and 10 workers. The main concern of the company is to sell the newly collected fry to the travelling customers from different parts of the country. When all the travelling buyers have got what they want the surplus fry will be bought by the shareholders of the company. Each shareholder or individual company rears fry in his, or their own ponds and continues to carry on business by selling fingerlings to fish farmers.

### COLLECTION OF FRY

Early in April the united company begins on the construction of 10 to 20 rows of high frames of china fir and bamboo poles on the bank of the river at each collecting station. Each frame is constructed of 10 to 16 vertical china fir poles 30 ft. long, spaced at intervals of 9 ft. each and strengthened by 3 or 4 horizontal poles of china fir or bamboo at intervals of 4 ft. 10 to 15 conical bag nets are fastened to each frame for collecting spawn from the river. The bag net is made of ramie netting of extremely fine mesh (actually

it is a kind of ramie cloth) measuring  $12\frac{1}{2}$  ft. in length. The posterior end is connected to a still finer-meshed ramie netting box, 4' long x 1' wide x 1' deep, which is suspended on an oblong wooden frame to keep it afloat. The body of the bag net is also kept afloat by inserting a pole of bamboo or china fir into the bag and any spawn either in the form of eggs or fry which are drifted into the bag pass along and collect in the box.

When large quantities of fry are collected in the end boxes, they are bailed out with a dip net and placed into a netting reservoir 5' x 4' x 4', suspended on a wooden frame and movable as desired. The fry netting reservoir is then drawn near to the shore.

Fry are transferred from it into water-proof baskets with the help of a dip net and carried to the nursery ponds for sorting and distribution.

Before discussing the collection of other carp from the river, a brief account of propagation of the common carp, (*Cyprinus carpio*) will not be out of place here:

During the months of December, January and February a small pond (50 to 100 sq. ft.) is prepared firstly by draining it and destroying all harmful creatures, and then by re-filling it with pure water from a nearby source such as a river or a canal. The water should be filtered through a small meshed bamboo screen placed in front of the bars of the sluice gate. Then a good supply of aquatic plants should be put into the pond, for it is upon these plants that the eggs of the carp will later adhere. Fully mature fat-bellied carp are then selected from the main ponds in the ratio of 2 or 3 males to 1 female and transferred to the spawning pond. To ascertain whether a fish is mature, and ready to spawn, one should hold it in the hands, press the belly and should any sperm or ova come from the cloaca, then the fish is mature.

The carp spawn very quickly, normally in one or two days. As soon as the eggs are laid and fertilized, they must be removed immediately and placed in a nursery pond for hatching and rearing in the same way as is done with fry of other kinds of carp.

When in 1934, I made trips to the West River in Kwangsi with a view to finding out the possibilities of improving the fry industry of China, I discovered that eggs of the mature spawning grass carp (Wan Yue) are not sticky and adhesive like those of

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The nets are tanned every fortnight or every month after they are used with cutch, Siu Leung (薯莨, a wild yam, *Dioscorea rhipogonoides* Oliv., or the bark of Yau Kam Tse (油金子), Myrobalan, *Phyllanthus emblica* Linn (Euphorbiaceae). The juice of Yau Kam Tse is stored in earthen pots for tanning purposes and a huge boiler is used for steaming the tanned nets. In Shiu Hing the bark of Yau Kam Tse is most commonly used.

the common carp and gold fish and could be artificially fertilised and hatched into ordinary fry for pond culture (Lin 1935). In the period 1936-40, a fresh-water Fisheries Experimental Station was established in Kweiping by the Kwangsi Government and experiments were successfully carried out on a large scale. In 1940, over 1,000,000 artificially bred fry were distributed to fish farmers in Kwangsi.

Every year, around the months of May and June, torrential rains cause the West River to flood and it is quite common for the river to rise more than 6 ft. in 24 hours. At this time many kinds of carp swim upstream to spawning grounds to breed. These carp are caught by drag seine nets or scoop-nets, and the ova and sperm pressed out by hand in order to effect artificial fertilization.

The method of collecting the ova and sperm for the purpose of artificial fertilization is quite simple. Two persons are needed, one to hold the female fish with one hand supporting the chest and the other grasping the head, whilst the other person holds the fish by the tail with one hand and with the other presses the belly so that the eggs flow out gently into a dry clean collecting basin. In the same manner the milt of the male is obtained and placed over the eggs. With a feather the ova and sperm are thoroughly mixed to ensure complete fertilization, and after a short interval, of 20 to 30 minutes, they are washed in clean water and placed in hatching boxes. These hatching boxes are made of ramie or jute cloth and are attached to an anchor and floated on the river. The fertilized ova will hatch overnight and the newly hatched fry are treated and reared as usual. Although the success of this artificial fertilization technique, using free, non-sticky ova, is of great scientific interest, no really practical value for it has been found. There are difficulties in procuring mature fish, and the number of ova which can be fertilized artificially is negligible compared with the quantity of fry or eggs collected from the river.

## MANAGEMENT AND WORK AT THE NURSERY

When sufficient fry have been collected from the river, they are conveyed to the nursery ponds in water-proof baskets. The site for the nursery ponds should be as near to the collecting station as possible. Where eggs are collected, they are not transferred to the nursery immediately but are first placed in a "hatching box" similar in structure to the fry netting reservoir, made of ramie cloth, 6' x 3' x 10".

The "hatching box" is suspended on a wooden frame to keep 1/3 of it afloat above the surface

of water and is anchored at some sheltered spot in the river or at the mouth of a small tributary where the water is comparatively clear. In bright sunny weather the eggs hatch in two or three days; they are allowed to grow for another three days on the nutrition of their own yolk sacs and on plankton in the river. They are then conveyed to the nursery ponds for further treatment. The practice of egg collecting is known only in two places:

- (1) Heng Yang (衡陽) on the Hsiang River (湘水) of Hunan Province.
- (2) Tsaichi (果溪) near Ichang (宜昌) of Yangze River in Hupei Province.

(1) *Nursery Ponds* (魚花塘)—There are two types of nursery ponds, the partitioned and the unpartitioned or whole pond, each varying from 1 to 3 mows (1/5 to 3/5 of an acre) in area and with the depth of water 2 to 3 feet. The partitioned ones are reserved for temporary rearing young Big Head and Silver Carp fry for 12 or 13 days, and also for rearing young Grass Carp fry and Mud Carp fry for 24 to 48 hours. The material used for partitioning a pond is a kind of bamboo matting, each piece about 7½' by 4' and small bamboo sticks about 7 ft. long. One waterway in the middle divides the pond into two unequal compartments, one compartment is further divided into two long sections in the middle with one wider section on each end. The other half is divided into six equal compartments called Tar Tsai or small sections. For example a pond of 1½ mows measuring 120' x 120', i.e., 14,400 ft<sup>2</sup> is divided into sections according to the above pattern so that we would have the following areas occupied by different sections:

6 equal division (Tar Tsai or small sections (簍仔) each	45' x 20' = 5,400 ft <sup>2</sup>
2 long section (長簍) each measuring	55' x 20' = 2,200 „
2 wider sections (耳簍) each measuring	55' x 40' = 4,400 „
1 water way (水路)	120' x 20' = 2,400 „
Total area of the pond	14,400 ft <sup>2</sup>

The area of the Tar Tsais, the waterway and long sections should be kept as near to the above standard measurements as possible but the wider section will occupy any area left after the standard sections have been built. Some large Big Head are

kept in the water-way to clean up the water because Big Head are macroplankton feeders.

The unpartitioned ponds are provided for the rearing of Grass Carp or Mud Carp alone.

(2) *Sieve* (篩)—Sieve measuring 2 ft. diameter 10 ins. deep are made of rounded bamboo splits and are divided into 20 or more grades for the purpose of separating different kinds and sizes of fry. Each grade is named and numbered according to the fineness of the holes provided in the sieves for the fry of certain fish to pass through at certain age. The grade 1 and 1½ sieve, for example, will let only very fine fry of a certain wild Mud Carp pass through, whilst grade No. 2, will separate the fry of Mud Carp from those of the Grass Carp. As the very young fry of the Big Head and Silver Carp are always bigger than those of Grass Carp, sieve No. 2½ is used to isolate the former two from the latter. Older fry will be separated from the young ones with Nos. 3, 4 etc., whichever is appropriate; fry are named according to the grade of sieve through which they pass. Sieves are made by hand; it requires special technique and skill to manufacture good sieves. Only one Pan Yu Lin in Kwang Li and Ka Tze in Shiuhing are recognised as the best makers.

(3) *Ramie cloth troughs* (魚花池)—As the name implies, troughs employed in the course of fry handling are made of ramie or china grass, *Boehmeria nivea*. There are 3 kinds of these troughs; the first is finest in texture and is called *Kwok Chi*, the second *Sam Chai Chi* and the third kind *Tai Chi*.

A. The *Kwok Chi* (絡池) or No. 1 trough, is made of finest ramie cloth and is used to hold the fry belonging to the grades from newly hatched ones to No. 4. The size of this type of trough varies from 40 to 60 ft. long, 25 ins. wide and 20 ins. deep.

B. The *Sam Chai Chi* (三紗池) or No. 3 trough is made of courser ramie cloth for holding fry of grade No. 5 or 6.

C. The *Tai Chi* (大池) or big trough is made of very coarse ramie cloth for handling fry over 7th grade.

(4) *Dip nets* (魚撇)—Dip nets are used to transfer fry from one container to another. They are also made of ramie cloth with a piece of rattan or bamboo bent to form a ring 1½ to 2 ft. in diameter and with a handle 8—10 ins. long. The net is about 10 ins. deep.

(5) *Big fry sorting basket* (大秘籬)—This basket is used to sort mixed fry. It is made of bamboo splits and rendered waterproof by a thick mixture of glue and cow dung smeared on the inside and dried over a charcoal fire. The basket measures 3—4 ft. at widest diameter and 3 ft. 6 ins. deep.

(6) *Fish fry dishes and cup* (碟及杯)—The dishes are made of light wood (such as *Bombax*) and painted with white enamel. There are two sizes, the big one measuring 10 ins. diameter, 1¾ ins. deep and the small 8⅞ ins. in diameter and 1½ ins. in depth. The cup is usually made of tin, 3⅞ ins. diameter and one in. in depth. Dishes are very useful tools and units in handling, counting and sorting or fry. Newly hatched fry (or river fry) cannot be counted in the same manner as large ones; they are measured by dishes and cup. A big dish when full contains 400,000 newly hatched fry of Grass Carp, Big Head or Silver Carp and 800,000 of Mud Carp. A small dish contains only half as many. A cup can hold 40,000 Grass Carp, Big Head, or Silver Carp and 80,000 Mud Carp.

(7) *Fry carrying baskets and tubs* (魚籬及桶) Baskets and tubs are used for transportation of fry. The former are made of bamboo-splits to any convenient size for one person to carry a pair easily. The baskets are rendered water-proof in the same way as the fry sorting baskets. To convey fry by means of railway and lorry big baskets are used. Large wooden tubs, 3 or 4 ft. high and 2 or 3 ft. diameter are employed to transport fry on ship, rail or trucks.

(8) *Bamboo mattings* (竹簞)—Nursery ponds are partitioned by this type of matting which is made with broad bamboo splits to measurements about 7½ by 4 ft.

(9) *Bamboo screen* (箔)—Strong bamboo-splits are used to make screens, each piece measuring 17 ft. long and 4 ft. high, for the purpose of fishing fry from the ponds.

## WORK IN THE NURSERY

**Preparation of the Nursery Ponds**—Shortly before the appearance and collection of the newly hatched fry from the river, clean and adequately fertilized nursery ponds must be well prepared and completed. To prepare a good pond, work has to be begun early in December, when the pond may easily be dried up during the winter drought; all kinds of harmful creatures such as Snake-head (*Ophichthys phalus*), Goby (*Gobius*), River pike (*Elopichthys bambusa*), the Giant bug (*Belostoma deyrollei*), and the water beetle (*Cybister*) must be destroyed with lime and tea-seed cakes. A week after this clean-up

action the pond is re-filled with clean and screened water to a depth of 2 or 3 ft. and then to every mow (1/5 acre) of pond 3 piculs of goat weeds, *Ageratum conyzoides* Linn., and *Siegesbeckia orientalis* Linn. and some cow dung are added. These plants are left near the bunds and the cow dung is distributed equally over the pond; they decay and the water becomes brownish green in colour. The pond is then ready to receive the fry. Three days after fry are introduced to a pond with Big Head and Silver Carp, 200 catties (260 lbs.) of goat weed should be added once every three days; to a pond with Mud Carp 260 lbs. of cow dung per mow (1/5 acre) once every day and to a pond with Grass Carp 260 lbs. of goat-weed and cow dung once every 4 days.

**Procedure of Fry Sorting**—The work of sorting and rearing the newly hatched fry may well be discussed and explained by describing an actual operation. One morning, for example, the fishermen at the collecting stations bring 100 dishes of 40,000,000 fry to the nursery from the river. The fry expert sets to work immediately to ascertain the percentages of various types of fry as close as possible. He takes at random a small sample from the big lot and brings it to his simply equipped laboratory to sort out the different kinds of fry, each to be placed in a bowl containing clear water. When the number of fry in each bowl has been counted the percentage of each kind is calculated.

Now suppose through the expert's assay we come to know that from the 100 dishes we should have 10% Big Head and Silver Carp, 40% Mud Carp, and 20% Grass Carp. The rest are miscellaneous fry. In case there are no customers to buy the "river fry" immediately the following work on sorting and rearing must be started without delay. The river fry are poured together into a big ramie trough (Tai Kwok Chi) which has been spread and suspended on small bamboo sticks erected in a big fish pond with 2/3 submerged in water. Any dead fry and dirt are removed with the help of a dish and hand. Next the fry of *Elopichthys*, *Siniperca* and other undesirable species are sieved out and got rid of by No. 2½ or 3 sieves. On account of the fact that most undesirable fishes are bigger than the domesticated ones, the No. 3 sieve will virtually let the latter pass through and retain the former in the sieve.

Forty to fifty dishes of the good fry left in the trough are transferred to a big sorting basket about half full of water. Waiting for 10 minutes and watching carefully for numerous tiny brilliant and sparkling specks of eyes to appear on the surface of water in the basket, the expert then quickly splashes

water from the pond over the fish in the basket with the help of a dish. In half a minute the various kinds of fry will group themselves into upper, middle and lower layers. The very fine *Elopichthys* and other miscellaneous fish usually occupy the upper-most layer, the Big Head and Silver Carp on the upper layer, the Grass Carp on the middle layer, and the Mud Carp and Wild Mud Carp in the lower layer. Taking advantage of this self-separating habit of the various fry under the special conditions, the expert uses simply a dish to skim off and destroy the undesirable fish which are in the upper-most layer. He must remember, however, to splash appropriate quantities of water into the basket on the side or at the middle at proper intervals in order to supply some oxygen to the fish; steps must be followed as quickly as possible, otherwise the fry die from suffocation and cease to be segregated. In the same manner the Big Head and the Silver Carp in the lower are removed and put in different sections of the trough for further treatment.

The remaining mixed fry in the trough are treated in the same manner. This work should be completed in about an hour.

Although there are no scientific data available at present, the under-lying principle of the above phenomena and practice of fry sorting may be ascribed to the fact that the oxygen requirement of fry and the capability of maintaining normal respiration in oxygen-deficient water, varies to a great extent from species to species. The Silver Carp are most active and need more dissolved oxygen. They always come to the surface when the air content of the water or the pond is low in the morning and evening. The Big Head requires comparatively less oxygen so they remain in the sub-surface. The Grass Carp requires still less and the Mud Carp the least, so they stay in the middle and lower layers respectively.

#### **Separation of Silver Carp from Big Head—**

Thus from the 100 dishes containing 40,000,000 fry as estimated, 4,000,000 Big Head and Silver Carp are sorted out and retained in 2 small sections of the partitioned pond in the morning. At about 4.30 p.m. on the same day when most of the Silver Carp will come to the surface of the water probably in search of more oxygen and food, while the Big Head remain in the lower layer, a fine netting is used to drag along the surface of the water keeping only about 2 inches deep; in this way it is possible to remove part of the Silver Carp from the Big Head. The Silver Carp singled out in this manner are then placed in an empty small section of the pond. The remaining mixed fry in the 2 small sections are again fished out as completely as possible

and retained in a long section on the same evening. This operation is known as "first sorting".

Next morning at 10.30 a.m. "second sorting" is to be carried out. The first catch from skimming 2 inches deep in the water with a net consists practically of pure Silver Carp; second catch from fishing at 6 inches deep consists of both Silver Carp and Big Head, half and half (this is called the mixture) and the remainder in the pond is composed solely of Big Head. The pure lots of Silver Carp and Big Head are retained separately in the long or wide sections and the mixture in wider sections of the pond. Four days afterward as the fish become bigger, they are fished and removed to other wider sections or any bigger unpartitioned ponds for further rearing.

The Grass Carp from the middle layer in the sorting basket are released in the unpartitioned pond or ponds. Eight Million Grass Carp fry should be placed in four 6-mow (1 1/5 acre) ponds (20% of 40,000,000 "river fry"). The sixteen million Mud Carp fry from the 40 million should be put in four 6-mow (1 1/5 acre) ponds for temporary rearing.

### TRANSPORTATION OF FISH FRY

Fish fry are extremely delicate creatures and their transportation requires special skill and technique. There are three practical methods of conveying fish fry from one country to another; (1) Land and sea Transportation; (2) River Transportation; (3) Air Transportation.

**Land and Sea Transportation**—On land fish fry ranging from tiny newly hatched larval forms to several inches in length are conveyed from one place to another in different types of baskets made of bamboo-splits or wood. One man can carry on his shoulder 2 baskets each holding about 30 to 40 lbs. of water containing 2,000 to 3,000 fry 1 inch in length. Of course more fry will be carried if they are smaller.

In carrying the fry the man must walk quickly to produce such motions as to effect proper shaking of the baskets and of the water in them. The shaking of the water will probably facilitate elimination of carbon dioxide from the water and absorption of oxygen from air.

Where fry have to be carried over a long distance requiring several days or weeks of walk the carriers have to select some intermediate stops. In a station for intermediate stop which usually extends from evening to early next morning the fry are liberated into a ramie trough suspended on bamboo

sticks over a pond, and they are fed with a mixture of yolk of egg and flour smeared over a small rectangular piece of wood with the smeared surface overhanging in water. The fry will come frequently to snip the food whenever they are hungry. In many cases like those in which fry are transported from Hankow to Wan Hsien in Szechuan and big quantities of fry are transported from Hong Kong to Siam and Singapore the fry are fed with cooked yolk of eggs or soya bean. The well-cooked yolk of egg or soya bean are ground into a very fine paste in a stone mill. The fry are fed by mixing some of this fine paste in the trough, watching carefully that most of the suspended particles of the paste are eaten up by the fish.

Fish fry are transported over long distance by rail, ships or lorries. Big baskets or wooden tubs of various sizes (the biggest measuring 7 ft. high, 6.5. in bottom diameter) are placed on board a ship or rail and in one of them 50,000 fish of 8 1/2 grade, 1 1/2" to 2" in length are put with the tub half full of water. Fry smaller than 1 1/2" in length are not hardy enough to survive long travel. The surface of water is kept in motion all the time (day and night) during transportation. A few minutes or even seconds negligence by a fatigued worker leaving the paddle idle, will cause complete mortality of the fry. Filthy water from the container is bailed out continuously in small quantities and new fresh water added whenever possible. In river transportation where fresh water supply is plenty, there is no difficulty but in sea transportation, fresh water is scanty and since the supply diminishes whilst the journey is in progress the workers must exercise strict economy in water changing and pay great attention to the job. Three to four such big tubs, holding a total of 150,000 to 200,000 fish fry, are placed on board ships sailing from Swatow or Hong Kong to Singapore, and 4 to 6 experienced workmen are engaged to look after the fish. Mortality of fish on such trip depends a great deal on weather conditions and on the length of the journey. If the weather is good enough to permit the workers to work regularly and if the journey should last less than 6 or 7 days, 60% survival may be expected.

**River Transport**—There are two means of river transportation namely, first, fish fry in baskets which are put on board a vessel as described above, and secondly fish fry are put in live holds with a few or many holes to permit water coming in and out freely. The arrangement of the live holds can be classified into 2 different types. To the first type belong those holds with many holes on the bottom of the boat, which can be closed with stoppers when-

ever desired. A boat about 24 ft. long is provided with 4 such many-holed compartments each of which can hold 1,000,000 to 1,500,000 river fry. The walls of the hold are carefully screened with fine ramie cloth to prevent the fry from escaping.

In a hold of the second type only 3 holes are cut in the bottom of the boat; into each hole a short pipe is fitted to let water in. The upper end of this pipe is fitted with a piece of short bamboo piping with a few holes to give a good spray of water over the compartment. The tip of the pipe is placed below the surface of the river outside the boat so as to give a fountain under hydraulic pressure which can be increased or decreased by varying the level of the pipe. A boat with this fountain type of holds is divided into 6 or 7 compartments, communicating with one another by openings cut on the bulkheads between them. These openings are screened with ramie cloth to prevent mingling of the fry. The middle compartment or hold into which water from all holds can come in, is reserved for a water wheel to pump water out in order to keep all the holds in good circulation of water. This type of boat with six compartments can hold 10,000,000 river fry.

**Air Transport**—For air transportation fish fry are picked in hermetically sealed containers (usually tin cans 9" x 9" x 14") with oxygen and water. The voyage from Hong Kong to Singapore, takes several days by sea but only a few hours by air. As experiments have shown that considerable quantity of fish fry can be packed with oxygen under slight pressure in sealed tins and last over 20 hours with safety, the possibility of air transportation is quite real.

By a series of painstaking experiments, it has now become a practical means of fry transportation on commercial scale.

The idea of supplying oxygen to fish in aquarium is an old one and many experiments on packing fish with oxygen and water in sealed containers had been carried out by scientists over the world. Birtwistle reports the use of a method described in Document No. 1045 published by U.S. Bureau of Fisheries by which he experimented on common Carp and Silver Carp transport with excellent results. His fish survived packing of 26 to 30 hours.

In 1947 when C. F. Hickling, Fisheries Adviser to the Secretary of State for the Colonies visited

Hong Kong, a trip was made with me to the West River to see the fish fry industry and pond culture. He mentioned the possibility of sending Carp to Singapore in oxygenated tins by air. Later in the same year the Fisheries Department of Singapore suggested to the Hong Kong Fisheries Research Station to carry out some trial shipment by "Skyways" planes. The first experimental shipment of 2 tins containing 1,213 fry made in July 1947 was a failure due to some technical defect. The second shipment of 600 fish in tins in the same month proved a success. Following this, the Hong Kong Fisheries Research Station has made 40 shipments of 157,737 fry by air to Singapore and Bangkok up to the end of November 1948.

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