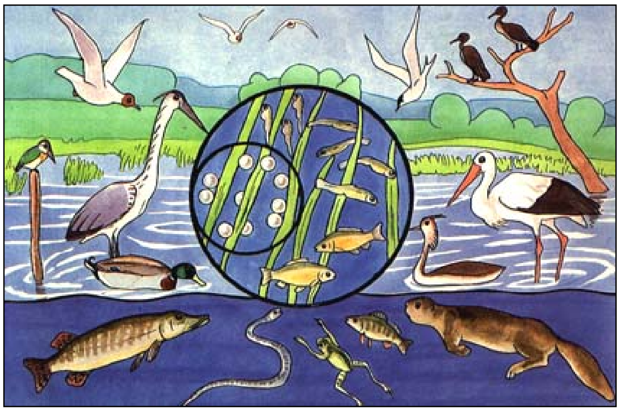
Food and Agriculture Organization
of the United Nations

# TRAINING MANUAL ON THE ADVANCED FRY AND FINGERLING PRODUCTION OF CARPS IN PONDS

## A handout for on-farm training workshop on fish seed production of common carp and Chinese major carps in Central and Eastern Europe, the Caucasus and Central Asia

**Second revised edition**

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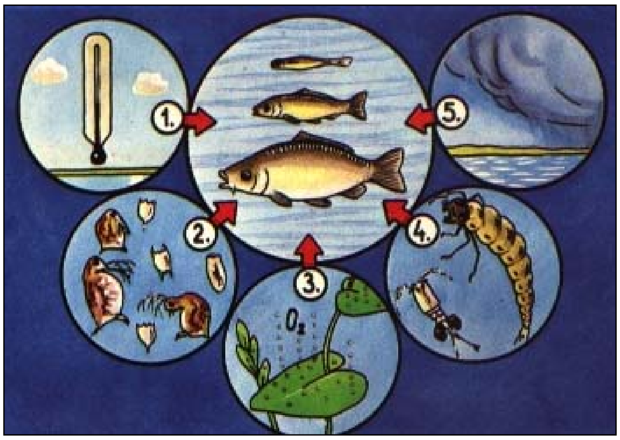


**FAO REU, Budapest, 2015**

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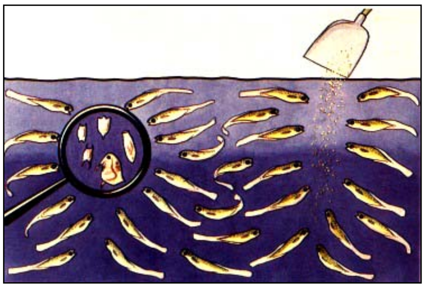
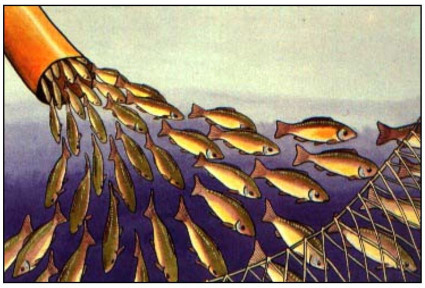






## FOREWORD

FAO has always played a leading role in the publication of practice-oriented technical papers and training materials on fisheries and fish cultures. One of the objectives of producing this huge wealth of ready-to-use technical information is to support the sustainable development of fish production all over the world.

Following these principles, two very successful, richly illustrated practical technical guides were produced in the mid-1980s on the mass production of eggs, early fry,[1] advanced fry and fingerlings of common carp.

Owing to profound political, social and economic changes, the production of fish ponds and small water reservoirs in many countries of Central and Eastern Europe (CEE) and in the Caucasus and Central Asia (CCA) has declined considerably in recent decades. In order to restart and increase carp production in these regions, hands-on training courses supported with handouts has proved useful in the practical training and self-education of concerned and interested fish farmers.

The present handout builds on fish seed production of carps, an earlier FAO publication.[2]

The original watercolour illustrations used in this publication are the work of László Horváth, father of the senior author. Although the set of these pictures is practically complete, in order to prepare an even more understandable technical reference, additional black and white illustrations of another publications, as well as tables and texts, have been inserted where sources were correctly indexed and listed under References.

**Horváth, L., Tamás, G., Coche, A.G., Kovács, E., Moth-Poulsen, T. & Woynarovich, A.** 2015. *Training manual on the advanced fry and fingerling production of carps in ponds. A handout for on-farm training workshop on fish seed production of common carp and Chinese major carps in Central and Eastern Europe, the Caucasus and Central Asia*. Second revised edition. Budapest, FAO-REU. 32 pp.

[1] Today they are called feeding larvae.

[2] Horváth, L., Jr, G. Tamás & Coche, A.G. 1985. *Common carp 2: Mass production of advanced fry and fingerlings in ponds*. FAO Train. Ser. No. 9. Rome, FAO. 83 pp. (also available at www.fao.org/docrep/X0086E/X0086E00.htm).

# 1. INTRODUCTION

Modern common carp production dates from the development of artificial propagation of carp under controlled hatchery conditions, which includes preparation of broodfish, ovulation induced by hormone injections and elimination of the stickiness of eggs as integral parts. This efficient technology has already been discussed in another handout.[1] By the application of technology presented, a great quantity of common carp feeding larvae can be produced.

To achieve better results, larvae could be raised to larger sizes. A very reliable technology has been developed on the rearing of fish larvae. This is discussed in detail in the present handout. This technology is based on a sustainable exploitation of aquatic resources and is explained on the basis of biological cycles and processes of pond life with a focus on the structure and development of zooplankton. Zooplankton is a most important natural food for growing young fish.

It is a common experience that a fish farmer skilled in the rearing of advanced fry and fingerlings of common carp will have no problem in adopting the technology to the rearing of other valuable carps of the region such as Chinese major carps, e.g. grass carp (*Ctenopharyngodon idella*), silver carp (*Hypophthalmichthys molitrix*) and bighead carp (*Aristichthys nobilis*).

Following the above-mentioned concept, this present handout was prepared as a detailed guide to advanced fry and fingerling rearing of common carp, with supplements to the rearing of Chinese major carps. Accordingly, chapters detail key aspects, data and know-how about the rearing of advanced fry and fingerlings of common carp, while the attached annex contains specific information and data for successful growing of Chinese major carps. In addition to the annex, five appendixes are also attached to the document, introducing the most frequent phytoplankton and zooplankton species found in pond water, techniques for how to count young fish, and methods for transporting advanced fry and fingerling of carps.

[1] **Horváth, L., Tamás, G., Coche, A.G., Kovács, E., Moth-Poulsen, T. & Woynarovich, A.** 2014. *Training manual on the artificial propagation of carps. A handout for on-farm training workshops on artificial propagation of common carp and Chinese major carps in Central and Eastern Europe, the Caucasus and Central Asia.* Second revised edition. Budapest, FAO-REU. 36 pp.

## 2. ADVANCED FRY PRODUCTION OF CARP IN PONDS

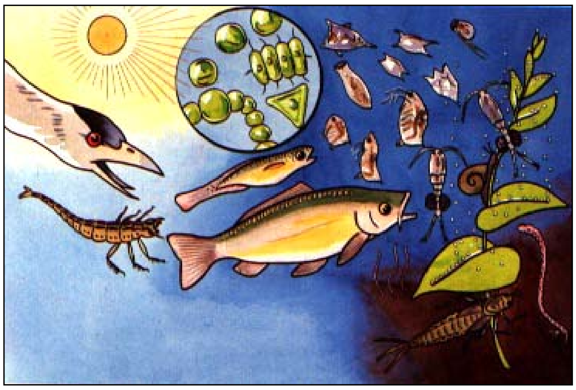
According to present knowledge, larvae of common carp can only be reared in tanks, with huge losses and in an expensive, labour-intensive way. The reason for these losses is that some of their liver enzymes are not fully functioning, and, therefore, artificial fish feeds cannot be digested sufficiently. The most appropriate diet would be live food with a high water and protein content and of a suitable size. However, collection or production of large quantities of suitable natural food is very difficult.

For the above-mentioned reason, the only profitable way to produce large quantities of advanced fry of carps is to rear them in suitable fish ponds where the pond environment itself provides the necessary quality and quantity of natural food for stocked larvae and developing fry.

In order to utilize renewable natural resources appropriately, in this case zooplankton, fish farmers should know about the essential hydrobiological processes that occur in the pond biocoenosis, as well as about techniques to control these processes in order to maximize the survival rate of fry.

### 2.1 Biology of advanced fry production

#### 2.1.1 General aspects

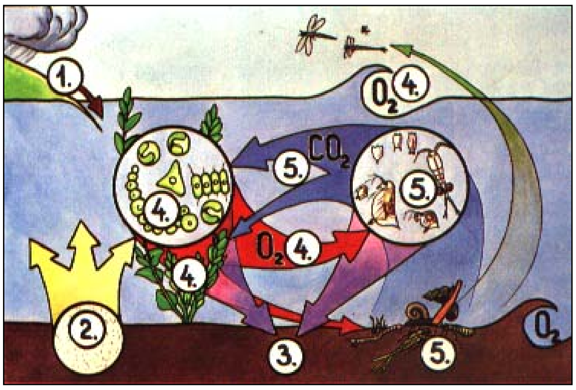


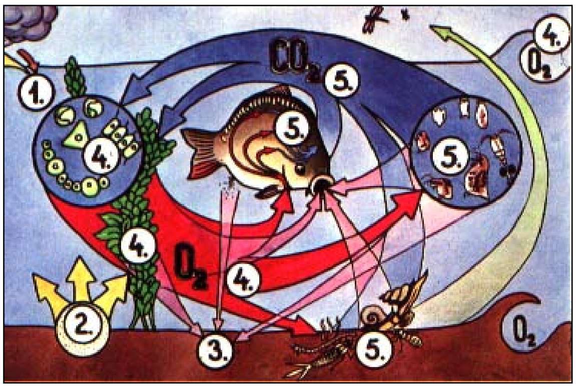
Where ponds are used for advanced fry production of carps, they become part of the biological production cycle.

Solar energy, through photosynthesis, contributes to the production of phytoplankton and higher plants.

Stocked carp larvae feed on zooplankton. From among zooplankton organisms, growing young fish always choose the size that best fits the size of their own mouth.

Predators consume small carp, and losses can be great. Copepods belonging to the subphylum of crustaceans (see *Cyclops* in Appendix 1) are dangerous because they predate on stocked feeding larvae.




As shown above, there are several factors in the biological cycle that influence results:

(1) Soil erosion washes nutrients into the water, and bacterial activity in the water column and at the bottom of the pond release additional ones.

(2) and (3) Organic matter of bottom mud, which consists of thousands of dead organisms, is partly recycled into the production system in this way.

(4) Oxygen in the water originates mostly from plant photosynthesis and absorption from the atmosphere.

(5) Carbon dioxide ($CO_2$) is the result of respiration of animals. This is utilized by phytoplankton (see Appendix 1) and other water plants. Where no advanced fry of carp are present, the volume of mud in ponds steadily increases.

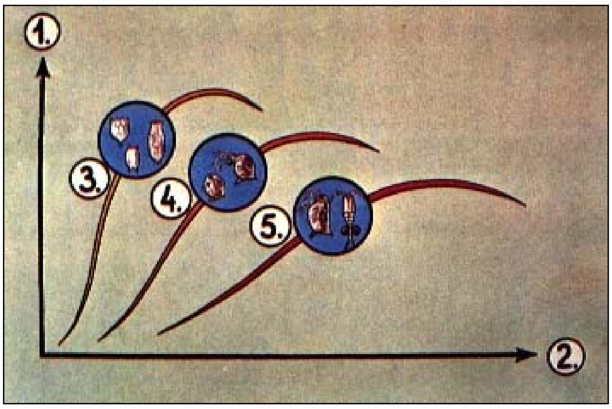
Where advanced fry of carps are present, plankton listed in Appendix 1 and other organisms in the pond are consumed, hence transformed directly or indirectly into fish flesh as shown by red arrows.

Consequently, where carp fry are reared in ponds they become part of the biological production cycle.

### 2.1.2 Specific aspects

For carp fry rearing in ponds, suitable nursery ponds are flooded with water after physical preparation.

Fish farmers are in a better position if the feeding water is poor in phytoplankton and zooplankton.

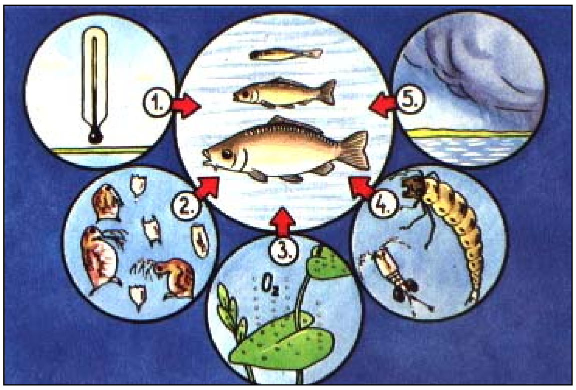



In a fish pond freshly filled with such "empty" water, smaller plankton organisms, mainly rotifers, start to develop. These are ideal as a first natural food for feeding carp larvae (see 3 in the figure). After rotifers, the number of smaller crustaceans (4) increases; these are also ideal food for growing fry. Finally, all types of larger crustaceans appear (5), which at that time are also ideal natural food for already grown fry.

In nursery ponds that receive water from a source originally rich in larger planktonic organisms, such as planktonic crustaceans, the situation is different from the one described above. As the graph above demonstrates (axis 1 indicates quantity, and axis 2 indicates time), within a few weeks after pond filling, the copepods that become dominant (5) are both too large to be the first natural food for stocked, just-feeding carp larvae and are also dangerous predators of them. For this reason, if the incoming water contains such zooplankton, the required treatment will be more complex. In this case, fish farmers have to interfere by modifying zooplankton composition in order to eliminate temporarily unsuitable planktonic organisms while advancing the growth of suitable ones See details in Appendix 2.

***Tip**: Always check the quality and zooplankton composition of source water that fills the nursery pond.*

## 2.2 Production of advanced fry




Intensive production of advanced carp fry (about 3 cm) is done in well-prepared earth ponds.

Production usually lasts for 21–30 days, during which many physical and biological (environmental) factors can influence the survival rate of advanced fry:

(1) Water temperature.

(2) Quantity and quality of natural fish food (and supplementary feeds).

(3) Oxygen.

(4) Predators.

(5) Weather conditions.

There are three distinct phases of advanced fry production:

- Preparation of nursery ponds.
- Rearing advanced fry.
- Harvesting advanced fry.

### 2.2.1 Physical and biological preparation of nursery ponds

The objective of pond preparation is to ensure optimal conditions for stocked fragile feeding larvae.

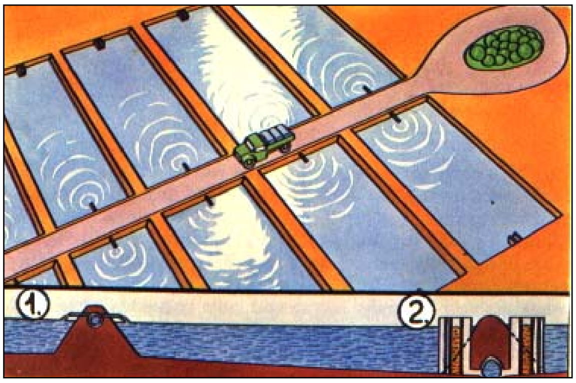
**Physical preparation of nursery ponds**

Fry rearing ponds, also called nursery ponds, are relatively small, generally varying between 0.01 and 1 ha in size with an average depth of 1 m.

(1) they should have a good water supply, a regularly sloping bottom ensuring complete drainage; and

(2) an adequate water-level controlling structure at the outlet.

Good road access to all ponds is also essential.




(A) Pond outlets can be either monks or sluices. A monk structure may be built:

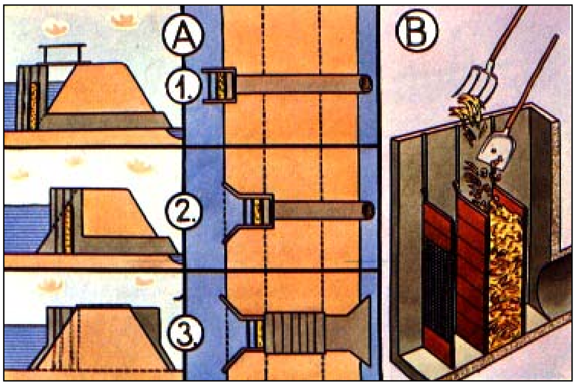
(1) in front of a dyke.

(2) as part of a dyke.

(3) a sluice structure, an "open monk" is built across the dyke and there is no need for a pipe.

(B) Water level is controlled by using two rows of planks. The space between them should be filled with organic manure swelling in the water and closing water seepage.

A screen on the top of a third row of planks prevents fish from escaping.

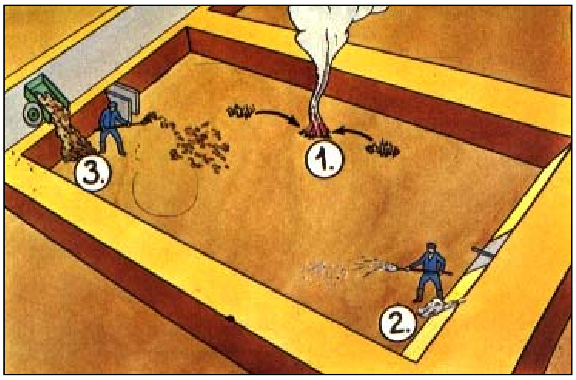



Nursery ponds should be kept dry when they are not used, and should be prepared for the new season:

(1) The dry bottom should be cleaned.

(2) Quicklime should be spread all over the pond bottom at an average rate of 150 kg/ha.

(3) Manure (organic fertilizer) should then be distributed at an average rate of about 3–5 tonnes/ha to ensure the growth of natural fish-food organisms.




**Filling of nursery ponds with water**

Nursery ponds should be freshly filled.

Care should be taken to avoid the entrance of invasive fish species such as Prussian carp, bullhead, rasbora or any age groups of other fish species.

Filtering water is done through a:

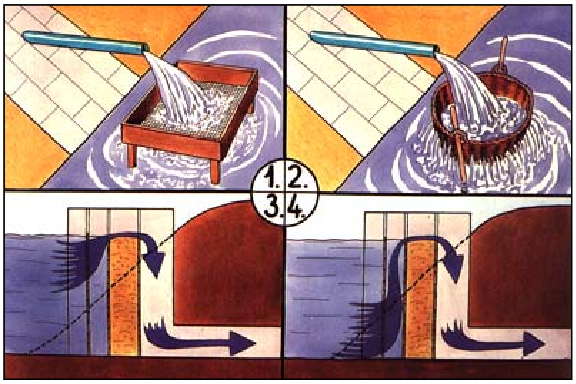
(1) frame covered with fine mesh placed into a filtering box; or

(2) a densely woven basket.

Monks with three rows of planks allow taking water:

(3) from the surface; or

(4) from the bottom.



**Fertilization of nursery ponds**

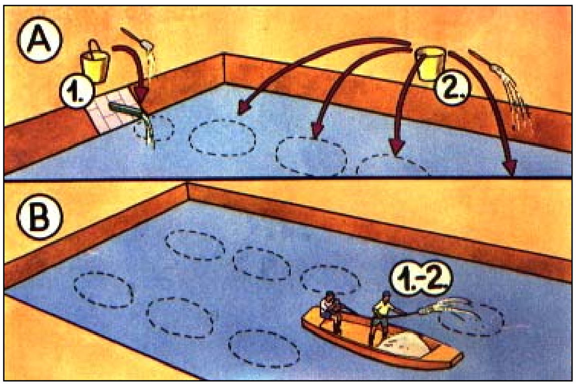
(A) In small ponds (max. 400 m²), inorganic fertilization happens from the banks.

(B) In larger ponds, it is done from a boat.

The doses are:

– 150 kg/ha ammonium nitrate (43 percent nitrate nitrogen) when the pond is half full.

- 100 kg/ha superphosphate fertilizer (18 percent active ingredient) when the pond is full. Old ponds with a high mud content do not need phosphoric fertilizer as the mud is full of precipitated phosphorus compounds.



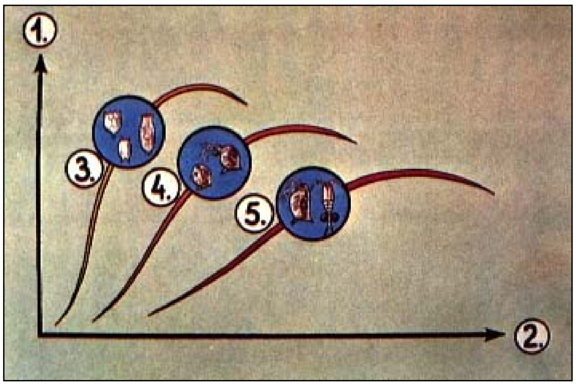

**Decision on the chemical preparation of nursery ponds**

Pond preparation will result in various groups of zooplankton. As explained earlier, relative abundance (1) and dominant groups of zooplankton vary with time (2) starting from pond filling.

(1) First, rotifer population develops.

(2) This is immediately followed by small cladocerans.

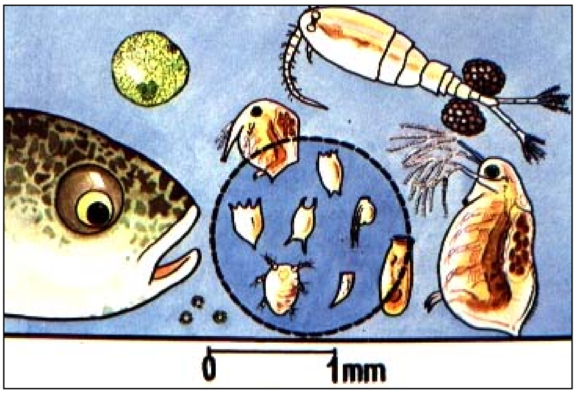
(3) Later, larger cladocerans and copepods dominate in the zooplankton.



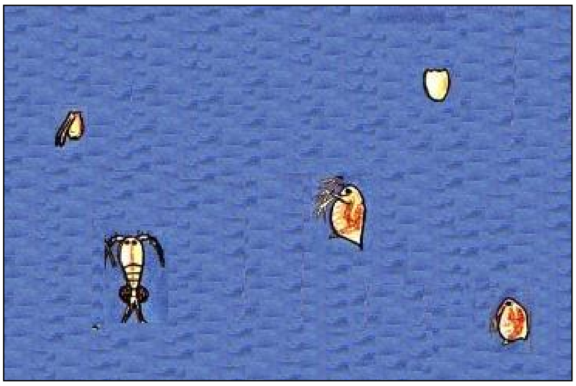

The mouth size of the developing fry determines which groups of zooplankton can be consumed.

First, rotifers and, later, larger members of the zooplankton are consumed.

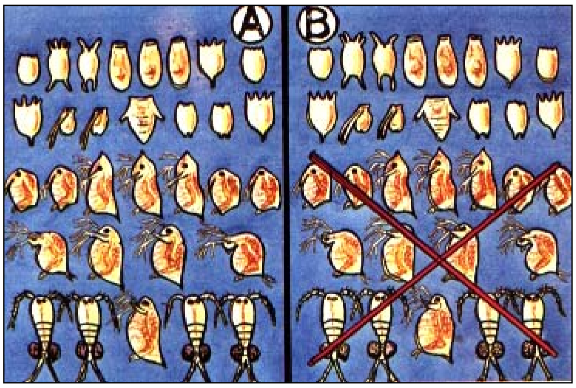
For the above-mentioned reason, the objective of a biological preparation of nursery ponds is to ensure a dense population of those members of zooplankton that are most suitable as a first natural food for stocked feeding larvae.




There are two options:



First option: If the source water is poor in zooplankton, a quick flooding and fertilization of the already cleaned nursery pond is enough, as explained above.



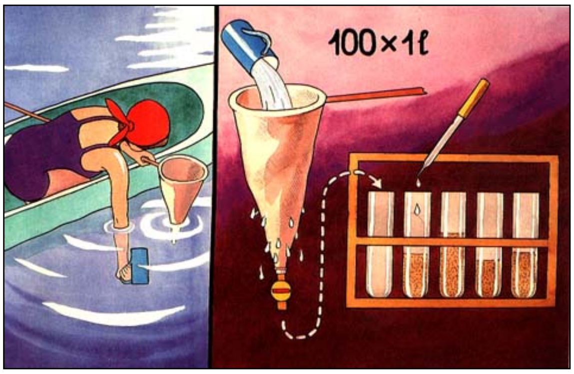

Second option: Where the water source is full of planktonic crustaceans, chemical treatment will be needed after the fertilization of pond water.

*Tip:* *Always check the quality and zooplankton content of the source water that fills the nursery pond.* ***For a proper completion of chemical pond water preparation, Appendix 2 provides a detailed guide****.*

After filling, fertilization and chemical preparation of a nursery pond, it is important to check the quality and quantity of zooplankton. It should be done as follows:

- 100 litres of pond water should be screened through a 120–180 micron mesh-size plankton net.
- The sample should be sedimented by adding 1–2 drops of formalin to it.

The result is satisfactory when the zooplankton (mainly rotifers) is about 2–3 ml/100 litres of pond water.




### 2.2.2 Stocking of feeding larvae

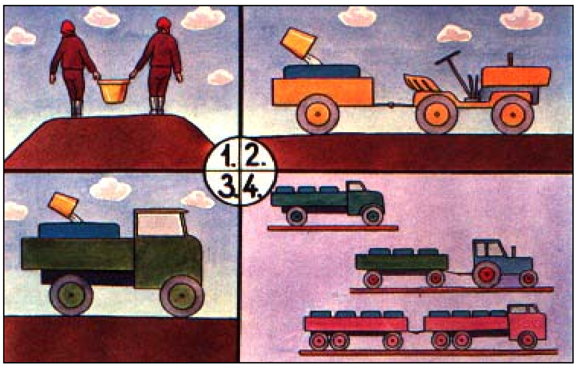
When the pond water is ready and full of rotifers, the feeding larvae can be transported from hatchery to the ponds by various means:

(1) Close to the hatchery, a 30 litre plastic container serves well for the purpose.

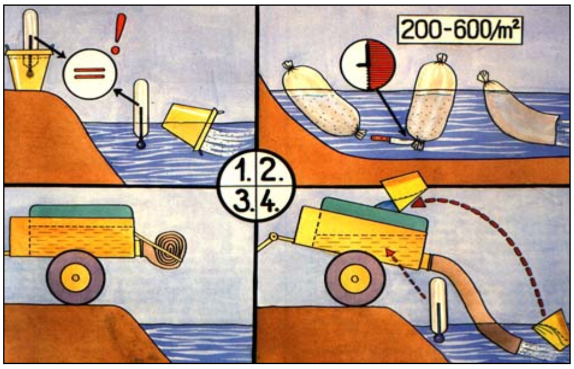
(2) For longer distances, a small tractor/trailer.

(3) Small trucks.

(4) Lorries are used, equipped with oxygen supply.



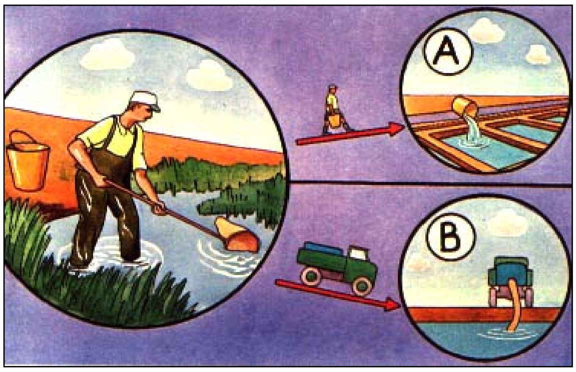

(1) To avoid heat shock, it is necessary to ensure that the water temperature in the transport containers does not differ by more than 1–2 °C from that of the pond water. To equalize the temperature, pond water should gradually be added to the transport water.




***Tip:*** *In order to increase the population of plankton crustaceans in advanced fry rearing ponds, they should be inoculated with zooplankton collected from another pond. It should be done as follows:*

*About 4–5 days after stocking feeding larvae into a rearing pond, plankton crustaceans should be collected from other ponds with a zooplankton net and transported either in buckets or in a tank.*

*(A) In small nursery ponds (100–400 m²), a living biomass of about 100–200 ml (one full bucket of dense zooplankton population) is required.*




*(B) In larger nursery ponds, about 1 000 ml (4–5 buckets of dense zooplankton population) is required.*

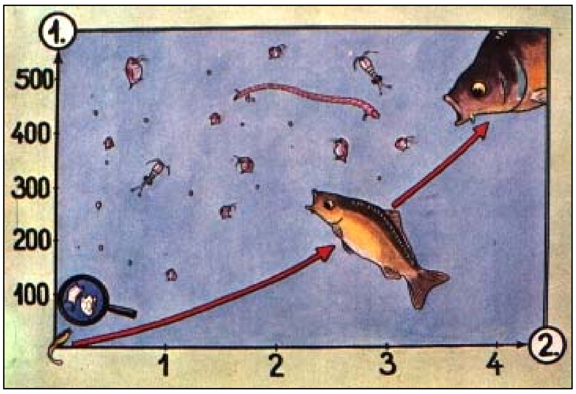
*This zooplankton will rapidly reproduce and boost the resident population in well-fertilized ponds.*

### 2.2.3 Feeding of advanced fry

Soon after stocking, feeding larvae start to feed on rotifers and other types of zooplankton of a suitable size.

The fish grow fast, and their survival rate is high.

As they grow, they progressively require larger prey to feed on.

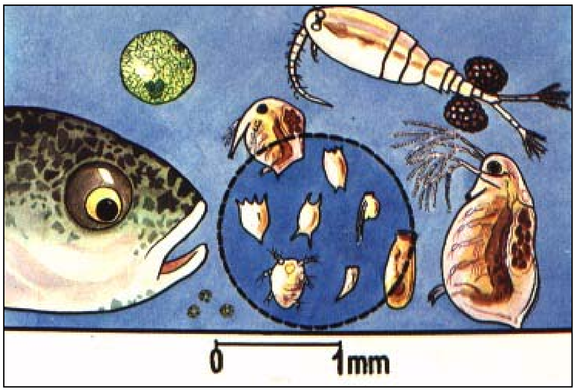



Three main feeding phases may be defined when rearing advanced fry in ponds.

**First feeding phase**:

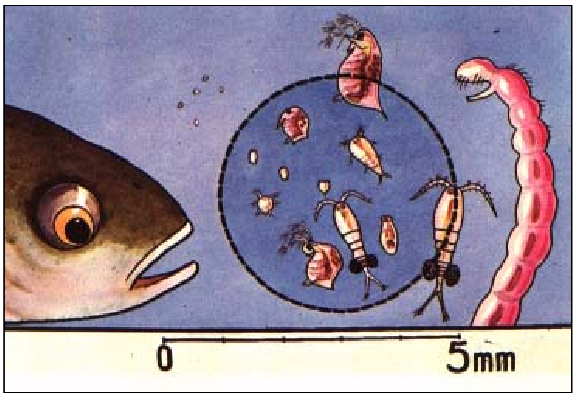
In the first ten days after stocking, feeding larvae will preferably feed on rotifers.

By the end of this period, the individual size of rotifers becomes too small to fully satisfy the needs of the growing fish.




**Second feeding phase**:

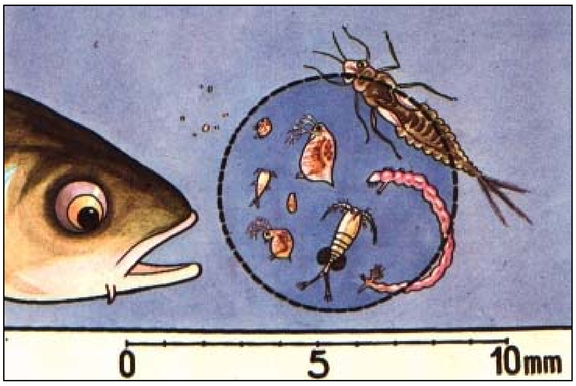
From about the tenth to the twentieth day, the best food for carp fry consists of small planktonic crustaceans.




**Third feeding phase:**

In the last 5–10 days, fry feed on different planktonic crustaceans.

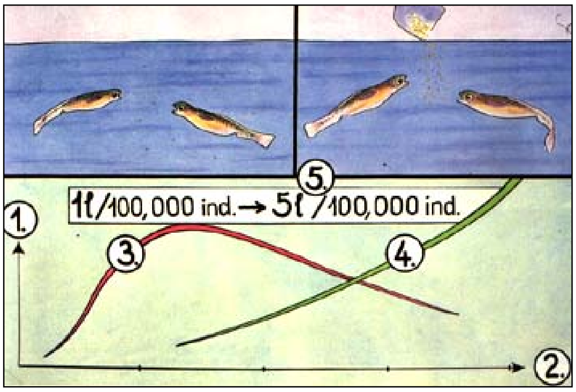
They are also able to consume small larvae of insects such as chironomids and mayflies.




In addition to the very important natural food, it is also necessary to provide energy-rich feed (artificial food) to developing fry in order to ensure the best possible growth and survival rates.

Quantity and importance of natural and supplementary food are shown in the next graph.

(1) Quantity.
(2) Time.
(3) In the first period, only natural food is consumed, reaching its peak about ten days after stocking. However, artificial feeding should already be started in this period to confirm time for fry to accustom to the presence and flavour of the feed, which is not wasted as zooplankton can also utilize it.
(4) Consumption of artificial feed is gradually increasing.
(5) Consequently, it is also necessary to increase the quantity of this feed.



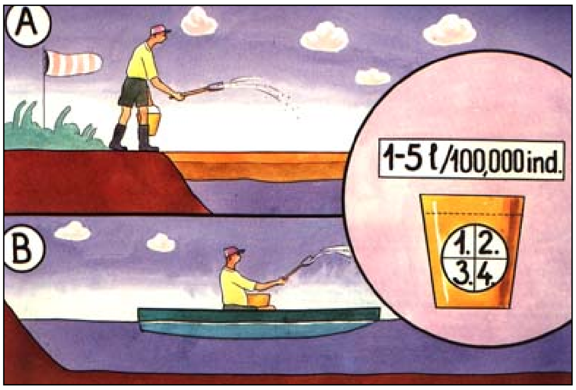

A simple but good fry feed consists of a mixture of soybean meal (1), wheatmeal (2), fishmeal (3) and blood (or meat) meal (4) in a 1:1 ratio.

It should be a very fine dry powder made up of particles that are 0.1–0.2 mm.

At first, it should be distributed at a daily rate of 1 litre/100 000 fry, which should gradually be increased to 5 litres/100 000 fry.

The daily share of feed could be released in one amount in the morning, or preferably be divided into small portions delivered several times a day.

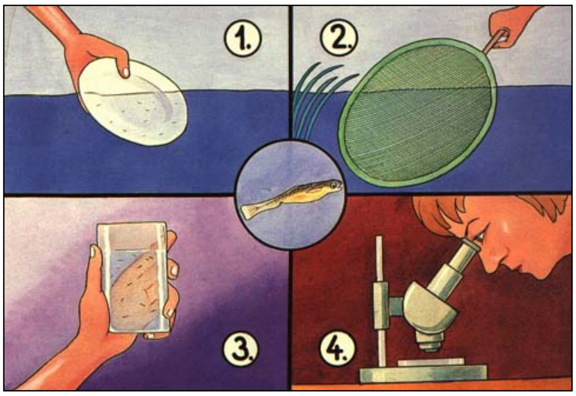
In the first few days, powderized feed should be mixed with water before it is distributed. Later, the distribution of dry powder will already be enough.



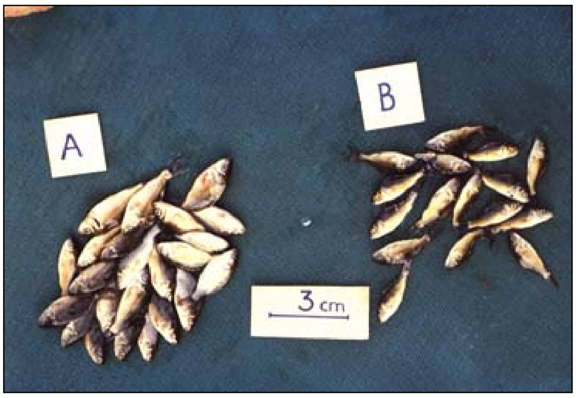

### 2.2.4 Checking growth and health of growing advanced fry

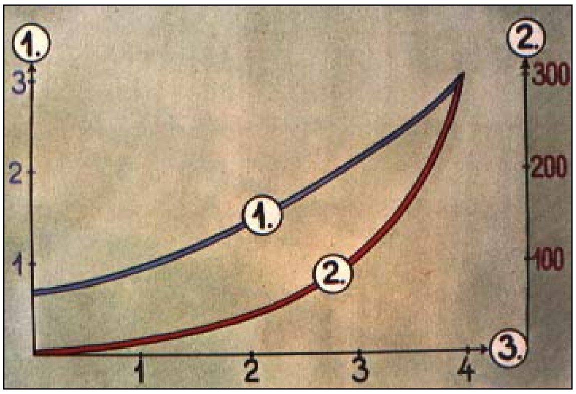
Growth, survival rate and health of growing fry should be checked regularly.

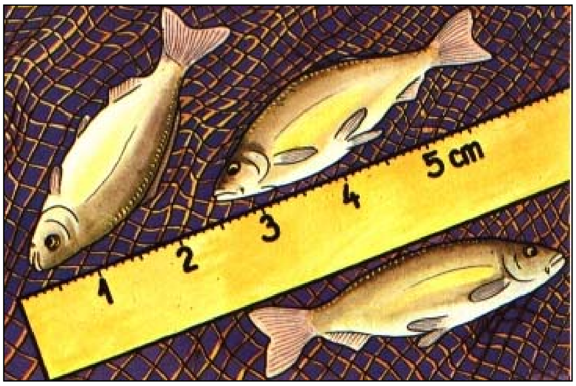
(1) Fry can be observed directly in the pond using a white plate as background.
(2) They may also be fished along banks and in grassy areas with a fine-mesh dip net.
(3) Swimming behaviour together with their general conditions can be observed in a glass.
(4) Presence of ectoparasites can be detected with a binocular microscope.




| Criteria | | of **good** (A) | and **bad** (B) fry: |
|---|---|---|---|
| Body shape: | | deep, plump | slender, big head |
| Colour | Belly: | deep yellow | yellowish |
| | Back: | greyish green | dark |
| | Tail: | bright, shiny | dull |
| Tail movement: | | very rapid and hardly visible | slow and easily visible |





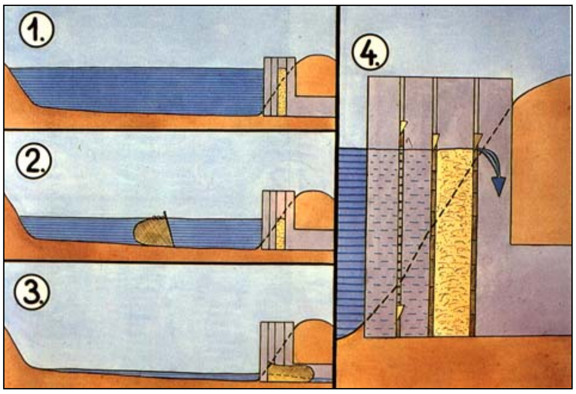

The growth of fry in length (1) and weight (2) varies according to environmental conditions.

(1) Total length of fry should not be less than 2.5–3 cm.

(2) Live weight should be about 0.2–0.3 g by the end of the rearing period.

(3) Survival rates during these 25–30 days usually vary between 30 and 60 percent.

### 2.2.5 Harvesting of advanced fry



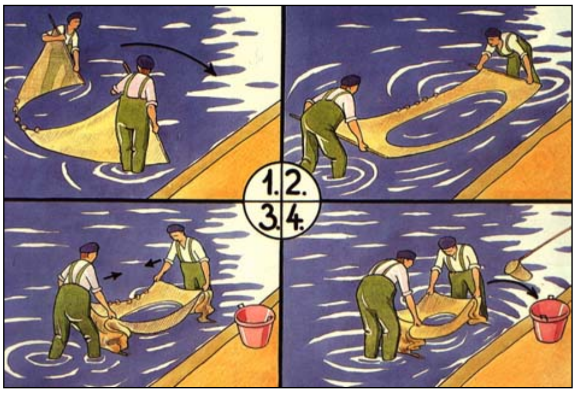

At harvest:

(1) The water level should slowly be reduced.

(2) In half-drained ponds, fishing starts with a fine-mesh seine net.

(3) When most fry have been removed, the water depth is further reduced and fish are trapped at the outlet.

(4) During the operation, a long fine-mesh screen is slid into the outlet structure. At the end of the harvest, this screen is replaced by a trap.

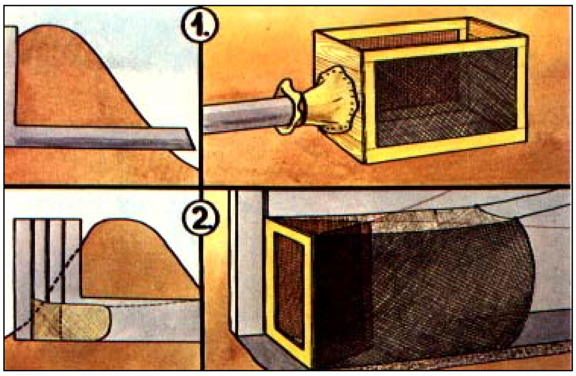



Fishing with a seine net is done along pond banks.

Depending on the average size of the fry, the mesh size of the seine net should be:

- 2 mm for 2 cm long fry; or
- 4 mm for 3 cm long fry.

In both cases, the fishnet is generally made of a nylon curtain material. Seine nets are usually 10–20 m long, depending on the size of the pond, and about 2 m high.



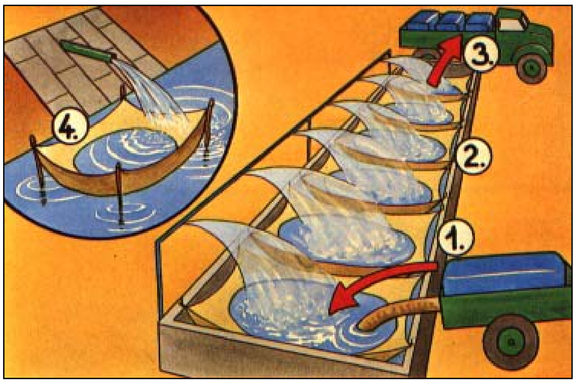

Fixed traps can be of two types:

(1) A wooden frame covered with a fine-mesh net on two of its sides is directly attached to the draining pipe with a flexible joint.

(2) A V-shaped net trap mounted on a wooden frame is slid into the outlet structure and held open by stretched lines.

In both cases, fry should constantly be removed from the trap with a dip net.

Advanced fry should be transferred from ponds to storage nets to be sorted and counted before they are further transported.




Holding nets (e.g. 2 × 1 × 0.8 m) are made of fine-mesh (2–4 mm) textiles, such as nylon curtain material. A light frame placed into each net keeps the bottom part down.

(1) – (3) Advanced fry are stored here without feeding for a maximum of 24 hours, because fish with full digestive tracts must not be transported.

(4) A similar system can be built in a corner of a pond.

## 3. FINGERLING PRODUCTION OF CARP IN PONDS

This chapter deals with fingerling rearing and wintering of carps in ponds where the objectives are:

- To grow advanced carp fry to fingerling size of about 10–40 g. In temperate climates, this generally takes about 3–4 months, from July to October. In comparison with advanced fry rearing, survival rates are much higher while growing fish require less protection and a larger habitat.
- Keeping produced fish healthy during cold winter months. In temperate climates, the overwintering season starts when the water temperature sinks to below 10 °C and lasts for about five months until the following spring.

### 3.1 Influencing environmental factors

Similarly to rearing advanced fry, carp fingerlings are also reared in earth ponds where they are also part of the biological production cycle. The main environmental factors influencing production are:

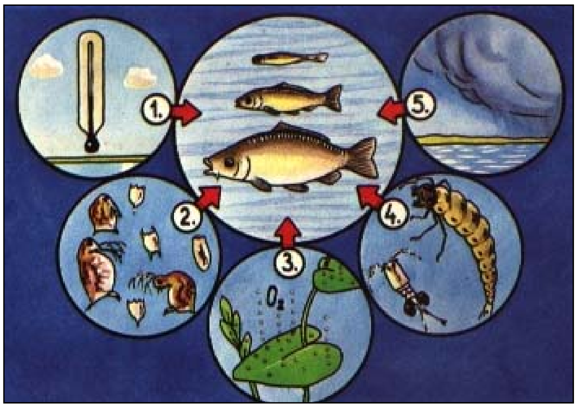
(1) Adequate water temperature.

(2) Availability of natural food.

(3) Dissolved oxygen content (5–8 mg/litre) of water.

(4) Number of predators (e.g. snails, insect larvae, larger fish, frogs, snakes, birds).

(5) Weather conditions are less important.

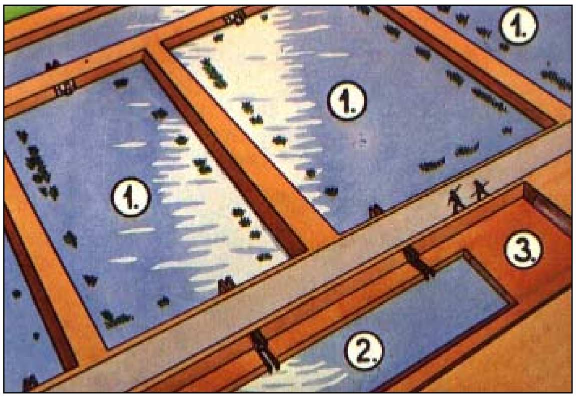


### 3.2 Pond preparation and stocking

(1) The size of fingerling ponds varies from 1 to 10 ha (average water depth: 1–1.5 m).

(2) Usually, a monk is the outlet structure of these ponds; it often connects the pond to a common fishing canal.

(3) Next to the harvesting area, a working platform with road access helps in the handling (e.g. sorting, weighing) of harvested fish.



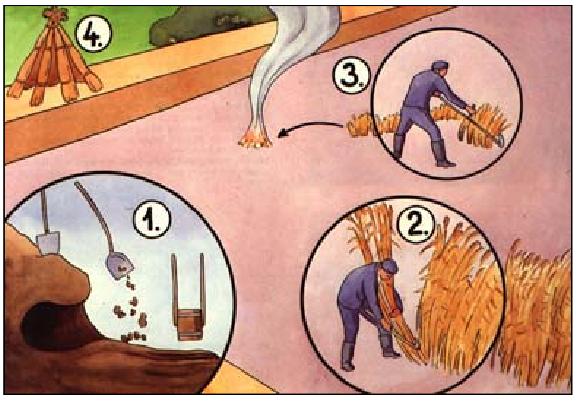
Ponds should be kept dry during winter. In early spring:

(1) Repair ponds.

(2) Cut dry permanent vegetation short.

(3) Cut/remove unwanted vegetation.

(4) Prepare valuable reed (*Phragmites communis*) for sale.



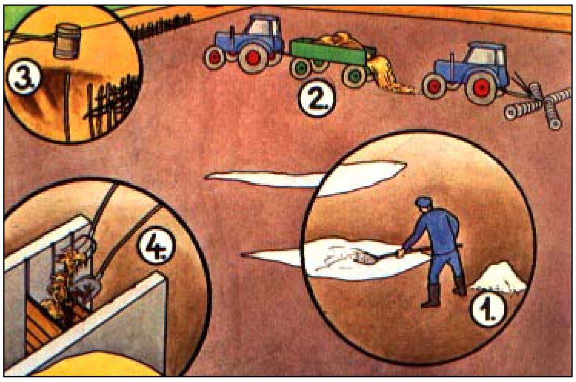
About 10–14 days before stocking, it is time to prepare the pond. Before filling with water:

(1) Wet parts of pond bottom should be limed (150 kg/ha).

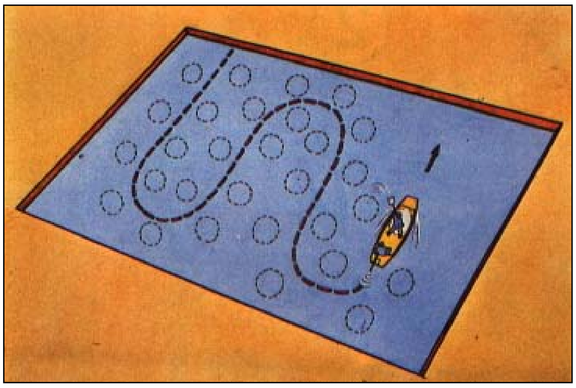
(2) Organic fertilizers, such as pig, chicken, cattle or horse manure, should be spread over the entire bottom (2–3 tonnes/ha). Then disc harrow if possible.

(3) Protect bank with woven branches.

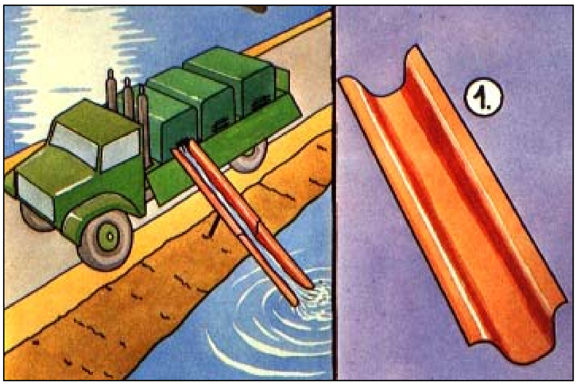
(4) Water outlet should be sealed.




Inorganic fertilizers should be applied when the pond is completely filled. About 100 kg/ha of superphosphate and 150 kg/ha of ammonium nitrate should be evenly distributed from a boat.



The water temperature of transporting containers must be adjusted to the temperature of the pond water within a maximum range of 2–3 °C. Carps should be stocked in polyculture with stocking rates as presented in Appendix 3.




## 3.3 Tasks during the rearing period

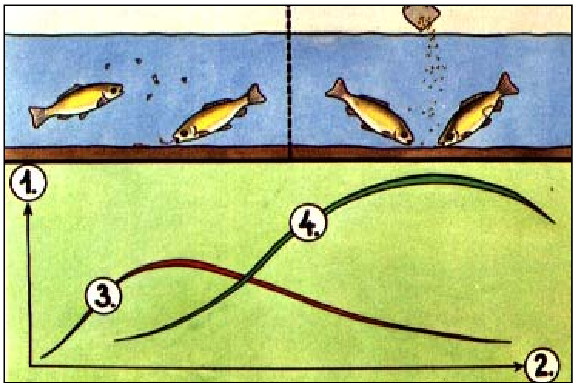
### 3.3.1 Feeding

The feeding regime of advanced fry changes as they grow larger. Hence, important factors to consider are:

(1) Amount of feed consumed.

(2) Time.

(3) Abundance of larger zooplankton and other kinds of natural food (chironomids). Therefore, it is advisable to use manure and fertilizer to increase natural fish food production. If the pond is old and its bottom is covered with thick mud, it is enough to stir it up to recover phosphoric compounds.




The quantity of feed should be increased as fish grow. If ground grains are fed, they should be soaked for one day before using them. Pelleted feeds should not be soaked.

(A) At a lower density (50 000 fish/ha), the diet of advanced fry consists of

(1) Feed (ground wheat). Feed should be given at a maximum daily rate of 10 percent BW.

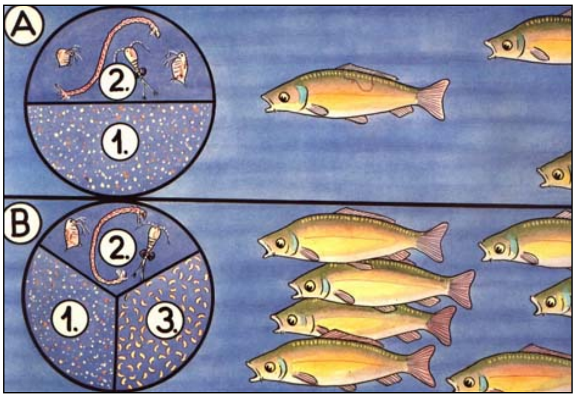
(2) Natural food.

(B) At a higher density (100 000 fry/ha or more), the diet of advanced fry consists of

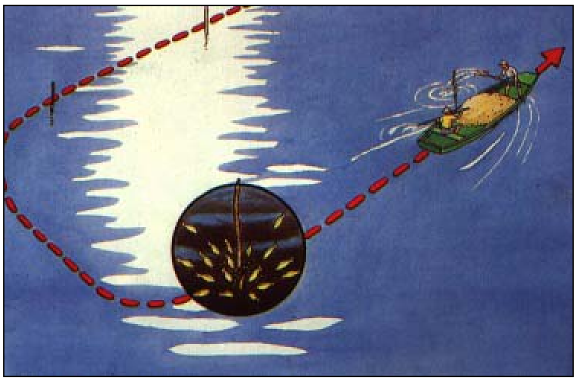
(1) Ground wheat distributed at a daily rate of 10 percent BW.

(2) Natural food and two kinds of artificial feed in about equal proportions.

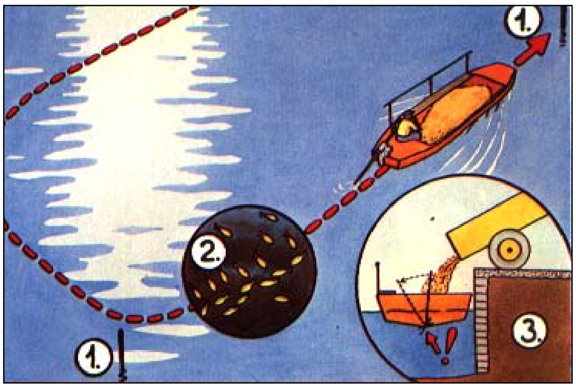
(3) Balanced feed, preferably in pelleted form (30 percent of protein[1]), should also be given at a daily rate of 5–10 percent BW.




Feed is distributed daily from a boat at fixed feeding spots marked by wooden poles or floats. About 5–7 feeding spots should be marked in each hectare of a fingerling rearing pond.



On large ponds, special motorized feeding boats are used from which the feed is washed out through a bottom slot. In such cases, only the route of the boat is marked.

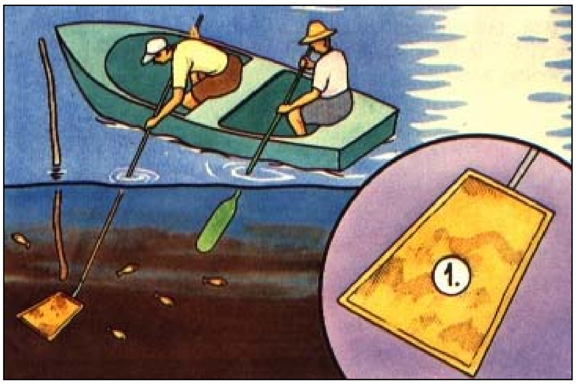



The daily ratio of feed should be adjusted to the appetite of the fish. Therefore, feed consumption must regularly be checked (1) using a light fine-mesh metal netting.

About 2–3 hours after morning feeding, some of the feeding spots should be checked. If there is no feed left, the daily ratio has to be slightly increased.

If a lot of feed remains, a second check after 5–6 hours is advisable. If feed is still found, reduce the daily portion.

If feed consumption reduces or stops, possible reasons should be identified.




[1] Half of it should be protein of animal origin.

Fish samples should also be examined to determine the feeding regime.

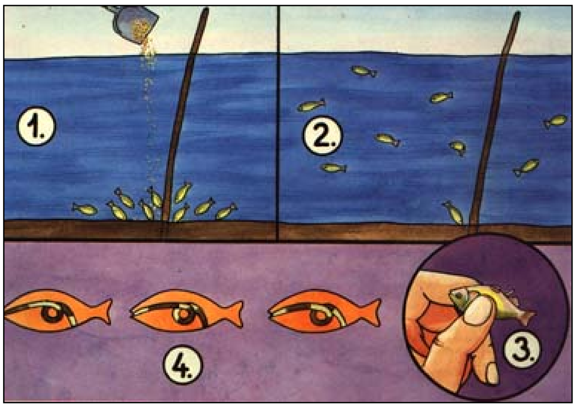
(1) After feeding, carp consume distributed feed.

(2) Later, fish collect natural food.

(3) A gentle press on the abdomen of fish will help to estimate the proportion of supplied and natural foods consumed. This is because:

(4) Colour shows which type of food was consumed. Faeces of natural food origin are dark while those of supplied origin are greyish/white.

Adjust feeding of fish accordingly.




### 3.3.2 Water management

In the production period, ponds should always be fully filled with water.

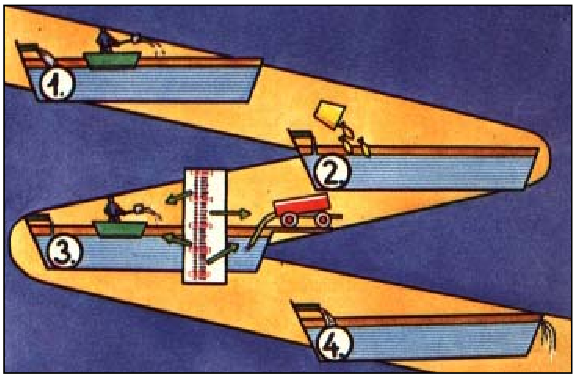
(1) Pond preparation.

(2) Stocking of fish.

(3) Every two weeks, pond water should be fertilized with, for example:

- 10 m³/ha of liquid pig manure or equivalent.
- 20–30 kg/ha of superphosphate
- 20–30 kg/ha of ammonium nitrate

(4) Towards the end of the rearing period, partial or continuous water exchange may become necessary.




## 3.4 Follow-up on growth and health of fish

### 3.4.1 Follow-up on fish growth

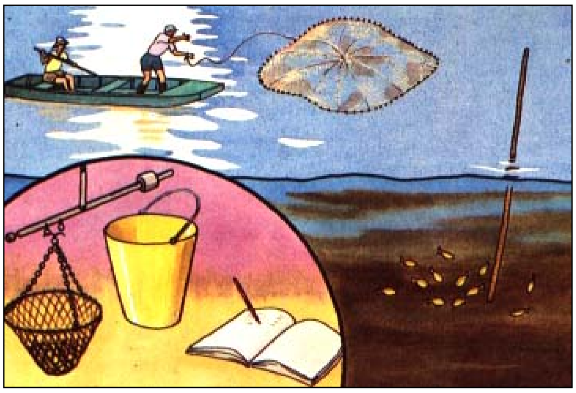
About a few hundred fish per pond should be sampled every 2–3 weeks.

On the basis of the quantity supplied, the feed conversion rate (FCR) can be calculated and so the efficiency of production evaluated.

It is good if the FCR remains below 3.5–4.

If it is higher, the reasons should be determined.

The following example shows how to evaluate the



production efficiency in a fingerling pond for a specific two-week period:

Number of fish: 100 000/ha

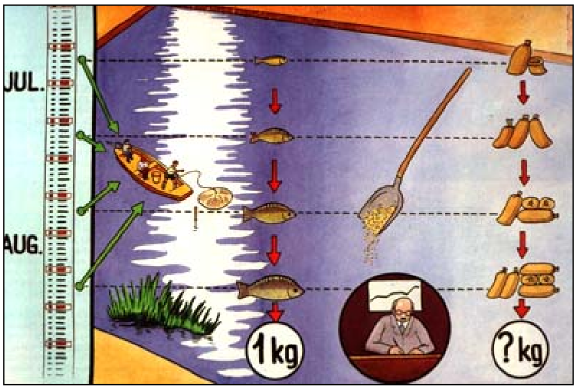
Start: average weight 1 g/fish

End: average weight 2 g/fish

Gained weight: 100 kg/2 weeks

Feed given: 210 kg[2]

FCR: 2.1, which is a good result.




### 3.4.2 Follow-up on fish health

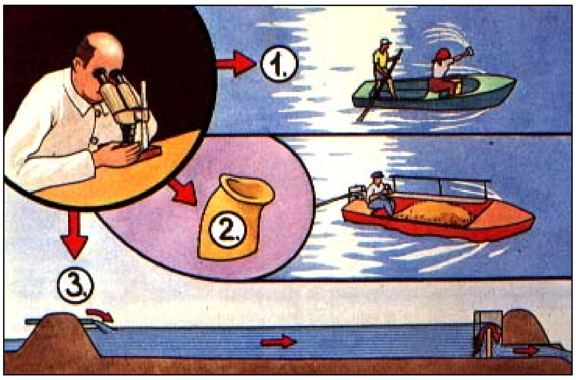
Health aspects of sampled fish should be examined under a binocular microscope. This is best done by a veterinarian or a biologist.

If necessary, therapeutic treatments are applied:

(1) Chemical treatment of pond water.

(2) Distribution of medicated feed.

(3) In simpler cases, increased water exchange in the pond may be sufficient.




During fingerling rearing, the most common diseases are:

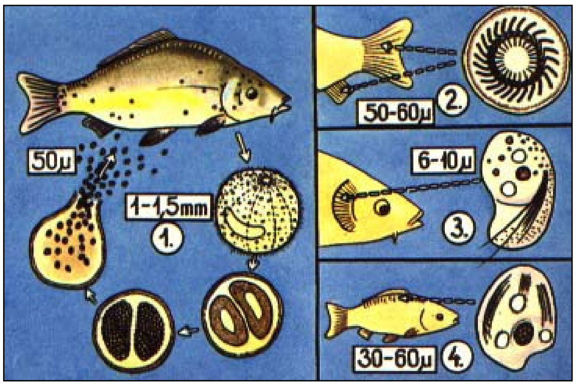
(1) White spot disease or "ich" (*Ichthyophthirius multifiliis*). It is a monocellular ectoparasite.

(2) *Trichodina* on fins.

(3) *Costia* on gills.

(4) *Chilodonella* on gills and fins.

Against the last three parasites, ponds should be treated with copper oxychloride, where it is an approved chemical. Its final concentration in the pond should not be higher than 4 ppm.




Other ectoparasites can also cause great damage:

(1) *Argulus foliaceus*.

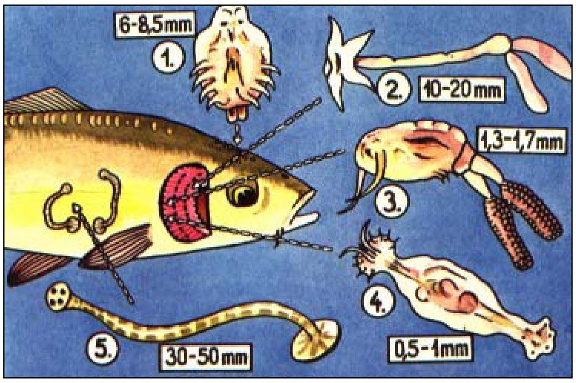
(2) *Lernaea cyprinacea*.

(3) *Ergasilus sieboldi*.

(4) *Dactylogyrus vastator*

Against these parasites, the pond should be treated with an approved and previously tested agricultural insecticide in a final concentration of 0.2–1 ppm (0.2–1 g/m³).

(5) Leeches (*Piscicola geometra*)



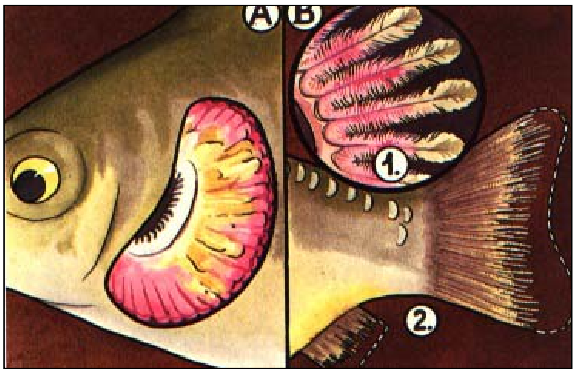

[2] During the entire period (2 weeks) 15 percent BW/day a total of 15 kg × 14 days = 210 kg was fed. This 210 kg of feed produced 100 kg weight gain, therefore the FCR was 210 kg : 100 kg = 2.1.

Occasionally, serious fish diseases may develop in fingerling ponds. In such cases, the advice of a veterinarian becomes necessary.

Examples are:

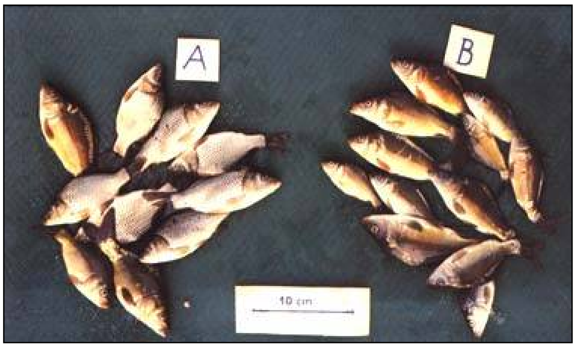
(A) Gill rot and gill necrosis are caused by a combined action of fungi and bacteria. They develop when pond conditions deteriorate.

(B) Gill infection (1) and fin rot (2) are bacterial diseases.




Criteria of good quality fingerlings are:

| Parameters | | of **good** (A) fry | and **bad** (B) fry |
|---|---|---|---|
| | **Body shape:** | deep, plump | slender, big head |
| **Colour** | **Belly:** | deep yellow | yellowish |
| | **Back:** | greyish green | dark |
| | **Tail:** | bright, shiny | dull |
| | **Tail movement:** | very rapid and hardly visible | slow and easily visible |




## 3.5 Harvesting and sorting of fingerlings

By the end of a rearing period, which lasts for 3–4 months, advanced carp fry have grown to fingerling size.

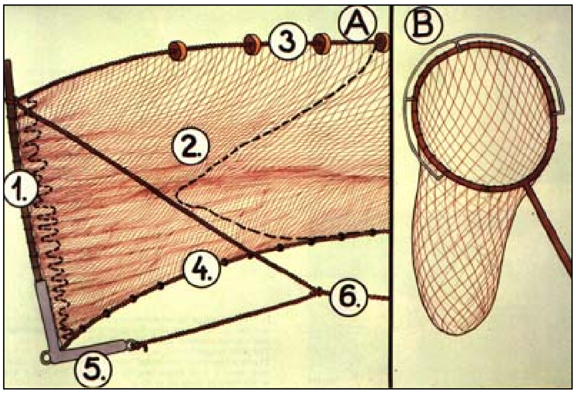
The expectable survival rate is about 70–80 percent.

Carp fingerlings, also called “yearlings” in temperate countries, have a total length ranging from 8 to 12 cm and a live weight varying from 10 to 40 g.

(A) Fingerlings are harvested with large seine nets that are 20–30 m long and 2.5 m high. Their 10–15 mm mesh netting (2) is attached to a 1.5 m long wooden pole (1) with float and weight lines on the top and bottom (3 and 4).

Two corners are reinforced with steel tubing, and the poles are pulled with strong ropes (5 and 6).

(B) During harvest, double-framed dip nets of about 30 cm diameter are also used.



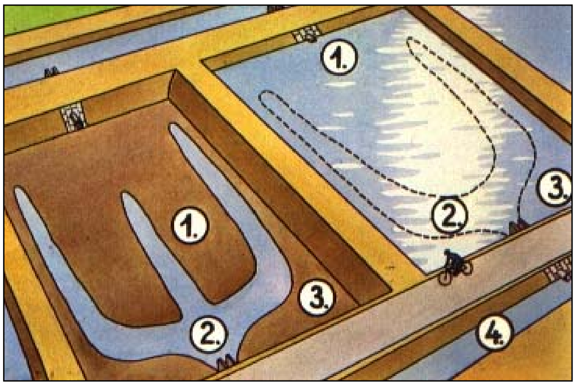
Before harvest:

(1) The water is partly (about half) drained.

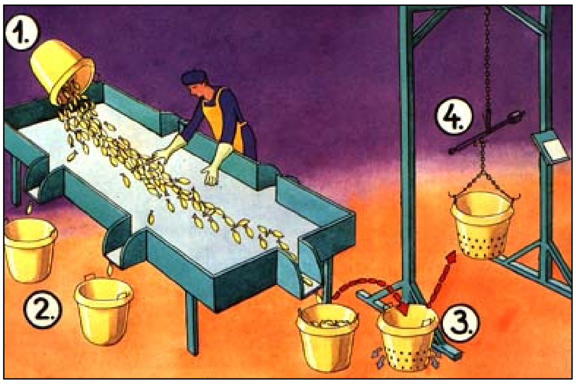
(2) Therefore, water and fish both concentrate in deeper parts of the pond (known as fish beds).

(3) These areas are fished with seine nets towards harvesting areas.

(4) Water drains out of the pond into a draining canal.

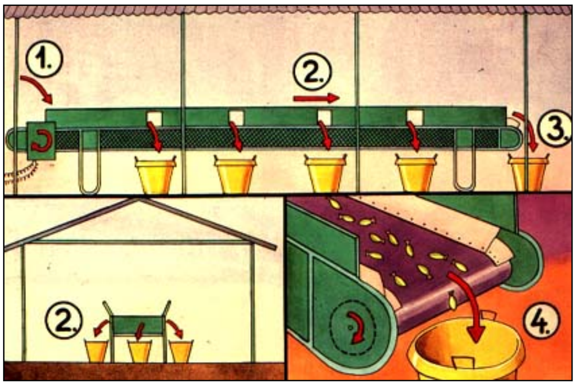



Harvested fingerlings are sorted by size and, if necessary, by species. (1) Fish are poured onto a sorting table. (2) Different species and sizes are sorted into different 50 litre containers. Live fish are kept in water until they are transferred.




For sorting large quantities of fish, a rubber conveyor belt moving horizontally can be used.

During transport to wintering ponds, approved and tested chemicals may be used against ectoparasites.




For the sake of precise calculations and analysis of the results of fingerling production, fish farmers should know and use the following terms:

- Gross yield: Total weight of harvested fish.
- Net yield: Total yield minus total weight of stocked fish, or the sum of natural and feeding yields.
- Feeding yield: It is that part of the net yield that derives from applied feed. Accordingly, it is the total weight of used feed divided by 3.5. This is a practical figure that indicates the FCR of such feeds under pond rearing of this age group of common carp.
- Natural yield: It is that part of the net yield that derives from the natural food consumed by fish. Consequently, it is the total net yield minus the feeding yield.

## 4. WINTERING OF FINGERLINGS

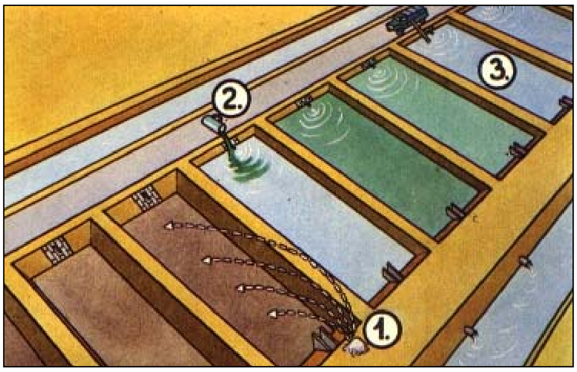
In a temperate climate, the wintering season starts when the water temperature sinks to below 10 °C. During winter, fish are stored in special small (600–1 000 m²) but deep (2 m) wintering ponds.

Preparation of wintering ponds:

(1) The bottom should be treated with lime (200 kg/ha)

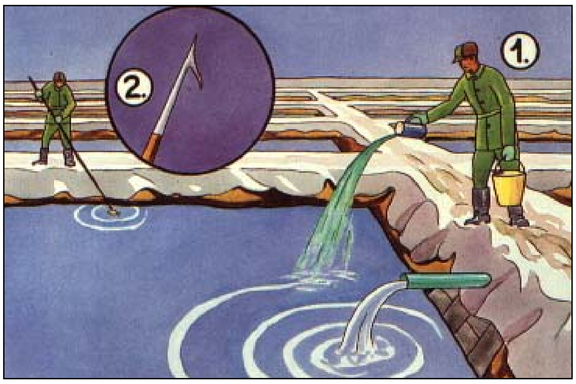
(2) The water should be treated with approved and tested chemicals for disinfection.

(3) After the chemicals used have been progressively washed out, fingerlings can be stocked (100 kg/10 litres/min water inflow).




In a pond 2 m deep with a surface of 1 000 m² that receives 600 litres of water per minute through an inlet pipe of 20 cm, a maximum of 6 tonnes of fingerlings can be overwintered (an average of 3 kg fingerlings/m³).

As common carp consume very little food below 10 °C, and practically stop feeding at 7 °C, still fingerling are still fed once a week in order to reduce weight loss during winter. The usual weekly quantity of good-quality fish feed is about 0.3–0.5 percent of the weight of the stored fingerlings.




(1) Every week, approved and tested chemicals should be used to prevent diseases.

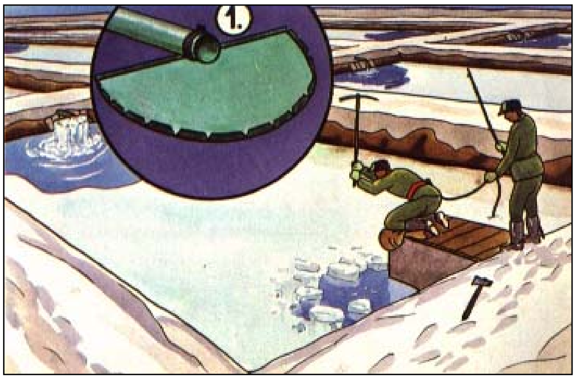
(2) Every day, dead fish must be removed either with a scoop net or with a grappling hook.

Also every week, fish should be sampled using a casting net in order to follow up on their health.

Ectoparasitic infections predominate in warmer waters, while bacterial and viral diseases are particularly common in cold waters.

Viral diseases usually develop in early spring. Therefore, fish feed enriched with multivitamins should be given one week before stocking, in a quantity of about 0.3–0.5 percent of actual body weight.

When the wintering pond is frozen, ice should be removed from around the monk. (1) A plate is fixed under the water inflow to increase oxygenation of water.



Predatory water birds such as gulls, herons and cormorants should be scared away to prevent losses of fingerlings.

## LIST OF REFERENCES

During the preparation of this handout[1] on artificial propagation of carps, an earlier FAO training material published in 1985 was updated and adopted to the needs and conditions of fish seed production of today. This publication is:

**Horváth, L. Jr, Tamás, G. & Coche, A.G.** 1985. *Common carp 2: Mass production of advanced fry and fingerlings in ponds*. FAO Train. Ser. No. 9. Rome, FAO. 83 pp. (also available at www.fao.org/docrep/X0086E/X0086E00.htm).

Other publications referred to are those listed below:

**Antalfi, A & Tölg, I.** 1971. *Halászati ABC*. Budapest, Mezőgazdasági Kiadó. 218 pp.

**Horváth, L. & Pékh, G.** 1984. *Haltenyésztés Tógazdasági halászmesterek könyve*. Budapest, Mezőgazdasági Kiadó. 175 pp.

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**Horváth, L., Tamás, G. & Tölg, I.** 1984. *Special method in pond fish husbandry*. Budapest, Akadémia Kiadó, and Seattle, USA, Halver Corporation. 147 pp.

**Woynarovich, A. & Woynarovich, E.** 1998. *Reproducción artificial de las especies colossoma y piaractus, una guia detallada para la produccion de alevinos de gamitana, paco y craña*. Lima, Fondo National de Desarrallo Pesquero – FONDEPES. 67 pp.

**Woynarovich, A., Moth-Poulsen, T. & Péteri, A.** 2010. *Carp polyculture in Central and Eastern Europe, the Caucasus and Central Asia: a manual*. Chapters 3, 4 and 7.2. FAO Fisheries and Aquaculture Technical Paper No. 554. Rome, FAO. 73 pp. (also available at www.fao.org/docrep/013/i1794e/i1794e.pdf).

**Woynarovich, A., Bueno, P.B., Altan, Ö., Jeney, Z., Reantaso, M., Xinhua, Y. & Van Anrooy, R.** 2011. *Better management practices for carp production in Central and Eastern Europe, the Caucasus and Central Asia*. FAO Fisheries and Aquaculture Technical Paper No. 566. Ankara, FAO. 153 pp. (also available at ftp://ftp.fao.org/FI/DOCUMENT/t566_advanced/CACFish_I_2011_Ref5.pdf).

[1] Earlier versions of this handout had already been used and tested in Georgia (2011) and Albania (2012), where it was shown in practice that such training materials translated into national languages are very useful.

## COMPARATIVE NOTES ON ADVANCED FRY AND FINGERLING REARING OF CARPS

### Advanced fry rearing

The objective of advanced fry rearing is to produce 2–4 cm large (0.2–1.5 g) one-month-old fish. Advanced fry rearing of Chinese major carps is done in exactly the same way as described for common carp in Chapter 2.

Preparation of nursery ponds:

- The pond bottom must be kept dry during winter, and cleaned and tilled before use.
- Immediately before use, the pond bottom and underwater slopes of dykes should be disinfected with lime. Recommended quantities are described in Table A1-1.
- Water productivity should be increased with manure and fertilizers. Quantities are shown in Table A1-2.
- The water for the ponds should be filtered through a dense sieve with a mesh size smaller than 1 mm.
- Nursery ponds should be half-filled with water, then manured/fertilized the same day when larvae are hatched. Using bundles of straw fixed to sticks around the pond will increase zooplankton quantity and provide shelter for stocked larvae.
- The stocking density of a properly prepared nursing pond varies between 1 and 2 million feeding larvae per hectare.
- When stocking, special attention should be paid to equalizing the temperature of the water used for transportation with that of the pond water.
- Larvae should be gently released in equally distributed batches along wind-protected sides of ponds.
- Feeding with good-quality feed of suitable consistence and size should start on the day of stocking. Feed should contain 40–50 percent protein. The size of the feed particles should gradually be increased from 0.2–0.3 mm at the start to about 1 mm at the end of the nursery period. A good way of feeding is to offer about 1–1.5 kg of artificial feed per 100 000 larvae per day in two portions.

Table A1-1:Application of lime at pond preparation and during production season

| pH | Preparatory dose (kg/ha) | Monthly dose (kg/ha/month) |
|---|---|---|
| **8** | 50–100 | 10–25 |
| **7.5** | 100–200 | 25–50 |
| **7** | 200–300 | 50–75 |
| **6** | 300–400 | 75–100 |
| **Less than 6** | 400–450 | 100–125 |

Table A1-2:Recommended quantities of manure and fertilizers in nursery ponds

| Name | Total quantity (tonnes/ha) | % of total quantity | |
|---|---|---|---|
| | | At start | Later |
| **Manure** | 1.5–2.5 | 100 | 0 |
| **Carbamide (urea)** | 0.15 | 100 | 0 |
| **Superphosphate** | 0.1 | 100 | 0 |

After 3–5 weeks, the nursing period is finished. Advanced fry must be harvested and transferred to rearing ponds for further rearing.

- ☐ During harvesting, ponds should partially be drained with great care. Fine-mesh screens (about 1 mm mesh size) should be used, and these should be continuously inspected and cleaned. Fish feeding should stop one day before harvesting.
- ☐ Before transport, advanced fry should be stored in a flow-through tank or hapa in a density of about 200 000–500 000 per 5–10 $m^3$ of water for a few hours.
- ☐ Advanced fry should not be touched by hand. Handling should only be done with the help of plastic sieves (see Appendix 3).

**Fingerling rearing**

Fingerling of carps (e.g. common carp and Chinese major carps (silver, bighead and grass carp) are reared in pond polyculture where pond preparation, stocking, feeding, follow-up on growth of developing fish and harvest are done as detailed in Chapter 3.

It is a general rule that the proportion of different carps in a polyculture depends on market demands.

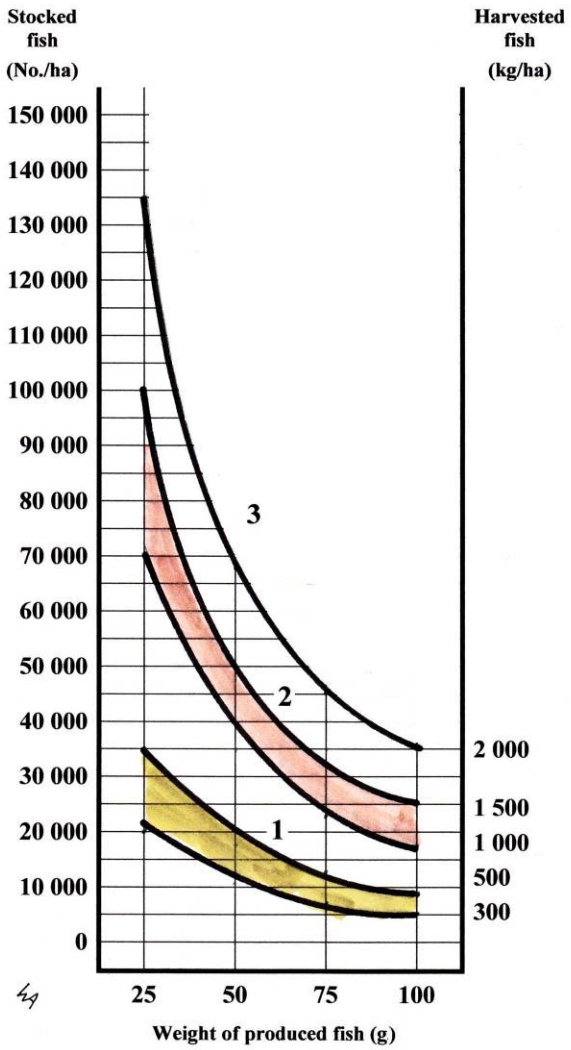
Manuring is especially important if silver carp is stocked and reared because this fish grows on phytoplankton.

Feeding grass carp with fresh and tender terrestrial plants such as clover will ensure a healthy growth of this species.

This graph shows the strong inverse correlation between the number of stocked fish (number/ha) and the attainable size of fingerlings at different levels of production intensity.

The graph of fingerling[1] production of carps is based on the assumptions that:

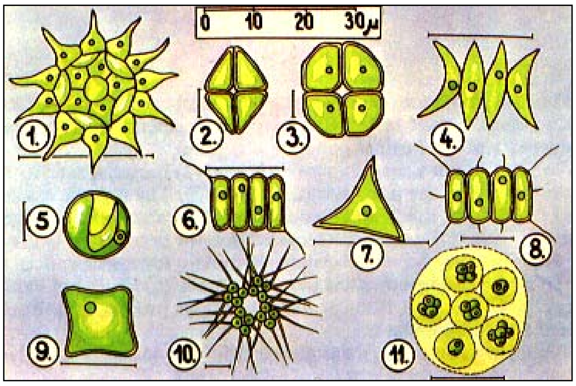
- Advanced fry is stocked.
- The rearing period is about 10–12 weeks.
- The expectable average survival rate is about 60 percent, which in reality may vary between 50 and 70 percent.
- Expectable gross yields of fish weighing 25–100 g large are (Woynarovich and Woynarovich, 1998; Woynarovich *et al*., 2011).
  1) At extensive production:
     Total weight: 300–500 kg/ha
     Harvested number: 3 000–20 000 fish/ha
  2) At semi-intensive production:
     Total weight: 1 000–1 500 kg/ha
     Harvested number: 9 000–60 000 fish/ha
  3) At intensive production:
     Total weight: > 2 000 kg/ha
     Harvested number: 18 000–80 000 fish/ha



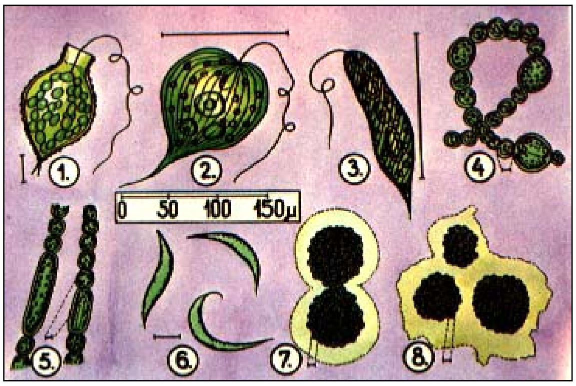

[1] One-summer-old fish.

## MOST FREQUENT PHYTOPLANKTON, ZOOPLANKTON AND PREDATORS FOUND IN AND AROUND FISH PONDS

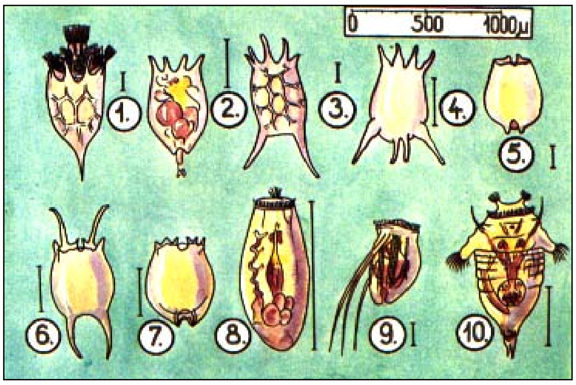
**Green algae**: *Pediastrum* (1), *Crucigena* , (2, 3) *Scenedesmus* (4, 6, 8), *Chlorella* (5), *Tetraedron* (7, 9), *Richteriella* (10), and *Gloeococcus* (11).



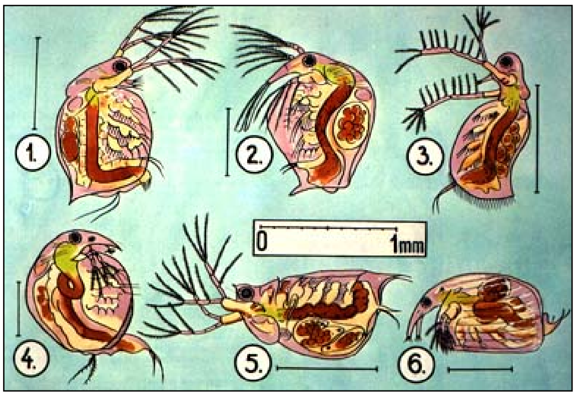

**Blue-green algae** (cyanobacteria) indicate unbalanced environmental conditions. Flagellates (1–3) develop well in polluted water. Some examples of flagellates are: *Trachelomonas* (1), *Phacus* (2) and *Euglena* (3). Examples of blue-green algae are: *Anabaena* (4), *Aphanizomenon* (5), *Dactylococcopsis* (6 ), and *Microcystis* (7, 8).



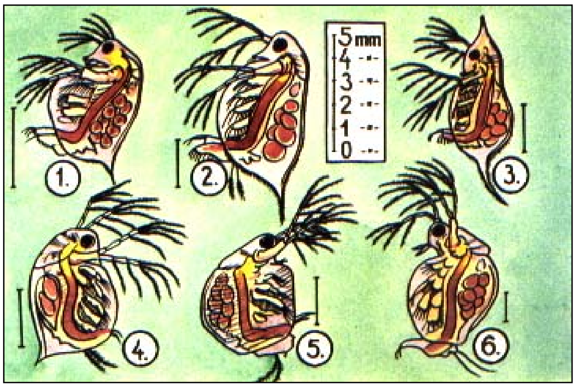

Slow-moving **rotifers** are the most important group of microscopic animals for the rearing of feeding larvae. They belong to zooplankton species. Some examples are: *Keratella* (1, 3), *Brachionus* (2, 4–7), *Asplanchna* (8), *Filina* (9) and *Synchaeta* (10).



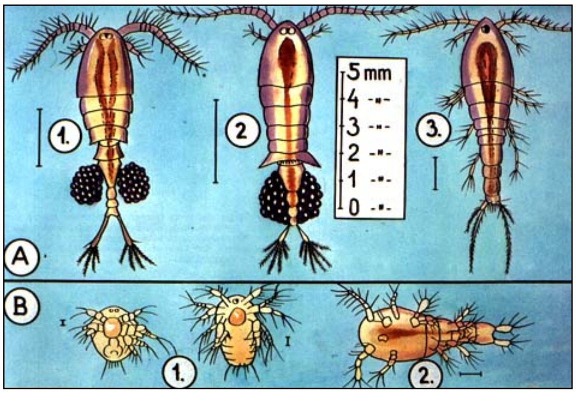

**Small cladocerans** (0.2–0.5 mm) may compete with rotifers for food. *Ceriodaphnia* (1), *Bosmina* (2), *Diaphanosoma* (3), *Chydorus* (4), *Scapholeberis* (5), and *Alona* (6).



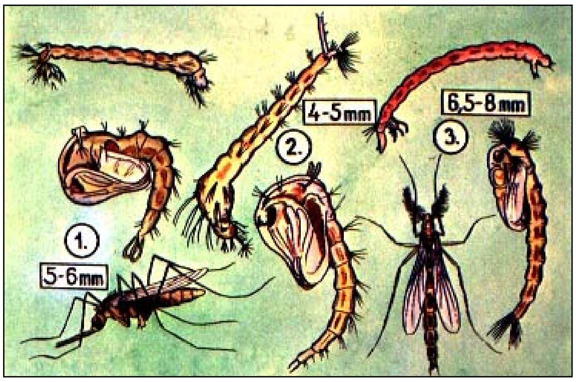
**Large cladocerans** are undesirable as they compete for food with smaller zooplankter. Some examples are: *Daphnia* (1–3, 5), *Simocephalus* (4), and *Moina* (5).



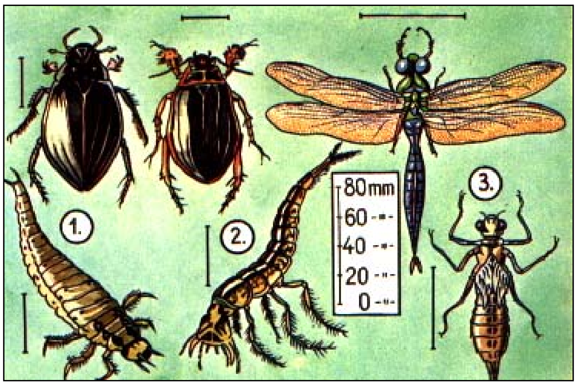

**Adult copepods**: *Cyclops* (1), *Diaptomus* (2), and *Canthocamptus* (3). Juvenile copepods (B) could be very useful natural food for carp fry, but in practice they cannot be separated from adults. Several juvenile stages exist such as nauplius (1) and copepodite (2) stages.



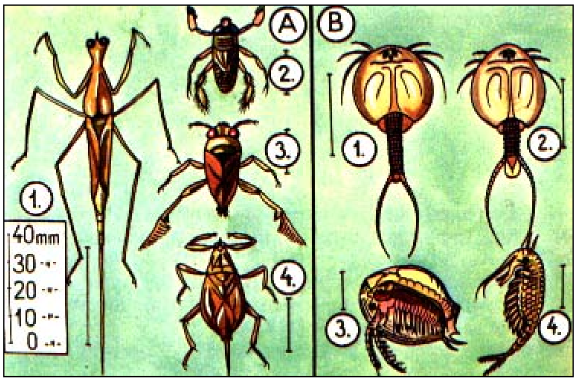

**Mosquito larvae and pupae** live near the water surface, hidden among aquatic vegetation as, for example, species of *Anopheles* (1) and *Culex* (2). Chironomid larvae and pupae such as *Chironomus plumosus* (3) live in the bottom mud of ponds.



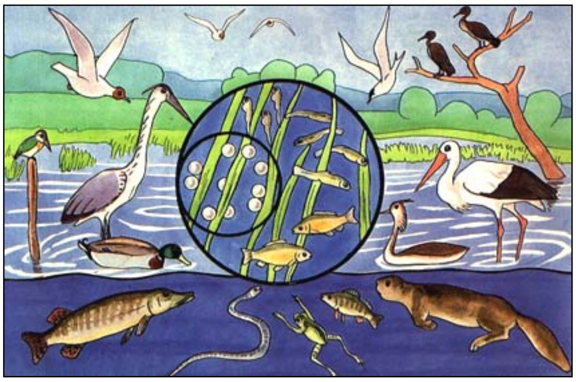

**Water beetle larvae** *Hydrous piceus* (1) and *Dytiscus marginalis* (2), as well as dragonflies such as *Anax imperator* (3).



**Predatory aquatic insects**: *Ranatra* (1), *Corixa* (2), *Notonecta* (3), and *Nepa* (4). Losses may also result from small crustaceans (B) such as species of *Triops* (1), *Lepidurus* (2), *Limnadia* (3) and *Branchipus* (4).

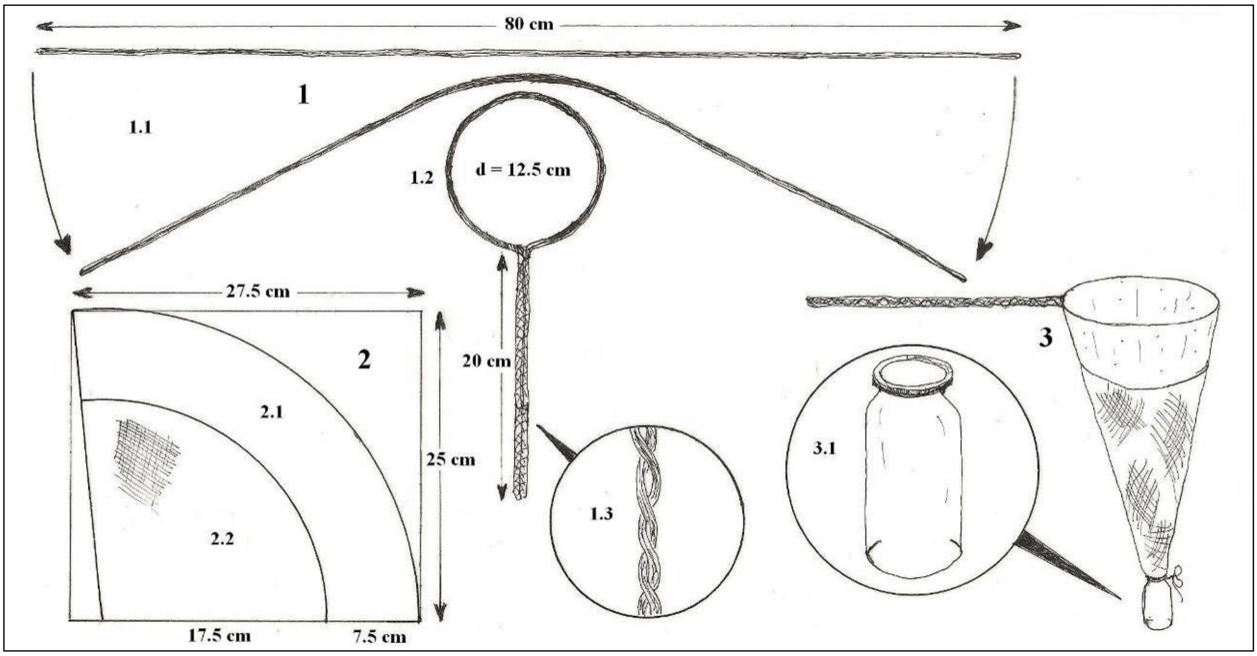



**Predatory aquatic vertebrates**: Fishes, snakes, frogs, water birds and mammals.



Checking zooplankton is done with a plankton net, which can easily be made as described in the image below.

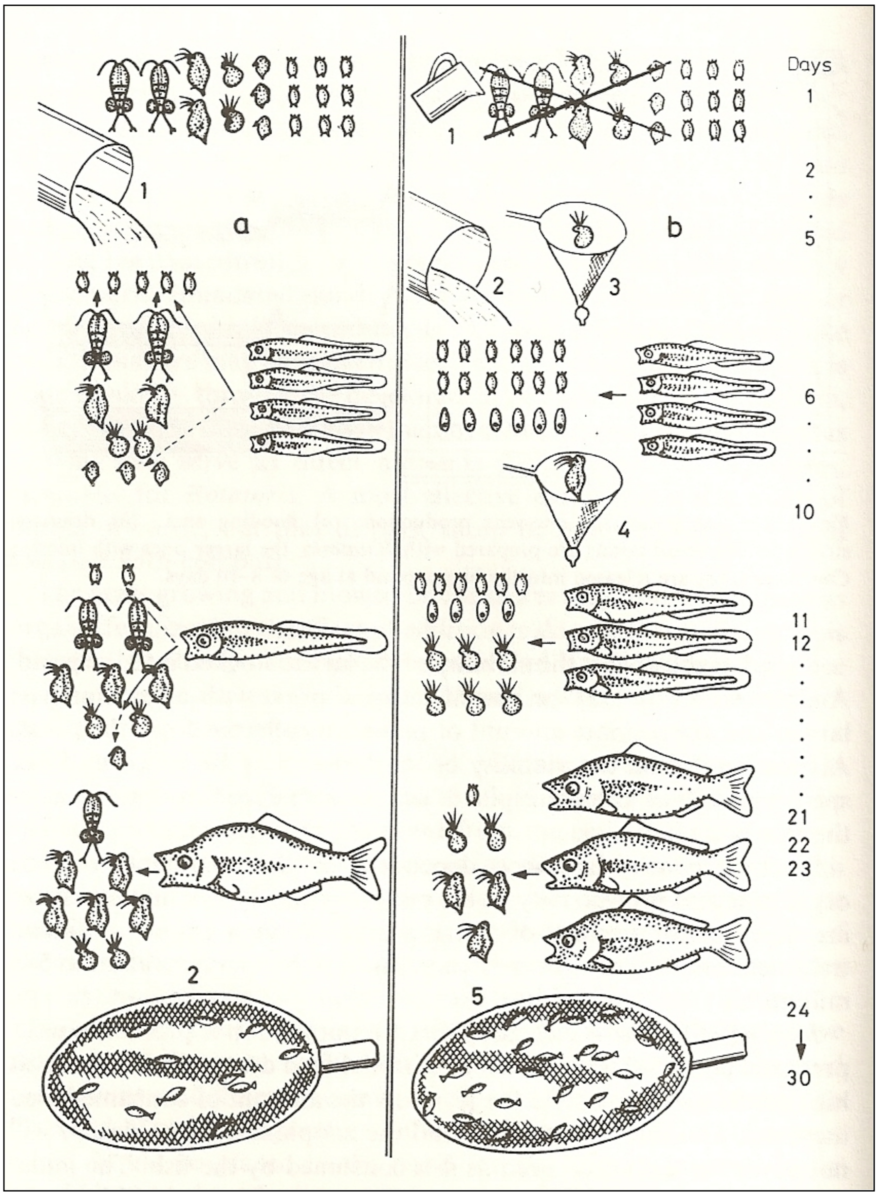
**Steps in plankton net preparation**




1) An about 80 cm long strong wire should be bent into a frame (1.1, 1.2 and 1.3).
2) A proper-sized sieve (70–80 microns) should be cut out (2.2) together with a material that will hold the sieve on the frame. It should then be sewed to the sieve (2.1).
3) When the sieve is attached to the frame, a transparent vial or small glass container should be fixed to the bottom of the plankton net (3.1).

*Source:* Woynarovich *et al*. (2011).

## CHEMICAL PREPARATION OF NURSERY PONDS – SELECTIVE ELIMINATION OF LARGER ZOOPLANKTON




The above flowchart (Horváth, Tamás and Tölg, 1984) demonstrates the differences between an untreated (a) and a treated (b) nursery pond. It shows how important the selection of zooplankton is before the feeding larvae of carps are stocked.

There are various methods of plankton selection. An effective one is where a licensed and tested selective insecticide[1] is used[2] which leaves rotifers alive. Chlorinated lime in a quantity of about 10–15 kg/10 000 $m^3$ is less effective but can still be an acceptable solution in countries where the use of selective insecticides for nursery pond preparation is prohibited.

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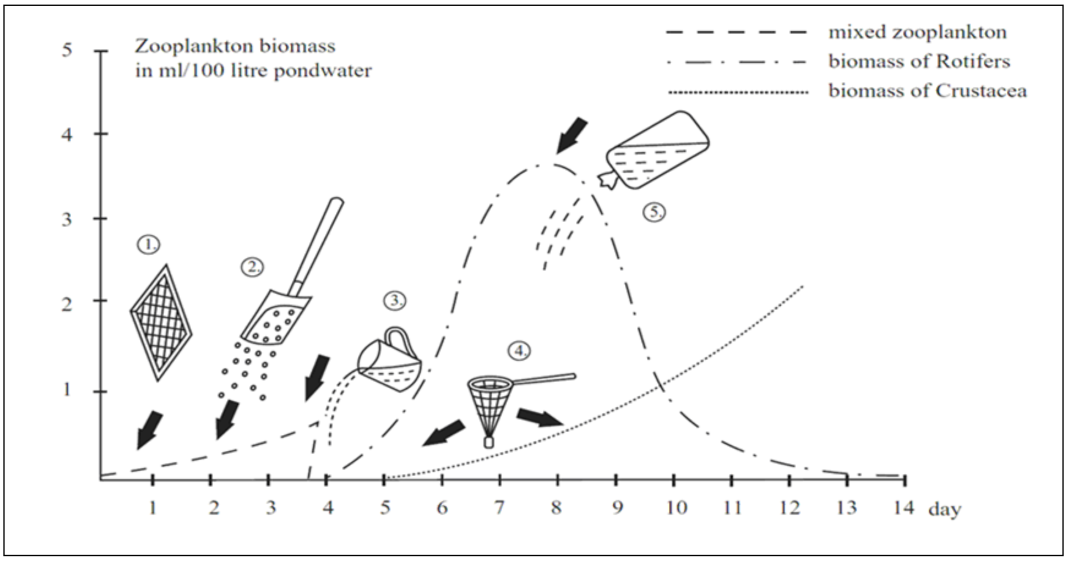
[1] Chemicals that contain either organophosphoric acid ester or trichlorfon are usually suitable for this purpose (Horváth, Tamás and Tölg, 1984). As rotifers are from another taxonomic group, they are not sensitive to insecticides. Before using a new brand of insecticides, laboratory and field tests should prove its suitability. The list of permitted or banned chemical products varies from country to country. Therefore, the use of some otherwise suitable insecticides may be banned in one country while permitted in another (Woynarovich, Moth-Poulsen and Péteri, 2010).

[2] Although this water treatment is effective, environmentalists often criticize it.

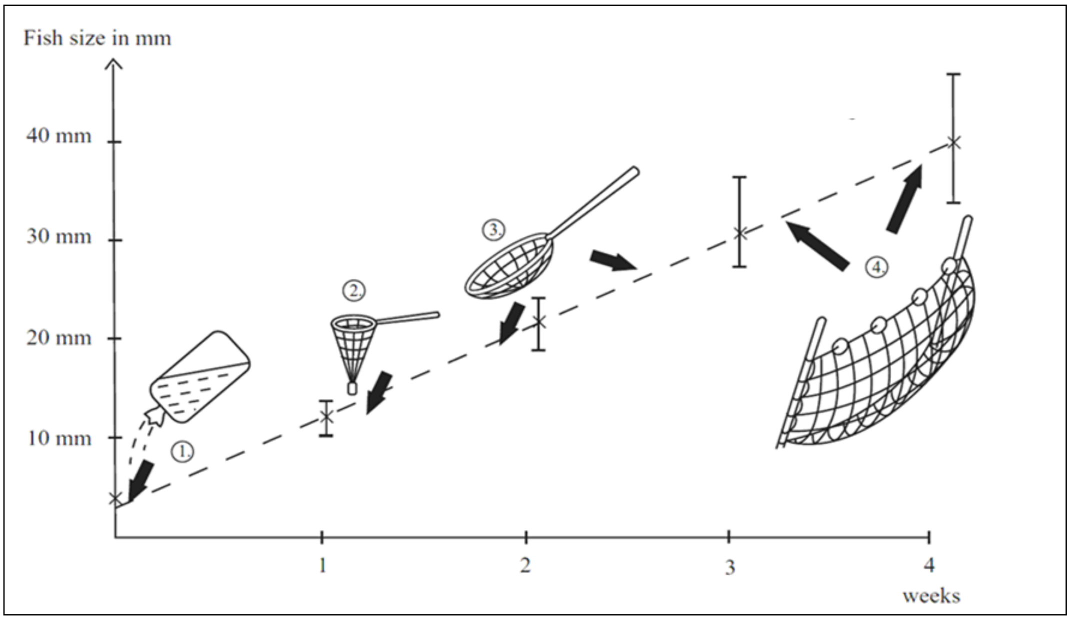
Where the larger predator crustaceans are eliminated from the zooplankton, in the first five days of rearing the population of rotifers will quickly develop in the manured and fertilized pond water. Rotifers are the most-needed first food for stocked feeding larvae. To facilitate their increase, food competitors and consumers such as cladocerans and copepods must be temporarily removed from the zooplankton.

Hatchery operations and pond preparations have to be well synchronized in order to reach the highest-possible density of rotifers by the time the feeding larvae are stocked. For this reason, application of a selective insecticide should be done immediately after flooding, manuring and fertilizing nursery ponds.




Activities of nursery pond preparation, as illustrated above (Horváth, Tamás and Tölg, 1984), are:

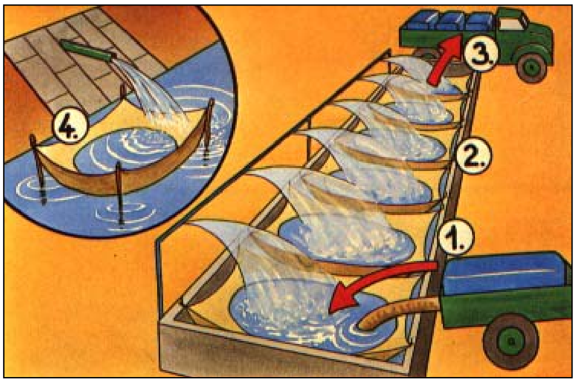
1. Filling the pond with water through a fine-mesh filtering screen
2. Manuring and fertilization
3. Application of a selective insecticide
4. Checking the effect of the treatment
5. Release of feeding larvae of carps




Activities during the nursery period of carps, as illustrated above (Horváth, Tamás and Tölg, 1984) are:

1. Release of feeding larvae
2. Sampling with a plankton net
3. Sampling with a hand net
4. Fishing with a seine and/or a trap

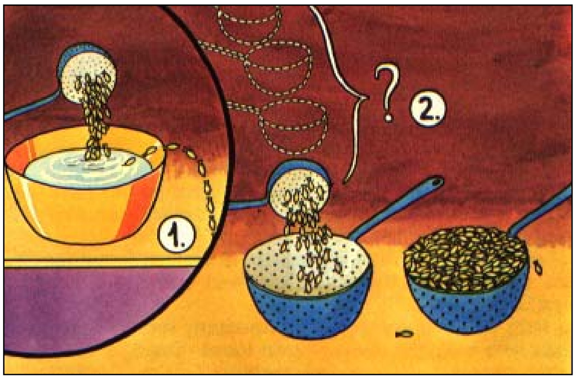
## COUNTING ADVANCED FRY AND FINGERLINGS OF CARPS




Both advanced fry and fingerlings are taken from ponds to storage nets to be sorted and counted before they are transported and stocked into a pond or are sold to other fish farms.

Information about the number of fish is essential. Therefore, counting techniques are discussed below.

### Counting advanced fry




Counting of advanced fry is done on the basis of the volume of a known number of fish.

(1) A small 8–10 cm tea strainer should be filled with fish, which should then be counted one by one.

(2) Using the same small strainer a larger strainer (about 1 litre in volume) should be filled. It helps to appraise the number of fish in the large strainer.[1]

### Counting fingerlings

Mass counting of fingerlings is done on the basis of their individual and total weight:

- First, 2 or 3 carefully measured batches of about 0.5 kg fingerlings with average sizes are taken.
- Second, fish in the samples (batches) are accurately counted.
- Finally, the total (summed) weight of batches is divided by the total (summed) number of fish, which gives the average weight of a fingerling.

The calculated individual weight of fingerlings will facilitate an estimation of the number of fish found in 1 kg or in any given weight. It will also allow the calculation of the total weight of a given/required number of fingerlings.

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[1] For example: 175 fry are counted in a small tea strainer. Ten small strainers are needed to fill a large one. Thus, the large strainer holds 175 × 10 = 1 750 fry.

**Appendix 4**

## USEFUL TABLES ON THE TRANSPORT OF LARVAE, ADVANCED FRY AND FINGERLINGS

### Transport of feeding larvae

Table A4-1:Transport of larvae in containers and in plastic bags

| Species | Temperature of transport water | | | |
|---|---|---|---|---|
| | 10 °C | 15 °C | 20 °C | 25 °C |
| **In fish-transporting containers under continuous oxygen diffusion (1 $m^3$ water) Transportation period: 2–6 hours** | | | | |
| **Common carp (no.)** | – | – | 750 000–1 250 000 | 500 000–1 000 000 |
| **Chinese major carps (no.)** | – | – | 750 000–1 250 000 | 500 000–1 000 000 |
| **In plastic bag with pure oxygen (30 litres water and 30 litres oxygen) Transportation period: 2–12 hours** | | | | |
| **Common carp (no.)** | – | 200 000–400 000 | 100 000–200 000 | 60 000–120 000 |
| **Chinese major carps (no.)** | – | – | 80 000–150 000 | 30 000–80 000 |

*Source:* Antalfi and Tölg (1971).

### Transport of advanced fry

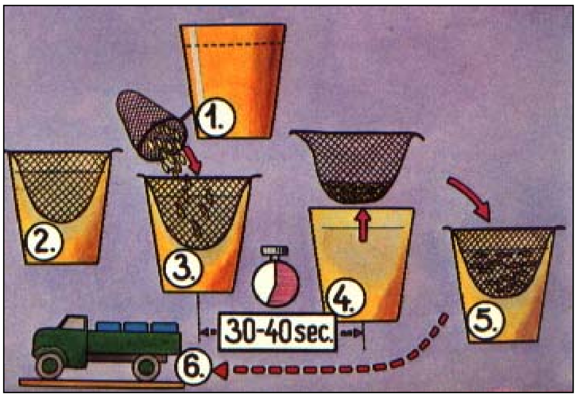
Before transport and stocking, advanced common carp fry are given a quick salt bath to control ectoparasites, *Trichodina* in particular.

(1) A 2–3 percent salt solution is prepared by adding 1–1.5 kg of common salt to 50 litres of water.

(2) A piece of fine-mesh netting is placed within the container.

(3) – (4) Batches of fish are successively treated by being dipped for 30–40 seconds in the solution.

(5) Then, the fish are kept in clean and well-aerated water (6) until loading.




Advanced fry can be transported for long distances by road or air in plastic bags 55–60 cm in diameter and 80–90 cm in height.

(1) 20 litres of clean water is poured into the bag.

(2) Depending on the duration of transport 2 000–5 000 advanced fry are put into the water, and the rest of the bag (at least 20 litres) is filled with oxygen.

(3) The bag is tightly closed with a piece of rubber string.

(4) It is placed into a cardboard box for transport.

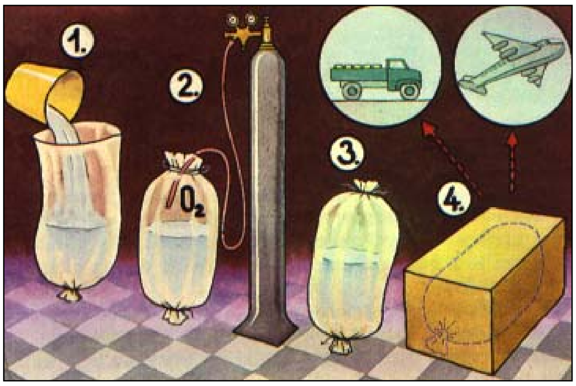



Table A4-2: Transport of advanced fry (2–3 cm) in 0.1 $m^3$ water under continuous oxygen diffusion

| Species | Temperature of transport water (duration of transport: 2–12 hours) | | | | |
|---|---|---|---|---|---|
| | 10 °C | 15 °C | 18 °C | 20 °C | 25 °C |
| **Common carp** | – | 13 000–30 000 | 6 000–20 000 | 5 000–15 000 | 2 000–5 000 |
| **Chinese major carps** | – | – | 8 000–22 000 | 6 000–18 000 | 3 000–7 000 |

*Source:* Antalfi and Tölg (1971).

Table A4-3: Transport of advanced fry (2–3 cm) in a plastic bag with pure oxygen (30 litres water and 30 litres oxygen)

| Species | Temperature of transport water (transportation period: 8–48 hours) | | | |
|---|---|---|---|---|
| | 10 °C | 15 °C | 20 °C | 25 °C |
| **Common carp** | – | 8 000–15 000 | 6 000–12 000 | 5 000–10 000 |
| **Chinese major carps** | – | – | 5 000–10 000 | 3 000–8 000 |

*Source:* Antalfi and Tölg (1971).

Table A4-4:Transport of advanced fry in 1 $m^3$ water under continuous oxygen diffusion

| Species | Temperature of transport water and transportation period (hours) | | | |
|---|---|---|---|---|
| | 4–15 °C | | 16–20 °C | |
| | 2–6 hours | 6–12 hours | 2–6 hours | 6–12 hours |
| **Common carp (no.)** | – | – | 150 000 | 100 000 |
| **Chinese major carps (no.)** | – | – | 120 000 | 80 000 |

*Source:* Horváth and Tamás (1981).

## Transport of fingerlings

Table A4-5:Transport of fingerlings in 1 $m^3$ water under continuous oxygen diffusion (Ref: 2)

| Species | Temperature of transport water and transportation period (hours) | | | |
|---|---|---|---|---|
| | 4–15 °C | | 16–20 °C | |
| | 2–6 hours | 6–12 hours | 2–6 hours | 6–12 hours |
| **Common carp (kg)** | 120 | 80 | 70 | 50 |
| **Grass carp (kg)** | 130 | 90 | 80 | 60 |
| **Silver carp (kg)** | 50 | 30 | 30 | 25 |
| **Bighead carp (kg)** | 130 | 90 | 80 | 65 |

*Source:* Horváth and Tamás (1981).

## Appendix 5

### USEFUL TABLES ON WINTERING FINGERLINGS OF CARPS

Some guiding figures on wintering fingerlings are presented in the two tables below:

Table A5-1: Practical figures on wintering fingerlings – 1

| Age groups | $kg/m^3$ | $fish/m^3$ | Quantity of water per 100 kg of fish (litres/min.) |
|---|---|---|---|
| **One-summer-old fish** | 4–8 | 80–400 | 7–10 |

*Source:* Horváth and Tamás (1981).

Table A5-2: Practical figures of wintering fingerlings – 2

| Individual size of fish (g) | Fish species ($kg/m^3$) | | | Quantity of water per 100 kg of fish (litres/min.) |
|---|---|---|---|---|
| | Grass carp | Common carp | Silver carp | |
| **10–20** | 8–12 | 8–10 | 7–8 | 6–12 |
| **20–50** | 12–14 | 10–12 | 8–10 | 6–12 |

*Source:* Antalfi and Tölg (1971).

Owing to profound political, social and economic changes, the production of fish ponds and small water reservoirs in many countries of Central and Eastern Europe (CEE) and in the Caucasus and Central Asia (CCA) has declined considerably in recent decades. In order to restart and increase carp production in these regions, hands-on training courses supported with handouts has proved to be useful in practical training and self-education of concerned and interested fish farmers.

This present handout was prepared as a detailed guide on the rearing of advanced fry and fingerling of common carp, with supplements on the rearing of Chinese major carps. Accordingly, chapters detail key aspects, data and know-how about the rearing of advanced fry and fingerlings of common carp, while the attached annex contains specific information and data for successful growing of Chinese major carps. In addition, five appendixes are also attached to the document, introducing the most frequent phytoplankton and zooplankton species found in pond water, techniques on how to count young fish, and methods for transporting advanced fry and fingerling of carps.

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