ARTIFICIAL
HIMALAYAN MAHSEER SPAWNING

Tej Kumar Shrestha, Ph. D.

MAHSEER ECOLOGY PROJECT
INNOVATIVE SCIENTIFIC PROGRAM (ISRP-USAID)
PROJECT NO. (936 - 5542) (3E - 30)
TRIBHUVAN UNIVERSITY KIRTIPUR CAMPUS
KATHMANDU, NEPAL
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A MONOGRAPH

By

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"Conservation that limits kill isn't enough". The decline of mahseer has gone down too far a fact which all fishery scientists admit. Conservation must be extended, wherever possible, by means of positive havitat promotion. We cannot dam free-flowing rivers and have Mahseer. We cann't poach, dynamite river and have mahseer. Hatcheries do help but not always, for where do we get stock for all hatcheries? Even cleaning river won't help, unless dammers are convinced of the need of building fish ladders. Clean water itself, moreover, does not mean anything to mahseer unless they can get over the dam for spawning. As a remedial measure, artificial propagation programme must be started immediately at places where there are mahseer running brooks and creeks still left intact.

INTRODUCTION

This monograph is designed for the fishery biologist engaged in fish culture in Himalayan waters. The practical guidelines given herein are quite flexible. With time and experience some procedural changes may be made to suit various working situations. The guidelines are also tentative since all of them have not yet been varified and tested scientifically. At places where they have been used, happa or hatching trays have been filled with live fertilized eggs. Much of the advice outlined has resulted from the experience gained from first egg taken at field laboratory located at Trisuli, Tadi and Malaekhu rivers, and Gadkhar Fish farm of His Majesty's Government, Fishery Section. It is hoped that this monograph may provide a practical guideline for breeding rare species of mahseer increase its fertilized eggs and fry resources and help to bring back its population in original level of abundance. I would appreciate any suggestions for the improvements of this monograph.

TEJ KUMAR SHRESTHA PH.D.

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TEJ KUMAR SHRESTHA PH.D.

PREFACE

Mahseer or Himalayan Salmon as a premier game fish has intrigued naturalists and anglers from centuries. Macdonald (1948) gave a vivid account of its game value. Hora (1940) studied taxonomy and biology of mahseer of India. Shrestha (1984) studied ecology of mahseer in Nepal highlighted the need and opportunity of the mahseer research for its propagation in Nepal.

Propagation of the declining Mahseer, is a demanding task. It is a task that requires a foundation of sound quantative data regarding its breeding needs, breeding success, and critical stages of life history, migration and spawning. Data and information on these aspects do not exist in sufficient precision in Nepal. This is the first time that attempt has been made on artificial breeding of mahseer by using stripping method. In the present monograph attempt has been made to adopt the breeding method persued in Salmon (Hayes, 1942, Bakkala, 1970, Leitritz, and Lewis, 1976, Lannan, 1978, McNeil, and Bailey, 1975). In order of achieve this coveted goal of breeding the Trisuli river, Tadi river and impoundments (Gadkhar fish farm, Trisuli fish farm, Trisuli reservoir and Balaju recreational fish ponds) were selected for the routine studies. Present study was started with the financial support from U.S. Agency for International Development Cooperation,Washington D.C., and in Collaboration with the University of Arkansas and U.S. Fish and Wildlife Service.

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CAPTURING ADULTS

To begin with the artificial spawning you will have to go to a remote area to catch adult mahseers. The easiest way to catch them will be with a gill or trammel net. Usually, gill nets are stretched across the stream during high flood at night to collect spawners. They are set just 20 meters above the confluence of a large river. The spawners at mid-night around 1.00 p.m. would arrive there and get entangled along the meshes of gill nets. Mahseers about 15 - 25 kg can be captured in this way. At day time mahseers can be captured by means of looplines and handlines.

One must not try to collect all brood fish from just one portion of the run. Instead, one should take fish in a ratio that is proportional to the natural run: a few during the early portion of the run, most during the height of the spawning run, and a few during the latter part of the run. This will give also aid to determination if the rhythm of maturation and spawning cycle of mahseer. During the height of run female mahseers predominate in the catch and males become fewer. In the prespawning and post-spawning periods males predominate in the catch and females become fewer. Soon after catching the adults mahseers must be kept in holding happa until they are ripe. They are delicate and withstand a little amount of handling and crowding. However, keep in mind that they can suffocate if too many are placed in a small space. Take care of holding them one at a time and do not plunge them around carelessly. Eggs and milt can be damaged by rough handling. Do not hold females head down because the pressure on the egg capsule may be too much for their hearts.

If the mahseer running stream is nearby you may save time and effort by transporting the fish live to your hatchery site. Mahseer will easily survive towing in a happa at the speed of 2 - 4 mph. If the towing forces

the fish against the rear of the happa, you can decrease the water velocity either by slowing the boat down or by stretching extra - cloth around the front of the happa.

Here are the guidelines:

Guideline No. 1: Do not try to take only the largest, heaviest mahseer. The little ones are there for a good reason. For example, if you have three times as many males as are needed, take every third male you come across in the net, not just the big ones. Do the same for females if they are plenty in number.

THE CONDITIONING OF RIPENING ADULT MAHSEER

At the distant areas of a riverside, you'll have to set up happa where the adult fish can mature. Probably the best type of holding pens are floating happa anchored on the river bank. Riverside floating happa should be located near human habitation, where they are protected from heavy weather and where freshwater from the creek will constantly flush through them. Fresh water is not always necessary, but it tends to hasten the ripening of your fish.

For holding adult mahseer you will need at least three separate happas: one for males, one for females, and the third which you will keep empty to receive female with just ripe ovary after they have been tested for ripeness.

The markin or nylon happa designed by the present investigator is a particularly good one. Rectangular happa (2 x 1 x 1 m) made up markin cloth has proved to be suitable for conditioning breeders. Happa of same size made up of synthetic vellon has also proved to be suitable. Also, double happa consisting of an inner mosquito curtain (2 x 1 x 1 m) and outer nylon happa (2 x 2 x 2 m) were used for hatching.

The happa should be sturdally anchoraged perfectly. Stout pegs that can withstand wear and tear of the current must be used. The happa should be well tied to the pegs. At night upper and lower parts should be shielded up with cloth to avoid escape of captive fish by jumping. Captive fishes should be fed with a mixture of oil cake and rice equal of barn to 1% of their body weight every day.

After a run has been established at your hatchery site, catching spawners will be much easier because you will be able to build an observing hut nearby. The hut is made at an elavated position so that migratory run can be easily seen. Knowing direction of fish run you have to put across gill net in mahseer running stream. Usually upstream mahseer run takes place between mid-night and around one a.m. clock and the descending run takes place at around 3 0' clock. Usually confluence sites of stream and river may be utilized for capturing mahseer. Your holding happa can probably be anchoraged near the creek where you will have the advantage of fresh water and gravel bottom - more natural situation. Consequently, the adults will ripen faster. During the hights of flood, it will be difficult to fix happa at suitable place due to strong prevailing current. In such circumstances happa can be set at the water mill dyke made by villagers.

Guideline No. 2: For holding happa fixed near the river bank allow 2.6 to 5.2 gallon of water per minute per 100 pounds of mahseer.

TESTING RIPENESS

Sexing and Seggregating Adults:

Mature male mahseers are much easier to identify than females. They have pronounced tubercles at the end of the snout. These spawning features are not so obvious in females. Sometimes, you will capture brightly coloured large fish which do not show these features. In that case, you will have to hold them in happa until they show them.

Males mahseers are separated from females for a number of reasons. For one thing, they conserve happa holding space since fewer males are taken than females. They also makes handling and processing the eggs and milt easier and more efficient. In addition, they avoid the chance of fish spawning prematurely in the holding pens (a hazard if the fishes are held in pens or happa).

Testing the Females for Ripeness:

This procedure requires two men: One to brail the female mahseer and the other to handle the fish. After the first person takes out the female out of the happa, grasp her by the thin part of the tail with your left hand. A strong grip is needed - cotton gloves help. With your right hand under her belly, cradle the fish against your chest or stomach. Then, with your left hand, cock her tail up, and with your right hand apply a gentle pressure against her belly.

If the eggs ooze out readily, quickly cradle the fish belly up so as not to lose any more eggs than necessary. (If 50 to 100 eggs are lost from each female, 20 to 40 extra females will be required per million eggs taken).

Guideline No. 3: The fish is ready to spawn if her belly muscles are soft and a few eggs are expelled from vent. If you have to use more than gentle pressure, the fish is not ripe and should be placed in the holding pen for green females.

After you have collect a fairly large number of female spawners, keep a close vigil on them - but don't overdo it. Check them every few days to observe their ripening process, and then check only 15 fishes on any given day. In this way you will avoid unnecessary handling of fish and will save time and effort.

When many of the females are ripe, check them all and take eggs from them which do not last long. In this situation it will helpful to have

several holding happas so that you can sort out the "nearly ripe" from the "very green" females.

Guideline No. 4: Wait until 5 to 15 females examined are ripe before you begin take eggs from a large group of fish.

Testing Males for Ripeness:

The male fish is held in the same manner as the female. Strip the male by squeezing along his belly with the thumb and forefinger of your right hand, pushing towards the tail. If milt is oozed readily, the fish is ripe.

Guideline No. 5: Always waste the first few samples of milt from the male. The first lot of milt from the male is impure. They may contain urine, fecal, material blood and/or water. They must be discarded. Take a few eggs from a ripe female and fertilize them with milt of male.

STRIPPING EGGS OR ROE

A ripe female mahseer need not be killed as in salmon. Usually mature females yield a free flow of ripe eggs or roes. Ripe eggs look like transparent yellowish orange. They are called spawns.

Stripping, or egg taking, should be done in a shady place or under a shady tree cover. If you are on a river bank alongside the holding happa, put up a plastic tent for protection from both the sun and the rain. After the fishes are handled and before they are stripped, they should not be left in the sun for more than a few minutes. This is true for both males and females. It is also essential that the eggs and milt be kept away from any contact with water. If the mahseers are injured while handling and stripping, their wound should be treated with Acriflavin. The wounded fishes to be kept separately before their release in holding happa or tanks.

Guideline No. 6: Don't let eggs in or out of the female; the temperature should not exceed 31°C. Keep the unspawned fish and spawned eggs and milt as cool as possible.

Two people are needed for egg or spawn taking. They stand facing each other on either side of a table or bench which holds the spawning basin. The first spawntaker, who should wear cotton gloves, grasps the female's head with the left hand, hooking the forefinger and middle finger under the fish's gill covers. With the right hand, the belly is wiped clean and the tail is grasped.

The fish is then gently lifted, with head held up with the belly towards the basin and the anal fin (the one behind the vent opening on the belly side) draped over the rim of the basin. The second spawntaker squeezes and milts the fish with fingers. If the fish is fully ripe or in a running stage her transparent eggs will spill quickly via the vent of fish into the basin. If she is just barely ripe or green, only a few eggs will ooze out.

Guideline No. 7: Any ripe eggs will fall into the basin. Eggs that do not readily fall away from the eggs are immature and will not fertilize. The immature or green eggs, which are opaque, can thus be distinguished from ripe eggs.

Guideline No. 8: Blood, slime, and broken eggs interfere seriously with good fertilization and should be kept out of the basin as completely as possible.

STRIPPING MILT OR SPERMATIC FLUID

Take milt or spermatic fluid from males in the same way as for females. Males need not be killed. If you have a shortage of males, they may be kept alive and stripped several times. Allow enough time between spawnings to

permit the milt to build up again - usually four to six hours. The males can be kept as a stand-by stock for entire spawning season.

Milt may be stripped directly into the eggs in the spawning basins if your incubation trays are nearby. Eggs become very tender soon after fertilization, so if your incubators are at some distance it is better to transport eggs and milt separately. Strip the male into a plastic bag or some sort of sandwich bag. Be careful not to get any moisture in the bag; don't even blow into it to inflate it. Milt is very sensitive to water and lives only a few seconds after contact with water. Put the milt from only one healthy male in each bag. (Some weak males produce infertile watery milt that could contaminate other milt). Tie the bag shut so that some air is trapped.

TRANSPORTING MILT, EGG AND FERTILIZING

Roe or milt can be transported in insulated plastic containers with crushed ice. Gently pour the eggs from the spawning basins into plastic bags. Rigid containers, (which tend to protect the eggs from physical damage better than a flexible bag) such as a plastic jar (one gallon capacity)m may also be used. Be careful not to introduce water into the containers. Tie the bags or close the containers tightly and pack them in the transportation ice box. Do not put ice right next to the milt or eggs as some freezing might occur. Sponge (or moss) can be used to separate the ice box from the eggs and milt. This device will protect egg or milt from shock during transportation.

Packed in this way, the eggs and milt will last a fairly long time - even until the next day. If your transportation breaks down you will have some time to spare. All packing work for transportation should be done at a shady place.

Guideline No. 9: If plastic bags are used, don't pile the eggs any deeper than about ten inches on the transportation box.

At the hatchery, take the eggs and milt out of the ice box and allow them to come to room temperature. (About 22 to 25°C.)pour the eggs from one bag into two or three basins. Open two bags of milt and pour about a half a cup of water into each. Then immediately pour some of the diluted milt from both bags into each basin of eggs. Two persons will be required for this operation because speed is essential. Once touched by water the milt will lose its potency in 15 seconds. Quickly swirl the eggs in basins with a chicken feather to mix the eggs and milt.

Guideline No. 10: In dry fertilization, fertilize with eggs and milt that have been freshly removed from fish. But in wet fertilization always add water to eggs and milt that have been removed earlier. Dry fertilization of eggs and milt from fish killed earlier will result in a much lower fertilization rate.

If you are stripping eggs on a river bank where transportation is unnecessary, the males can simply be stripped into the spawning basin. This, of course, is the safest procedure. Keep up six basins in a row, each with the eggs from one female. Strip the milt from two males into each basin. Then gently mix the eggs and milt with chicken plume or swirl the basins to mix the eggs and milt.

The fertilized eggs from the basins should be transferred into the hatchery incubators or floating incubation trays over river water as far as possible. Hold the lip of the basin under the water surface and leave the eggs into a layer on the screen of incubation trays. Remove the eggs attached in the side of basin by means of chicken feather and put them in the trays.

In the incubation tray the fertilized eggs are water-hardening meaning taking up water and swelling into a rigid balls. The hydration process will double the size and volume of each fertilized egg. The eggs are specially delicate at this time. After the water-hardening is completed, you can check dead eggs (they appear white) and remove them. For about 15 hours the

eggs will tolerate some gentle handling with a chicken feather. But after that they must be left undisturbed for about three days until the pigments of the eyes are visible. Even a little shock emanating through the hatchery floor can be harmful. Keep the developing eggs out of the light as much as possible. Put a cover over the incubators to protect eggs from direct light.

A mortality rate of 10 - 15 per cent is usual, but 20 to 30 per cent indicates trouble somewhere along the line. If there is no valid reason for poor fertilization, there may be doubt about the quality of the milt and you should try using milt from more males. Critically review your procedures to make sure that all possible care is taken to keep the eggs and milt clean, dry, and cool.

Guideline No. 11: Circulate the eggs with malachite green mixed water (2 ppm) to avoid fungal infection. Infection due to slime moulds are avoided in this manner.

Oxygen packed fry ready for transport

MANAGEMENT OF CRITICAL STAGES OF MAHSEER'S LIFE HISTORY

1. Hatchling

After two to three days of fertilization, the embryo changes into a minitature of fish which lies inside the egg in a coiled state. The squirming embryo exhibiting motion can be seen due to transparency of egg membrance. It manage to escape out through the weak point of the membrane. The fish-like embryo is now called hatchling. The hatchling cannot swim freely for it has no well-developed fin. It's large yolk sac in the abdomen is also a great hindrance for movement. For about three to five days the hatchling leads a latent or quiescent life remaining at the bottom of the happa or hatching tray. The hatchling is subject to infection of mould and bacteria if water is not properly circulated. The optimum temperature for survival of hatchling is 22-31^{o}C; pH 7-9; Oxygen 9 to 12 ppm.

Guideline No 11. The water supplied in the incubation tray is always silt-laden and take large toll to clean its floor. Therefore, water should be allowed to run through a desilting tank before supplying to the hatching tray. If the pipeline is used for water supply both ends of the pipe should be plugged with cotton so that considerable silt is trapped in the cotton material. Silt-free water is allowed to run through it.

Guideline No. 12. All dead hatchlings and broken egg membrane or shell should be removed. The dead eggs should be thrown and should be kept aside for physical examination under microscope. While removing dead hatchlings there is a chance of removing the live ones too. Only after scanning under the binocular microcospe dead hatchlings should be discarded or preserved in formalin for the life-history studies.

2. Passive Sac Fry

Hatchlings change into sac fries at about four days. They look more or less like fish. A brisk swimming tendency can be noticed in them, pectoral and caudal fins are well formed. After five days of fertilization the yolk sac becomes fully absorbed and gets converted into swimup fry stage. Sac fry does not need to take food. A sac fry measures about 5 to 8 mm in total length.

Guideline No. 12: Monitor water temperature, pH oxygen, turbidity and silt. Sudden changes of Oxygen, pH and turbidity is fatal for sac fry.

3. Active Swimup Fry

After 7 to 10 days swimup up fry absorbs all yolk content and starts its free swimming life. It exhibits a brisk movement for it has well developed fins. It come to the surface of the incubation tray for the gulp of air. It's gill racker is well formed at this stage and needs a fresh supply of oxygen. At the age of two weeks swimup fry starts taking zoo planktons. Up to this time the swimup fries are safe in the hatching trays. A swimup fry measures about 15 mm to 25 mm.

4. Jumping fry

After some days a fry shows a jumping tendency over the water level of the tray. It is to be transferred to rearing happa. A rearing happa is circular nylon bag about 10 meter deep and 1.5 meter wide supported by a circular iron frame at its open and closed end. The happas so made are suspended over a pond or river where water is clear and oxygen level is quite high. A jumping fry of about 35 to 45 days old can be put in such floating circular happa. A jumping fry needs to feed daily or at two days interval. A jumping fry measures about 30 to 35 mm.

Guideline No. 13: The jumping fry needs regular feeding. For this purpose the boiled yolk of egg is rendered into fine paste by mixing at with water the suspension yolk is then released into the circular happa to feed fry. Swimup fry snap quickly yolk particles.

Guidline No. 14: The circular happa should be cleaned twice in a week. A small net is to be used to capture and transport them safely into another hapa. Open end of happa should be closed with thick cloth to avoid direct light. Occasionally water snake (Natrix psicator) prey upon the fries. Sometime adult fish living in the pond tear immersed portion of the circular happa and bring it to collapse. Therefore regular watching is needed.

5. Fingerlings

Jumping fry of mahseer attain the fingerling stage after six months and measure 60 to 90 mm. The fingerlings have all the complements of fins and scales. They can fend for themselves. They are voracious feeders and are highly photopositive. As water of the stream begins to receede during December, the fingerlings leave for bigger rivers downstream.

Guidline No. 15: For rearing fingerlings circular happa measuring two meter wide and three meter deep should be used. Dry fish food, oil -cake, buffalo liver and rice barn should be supplied every day.

Guidline No. 16: For releasing fries to new habitat acclimitization trail should be made. Prior to their release fingerlings of about 90 mm should be put in a suspended happa in a new water mass to be released. The fingerlings are to be released if 90% of them survived well. Before the release fingerlings should be finclipped or tatooed or put identification marks.

TRANSPORT OF FRY FOR PROPAGATION

The fertilized eggs were reared in hatching trays and fed with river water. About 40% mortality was noticed due to fungal infection. Circulation of water treated with 2 ppm. level of malachite green helped greatly to protect the egg from fungal infection. In the farm fertilized eggs are raised to fingerling stage and transported to Trisuli farm and Balaju garden pond for stocking. Land transport of fry was developed for mahseer. As a for trial three consignments containing 500 fries in each in oxygen packed enevelope were sent to Balaju garden which reached the destination after 7 hours with only 10% mortality. Consignment without oxygen showed about 20% mortality. For water is changed at the interval of one hours and for this purpose earthen pots were used land transport. While carrying earthen pots through long distances splashing effects of water produced good aeration for mahseers. Red clay rich with haematite was put into water for better conditioning. The developing eggs were put in oxygen-packed plastic envelop consignment and reached the destination in 7 hrs. About 80% of the eggs hatched out. Development of these methods will enable one to transport eyed egg or fry from one waterbody to another and will enable faster propagation in space and time whenever it is required.

ADVANTAGE OF ARTIFICIALLY PROPAGATED MAHSEER

Artificially propagated mahseer fries have all the qualities of stamina and growth which maximize the opportunity to survive numerous netural and man-dade stress. They will be exposed to a new habitat of ponds, reservoirs and irrigation canals. In other words artificially bred mahseer fries are released from hatchery into the rivers. Others will be held in captivity for a few days to a year or longer and are raised on artificial diet before they are released.

BIRTH TO DEATH STUDY

Mahseer researchers in Nepal are on the way to complete a comprehensive birth to death study of the migratory mahseer population. In future mahseer bred in farm will be branded, tagged, tatooed or finclipped, and so can be identified enroute downstream or several years later when they return from the river as to spawn adult fish in the very water where their parents did. Such a study will also help to gain more knowledge about the age, growth, mortality and population dynamics of mahseer thus renew the hope of mahseer conservationists in the Himalayan waters.

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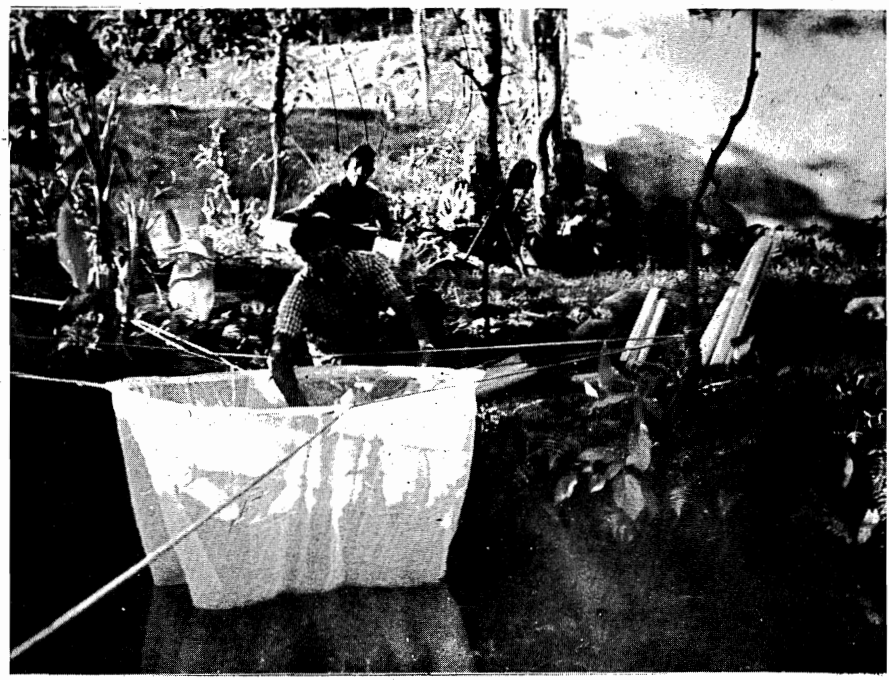
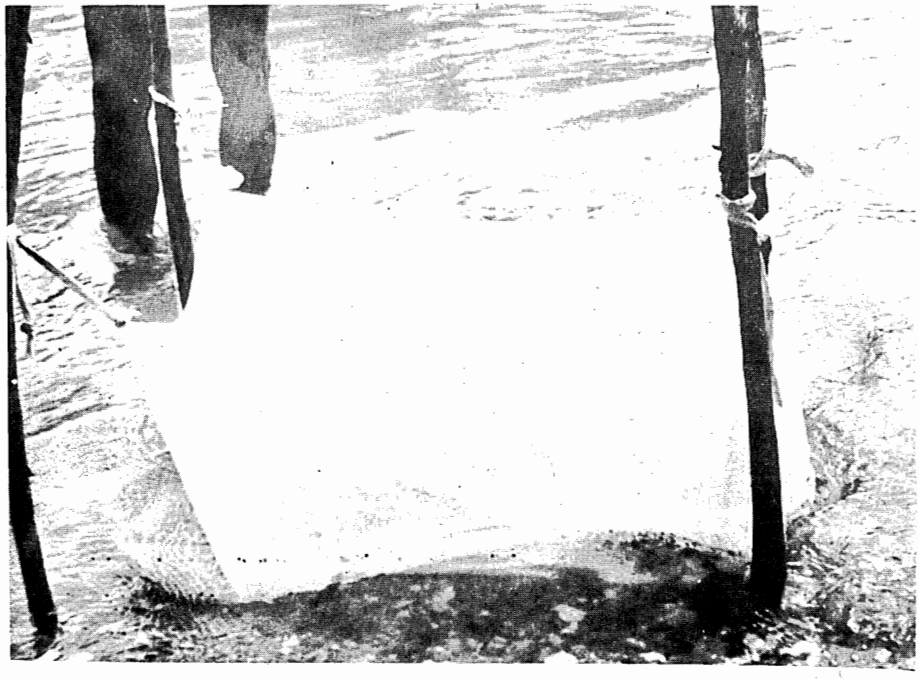
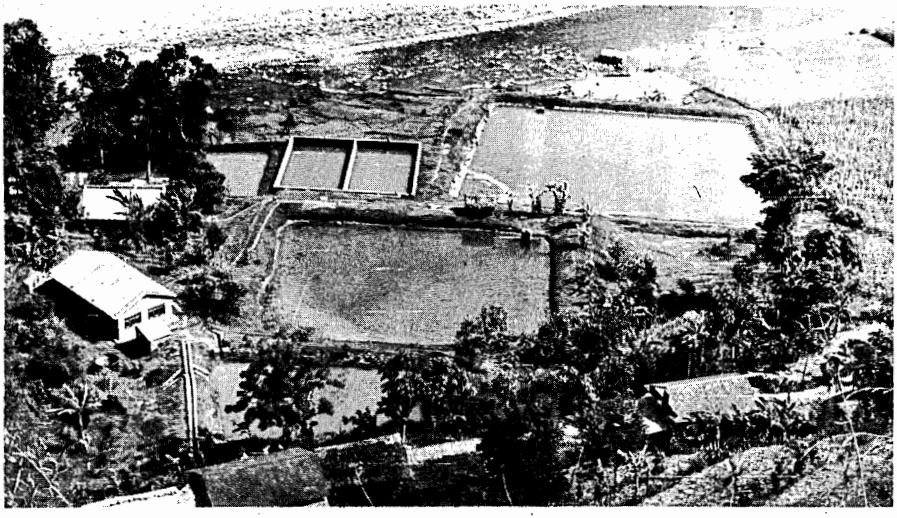


Circular happa suspended in over pond water for rearling fry.



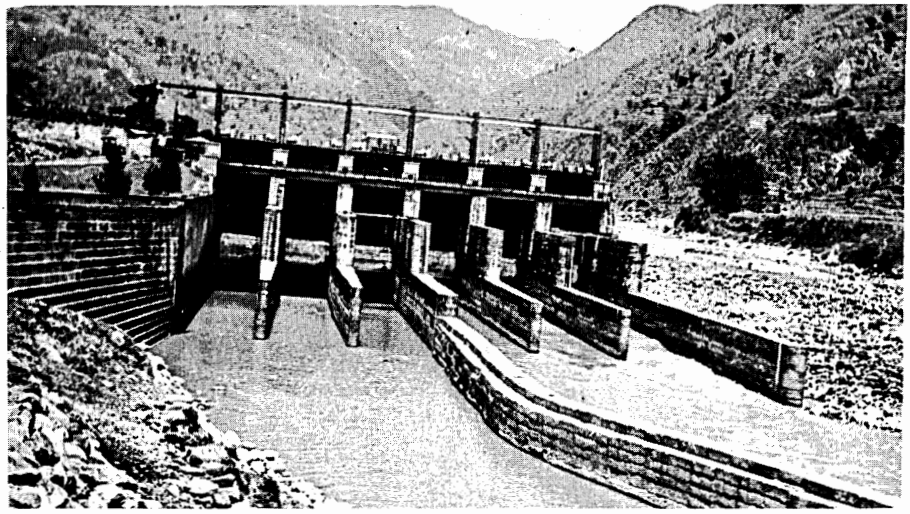
Happa Suspended in river water



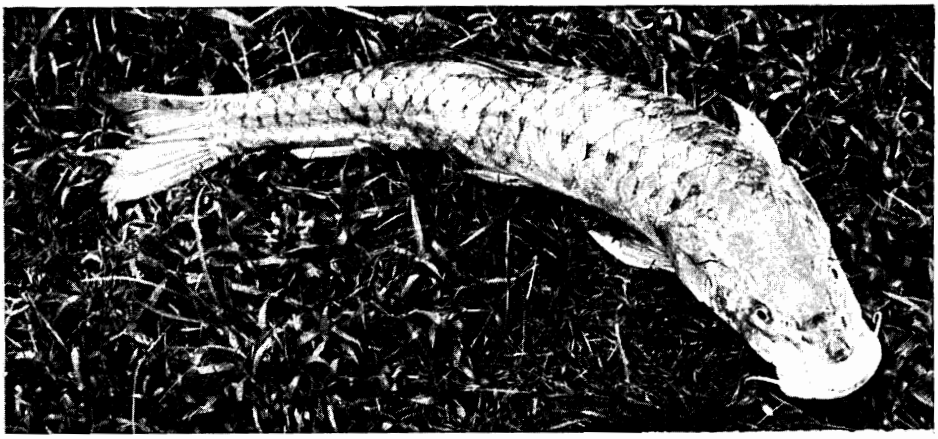
Royal Fish Farm at Gadkhar

Riverside hut made for
observing mahseer run

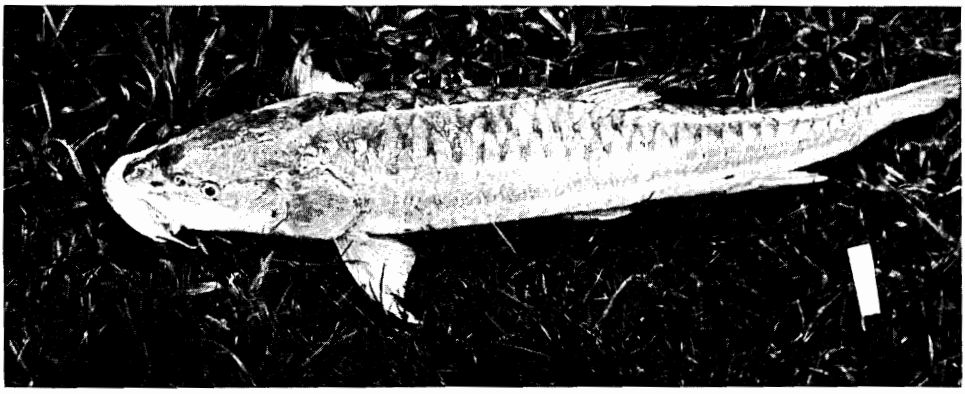
Gill net set at midnight to capture upstreaming spawners



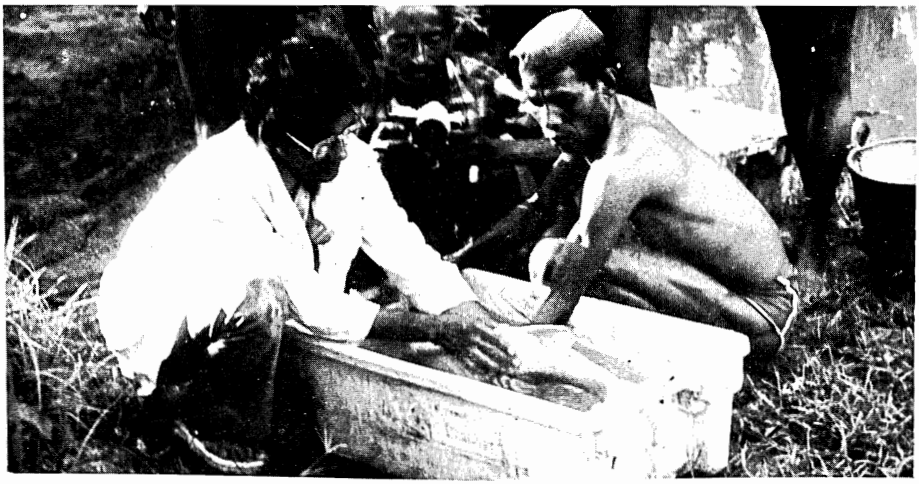
Trisuli dam



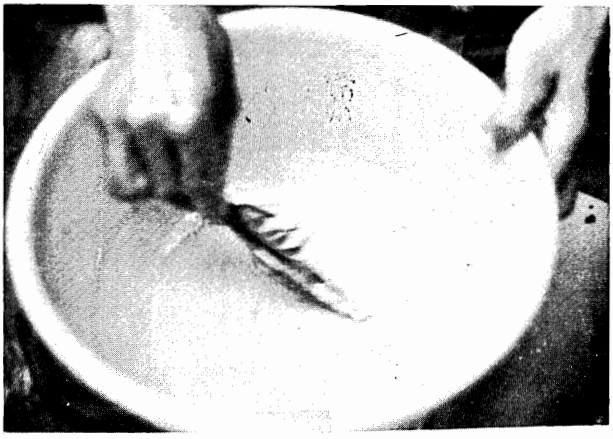
Male Golden Mahseer Tor putitora (Hamilton)



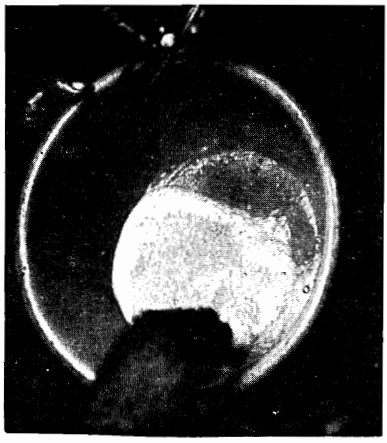
Female Mahseer Tor putitora (Hamilton)



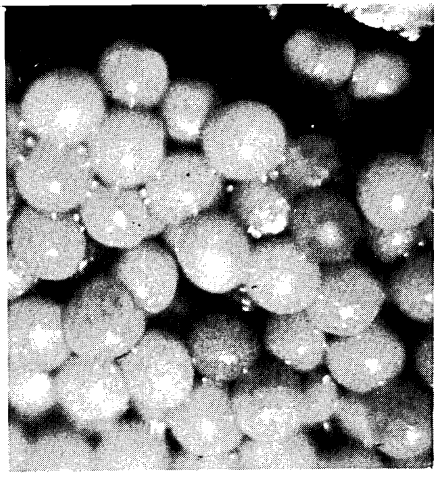
Testing Ripness by pressing abdomen of fish



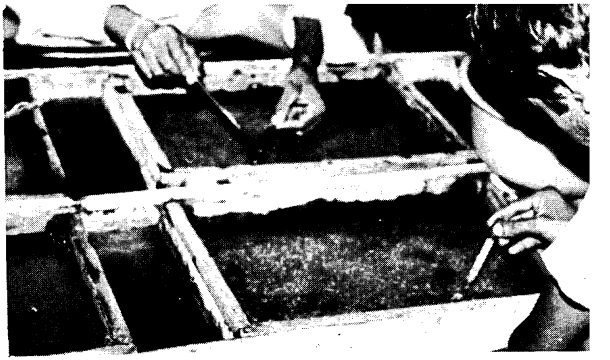
Mixing egg with milt by means of feather



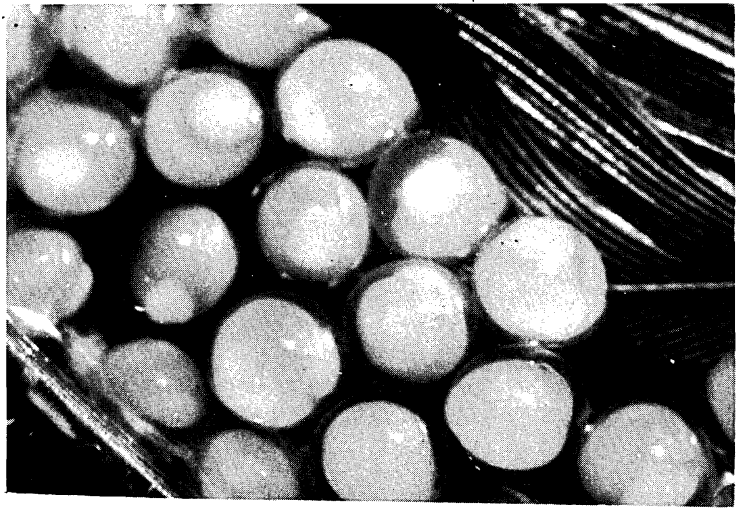
Stripping egg in spawning basin



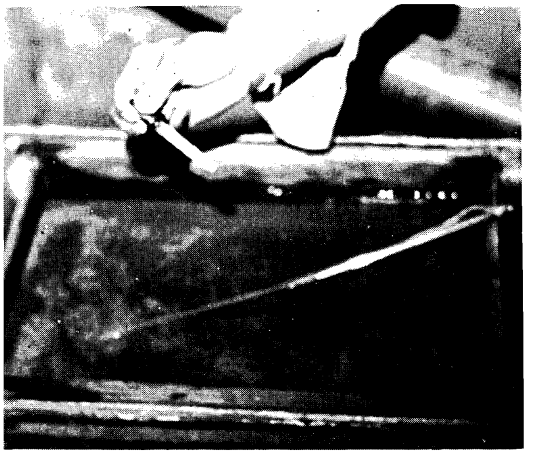
Sample of Mahseer Spawn



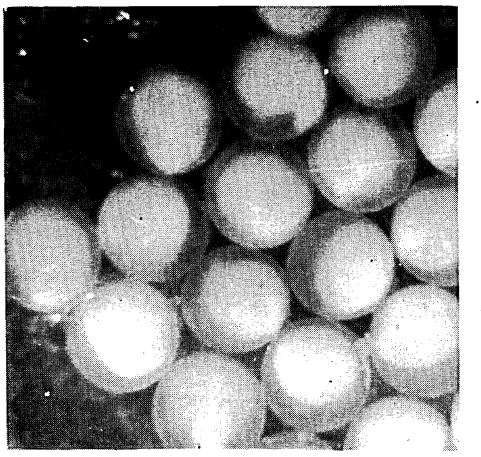
Method of releasing and spreading fertized eggs of mahseer



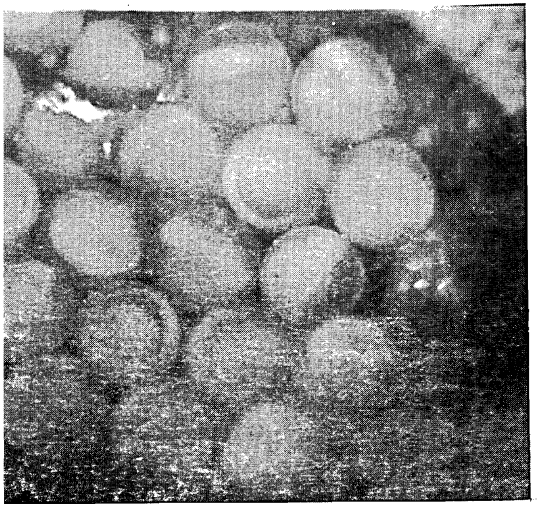
Eggs after one hours of fertilization



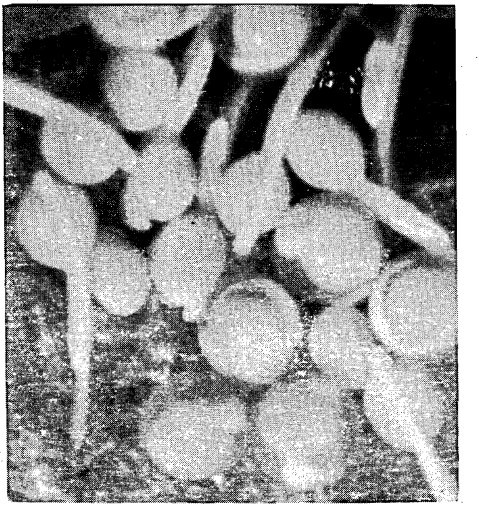
Picking dead eggs



Developing eggs

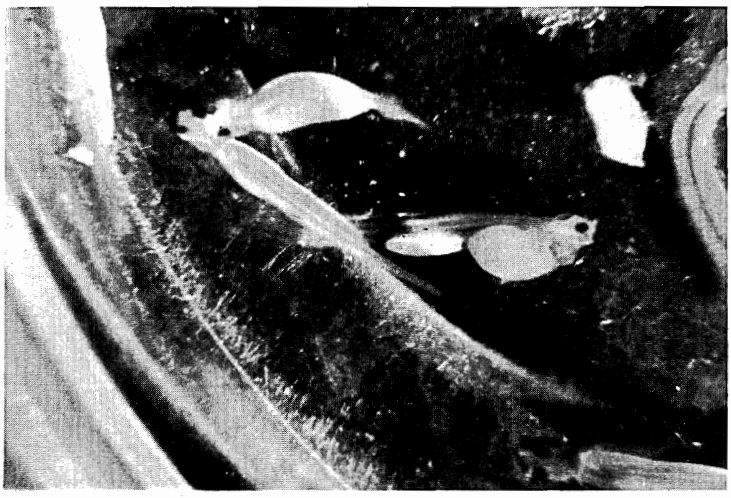


Comma shaped embryo.

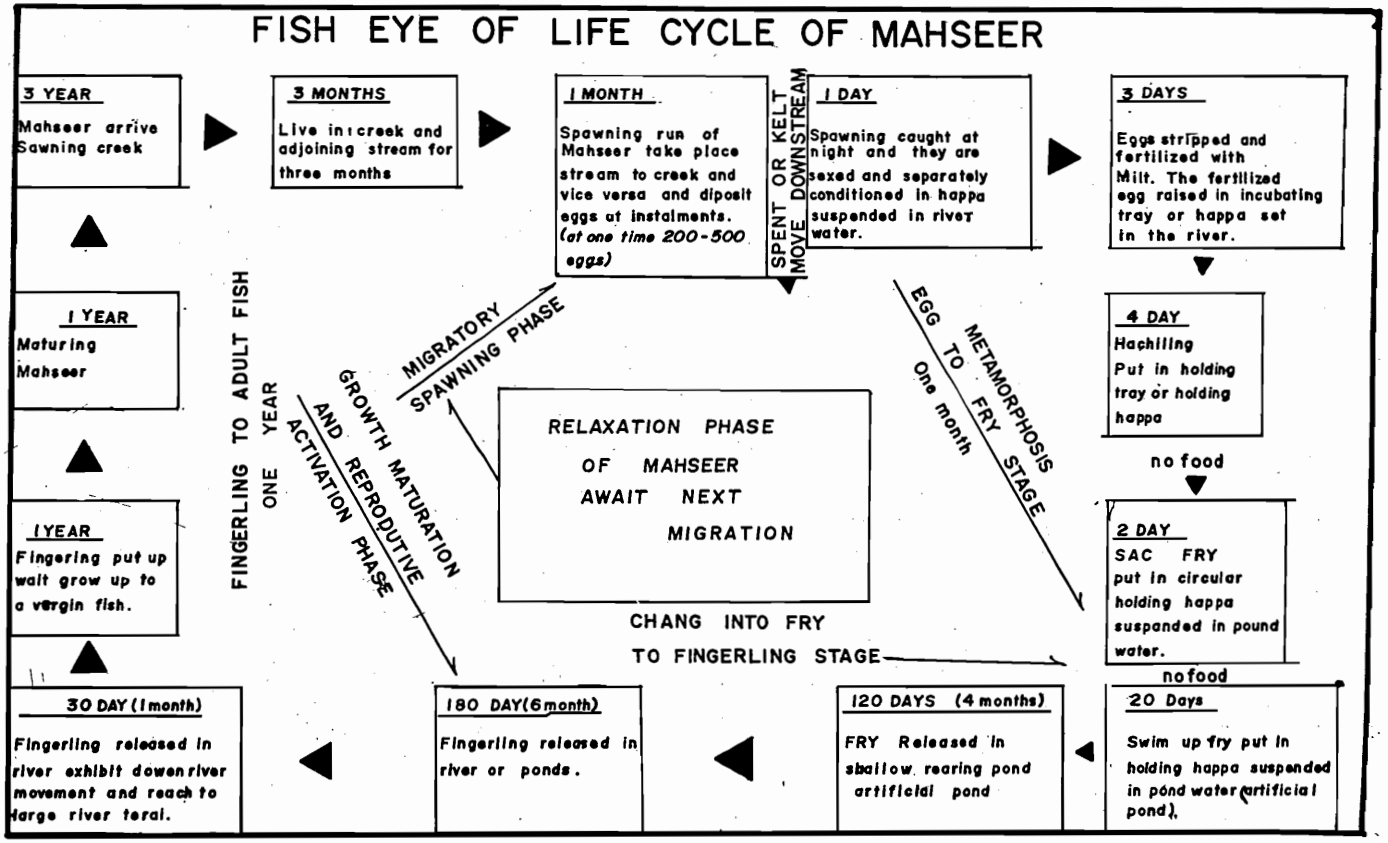


Young prehatching embryo with elongation of tail

Hatchling lying latent
in a nylon tray



Sac fry of Mahseer


FISH EYE OF LIFE CYCLE OF MAHSEER
3 YEAR
Mahseer arrive Sawning creek
3 MONTHS
Live in creek and adjoining stream for three months
1 MONTH
Spawning run of Mahseer take place stream to creek and vice versa and diposit eggs at instalments. (at one time 200-500 eggs)
SPENT OR KELT MOVE DOWNSTREAM
1 DAY
Spawning caught at night and they are sexed and separately conditioned in happa suspended in river water.
3 DAYS
Eggs stripped and fertilized with Milt. The fertilized egg raised in incubating tray or happa set in the river.
4 DAY
Hachiling Put in holding tray or holding happa
no food
2 DAY
SAC FRY put in circular holding happa suspanded in pound water.
no food
20 Days
Swim up fry put in holding happa suspended in pond water (artificial pond).
120 DAYS (4 months)
FRY Released in shallow rearing pond artificial pond
180 DAY(6 month)
Fingerling released in river or ponds.
30 DAY (1 month)
Fingerling released in river exhibit down river movement and reach to large river teral.
1 YEAR
Fingering put up wait grow up to a virgin fish.
1 YEAR
Maturing Mahseer
3 YEAR
Mahseer arrive Sawning creek
FINGERLING TO ADULT FISH ONE YEAR
GROWTH MATURATION AND REPRODUTIVE ACTIVATION PHASE
MIGRATORY SPAWNING PHASE
EGG TO METAMORPHOSIS One month FRY STAGE
RELAXATION PHASE OF MAHSEER AWAIT NEXT MIGRATION
CHANG INTO FRY TO FINGERLING STAGE

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