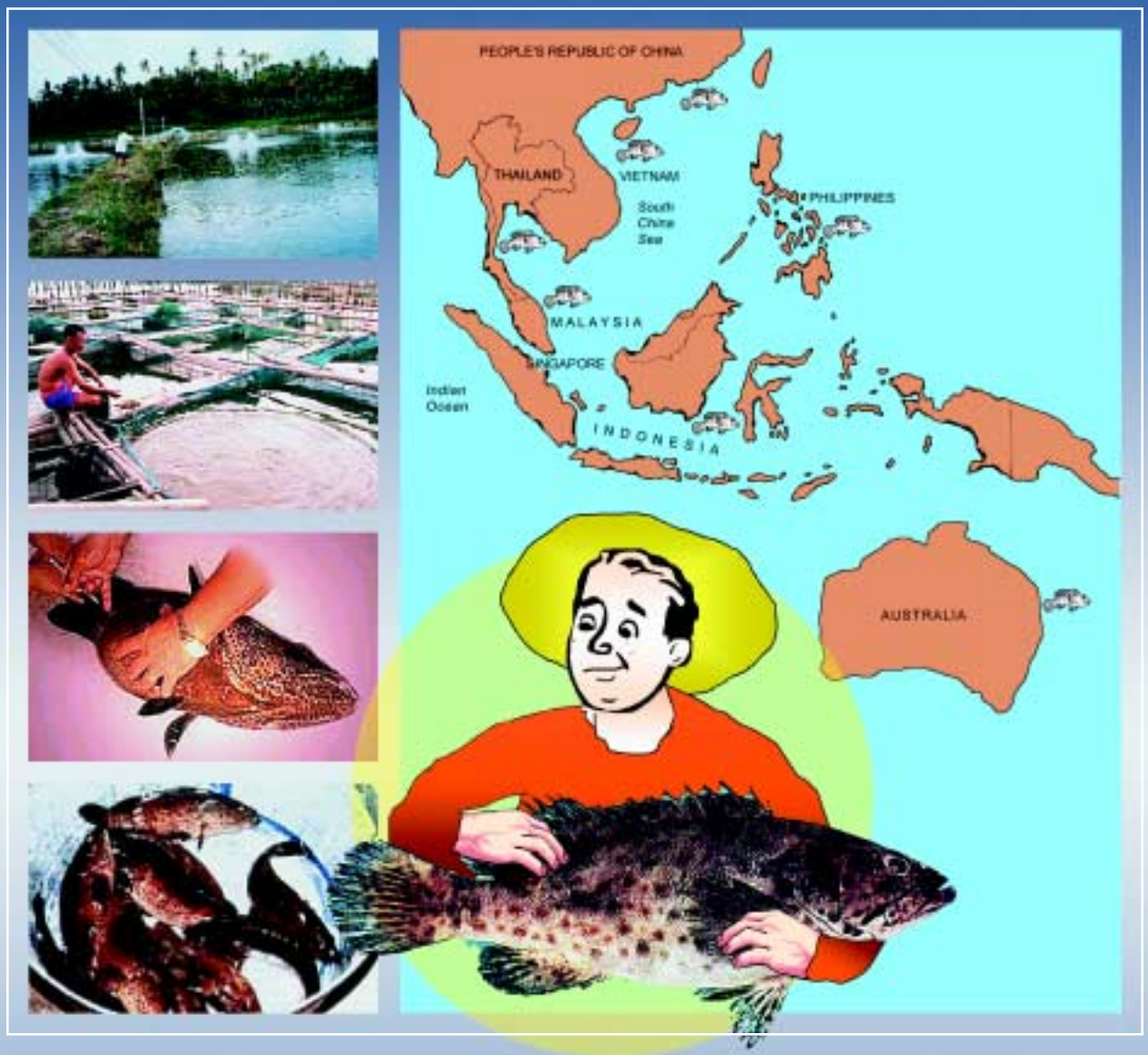
Husbandry and Health Management of Grouper



Prepared by

Aquaculture Department
Southeast Asian Fisheries Development Center
Tigbauan, Iloilo, Philippines

For

ASIA-PACIFIC ECONOMIC COOPERATION
Fisheries Working Group 01/2000

2001

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SEAFDEC Aquaculture Department
APEC Fisheries Working Group 01/2000

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Foreword

The Asia Pacific Economic Cooperation (APEC) was established in 1989 in response to the growing interdependence among Asia-Pacific economies. Since then, APEC has become the primary regional vehicle for promoting open trade and practical economic cooperation. The Fisheries Working Group (FWG) of APEC was created to promote: 1) the conservation and sustainable use of fisheries resources; 2) sustainable development of aquaculture and habitat preservation; 3) development of solutions to common resource management problems; 4) the enhancement of food safety and quality of fish and fish products; and 5) sector-specific work relating to trade and investment liberalization and facilitation.

The FWG of APEC has supported the development of a collaborative grouper research and development network. During the APEC grouper workshop conducted in collaboration with Network of Aquaculture Centers in Asia-Pacific (NACA), and held in Hatyai, Thailand in April 1999, a working group was tasked to: (1) develop a strategy to increase collaboration between countries and institutions involved in aquaculture research and development; and (2) develop an action plan to extend research and development outcomes to the industry. The working group – more formally known as the Fisheries Working Group 1: Production Technology – Research, Extension and Industry Development – identified the immediate need to develop a practical guide on husbandry and health management of grouper for fish farmers.

The contract to develop and publish the practical guide was awarded to the Aquaculture Department of Southeast Asian Fisheries Development Center (SEAFDEC AQD) in Iloilo, Philippines, through its Research Division Head Dr Clarissa L. Marte. The manual, originally written in English, is described and illustrated in regional languages for easy understanding by fish farmers throughout the region. The Philippine Bureau of Fisheries and Aquatic Resources, through Ms Cecilia G. Reyes, acts as the Project Overseer.

The Project Team from SEAFDEC AQD (E.R. Cruz-Lacierda, C.R. Lavilla, J.D. Toledo, N.V. Golez) and AJ Aqua Intercon Pty. Ltd., Australia (N.J. Ogburn) worked in collaboration with experts from the following agencies: Department of Primary Industries, Australia; Gondol Fisheries Station and Research Institute for Coastal Fisheries, Department of Fisheries, Indonesia; LTS Consultancy and Fisheries Research Center, Department of Fisheries, Malaysia; Guandong Daya Wan Fisheries Development Center, People's Republic of China; Bureau of Fisheries and Aquatic Resources, Philippines; Taiwan Fisheries Research Institute, Chinese Taipei; and National Institute of Coastal Aquaculture and Aquatic Animal Health Research Institute, Department of Fisheries, Thailand.

This practical guide is to aid farmers in grouper culture and is divided into seven sections. The first section presents the most important cultured grouper species in the Asia-Pacific region. The illustrations of the external and internal anatomy of the fish will guide farmers, especially in the location of organs affected by specific disease agents. Section 2 gives the basic considerations in selecting a good site for grouper culture, while Section 3 describes the grouper culture systems practiced in the region. The lay out, size, design and construction, and procedures involved in the preparation of the facility are given in detail. Section 4 describes and illustrates various gears used in the collection of grouper fry and fingerlings. It also outlines the procedures in handling and

transport of collected seed to minimize mortality. Section 5 discusses the operations and management protocols in nursery and grow-out phases of grouper culture. Information on stocking density, feed and feeding management, water management, grading, maintenance of facility, and culture duration are presented. Section 6 describes the procedures in harvesting and transport of marketable-sized grouper for live trade.

The health management aspect in grouper culture is presented as the last section. It provides information on the causes and effects of diseases, how diseases are transmitted, how to recognize early signs of a disease, and how to prevent further spread of diseases in the facility. A guide on how to submit samples for disease diagnosis is also illustrated. The target organ(s), causative agent, gross signs¸ effects on the host, and methods of prevention and treatment, if any, for each disease are included. Following the dictum “an ounce of prevention is better than a pound of cure,” very little presentation is made here about the usage of chemicals or therapeutic agents. In cases where treatment is indicated, it is best to do this under the guidance of a fish health specialist to avoid unnecessary loss of stock.

It is hoped that this practical guide will help farmers improve production and reduce fish mortality, and thus utilize more efficiently the existing grouper seed resources.

The Project Team

Contents

Introduction

The groupers (Family Serranidae) are among the most popular species in the live reef food fish industry in the Asia-Pacific region. Groupers are generally fast growing, hardy, suitable for intensive culture, and with excellent characteristics for processing. The high demand for these fishes is due to their unique culinary attributes and scarcity.

In 1997, the Asia-Pacific region contributed about 90% to the total world aquaculture production. The regional production of farmed grouper was estimated at 15,000 tons, with China as the biggest producer contributing 8,000 tons followed closely by Indonesia. Other countries in the region commonly produce 1,000-2,000 tons annually in 1990-1997.

Groupers are generally cultured in floating net cages or earthen ponds, but cage culture is more common in Southeast Asia. Grouper pond production is becoming an attractive alternative to intensive shrimp culture in countries where management problems have forced growers to abandon shrimp farming.

Although grouper culture is widespread in Asia and the Pacific, its continued development is constrained by the limited availability of fingerlings. Most economies, with the recent exception of Chinese Taipei, rely almost totally on wild-caught fry and fingerlings for stocking. This demand for wild seeds has led to unsustainable and illegal collection practices such as the use of cyanide to capture large numbers of seed with relatively less investment in time and effort.

The inadequate supply of seed is further aggravated by the lack of appropriate handling techniques during collection, transport and storage of collected fish, and sometimes by an unregulated management of the wild stocks. There is also the lack of appropriate techniques for efficient grouper culture to marketable sizes. A major production constraint is heavy mortality of groupers during the collection and culture phases due to handling stress and diseases.

The utilization of non-destructive devices for grouper collection, proper fish handling and increased efficiency in culture management can result to socio-economic and environmental benefits. A well-developed grouper culture operation complemented by appropriate wild grouper fishery management can provide sustainable employment to many people – from marginal fishers to farmers to traders. Grouper fisheries based on illegal or destructive fishing practices underlines the urgent need for habitat protection and sustainable utilization of natural resources.

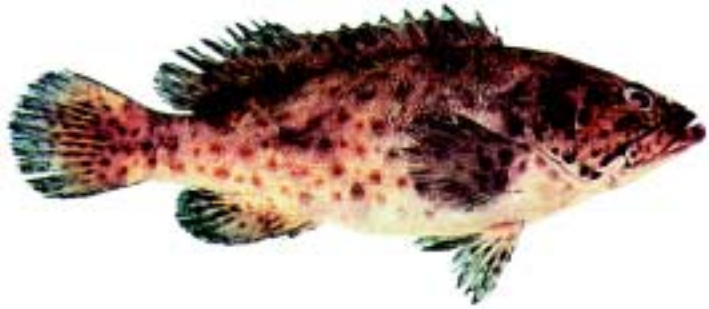
The objective of this manual is to provide a farmer-friendly practical guide for grouper farmers in the Asia-Pacific economies. It is hoped that this manual will enhance farmers' ability to culture and handle grouper, as well as to prevent and manage disease outbreaks.

As you read through, you will meet the following characters:

SECTION 1 What groupers are farmed, and what do they look like?

Commonly cultured species

Groupers are widely distributed in the tropical and subtropical coastal waters. They are of great economic value and form a major component of the live reef fish trade in the tropics.



Orange spotted grouper,
green grouper
Epinephelus coioides (Hamilton)

Malabar rock cod
Epinephelus malabaricus
(Bloch and Schneider)

Brown marbled grouper,
carpet cod, flowery cod, blotchy rock cod
Epinephelus fuscoguttatus
(Forsskal)

Dusky tail grouper
Epinephelus bleekeri (Vaillant)

Leopard coral trout,
blue spotted seabass
Plectropomus leopardus
(Lacepede)

Barred-cheek coral trout,
spotted coral trout
Plectropomus maculatus (Bloch)

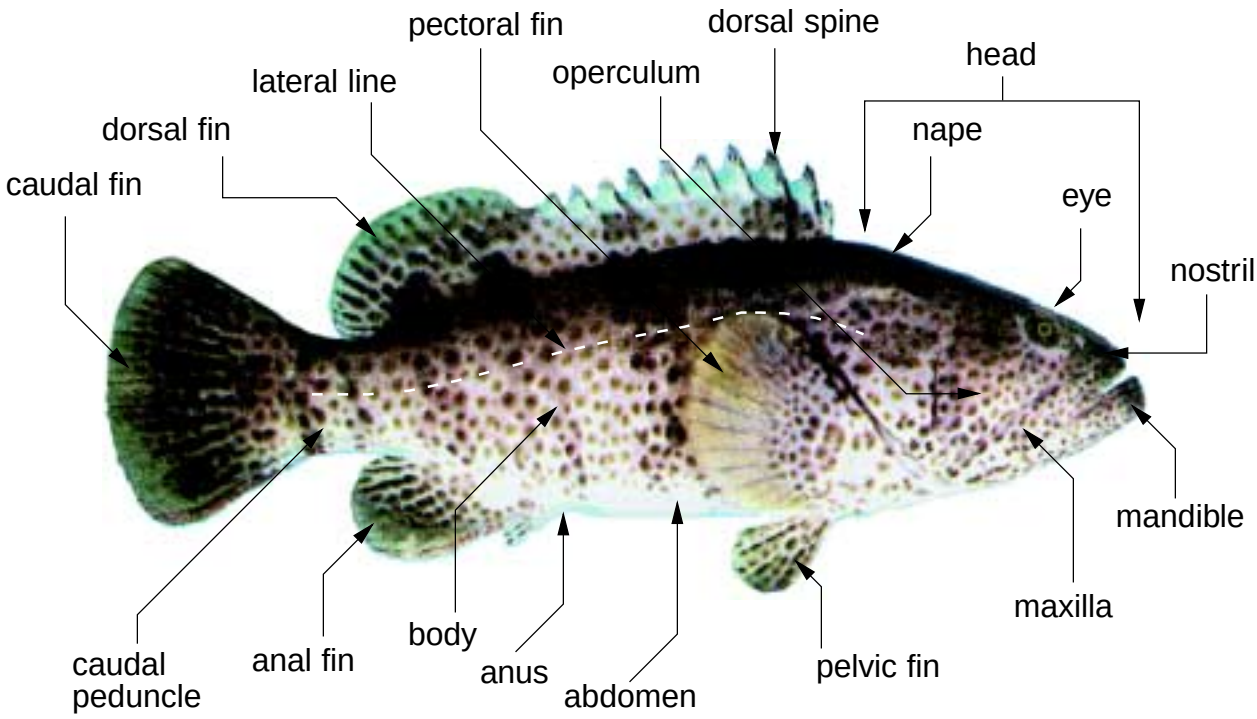
High-finned grouper,
hump back grouper,
barramundi cod,
polka-dot grouper
Cromileptis altivelis
(Valenciennes)

Other cultured species

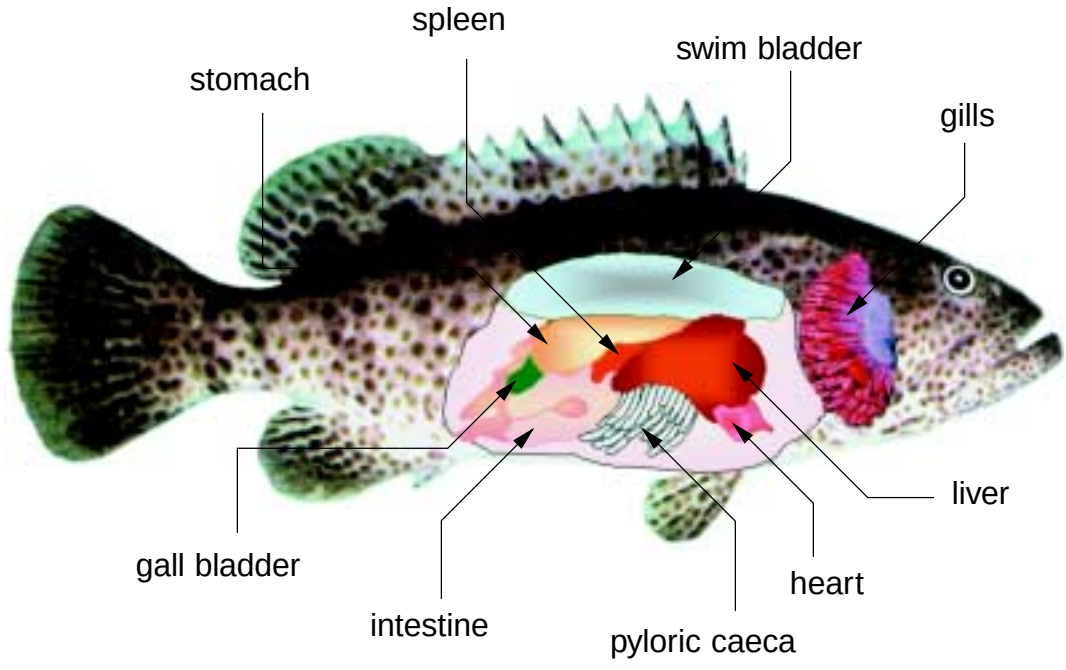
E. fario	***E. merra***
E. fasciatus	***E. sexfasciatus***
E. septemfasciatus	***E. awoara***
E. lanceolatus	***E. akaara***
E. moara	***E. polyphekadion***
E. ornatus	***E. amblycephalus***
E. areolatus	***E. chlorostigma***

The local names of the different grouper species are shown on pages 88-89.

External anatomy



Internal anatomy



SECTION 2 Where should the farm be located?

Site selection is the first and most critical step in establishing a grouper farm. Poor site selection can lead to failure. Brackishwater ponds and floating net cages should be located in areas which are...

- protected from strong winds, waves, currents, typhoons, floods, and siltation

- free from possible source of pollution like industrial, agricultural, and domestic wastes

- accessible but secure from vandals and poachers

Climate and weather in the area are important considerations as they affect water quality. The area should not be subject to abrupt changes in temperature and salinity.

Is freshwater needed?

Freshwater supply must be sufficient for support operations and treatment of fish diseases.

Brackishwater ponds

What is an ideal pond site?

The site must have good water and soil quality.

Seawater must be of sufficient quantity to meet optimum requirements of the cultured fish.

For better growth and survival, the following water parameters should be monitored and maintained.

pH	7.5-8.3
Temperature	25-32 °C
Salinity	20-32 ppt
Dissolved oxygen (D.O.)	4-8 ppm
NO_2-N (Nitrite nitrogen)	0-0.05 ppm
Unionized ammonia (NH_3-N)	< 0.02 ppm

The soil substrate should be clay, clay-loam or sandy-clay. Acid sulfate soil should be avoided as well as soils contaminated with chemicals. The area must have a good slope and elevation (above acid sulfate soil risk zone) to avoid erosion, run-off and flooding. The pond should be able to utilize tidal flow for good water exchange and at least 0.8 meters deep.

The site must provide a safe area for re-use or treatment of pond waste, especially for intensive systems.

So, that is what they call reservoir or settling pond!

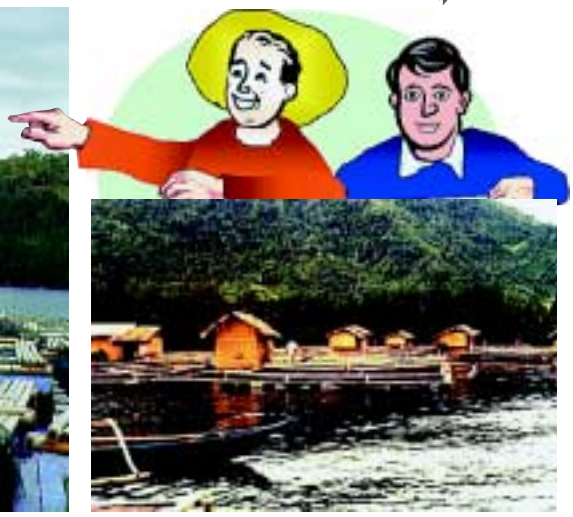
Why are these sites not good?

Because of the reddish coloration, which can indicate acid-sulfate soils. Low pH can kill your grouper.

Floating net cages

What is the proper set-up for floating net cages?

The cages should be set up in calm waters (sheltered lagoons, coves, inlet, bay, or behind an island) with adequate water flow. An access and space for navigation should be provided.



How deep should the water be?

Water should be more than 3 meters deep at lowest low tide (ideally, 15-30 meters). The site should have good water exchange or flushing and, preferably, an unrestricted deep water flow. The current speed should be at least 0.1 meter per second.

How about the substrate and location?

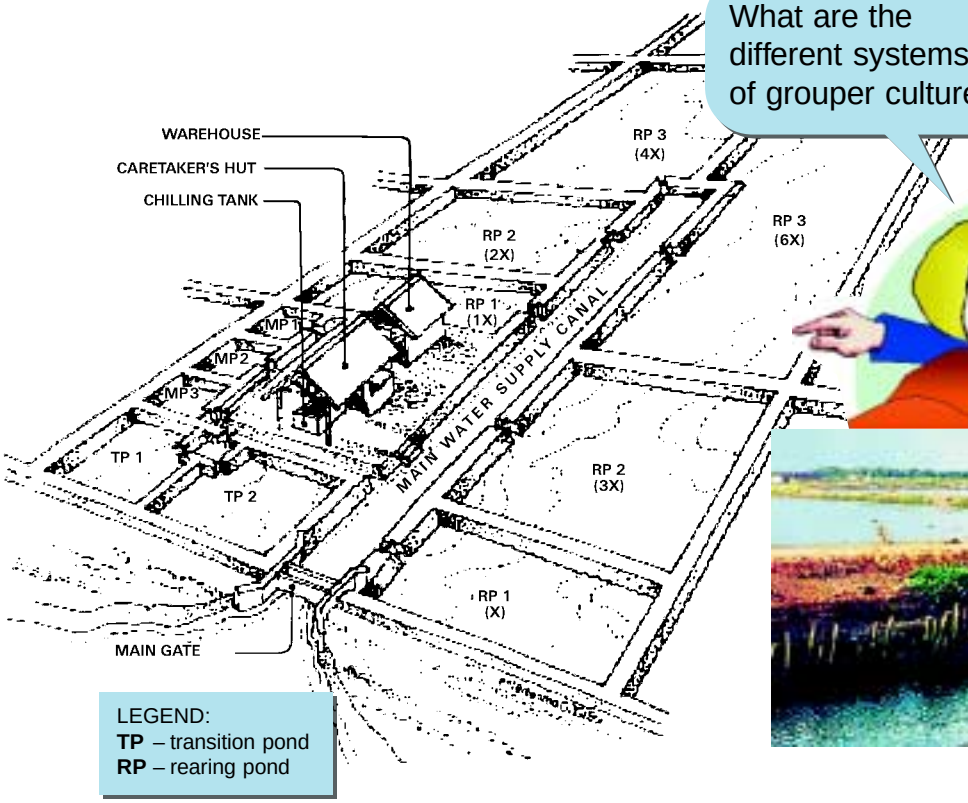
The substrate should preferably be coarse or sandy. The floating net cages should be located away from seagrass beds or coral reefs to avoid negative effects on them.

What other things need to be considered before any cage culture is started?

Land-based support facilities should be adjacent and accessible to cages, with space for net and cage maintenance, feed and equipment storage, product processing, and boat mooring, among others.

SECTION 3 What facilities are used in grouper culture?

Brackishwater ponds



LEGEND:
TP – transition pond
RP – rearing pond

What are the different systems of grouper culture?

Extensive system is generally patterned after traditional milkfish farms, semi-intensive shrimp or other fish farms without modifications.

Semi-intensive and intensive systems have a similar layout and specifications to intensive shrimp or other fish farms. Abandoned shrimp farms may be used with or without modifications.

Should the pond be very large?

Culture ponds can vary in size and shape, generally ranging from 100 square meter units to large 1-hectare ponds. They are often square or rectangular in shape. Smaller ponds of 0.1 to 0.5 hectare, 1-2 meter deep are preferred for better water management.

Variations in pond lay-out as practiced in Chinese Taipei, Vietnam or the Philippines:

- concrete dikes

- centralized bottom drainage system

- net cages within earthen or concrete ponds or raceways

- integrated system (with *Artemia*, tilapia-cum poultry or livestock, etc.)

- recirculating system

The main objectives of pond preparation are to provide the culture organism with a clean hard pond base and appropriate stable water quality. A number of activities should be carried out before the pond is used, as follows:

POND DRYING

TILLING

PESTS and PREDATORS ELIMINATION (by use of organic and inorganic pesticides)

LIMING

FERTILIZER APPLICATION

FILLING and FLOODING

POND DRESSING

- Allow a minimum of 2 weeks up to three (3) months of drying, depending upon the weather and pond bottom condition.
- Let pond bottom crack to help eliminate competitors such as gobies, and to mineralize the soil.

- Till or plow the upper 5-10 cm layer of pond soil manually or by using a corn tiller or plow to condition the ponds.

- Level pond bottom and slope towards the gate or harvest canal.

- Install gates and other operational devices. The use of ferroconcrete gates with steel-framed sliding screens is recommended. Ferroconcrete is cheaper than pure concrete.

- Provide a harvesting pit or canal.

- Eliminate predators and competitors by using:
  organic pesticides such as:
  - **40 kg/ha** derris root for rotenone extract; or
  - **150-200 kg/ha** teaseed cake (soaked in either fresh, brackish or seawater overnight); or

  inorganic chemicals such as:
  - quicklime (to raise soil pH to 11), followed by ammonium sulfate (21-0-0) fertilizer (to release ammonia gas) at **50 g** of lime to **10 g** ammonium sulfate per square meter in ponds with **5 cm** water depth.
- Apply lime on pond bottom and dikes at a rate of **1-2 tons/ha** calcium carbonate (**$CaCO_3$**) or **200-300 kg/ha** calcium oxide (**CaO**).This is a preventive or remedial process to increase alkalinity of the ponds and improve survival, optimize growth and ensure desirable water parameters and their efficient management.
- Provide fish shelters (e.g., bamboos, polyvinyl chloride pipes or PVC). These help increase survival of fry and fingerlings, and reduce disease occurrence. These also minimize cannibalism and provide protection. The shelters may be removed before harvest.
- Plant vegetables or non-destructive grass on dikes to help prevent erosion and avoid turbidity during adverse weather.

- Fertilize and let natural food grow prior to stocking of tilapia. These fish will serve as live prey for grouper. Fertilizers boost pond productivity by increasing organic nutrient concentrations and microalgal growth which then increase food for zooplankton, benthos and other animals in the food chain.
- Apply organic fertilizer to improve organic matter content of the soil. Inorganic fertilizer may be added to promote good phytoplankton growth:
  2 tons/ha manure (organic fertilizers)
  25 kg/ha urea (46-0-0) and
  50 kg/ha diammonium phosphate (16-20-0) (inorganic fertilizers)
- Fill or flood the ponds. Fill up the pond to a depth of 30-50 centimeter. Incoming water should pass through a fine mesh screen (24 holes per inch or per 2.5 cm) to prevent the entry of unwanted species.
- To prevent over bloom of phytoplankton, refrain from applying fertilizers or dressings as soon as trash fish or moist pellets are given in large amounts.
- To maintain good water quality, monitor the stock closely and keep the pond water at its optimum quality.

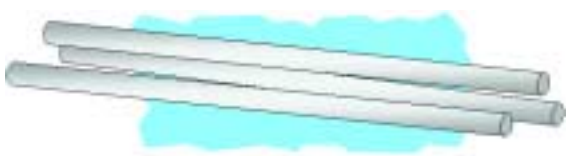
Floating net cages

Floating cages and stationary or fixed cages are mainly used in Southeast Asia. In the latter, the nets are anchored to the sea bottom and there is no net flooring. Materials for net cages should be strong, weather- and pest-resistant, non-corrosive, and with non-abrasive surfaces.

Frames for the net cages are suspended or fixed, the sides of which become walkways for working, feeding and monitoring. Frames can be made of bamboo, wood planks, galvanized iron pipes, polyvinyl chloride or polyethylene pipes. The frames should be able to withstand the high salt content of the sea and be resistant to fouling and boring organisms.

bamboo

wood

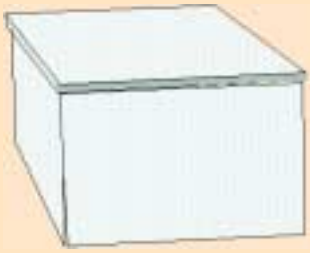


galvanized iron (GI) pipes

polyvinyl chloride (PVC) or polyethylene pipes

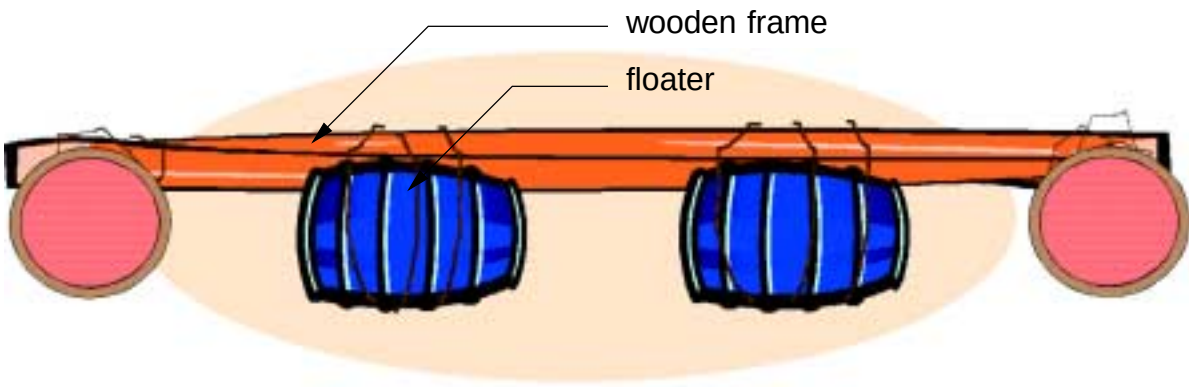
Floaters are installed to keep the frame stable above the water surface. Plastic drums, plastic containers, and styrofoam covered with non-abrasive materials and polyethylene knot or knotless netting are commonly used for this purpose.

barrel

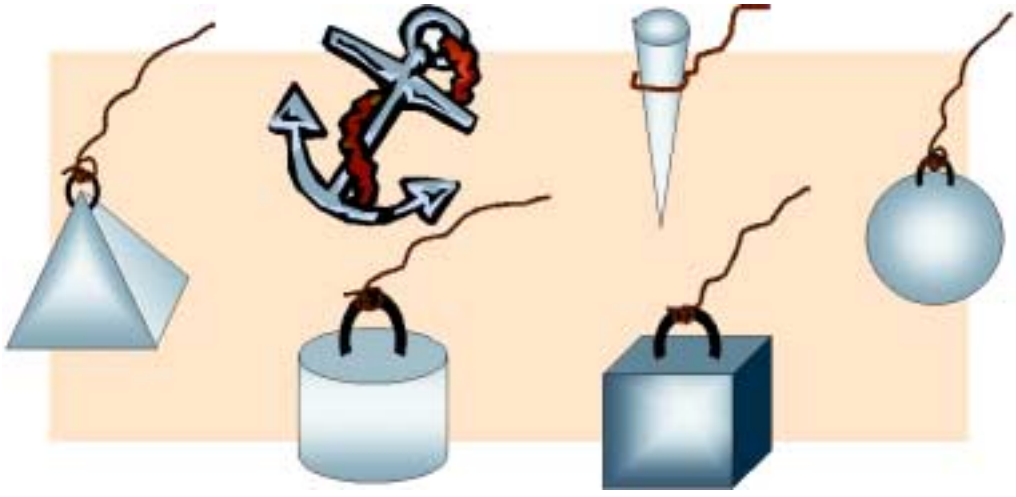


stryrofoam

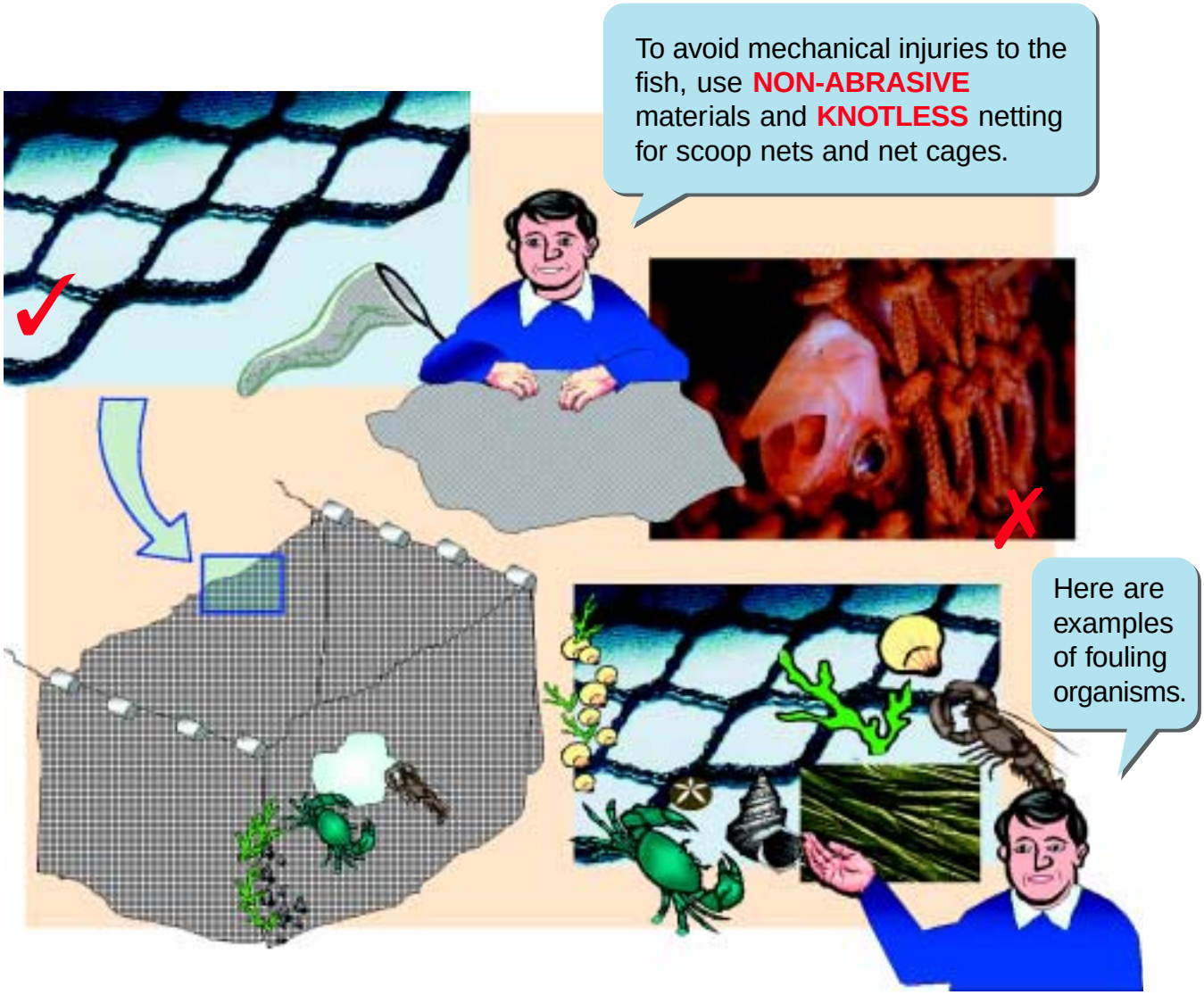
Plastic container



Mooring keeps the whole net cluster in a certain location and prevents towing of the cages by the water current.



Nets hold the fish and their mesh size depends on fish size. **POLYETHYLENE NET** is the best; it is durable, strong, resilient, less expensive and resistant to fouling organisms.

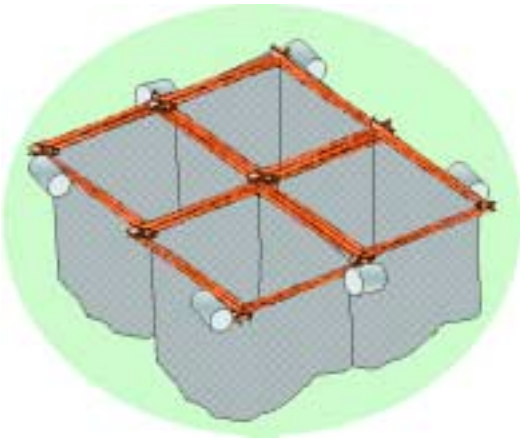


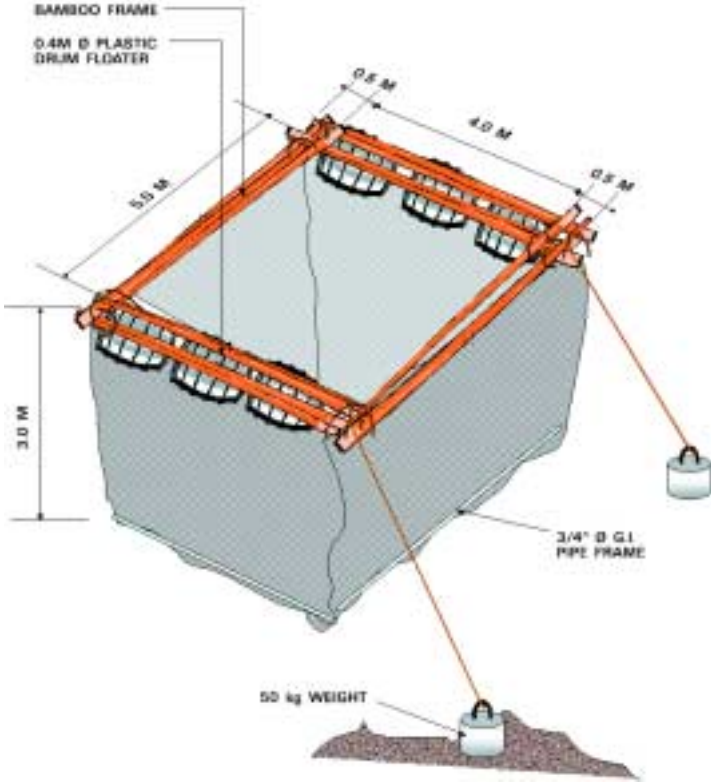
Cages are of various sizes :

Philippines	**: 5 x 5 x 3 m and/or 10 x 10 x 3 m (usually subdivided into 4-8 compartments)**
Malaysia	**: 3 x 3 x 2 m, 4 x 4 x 2 m, 5 x 5 x 2 m, 10 x 5 x 2 m**
Thailand	**: 3 x 3 x 2 m, 4 x 4 x 2 m, 5 x 5 x 2 m**
Singapore	**: 2 x 2 x 2 m, 5 x 5 x 3 m**
Hong Kong, China	**: 3 x 3 x 3 m, 6 x 6 x 3 m**
China	**: 3 x 3 x 3 m**

Design and construction

This is an example of square or rectangle cages in cluster. The cages can be subdivided into smaller compartments with temporary wooden beams to hold smaller nets. Alternatively, two adjacent nets can be combined to increase compartment size.



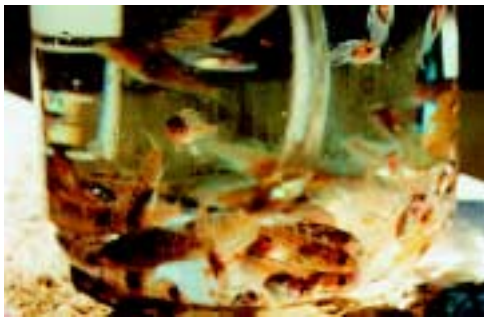


Below is a circular cage design in clover cluster. The frame has the advantage of equal resistance since there are no corner connections. However, it could not be subdivided into smaller compartments.

SECTION 4 How to collect, handle and transport grouper seed

Grouper culture in ponds or cages is largely dependent on fish seed from the wild due to low or inconsistent fingerling production in hatcheries, arising from diseases, cannibalism, lack of suitable natural food for larvae, broodstock availability and other problems.

What is meant by grouper seed?

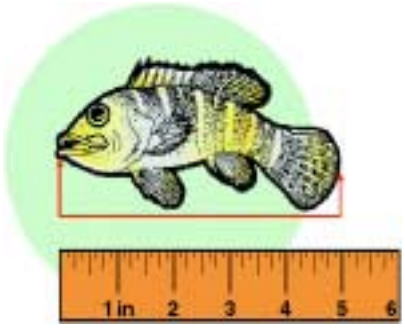


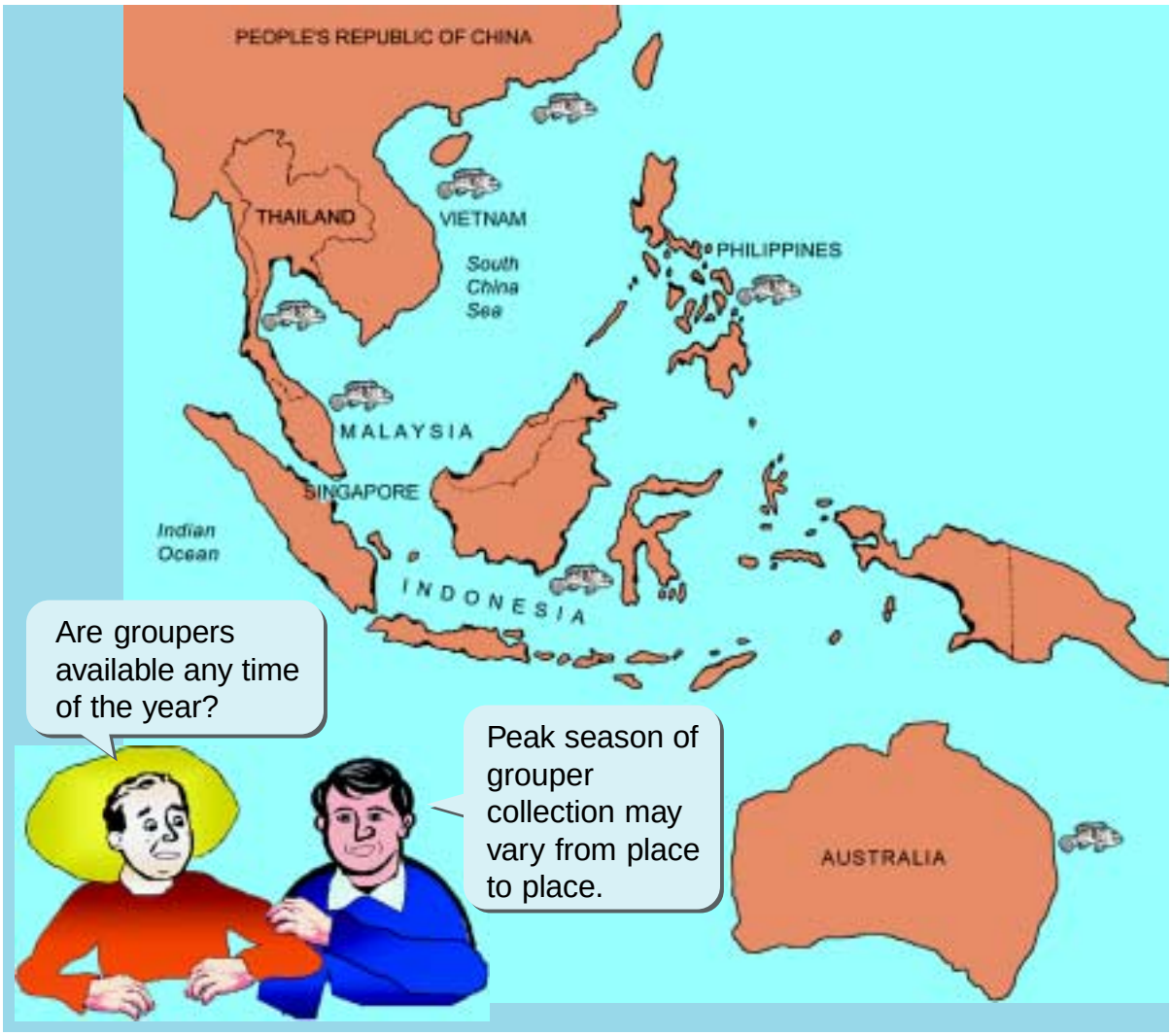
Grouper seed is a collective term that includes:

Postlarvae – transparent, brownish or reddish unscaled fish 1.0-2.5 cm (< an inch) in size and sometimes called “tinies.” They are collectively referred to as seed or fry.

Metamorphosed fry – scaled fish, darker than postlarvae, measure 2.5-7.5 cm (1-3 inch), with a single continuous dorsal fin, elongated second dorsal spine and pelvic spines.

Fingerlings – usually 7.5-12.5 cm (3-5 inch), color and appearance starting to follow the market sized stage. Size is often measured from tip of the mouth to the end of caudal fin.



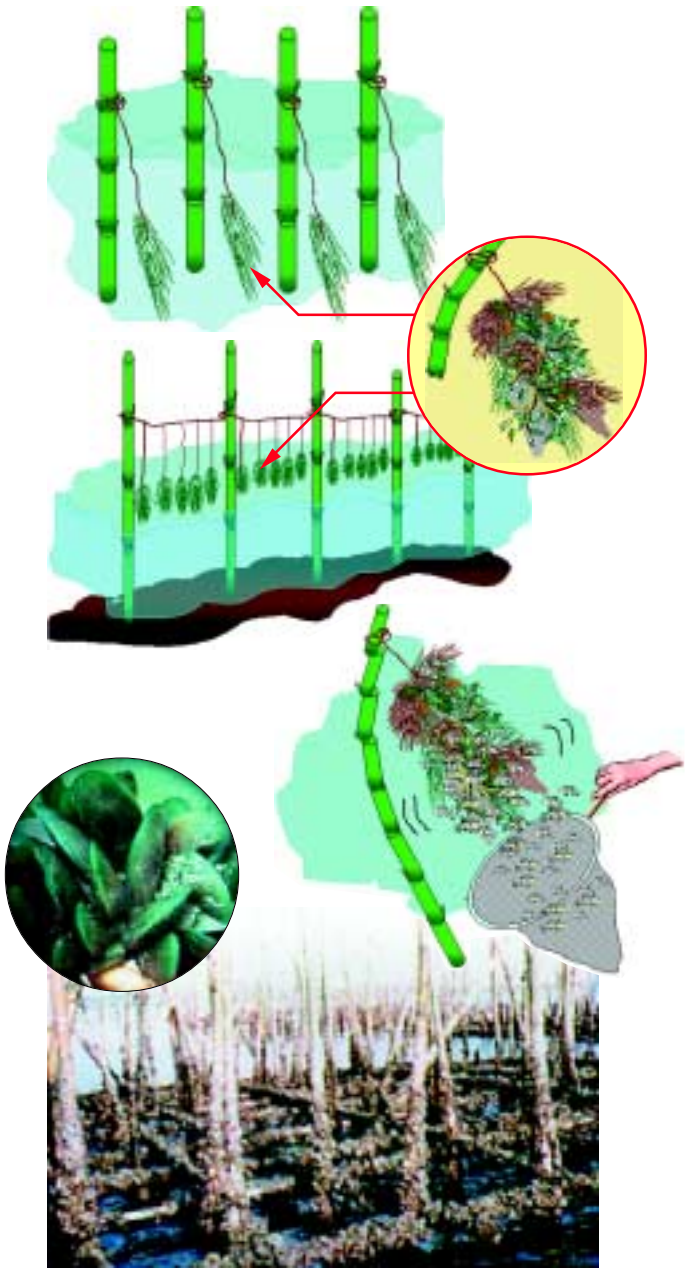


Collection area	Month	Grouper size
Peninsular Malaysia, east coast	**November to April**	Average **2 cm**
Indonesia (e.g., Banten Bay)	**February to April**	Fry
Thailand, southeast coast (e.g., Songkhla and Pattani)	**October to March**	**1-2.5 cm** fry
Thailand, coastal waters near mangrove areas	**January to March**	**7.5-10 cm** fingerlings
Andaman Sea	**May to December**	
Philippines: variable peak season in different provinces (most with 1-2 peak seasons; some with 3-4 seasons per year depending on rainfall)	**Peaks mostly in June to December** or **October to November** and **April to May**	Tinies, fry and fingerlings
Vietnam (north region)	**March to July (peaks April-May)**	Fry
Vietnam (central region)	**March to August**	Average size, **5-10 cm**
China, Guandong Province	**March to August**	

Collection gears

Different kinds of gears are used for grouper seed collection, at least 10 of which are used as major devices in one country or more. Gears may be grouped into passive or active types. Some of the gears that provide significant seed catch are illustrated below. Variations in design or modifications in these gears may be found.

PASSIVE GEARS are devices that are installed or left for a period of time in a known fish habitat to allow fish to gather inside, either alone by tidal action, current drift or by being trapped while swimming. Examples of passive gears are fish shelters, lighted boat with fish shelter, fish nest and fyke net.



Fish shelters (fish trap, bush park, bush pile, fish aggregating device) are used in China, Malaysia, Philippines, Sri Lanka, Thailand and Vietnam.

- Twigs, nets, ferns, grasses (30-50 cm long) and other materials are attached to bamboo poles or sticks (at least 1 meter long). Fish shelters are used mainly for collection of postlarvae and fry.

- Set these shelters on the bottom of shallow areas (coastlines near reef islands, reef flats, river mouths, mangrove estuaries) up to 1-2 m deep. Install singly or hang 10 to 30 shelters (e.g., up to 30 traps per 5 meter rope in Malaysia) from a rope supported by bamboo poles or anchor bags.

- After leaving the fish shelter overnight in the substrate, harvest by lifting and shaking it gently to collect groupers into a scoop net. For night harvest, use a light before pulling the shelter up.

- In mussel culture areas in the Philippines, the mussel clusters serve as attractant for tinies.

Fishers usually encounter few problems with this gear except when a high number of fish is harvested, requiring immediate transport to holding cages or tanks. Sorting becomes a problem when unwanted species mix with the harvested fry. As with most gears, careful handling is required to minimize mortality.

Lighted boat with fish shelter is used in the Philippines.

- Hang a series of fish shelters into ropes attached to the outrigger of a pump boat. Anchor the boat in 3-6 meters (10-20 ft)-deep clear coastal water, along bays or coastlines near reef islands. An average pump boat can carry as much as 40 shelters hanging from each outrigger.
- Use this device mainly to collect postlarvae or fry.
- Harvest at night by installing light on the boat near the supporting wood of the outriggers.
- Half an hour after lighting, test one shelter by lifting it up slowly into a scoop net. If tinies are in good number, harvest all shelters consecutively.

Use of light in fish shelters in the Philippines is a matter of convenience for night time harvesters and has not shown significant difference in number and quality of fish collected at daytime using the same collecting device.

Fish nest or small fish-aggregating device is used mainly in the Philippines.

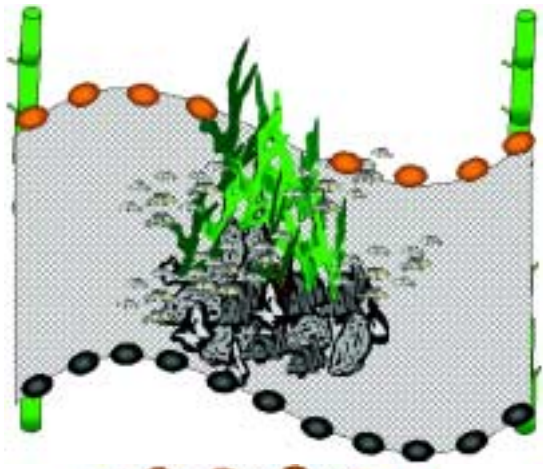
- Use crisscrossed wood or rocks, or combine with PVC pipe cuttings, bamboo sections or other shelter materials to build a fish nest. Use mangrove trunks or branches, preferably species of *Avicennia* and *Ceriops*. These last 4-5 years. Use wood on muddy bottoms and rocks on sandy substrate.

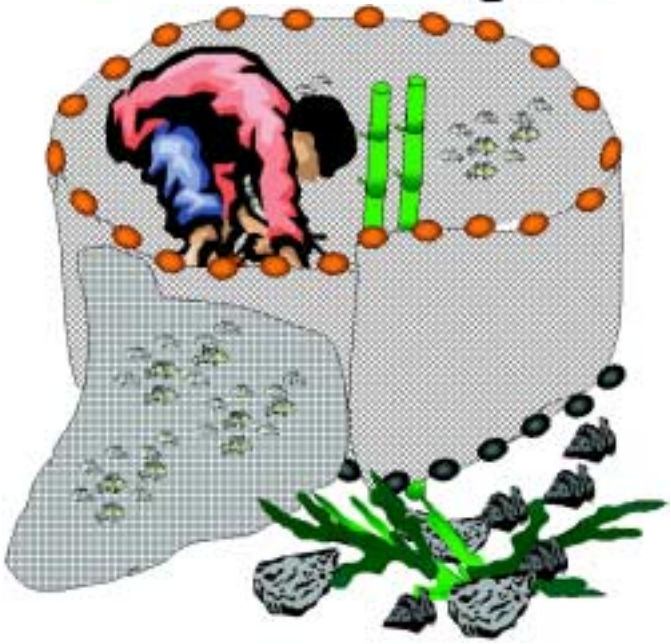
- Install fish nest in mudflats and estuaries. Fish nests are used mainly for collection of fry and fingerlings.

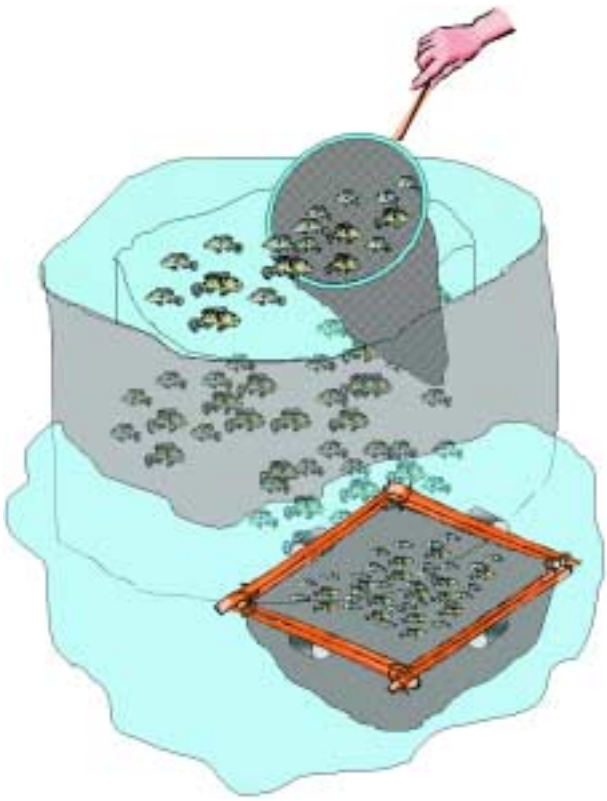
- Construct or harvest fish nests during low spring tides when it is easy for fishers to go on foot, where the water is no deeper than an average person's neck. Depending on area, employ 2-3 people to construct two fish nests per day.

- Fish nests are sometimes associated with artificial reef projects, except that fish nests are found in shallow coastal areas or mangrove estuaries.

- Start harvesting 2-3 months after construction when organisms that attract fish are well-established. Schedule harvest once every 2-4 weeks during very low spring tides in fry season.







- Before harvesting, install a short beach-seine-like net that is 1.5 meters or more in height, 6-8 meter long, with 1.5 cm stretched mesh to encircle the nest. Keep the net upright by using 2.5 meter bamboo poles at both ends. Attach sinkers to the bottom and keep the top of the net above water by floats. Join the two poles to collect trapped fish.

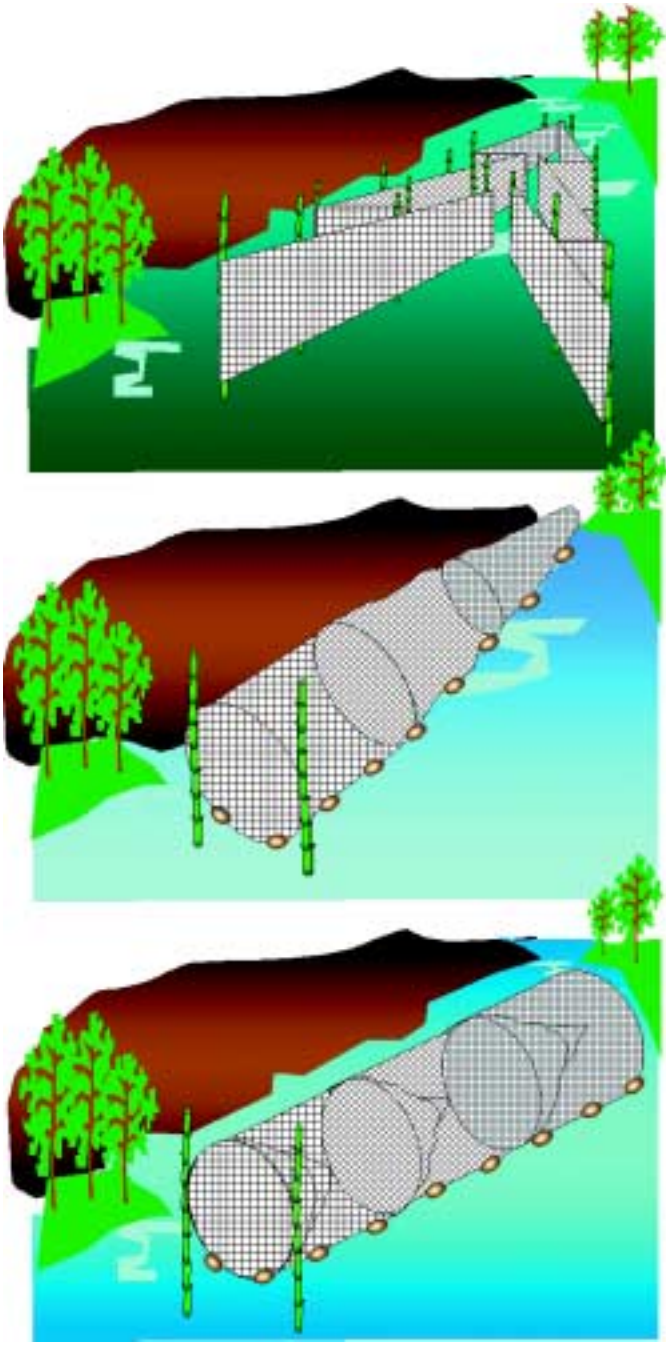
- Remove nest materials, then chase fish into the pocket of the harvest net. An experienced fisher can harvest 1-2 nests during very low spring tide, but in many cases, at least one partner assist the fisher.

  Gather the harvest net up, undo the pocket and sort the fishes collected. **Handle fish by-catch properly so that unwanted species can be returned live back to sea.**

- If more nests need to be harvested, temporarily hold harvested fish in a small floating net cage. Construct a square cage (e.g., 1m W x 1m L x 0.5m D) or a modified design, using fine mesh net with styrofoam or bamboo floats. If only one nest is opened, place harvest directly in a container on land. The floating cage may also be used to temporarily store grouper seed harvested using other collection gears.

  One problem with this device is usually the high percentage of fish by-catch as the gear can attract other species. Again, with proper handling, fishes can be sorted and other species can be returned to the sea. It is easy to sort harvest in this gear because bigger sizes of fish are usually caught.

Fyke nets (set net, river set net, stow net) are used in Malaysia, Philippines, Thailand and Vietnam.



- Install a series of cylindrical, conical, or triangular nets in river mouths during high tides (often two days before new moon) when the current is flowing. The fyke net is used to collect all stages of grouper seed.
- Hold fyke nets to the substrate with hooks, sinkers and bamboo support along the bottom edge of the front opening. Suspend fyke net from the surface with a rope and floats, with stake support in front. Use three mesh sizes, starting with bigger-mesh at the aperture followed by medium and finally finer net at the end.
- Fyke nets can easily obstruct river mouths and estuaries, especially when net dimensions increase, thus endangering entire runs of tiny or small fishes. This device can benefit a few people and has been banned in some municipalities in the Philippines.

Fish other than grouper (by-catch) must be handled carefully and returned to the sea.

Other passive gears:

Miracle holes (used in the Philippines)
Bamboo shelter or PVC pipe shelter (Malaysia, Philippines)
Mangrove net (Philippines)
Lift net (Philippines)
Fish trap (most Asian countries)
Fish corral (Philippines)
Gill net block (Thailand)

ACTIVE GEARS are devices that collect or search fish through movement and manipulation (e.g., pushing) of the gears by a fisher. The most common active gears are scissors net and push net.

Scissors net (drag net, push net) is used in the Philippines, Sri Lanka and Thailand to collect postlarvae and fry.

- Scissors net for groupers is a modified version of that commonly used for milkfish fry, where "shoes" are fitted to the bottom of the poles to enable it to be pushed along the sea bottom. Attach a triangular net to the crossed bamboo poles.

- Push the scissors net like a lawnmower in shallow waters near shore or in estuaries at low tide. In one lifting of the net, 5-10 groupers can be harvested. In one day, a fisher can get an average of 500 small groupers.

- In some areas, scissors net is declared illegal because of its destructive effect on the bottom. Areas scraped by scissors net for several months are visibly bare and deprived of grasses, shells and other organisms that used to be commonly found there. Fishers report that their catches are gradually decreasing with the use of this gear.

Push net (fry dozer, bulldozer) is used in the Philippines, Sri Lanka, Thailand and Vietnam.

- The gear is used for collecting postlarvae and fry.

- It is operated in small vessels in bays and rivers in Thailand. In the Philippines, the gear is used largely for milkfish fry collection.

- The problem with this gear is the high likelihood of by-catch since it sweeps everything in the water that fits the collecting device mesh size.

Other active gears:

Scoop net (used in most Asian countries either as primary collection gear or as secondary tool for other grouper collection devices)

Hook and line (most Asian countries)

Long line (Indonesia)

Beach seine, purse seine, trawl

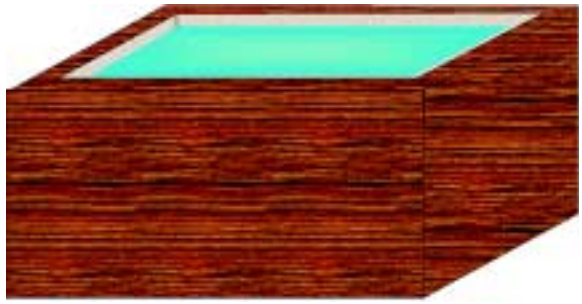
Cast net or zipper (Philippines)

Handling and holding facilities

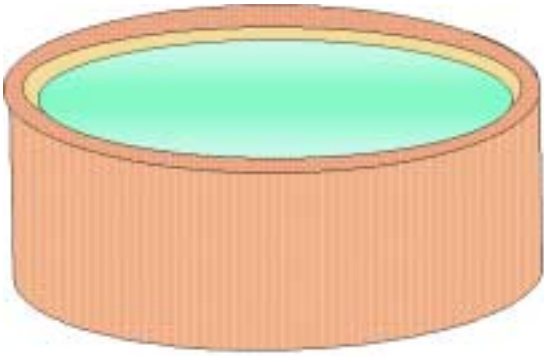
Newly caught grouper seed from the wild are temporarily held in aerated small containers such as basins or 30 cm (1-foot) deep tanks.

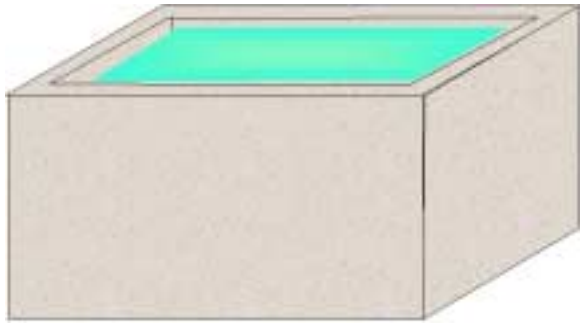
Basins are preferably plastic and white in color.

Sealed wooden tanks are made of marine plywood.



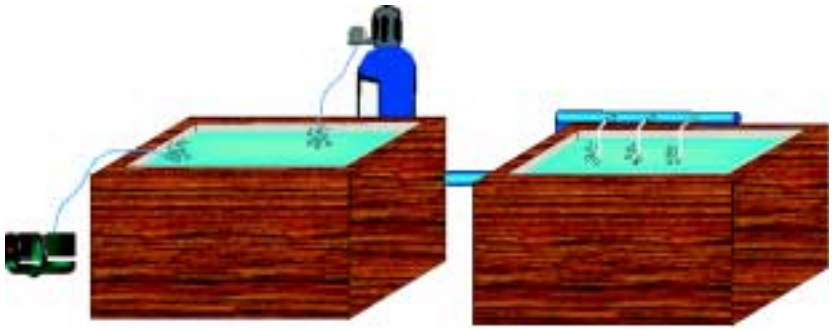
Fiberglass tanks and small concrete tanks are especially fabricated tanks to hold various sizes of groupers.





These basins, wooden tanks, fiberglass tanks and small concrete tanks are all provided with aeration, either simple portable aerator or compressor.

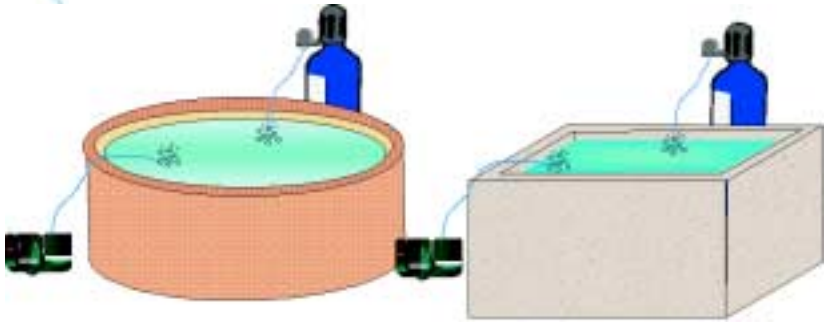
Electric compressor or blower



Aerated wooden, fiberglass and concrete tanks

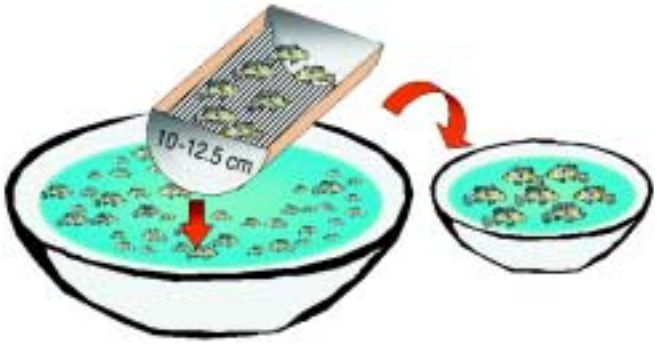
Portable aerators

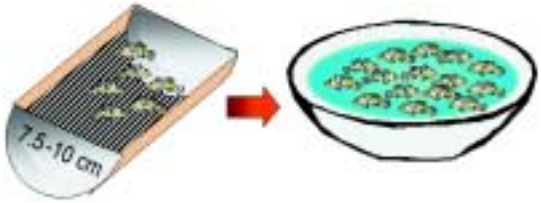
Oxygen tank

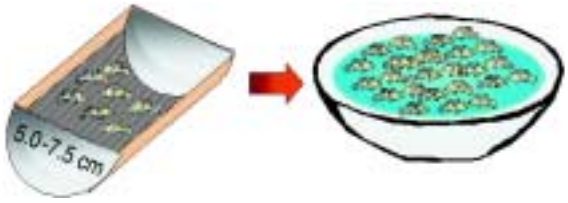


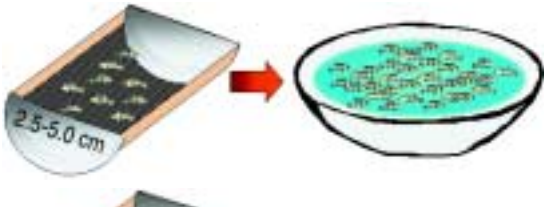
After collection, sort and segregate seeds according to size to prevent and minimize cannibalism. The stages and their corresponding sizes are:

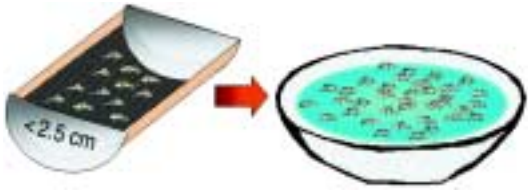
Type	Grouper size
postlarvae or tinies	**< 2.5 cm**
fry, small	**2.5-5.0 cm**
fry, big	**5.0-7.5 cm**
fingerlings, small	**7.5-10 cm**
fingerlings, medium	**10-12.5 cm**











Here's how :

- fill basins or tanks with seawater
- select size of colanders appropriate to size of fish
- scoop the fish gently and pour to colander floating in the basin or tank
- lower the colander and lift slowly so that only bigger fish that can not pass through the grid will remain inside the colander
- scoop out "shooters" and transfer to another basin or tank
- repeat the procedure until you have segregated about five different sizes of fish.

Utmost care must be observed to prevent injuries!

Disinfection and conditioning of wild-caught seed

Fish caught from the wild may carry harmful microorganisms. Newly collected fish can be disinfected by a freshwater bath treatment at the collection site or in the facilities of fry brokers.

- Disinfection of sorted fish is done by placing newly collected fish in aerated tanks or basins containing **freshwater** for **15-30 minutes**. Observe the fish during the disinfection process.
- In case fish are slightly wounded, isolate and place them in holding tanks or cages provided with shelters. Hold the fish here until they recover.

For badly affected fish, they may be treated based on disease manifestations **(refer to pages 65-87 for treatment of specific diseases)** through the guidance of a fish health specialist.

- Stocking density, water management and feeding of grouper in holding tanks or cages are similar to that of nursery phase (refer to pages 38-41). The only difference is size of tanks for easier monitoring and treatment. Also, a regular, more frequent checking and sorting of fish is necessary so those that recover ahead can be immediately transferred.

Transport procedures and packing techniques

Should I feed the fish before transport?

Do not feed the fish for at least **24 hours** prior to transport. Place unfed fish in holding tanks with shelters to prevent stress.

To pack the fish, use a double layer of clear flat, square, or rectangular-bottomed plastic bags **(100 cm x 65 cm x 0.11 mm)**.

Recommended density of fry/fingerling to be transported for at least 8 hrs at 20-22°C:

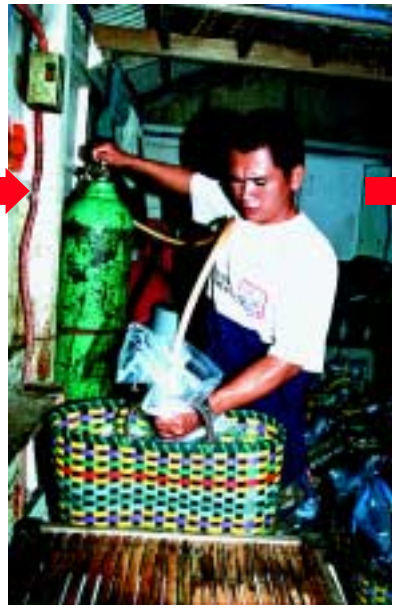
2.5 cm (1 in) size	–	100-150 fish/L
5 cm (2 in) size	–	30-50 fish/L
7 cm (3 in) size	–	10-15 fish/L

Fill plastic bag with **7-8 liters** of filtered, seawater that has been cooled to **20-22°C**.

Pack fish not greater than **120 g of fish** per liter of water.

THINGS TO DO

Avoid overcrowding.



Inflate the bags to contain **50-70% oxygen** by volume.

Tie inner and outer bags with double rubber bands.

Place one bag in styrofoam or cardboard box that measures **38 x 38 x 19 cm** or **48 x 36 x 32.5 cm**.

Place ice gels or ice in sealed plastic bags on the outside layer to keep the bags cool.

Try to prevent stress during transport. Fish to be transported should reach the destination early morning or late afternoon.

Transport fish in cool conditions, or if possible, in an air-conditioned vehicle until the shipment reaches its destination.

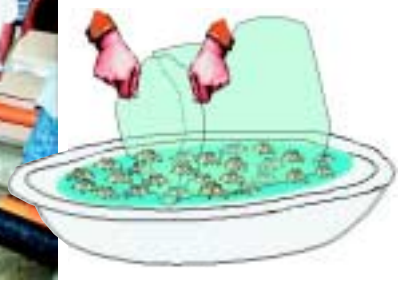
For *Cromileptis*, segregate the packed fish using newspapers or other opaque barriers between bags to avoid aggressive behaviour during transport.

Upon arrival at the farm site…

Do not expose transport containers with fish to direct sunlight.

Open the boxes gently in dim light to avoid startling the fish.

- Allow unopened bags to float in the holding facility with seawater for **10 minutes** to equalize water temperature in the bag and tank and the fish to the new environment.
- Release fish gently with mouth of bag underwater.



If water quality is poor or if sea current is strong, do not release fish into the cages. Keep them in holding tanks.

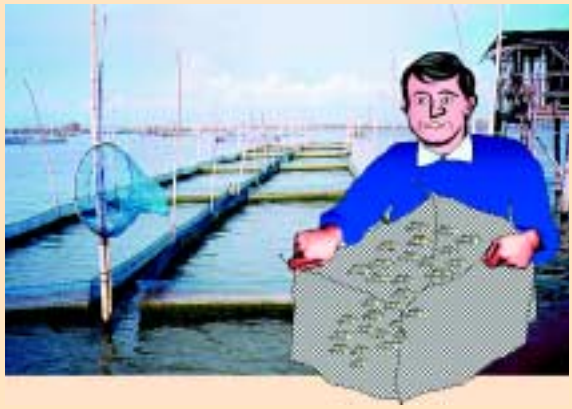
SECTION 5 How are groupers cultured?

Operation and management for grouper culture is straight forward. It involves the nursing of 2-3 cm (1 inch) wild-caught fry either in tanks or hapa nets until it reaches 6 cm (2 inches). At this stage, the fingerlings are transferred to earthen ponds or net cages for the grow-out phase.

Nursery phase in hapa nets

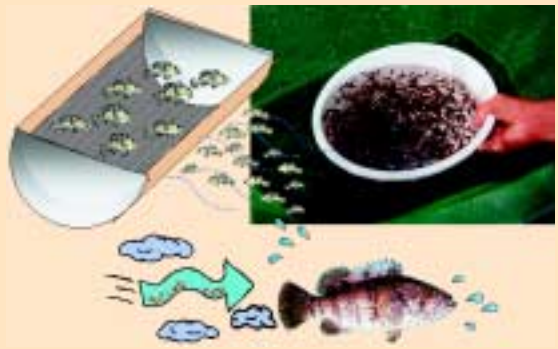
- Hapa net of size **1 x 2 x 1.5 meters** is set in ponds or inside floating net cages. Mesh size is usually **1-2 mm**. Hapa nets are preferred because they are more economical and easy to handle during size-grading.

Stocking density



Stock postlarvae (**<2.5 cm**) in hapa nets at **1,000-2,000** individuals per net.

Sorting and grading



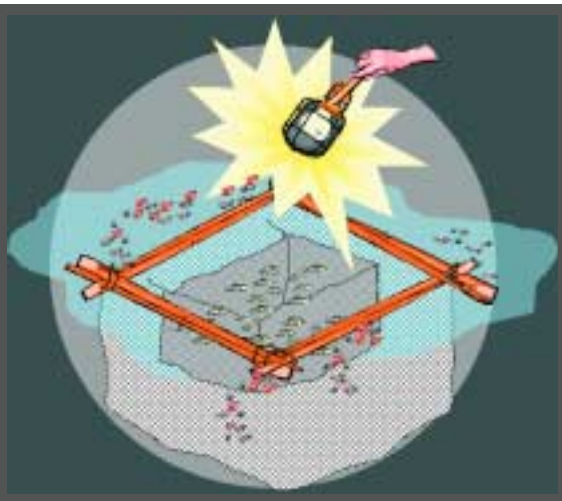
Grade the fish every **5-7** days and transfer “shooters” in a separate hapa net to prevent cannibalism. **Minimize exposure of fish to air**.

Net Maintenance

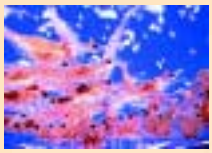
Avoid mechanical stress during grading by using mechanical size graders or nets.

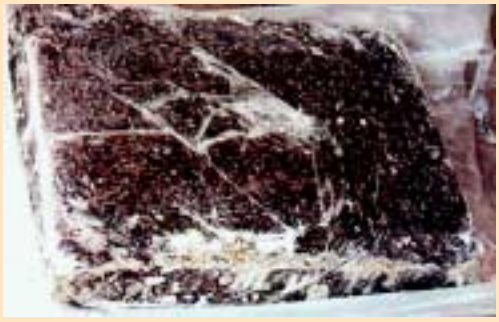
Clean hapa nets properly and inspect for any tear or damage during size grading.

Feeding



Place lamps at the center of hapa nets at night to attract grouper prey such as copepods, mysids and small fish or crustacean larvae.





Frozen or dried small shrimps *(**Acetes**)* may also be given.

Feed to satiation with finely chopped frozen or fresh fish mixed with vitamin-mineral premix at **1-2%** (1 kg trash fish: 10-20 g vitamin and mineral mix) **4-6** times a day. The size of feeds should be appropriate to the mouth size of the fish.

Mix finely chopped fish with formulated fish powder to acclimate grouper fry to pellets.

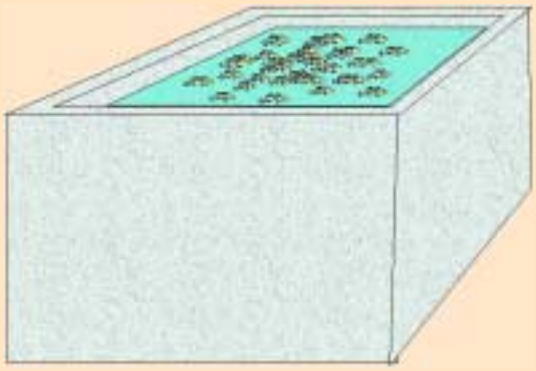
Nursery phase in tanks

Nursery tanks vary in size from **2** to **10 tons**.

nursery tanks

flow-through nursery tanks

Stocking density



Stocking density of **< 2.5 cm** fry varies from **50-200** individuals/m^3. Higher density **>1,000 m^3** can be used in flow through or recirculating water systems.

Sorting and grading

Grade the fish every 5-7 days and transfer "shooters" to a separate tank. Avoid mechanical stress during grading. **Minimize exposure of fish to air.**

Feeding and maintenance

At the start, feed with adult ***Artemia*** (brine shrimp). Feed to satiation with finely chopped frozen or fresh fish mixed with vitamins **4-6** times a day. The feed size should be appropriate to fish mouth. If possible, feed with live **mysid, small shrimps or mosquito larvae** at daytime. Wean the fry to pellet feeding by mixing chopped fish with artificial feed.

Siphon out uneaten feeds and feces, and change at least 50% of water daily. If possible, adopt a flow-through or recirculating water system to maintain or improve water quality.

Tank maintenance

Clean the tank properly during size grading.

Size of fish will reach more than **6 cm** after **45-60** days. At this stage, fish can be transferred to grow-out ponds.

Grow-out phase in earthen ponds

After pond preparation, what then?

Once natural food is abundant in the pond, stock adult tilapia to produce fingerlings to serve as live prey for groupers.

Stocking density

Stocking density of tilapia: **5,000-10,000**/ha

Stocking density of grouper fingerling **(about 6 cm TL)**: **5,000-10,000**/ha

Stock grouper fingerlings at least a month after the release of adult tilapia. If nursery rearing of grouper was not done in the same pond, stock **100-200** grouper fingerlings temporarily in **2 x 2 x 1.5** meter net cages placed in appropriate areas for weaning to artificial feeds. Slowly release the fingerlings into the ponds as soon as they have adjusted to the feed.

Sorting and grading

Sort and grade the fingerlings weekly, to prevent cannibalism and minimize competition for space and food. Extra net cages are necessary to accommodate the segregated and graded stocks.

Feeding

If tilapia fingerlings are abundant in the pond, feed with chopped fish daily at **5%** average body weight (ABW) with half of the ration given early in the morning and the other half late in the afternoon.

If tilapia is not available in the pond, feed with appropriate fresh or frozen chopped fish daily at **10%** ABW or pelleted feeds at **3%** ABW with half of the ration given early in the morning and the other half late in the afternoon. When the fish weighs about **200 g**, feeding may be reduced to once daily with fresh or frozen chopped fish at **5% ABW** or pellets at **2% ABW**.

Water management

Change the water by taking advantage of spring tides or pump water from reservoirs if needed. Water change is done at least 2x a week, 20-50% by volume depending on water quality.

- water with green color is better

Provide paddle wheel aerators when dissolved oxygen (D.O.) falls below **4 ppm**. If aerators are not available, change at least 50% of the water or agitate the water manually by using paddles.

Maintain the following water parameters during rearing:

- **pH 7.5-8.3**
- **Temperature 25-32°C**
- **Salinity 20-32 ppt**
- **Dissolved oxygen (D.O.) 4-8 ppm**
- **NO_2-N (Nitrite nitrogen) 0-0.05 ppm**
- **Unionized ammonia (NH_3-N) < 0.02 ppm**

Grow-out phase in floating net cages

Stocking density

- Stock **15-20 fishes / m^3**
- Higher stocking density is not recommended because fishes become more susceptible to diseases. Higher organic load can reduce available oxygen and can be stressful to fish.

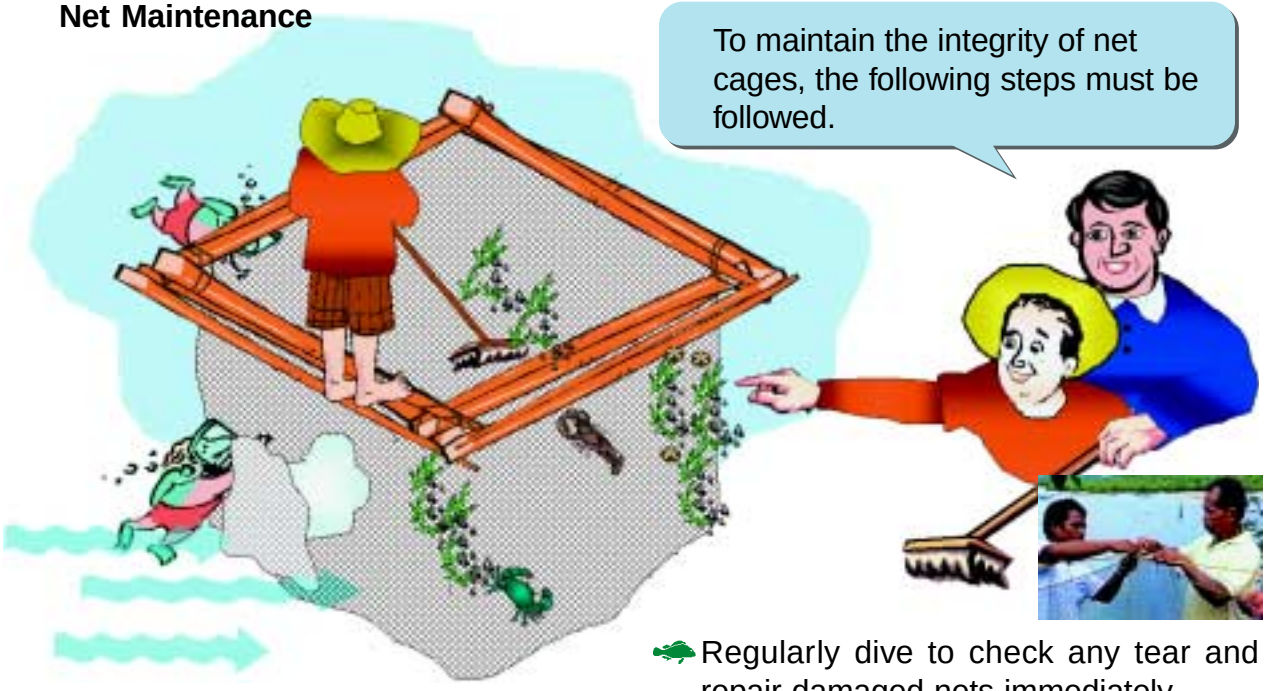
Sorting and Grading

- Grade the fish at least once a month. Change the nets during each grading.
- Avoid mechanical damage during grading by using graders and fine, soft, knotless scoop nets.

Feeding

- Feed the fish with fresh or frozen chopped fish daily at **10% ABW** or pelleted feeds at **3% ABW** with half of the ration given early in the morning and the other half late in the afternoon.
- When fish are about **200 g**, reduce feeding frequency to once daily with fresh or frozen chopped fish at **5% ABW** or pellets at **2% ABW**. Feed should be given in small quantities, enough for fish to swallow when they come up during feeding.
- Use fresh trash fish if possible. Frozen feeds should be properly thawed before feeding. **DO NOT USE RANCID, ROTTEN or SALTED FISH** as feeds.
- Add 0.5% vitamin and mineral premix to trash fish.

Net Maintenance



- Regularly dive to check any tear and repair damaged nets immediately.
- Net fouling could be minimized by cleaning the nets with a stick brush.

- Stock about 15-30 pieces (the number depends on cage size) 7.5-12.5 cm (3-5 inches) rabbit fish in each cage to minimize net fouling by macroalgae. Rabbit fishes (siganid) are herbivores and grazers.
- Remove drift wood and other floating debris that could damage the nets.
- Ensure sufficient water exchange by changing nets clogged with silt and fouling organisms such as algae, oysters, mussels and barnacles.

- Net cages should be inspected of any damage before use. If net change needs to be done before grading due to excessive fouling, avoid unnecessary handling of the fish by lifting the old net slowly to one side. Insert the new net below the old net. Slowly transfer the fish while lifting the old nets.

Plankton bloom and net fouling

- Generally, the smaller the net mesh size, the faster the fouling such that:
  - for **8 mm mesh size**, fouling occurs **after one week**
  - for **25 mm**, fouling occurs **after two weeks**
  - for **38 mm**, **after two months**.

- Net fouling is triggered by rainfall and run-off which increases the nutrient load of the water. It also:
  - decreases water circulation
  - causes rapid pollution due to poor water exchange
  - results in fish respiratory distress and mortality if gills are clogged with microorganisms in bloom or toxin from bloom.

- Floating net cages should be moved to a new site every 2-3 years of culture to allow deteriorating bottom conditions to recover.
- Duration of culture in grow-out phase is 4-7 months depending on the preferred size at harvest.

SECTION 6 How to harvest and handle grouper after harvest

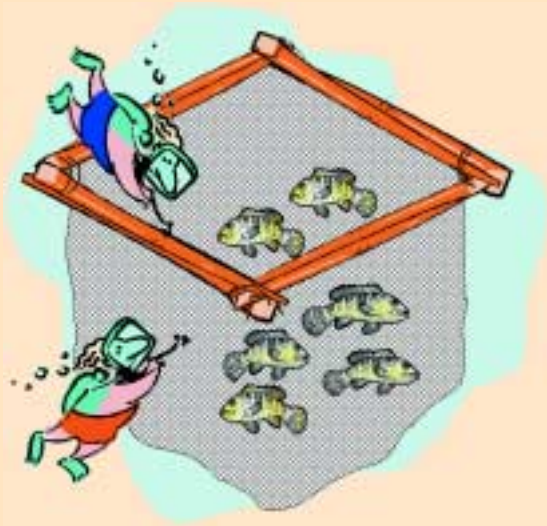
Grouper may be harvested when they are 400 grams or bigger depending on the desired size. Fish are marketed either live for the restaurant business and international market, or freshly caught for local wet markets.

Harvesting in earthen ponds

- Use a soft, knotless seine net to harvest the fish. Seine net should have enough rubber floats and sinkers.
- Harvest early morning or late afternoon. Disturb or agitate water 2 hours before harvest to prevent occurrence of rigid muscles in fish.
- Alternatively, modified lift nets installed in feeding areas may be used during partial harvest. Slowly lift these and transfer the harvested fish into net cages. The stocking density should not be more than **20 fish/m^3**.

Harvesting in net cages

Do not feed the fish inside the net cage **1-2** days before marketing. This also holds true for fish harvested from the ponds and temporarily held in net cages.



Before lifting the net cage for harvest, inspect net cage of any tear or damage to prevent fish from escaping.

Slowly lift the nets to concentrate the fish in one corner.

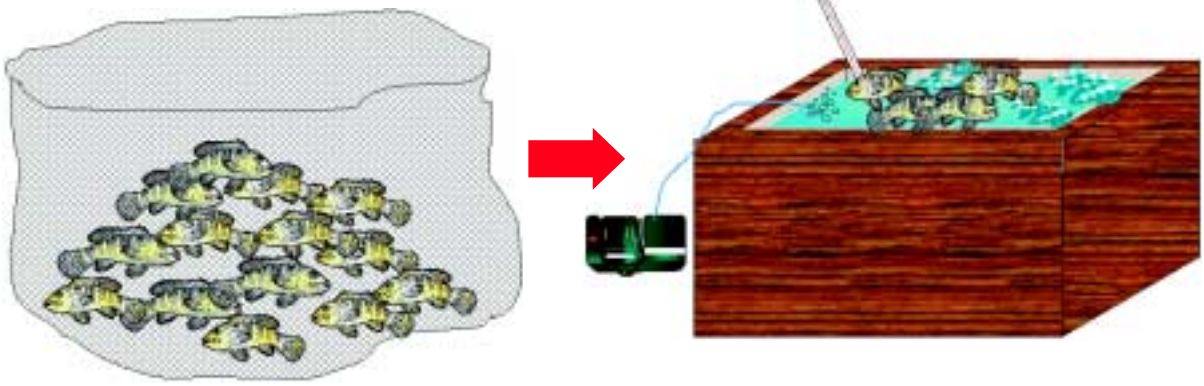
Use fine, soft, knotless scoop nets or soft plastic screens in catching the fish.

Avoid loss of scales and lesions on the fish during harvest since injured fish may be rejected by the buyer.

Packing and transport of live marketable fish

Fish can be transported live in plastic bags by these steps:

- Stock harvested fish in aerated conditioning tank.
- Slowly lower temperature to **20°C** (2-3°C/hour) by adding crushed ice in plastic bags or by use of cooling pumps.
- Lowering the temperature minimizes toxic metabolites of fish such as ammonia and carbon dioxide during transport.



- Put **3-5 fish** into a **20 x 20 x 30 cm** double lined plastic bags. Limit the biomass to **2-3 kg fish/bag**.

This method is recommended for transport by air not exceeding 8 hours after packing.

- Plastic bags should have **enough packing water** (20°C) to cover the eyes
- Add medical oxygen at **1:3** water:air ratio
- Seal bags with rubber band
- Pack bags in styrofoam boxes
- Add adequate amount of frozen gel packs or ice bags or frozen water in sealed plastic bottles wrapped in old newspapers to keep temperature low during transport

In Australia, a plastic storage bin is used to transport reef fish by air to Hong Kong, China. One bin is capable of holding **240 kg fish**. Temperature is maintained at **20-22°C**. Aeration is provided during transport.

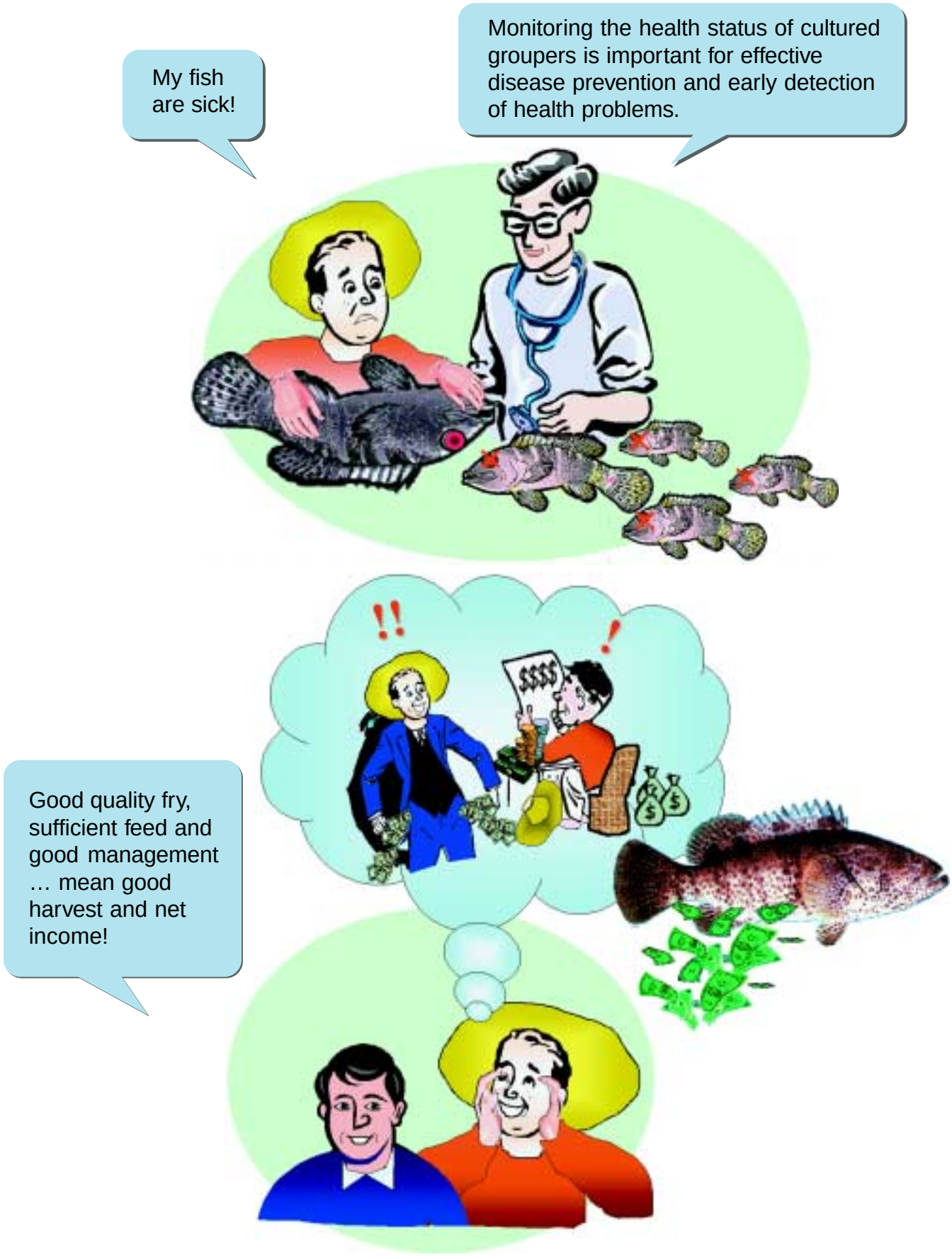
Fish can also be transported live in transport boats with large tanks provided with flow-through or recirculating water. The duration of transport can be from several days (inter-island) to **1-2 months** (other countries).

Marketing

Restaurants market live fish by setting-up an aquarium or tank with recirculating system, mechanical filters and protein skimmer.

SECTION 7 How to keep grouper healthy

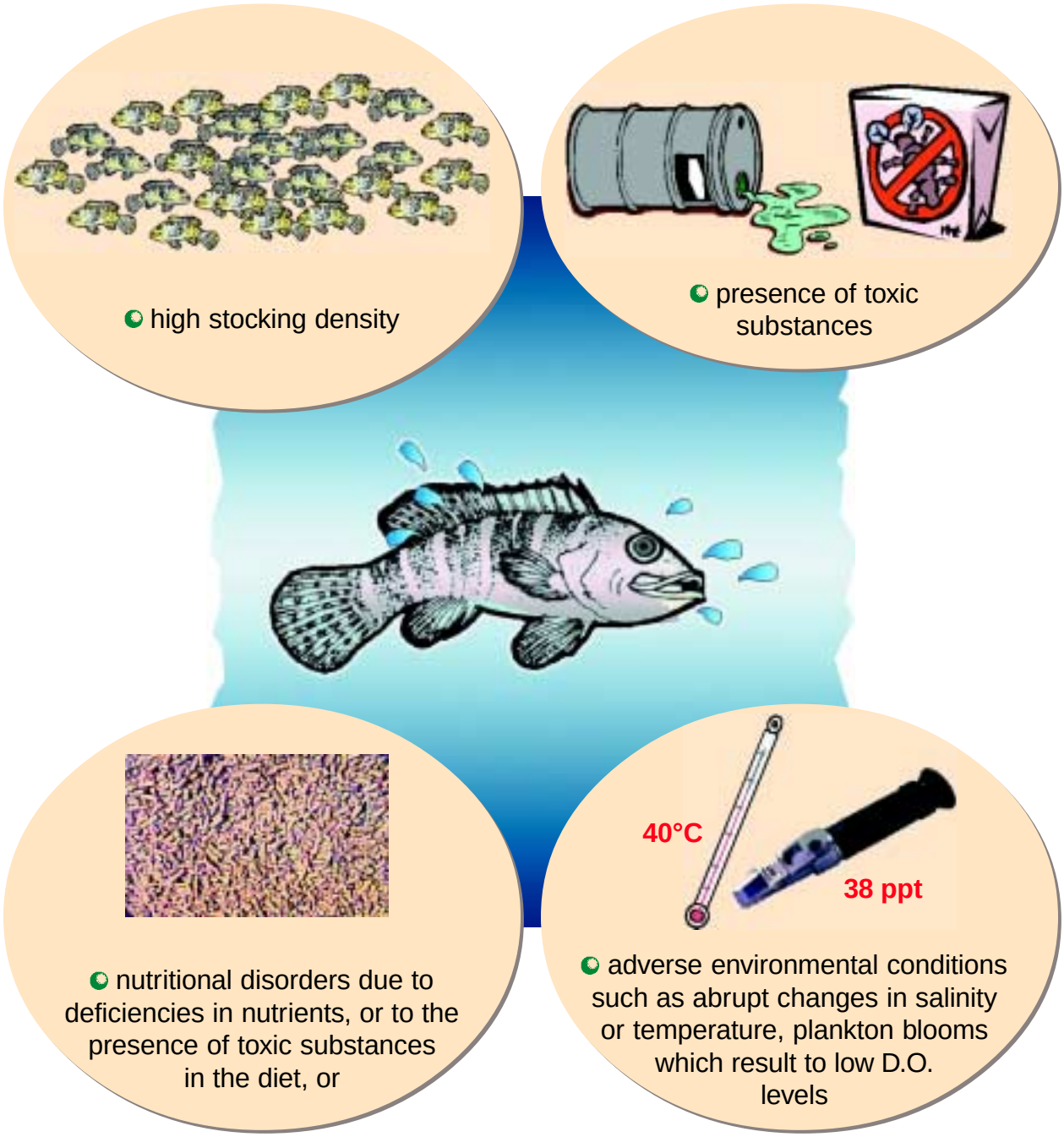
Monitoring of health status



Disease is defined as a disturbance in function or structure of any organ or part of the fish. It may arise for various reasons and it is common to find more than one cause of disease.

Causes of disease

- Disease can be caused by infectious microorganisms like viruses, bacteria, fungi and parasites.
- Disease can also be due to stress brought about by:

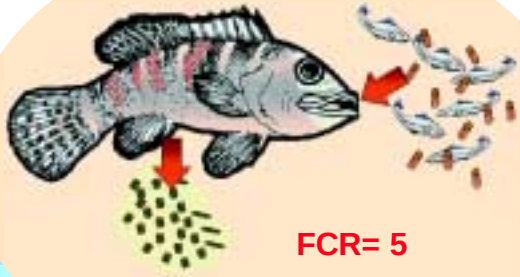


Effects of disease

Disease occurrence is costly to farmers because of economic and opportunity losses.

- Some of the negative effects of disease on the fish are:

- slow or stunted growth



- poor feed conversion ratio

- longer grow-out periods

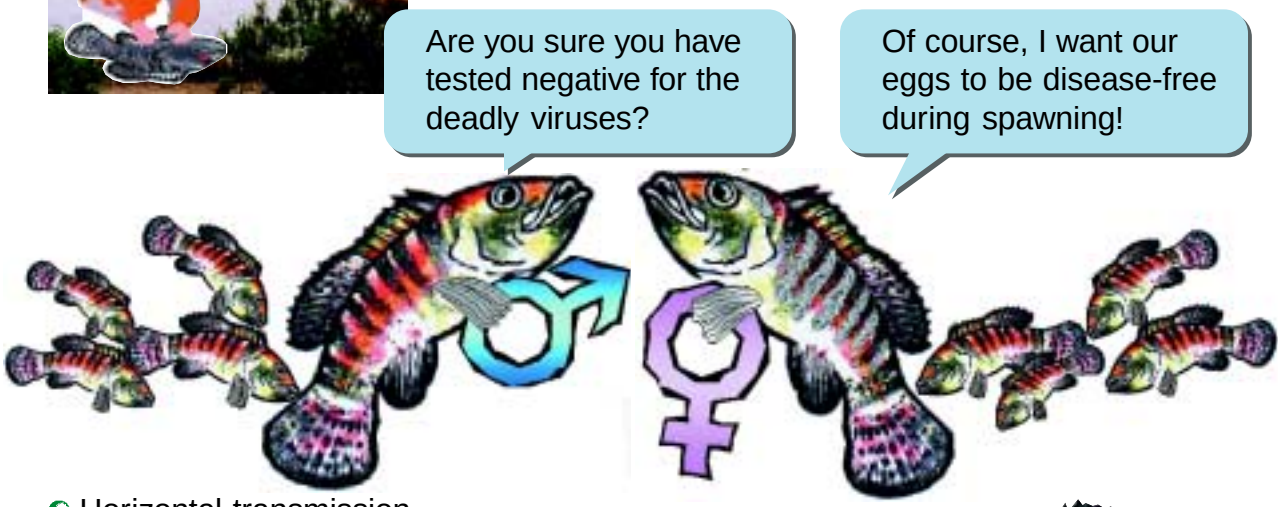
- unsightly body changes

If disease outbreak remains uncontrolled, it results to mortality and loss of valuable seed stock, especially for scarce and seasonally-occurring fish like grouper.

Transmission of disease

- Vertical transmission

Disease can be transferred vertically from parent to offspring through the eggs or sperm.



- Horizontal transmission

Disease can also be transferred horizontally through:

Water used during transport and culture

Artificial and fresh feeds

Other organisms found in the culture system and the environment

Important reminders about feed handling and storage

Trash fish

- Trash fish should always be given fresh
- Leftovers should be quickly frozen
- Frozen trash fish should be thawed properly before feeding

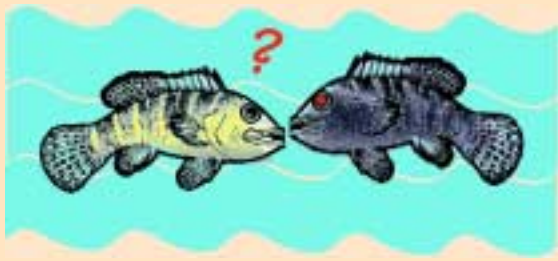
Artificial feeds

- Artificial pelleted feeds should not be stored for more than 3 months
- Keep the storage area cool and well ventilated to prevent molds from growing on the feeds
- Throw away moldy feeds as they contain toxic substances like aflatoxin, which may adversely affect the health of the fish

Fish oil in poorly handled fresh or artificial feeds may become rancid and oxidized causing the formation of toxic substances harmful to the fish.

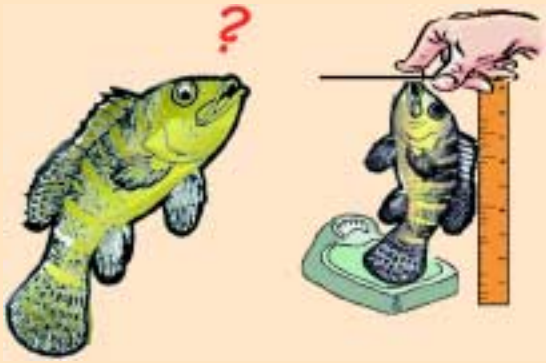
Signs of disease

Fish show several outward signs when they are sick like:



abnormal changes in color (generally, stressed fish are darker)

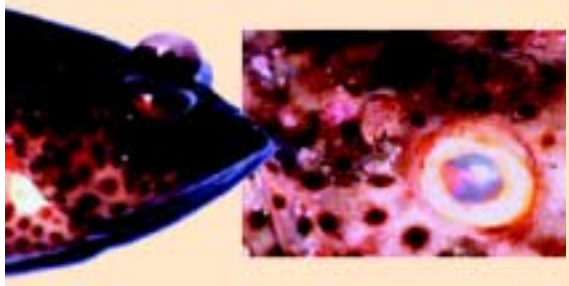
loss of appetite



retarded growth

abnormal swimming behavior

lesions and hemorrhages on the body



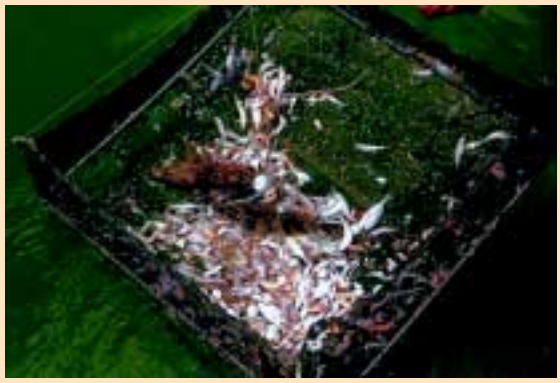
abnormalities in the anatomy

Signs of specific diseases are presented in the section "Common diseases of grouper" on page 65.

Surveillance and monitoring

This could be done by :

- regular monitoring of cultured fish, their feed and their environment;

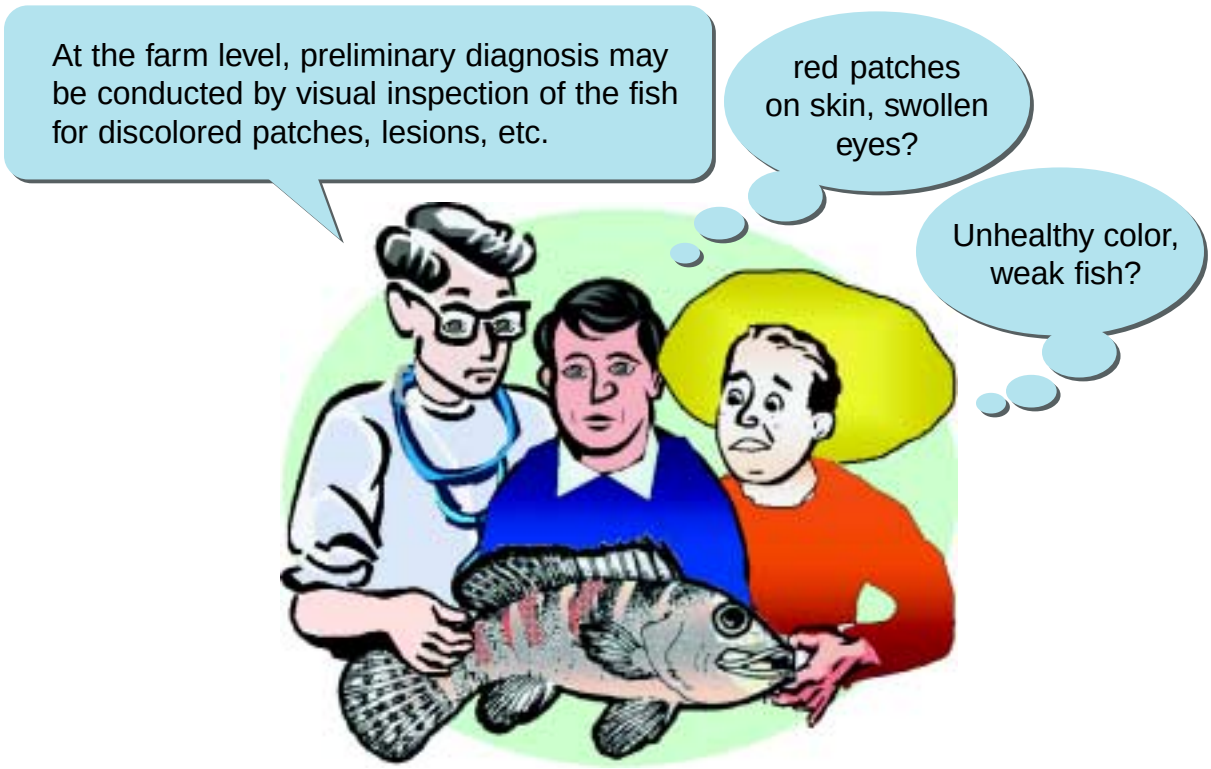


- good record keeping of stock size, pattern of mortality, treatments given, etc. These data are useful in computing growth, feed conversion ratio, and survival.

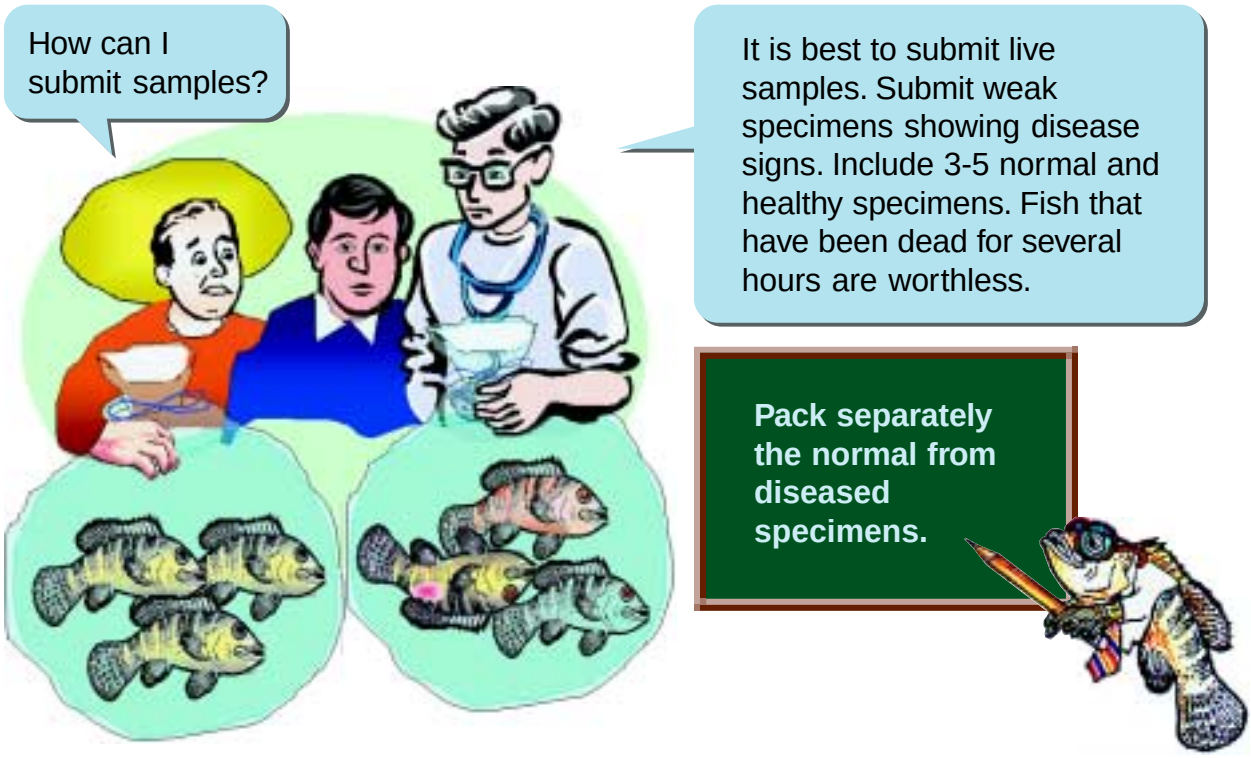
- removing floating and sinking dead fish to prevent the spread of more disease agents; or
- isolating diseased stocks.

Methods of sending specimens for diagnosis

When diseases or mortalities occur in the farm, samples for diagnosis should be submitted to an accredited laboratory. Correct diagnosis depends on accurate and detailed information on culture conditions and proper preparation of samples to be submitted to a diagnostic laboratory.



Submitting live samples



Transport live specimen in water-filled plastic bags with sufficient oxygen or aeration.

How much water is needed?

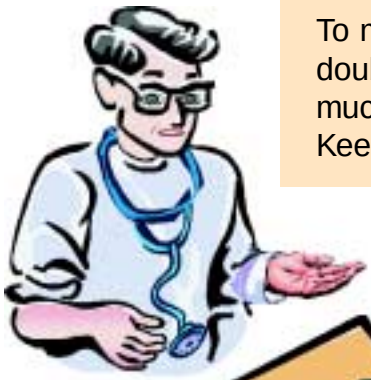
SICK FISH require greater volume of water than healthy fish. The minimum proportion is **20 parts water to 1 part fish**.

PRECAUTION

Use a double bag system to prevent leakage!

When transport conditions are **HOT**, fish may need to be shipped in **INSULATED** containers like styrofoam boxes.

To maintain cool temperature inside the box, **ICE** packed in double plastic bags should be provided. **DO NOT** add too much ice, as this would lower the temperature significantly. Keep temperature at 20-22°C.



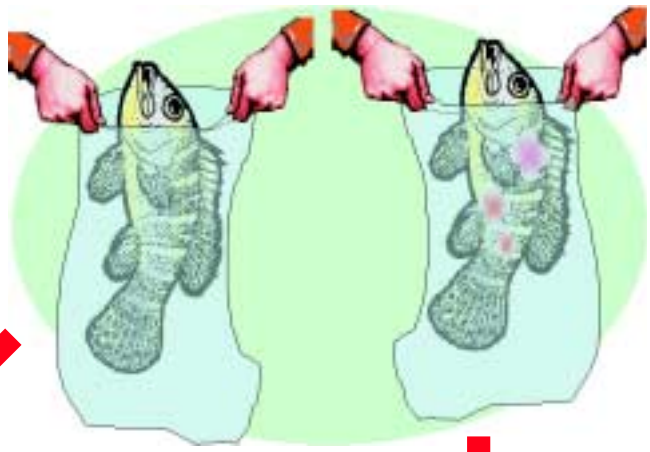
Do everything possible to ensure that specimens will get to the laboratory alive.

Sending iced samples

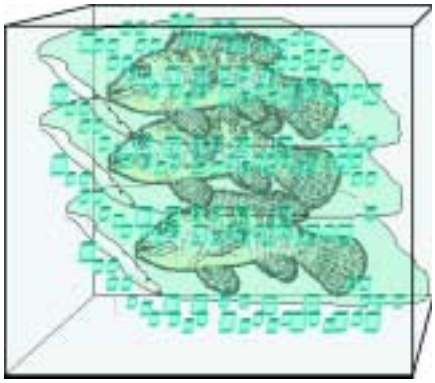
What if sending live specimens is NOT POSSIBLE?

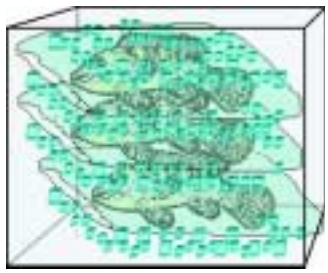
Submit **ICED or FIXED** specimens instead.

Obtain the same number of fish as in live samples and wrap them individually in plastic bags to **prevent water from damaging the tissues**. Separate normal from diseased specimens.



Place packed samples in between layers of ice in a styrofoam box or other insulated containers.





Make sure that specimens will reach the laboratory for analysis within 24 hours.

Submitting fixed samples

How about if specimens cannot be delivered within 24 hours?

Fixed samples are recommended. Obtain the same number of fish as in live samples and fix in **10% buffered formalin** solution in plastic or glass bottles.

First, make a longitudinal incision on the ventral side of the fish to facilitate penetration of the fixative.

Second, add **10%** buffered formalin.

Third, make sure samples are totally submerged in fixative. The ratio of fish to the fixative is **1:10** by volume. Close the cap of the bottles tightly to prevent spillage of fixative.

Formula for 10% buffered formalin:

Formalin	100 ml
Distilled water	900 ml
Sodium monobasic	phosphate, 4 g
Sodium dibasic, anhydrous	phosphate, 6 g

If sodium phosphate, monobasic or dibasic anhydrous are not available, use an equal amount of table salt.

What about **LARGE** fish?

Cut the fish into several pieces and send only parts that will be useful in the diagnosis.

First, cut the parts with external lesions.

Second, inspect and cut the head, tail, gills and internal organs if affected.

Third, put in a jar,add fixative, cover tightly and label specimens correctly.

Important reminders:

Include a detailed history of the disease case by providing details such as:

- signs of disease observed
- pattern of mortality
- date disease signs were initially observed
- water source, water management, and water quality conditions
- feed and feeding behavior, species, size or age group affected
- sketch of farm lay-out and number of ponds or cages affected in the whole farm
- new innovations in the system
- farms or industrial activities in the neighboring areas

Notify the laboratory by phone before sending the specimens. Send specimens by air or have them hand-carried.

Common diseases of grouper

Viral diseases

Viruses are the smallest of pathogens, generally less than 1/20th the size of bacteria. They invade living organisms, reproduce themselves within the host, and in the process, cause disease by damaging the host's tissues. In groupers, two major viral diseases have been reported: viral nervous necrosis (VNN) and iridovirus.

Affected organ	Signs	Effects
brain **eyes** **gills** **spleen and other internal organs**	dark coloration cork screw swimming pattern weak swimming pattern near water surface or on bottom occasional gasping for air from surface pale gill color	high mortality

High mortality could be minimized by preventing secondary bacterial infection.

It is possible for viral infections to set in when there is:

- Exposure to carrier fish, like infected broodstock or fry
- Salinity and temperature shock
- Exposure to poor environmental conditions, like heavy metals
- Handling and nutritional stress

Viral infection can be prevented by :

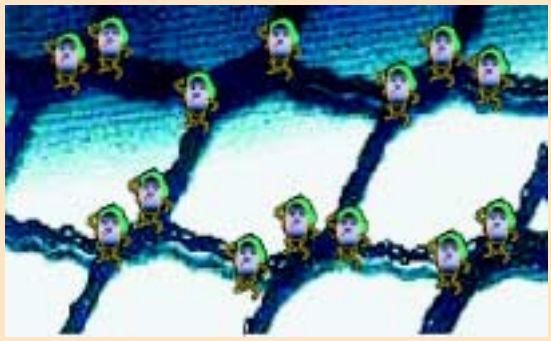
- Selection of fish that are not carriers of viruses. Engage the help of a laboratory for diagnosis of non-carrier fish.
- Disinfection of holding and transport tanks and other facilities prior to use.
- Minimizing stress during transport and stocking.
- Good rearing practices such as providing adequate nutrition and regular removal of weak fish from rearing facilities.
- Regulation of the trade of live fish and juveniles to prevent the spread of the disease in new areas.
- Quarantine and health certification of imported stocks.

Bacterial diseases

Bacteria are tiny organisms which cannot be seen without a microscope. Not all bacteria are harmful. They are considered opportunistic disease agents because they only cause harm to the fish when its health condition is compromised by poor husbandry and environmental conditions.

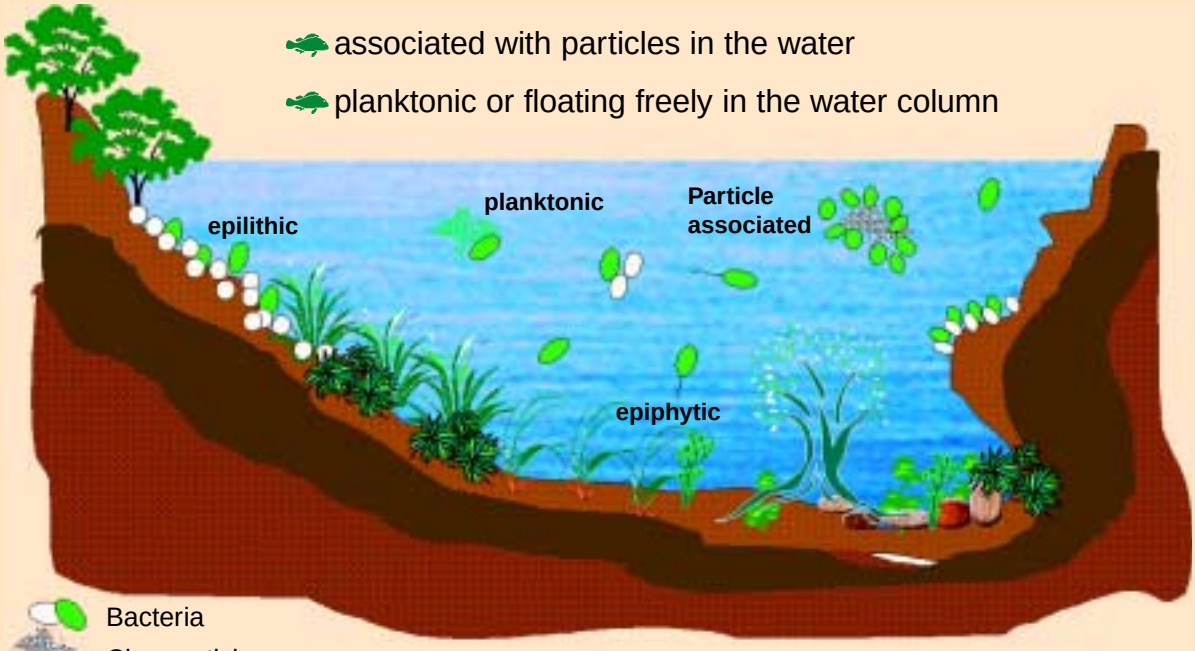
In the fish rearing environment, bacteria can be found :

- attached to the surface of nets



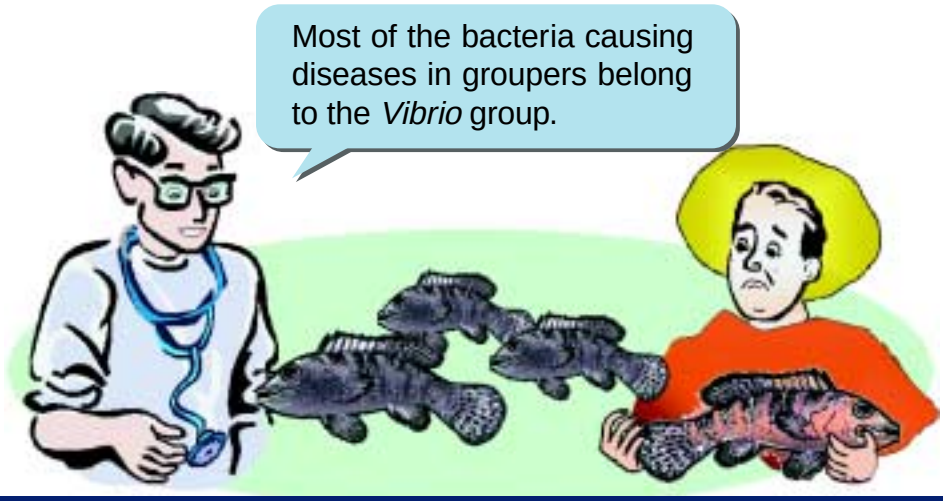
- associated with plants or animals in the culture system

- associated with particles in the water
- planktonic or floating freely in the water column

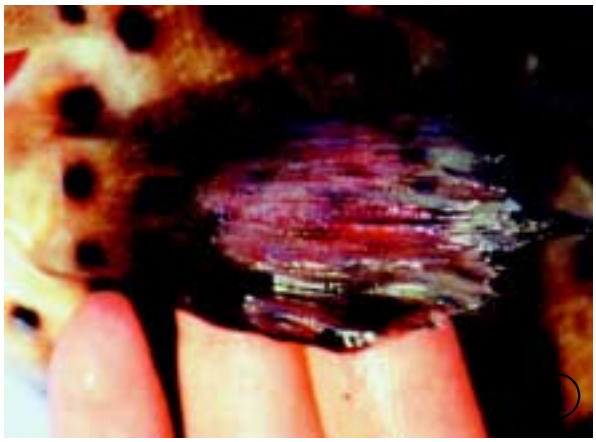


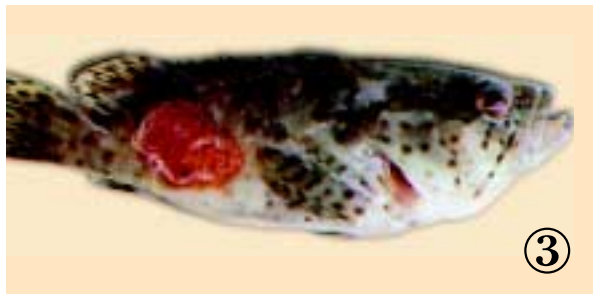
Relative locations of four distinct bacterial populations in aquatic environments

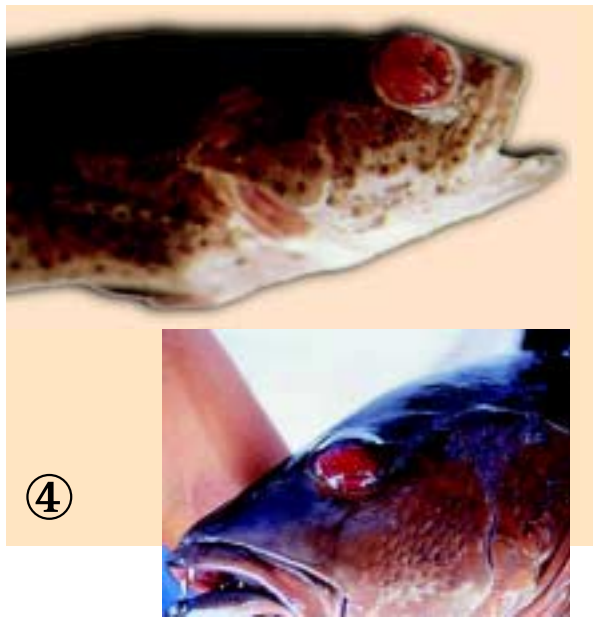
Trash fish, if handled poorly, may also carry harmful bacteria into the culture system.



Affected organ	Signs	Effects
fins and tail	fin rot ①	mortality (fish die at bottom of the cage)
	hemorrhage under the skin ②	
body	ulcer ③	
	dark coloration	
eyes	opaque eyes	
	bulging eye or popeye with or without hemorrhage ④	







Bacterial infections set in when there is:

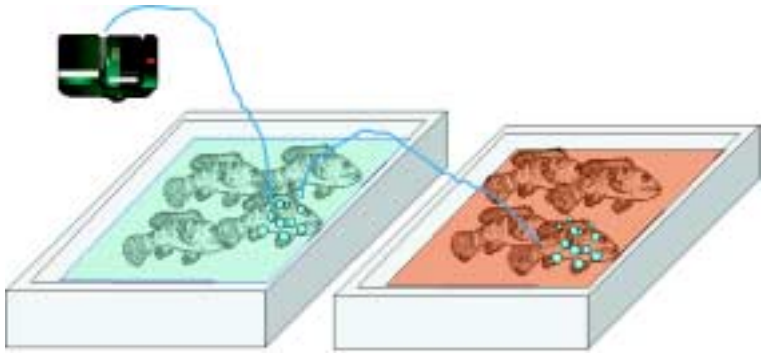
- Stress due to overcrowding, poor water quality and poor nutrition
- Parasitic infestation. Parasites create wounds that may serve as portals of entry of bacteria.
- Organic pollution due to overfeeding and poor water circulation
- Mechanical injury during transport and handling

Prevention

- Maintain appropriate stocking density and biomass within the rearing system
- Maintain good water circulation inside the cages by regularly changing the nets to prevent clogging with fouling organisms
- Avoid nutritional stress by giving only fresh trash fish and well-stored artificial feeds

Treatment

- Give affected fish a short bath with freshwater, lasting no more than 15 minutes
- Formalin and iodine short bath



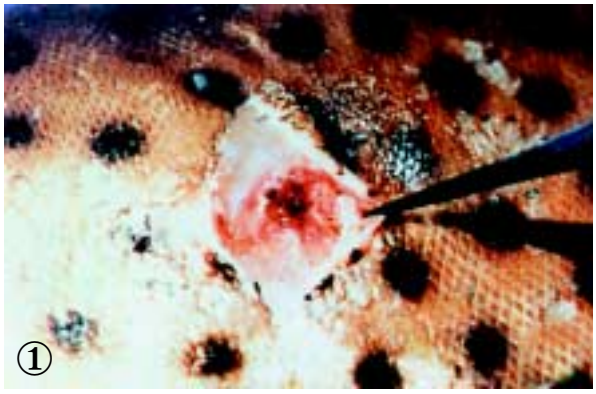
Freshwater bath **Formalin/Iodine bath**

Consult a competent authority for treatment application through feeds and water

Fungal diseases

A fungus is a filamentous microorganism that does not require light to grow, but obtains its energy by feeding on organic material. *Ichthyophonus* sp. is a fungus that causes disease in grouper.

Affected organ	Signs	Effects
muscle **internal organs**	whitish pads up to 2 mm in diameter in affected organs ①	deep erosion of the host tissue ② affects marketable size fish



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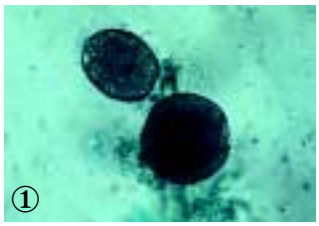
Prevention

- Avoid mechanical injuries during handling
- Quickly remove fish showing signs of fungal infection from the rearing system
- Avoid feeding dirty and contaminated trash fish
- Use properly stored artificial feeds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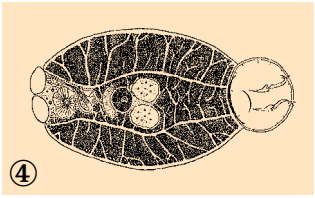
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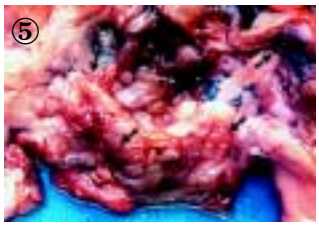
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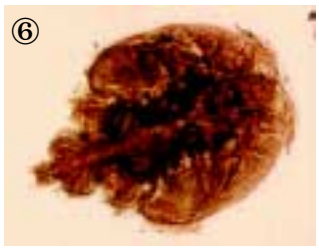
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Parasitic diseases

Parasites are organisms that live in a living host and give nothing in return. A parasite's demands on the host may be so great to cause disease, in which case it may also be considered a pathogen.

The major parasites of grouper are the following:

Protozoans are one-celled microscopic organisms with specialized structures for movement, food gathering and attachment. They can be external or internal parasites. The major protozoan parasites of grouper are:

- Dinoflagellates (ex., ①*Amyloodinium*)
- Ciliates (ex., ②*Trichodina, Cryptocaryon, Brooklynella*)
- Myxosporeans
- Microsporidians

Flatworms are external or internal parasites with posterior structure for attachment to the host. Most flatworms are large enough to be seen by the naked eye, while others are microscopic. The major parasitic flatworms in grouper are:

- Gill flukes (ex., ③*Pseudorhabdosynochus, Haliotrema, Diplectanum*)
- Skin flukes (ex., ④*Benedenia, Neobenedenia*)
- Didymozoid digenean

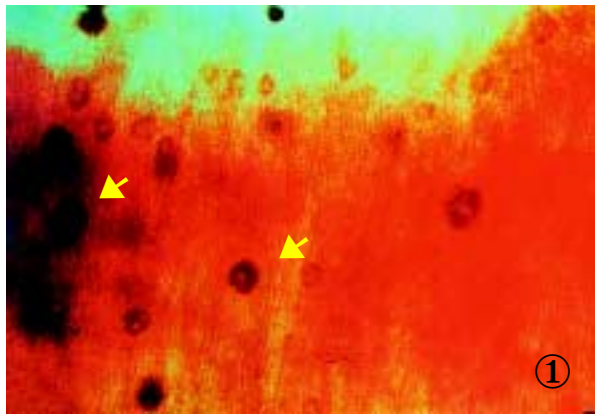
Roundworms ⑤ are unsegmented external or internal parasites. The adult stage of roundworm is big enough to be seen by the naked eye.

Crustaceans are external parasites with segmented bodies covered by shell with jointed appendages. Some parasitic crustaceans are microscopic (copepods), others are macroscopic (isopods).

- Copepods (ex., ⑥*Caligus*)
- Isopods ⑦

Leeches ⑧ are external parasites with pseudo-segmented bodies and have two suckers used for feeding and movement.

Dinoflagellates are external microscopic protozoan parasites with long, hair-like structures called flagella for movement. *Amyloodinium* ①, the most important parasitic dinoflagellate, measures up to 120 µm in diameter. It is attached to the gill filaments (arrows) or body surface of affected fish.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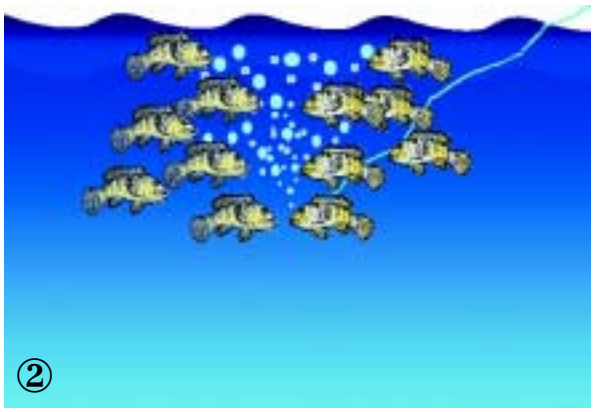
Affected organ	Signs	Effects
gills **body surface**	fish gather in the water surface or near the aeration ② pale gills ③ darkening of body surface; velvet-like appearance	destroyed gills and skin high or mass mortality if not treated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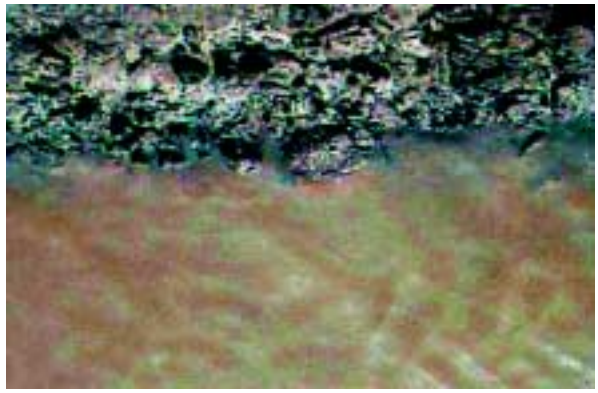
Dinoflagellate infection set in when there is:

- High stocking density

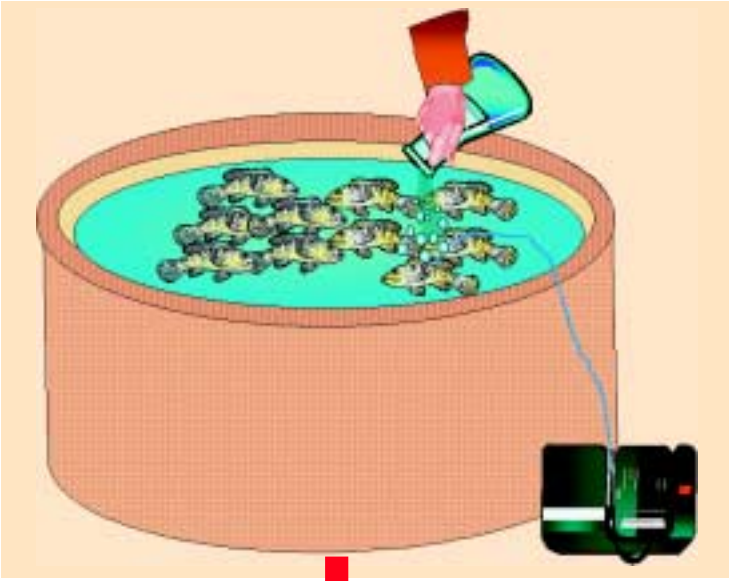


- High levels of organic matter in water

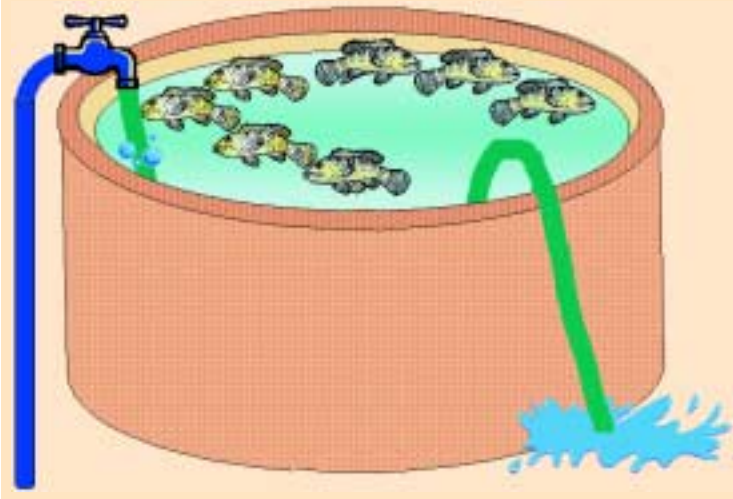
Treatment

- Long bath treatment with **0.5 ppm** copper sulfate (**$CuSO_4$**) for 3-5 days with strong aeration; replace treated water and replenish chemicals daily; or
- Short bath treatment with **200 ppm formalin** for 1 hour with strong aeration
- Transfer treated fish to clean, parasite-free tank, 2 times at 3 days interval

Bath Treatment



Replace tank with clean seawater



Treated water must be disposed in a safe area.

To make 0.5 ppm $CuSO_4$

- dissolve **0.5 mg $CuSO_4$** in a liter of water or **0.5 g $CuSO_4$** in 1 ton of water

To make 200 ppm formalin

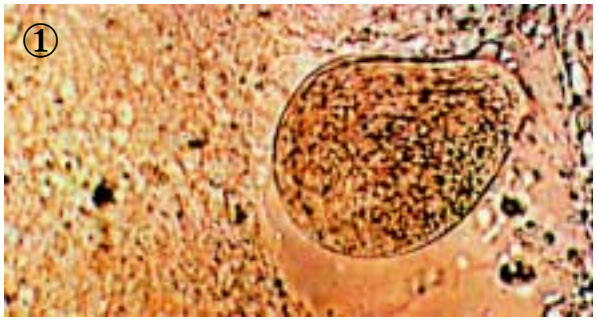
- add **200 ml formalin** in 1 ton of water

Add chemical solution to the rearing tank and provide strong aeration

After the treatment period, remove or siphon out treated water. Replenish tank with clean seawater.

Formalin must be handled and used with caution as it can be a health hazard!

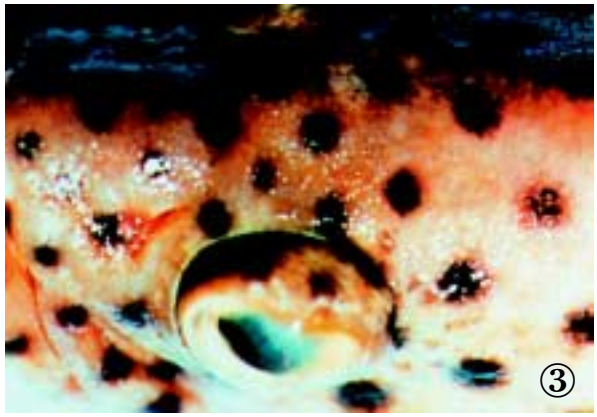
Ciliates are external microscopic protozoan parasites with short, fine structures called cilia which are used for movement. The most common ciliated protozoan parasites of grouper are *Cryptocaryon*, *Trichodina* and *Brooklynella*.



Cryptocaryon is the most dangerous parasitic disease in grouper culture because it can wipe out the stock. The parasites are round to pear-shaped ①, 0.3-0.5mm in size, with cilia on the surface.

◀ *Cryptocaryon* from the skin of affected fish

Affected organ	Signs	Effects
body surface	white spots on skin ②,③	respiratory problem
eyes	fish rub against objects when swimming	secondary bacterial infection
	increased mucus production	mass mortality if not treated



Cryptocaryon infection set in when there is:

- High stocking density
- Decreased water temperature
- Handling stress

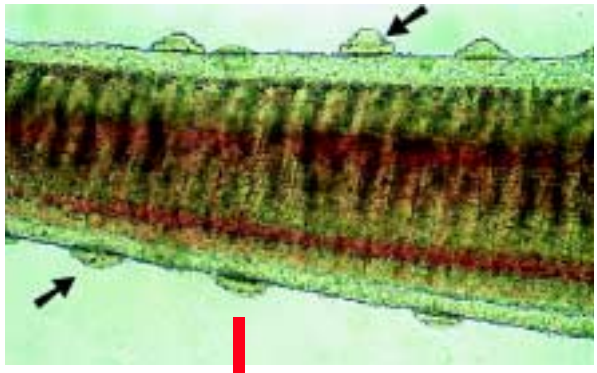
Treatment

- **0.5 ppm copper sulfate** (0.5 g $CuSO_4$ in 1 ton of water) for 5-7 days with strong aeration; replace treated water and replenish chemicals daily, or
- Long bath treatment with **25 ppm formalin** (25 ml formalin in 1 ton water) for 5-7 days, with strong aeration; replace treated water and replenish chemicals daily
- Transfer treated fish to clean, parasite-free tank, 2x every 3 days

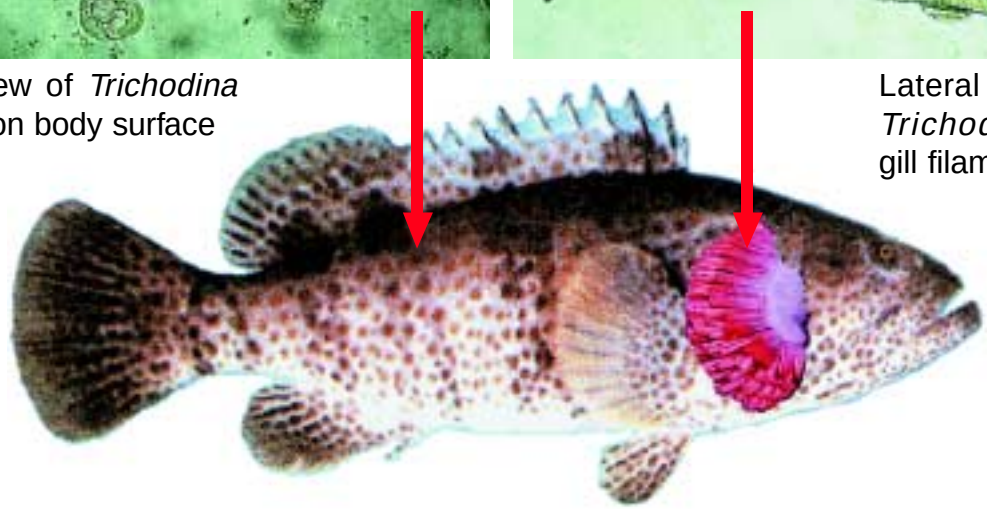
Trichodina has a saucer-shaped body, up to 100 µm in diameter, with cilia around the perimeter of the body

Affected organ	Signs	Effects
gills **body surface**	pale gills fish rub body against things excessive mucus production on gills and body surface fish weak during heavy infection	spinning motion of parasite damages host's tissues excessive mucus clogs the gill surface and causes respiratory distress

Top view of *Trichodina* found on body surface



Lateral view of *Trichodina* on gill filaments



Trichodina infection set in when there is :

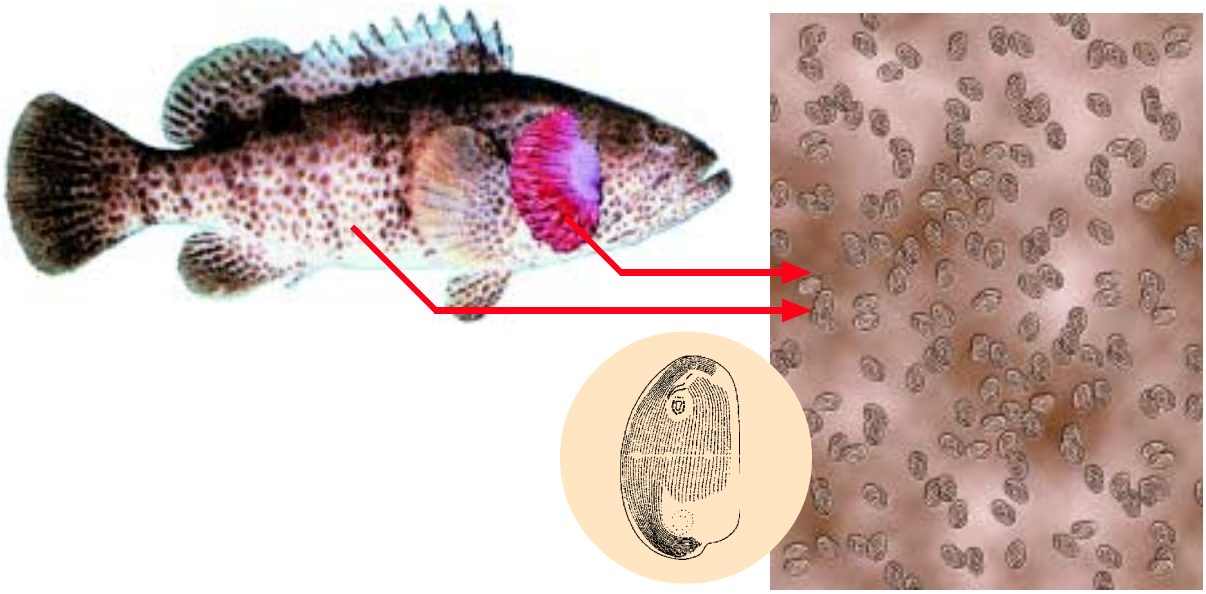
- High levels of organic matter in the water
- Poor water exchange

Treatment

- Short bath treatment with **200 ppm formalin** (200 ml formalin in 1 ton water), for **30-60 minutes**, with strong aeration; or
- Long bath treatment with **25 ppm formalin** (25 ml formalin in 1 ton water), for **1-2 days**, with strong aeration

Brooklynella is kidney-shaped, up to 60 µm in size, with long parallel lines of cilia

Affected organ	Signs	Effects
gills **body surface**	fish rub body against objects	skin damage respiratory problems secondary bacterial infection mass mortality

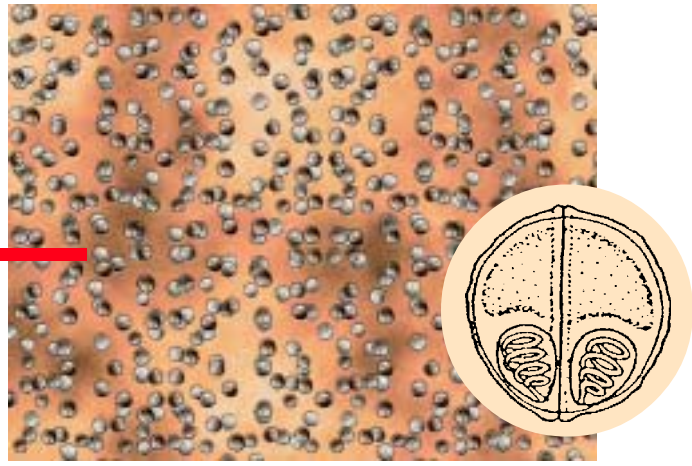


- Short bath treatment with **200 ppm formalin** (200 ml formalin in 1 ton water) for **30-60 minutes**, with strong aeration; or

- Long bath treatment with **30 ppm formalin** (30 ml formalin in 1 ton water) for **1-2 days**, with strong aeration

Myxosporeans are internal microscopic protozoan parasites composed of several spore shell valves. The average size of the spore is 10 µm.

Affected organ	Signs	Effects
kidney abdominal cavity	loss of equilibrium, floating or turning upside down some with hemorrhages on mouth and body surface	parasites invade and destroy the kidney, liver, intestine and spleen



Myxosporea

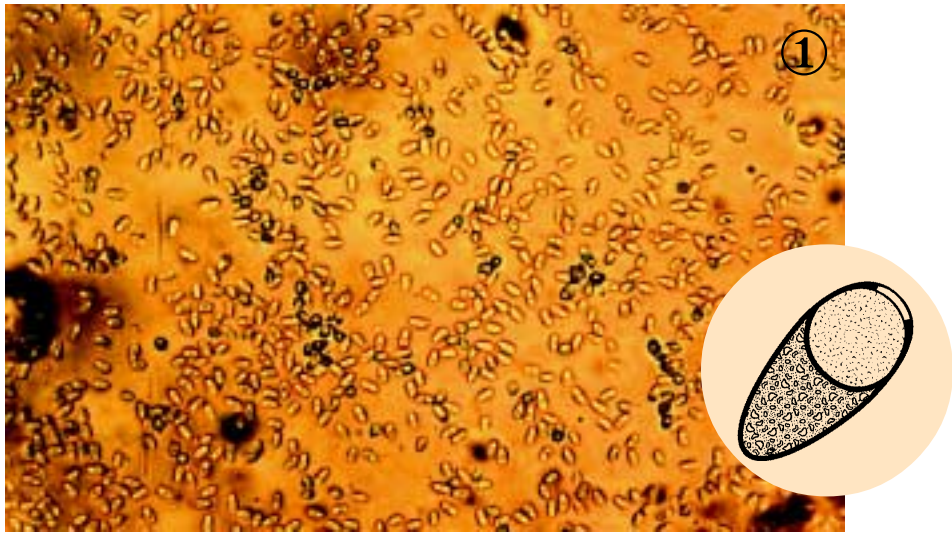
Myxosporean infections set in when there is :

- Poor water quality (fluctuating salinity and low dissolved oxygen)
- High stocking density
- Feeding with infected trash fish
- Lack of quarantine

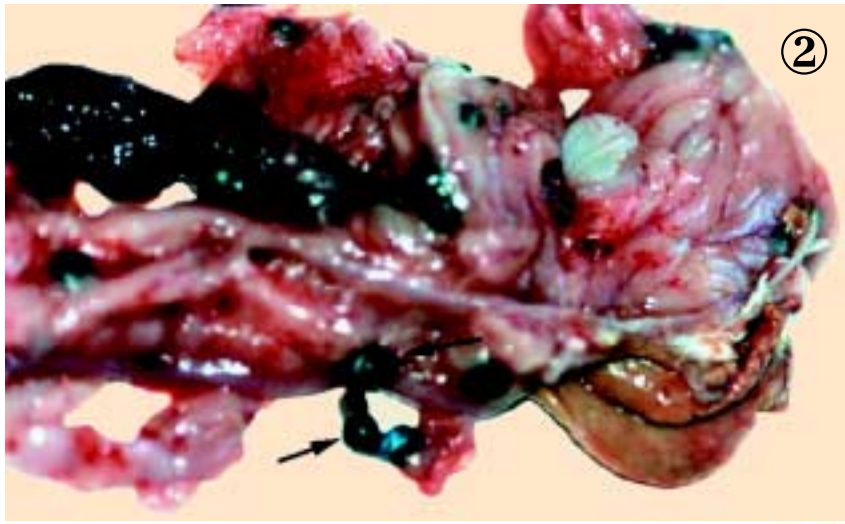
Prevention

- Efficient water exchange
- Avoid feeding with contaminated trash fish
- Quarantine new stock
- Discard affected stock

Microsporidians are internal parasites that form cysts. The spores ① are oval, 6 µm in size.



Affected organ	Signs	Effects
ovary **fat tissue** **other internal organs**	swollen abdomen brown to black cysts ② of various sizes on affected organs	destroy the ovary



Microsporidian infections set in when there is:

- Poor water quality
- Poor nutrition

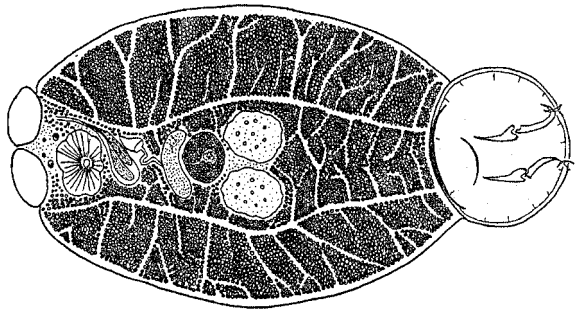
Prevention

- Good water exchange

Skin flukes are external parasitic flatworms, 2-6 mm long. The most common skin flukes parasitic on groupers are *Benedenia* and *Neobenedenia*.

Affected organ	Signs	Effects
body surface **eyes**	lethargic swimming fish rub body against objects opaque eyes skin lesions	blindness secondary bacterial infection high or mass mortality

Whitish skin flukes (arrows) on caudal fin of affected fish after freshwater treatment



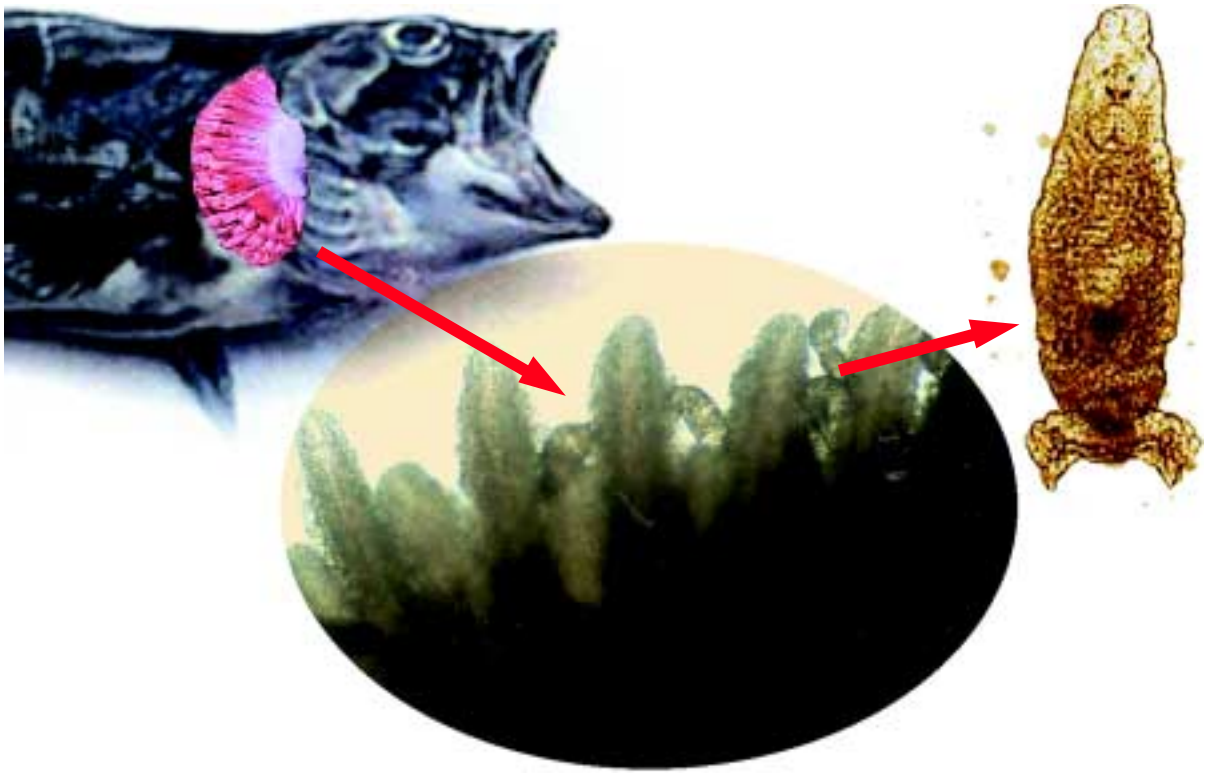
Skin fluke infections set in when there is:

- High stocking density
- Overlapping generation of cultured fish

- Short bath treatment with **freshwater** for 10-30 minutes; or
- Short bath treatment with **150 ppm hydrogen peroxide** (500 ml of 30% H_2O_2 in 1 ton of water) for 10-30 minutes with strong aeration

Gill flukes are external parasitic flatworms, 0.5-1 mm long. The most common gill flukes are *Pseudorhabdosynochus*, *Haliotrema*, and *Diplectanum*.

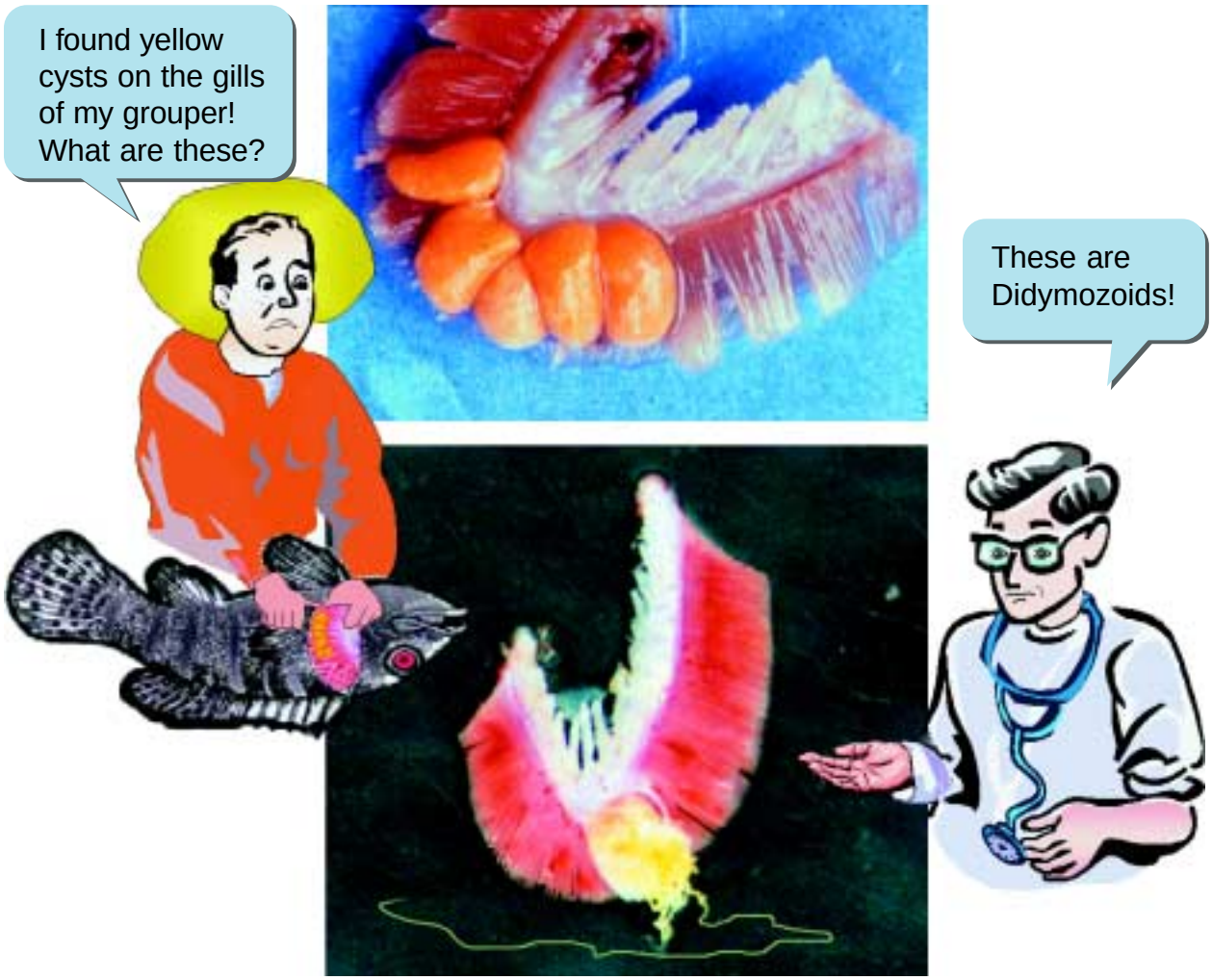
Affected organ	Signs	Effects
gills	pale gills erratic swimming behavior on water surface whitening of body loss of appetite	respiratory problems high or mass mortality



Gill fluke infections set in when there is :

- High stocking density
- Poor cage sanitation

- Short bath treatment with **200 ppm hydrogen peroxide** (667 ml of 30% H2O2 in 1 ton of water) for 1 hour, with strong aeration; or
- Short bath treatment with **100-200 ppm formalin** (100-200 ml formalin in 1 ton of water) for 30-60 minutes, with strong aeration



Didymozoid digeneans are very long (up to 80 cm) external parasitic flatworms that form capsules or cysts on the gills of the host fish.

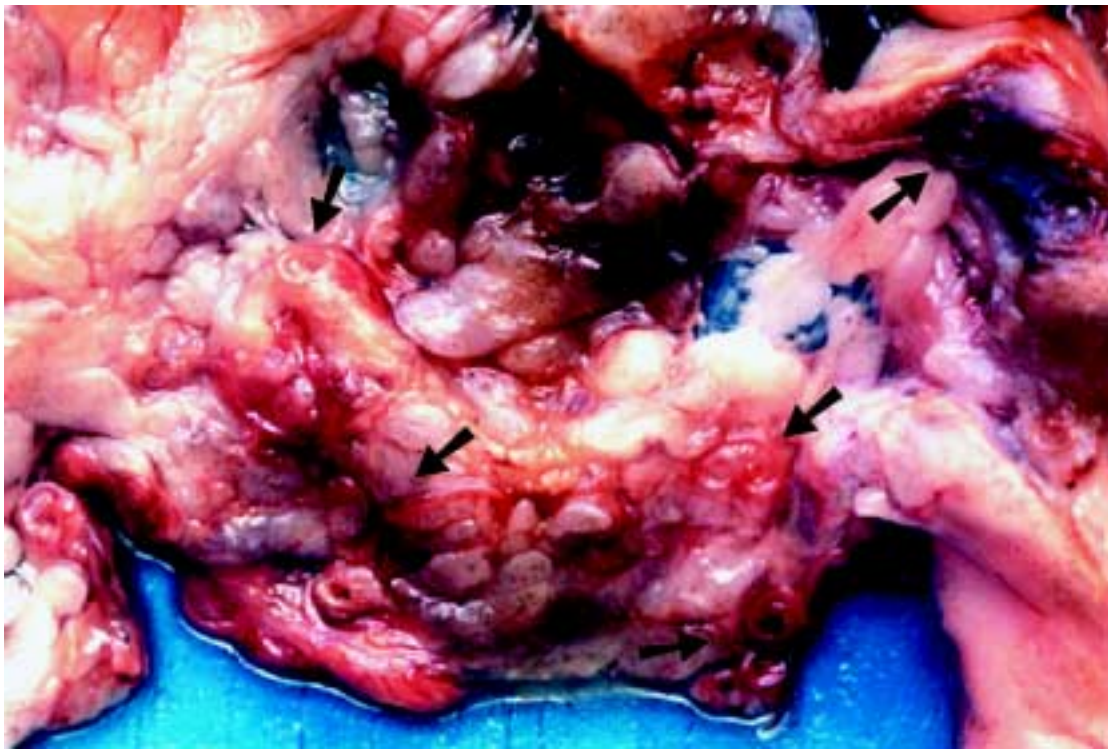
Affected organ	Signs	Effects
gills	yellow cysts on gills	reduced growth rate

Prevention

- Avoid mollusks in the culture facility which can be carriers of the larval stage of the parasite

Roundworms are external or internal parasites, 1-2 cm long with unsegmented body.

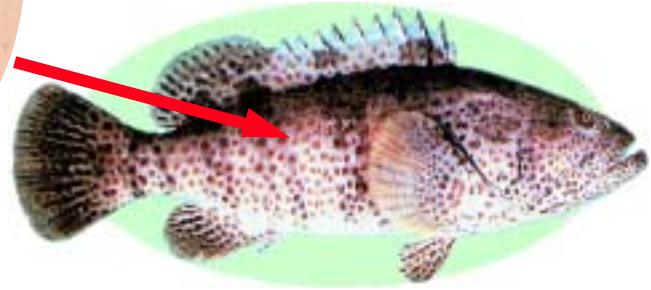
Affected organ	Signs	Effects
fins abdominal cavity	reddish parasite attached on affected organ	reduced growth rate reduced market value



- Avoid feeding with spoiled and infected trash fish.

The **copepod** *Caligus* is oval, up to 3 mm in length and 1.6 mm in width, with a pair of suckers on the frontal edge of the body and four pairs of legs.

Affected organ	Signs	Effects
body surface **gills**	lumpy body surface sluggish swimming near water surface loss of appetite fish weak in heavy infection	skin and muscle erosion secondary bacterial infection high or mass mortality



Copepod infections set in when there is:

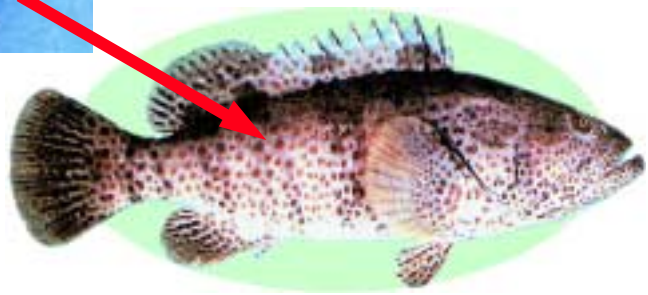
- Poor water exchange

Treatment

- Short bath treatment with **150 ppm hydrogen peroxide** (500 ml of 30% H_2O_2 in 1 ton of water) for 30 minutes, with strong aeration; or
- Short **freshwater bath** for 10-15 minutes; or
- Short bath treatment with **200-250 ppm formalin** (200-250 ml formalin in 1 ton of water) for 1 hour, with strong aeration
- Transfer treated fish to clean, parasite-free tank

Isopods are 10-50 mm in size, the body is divided into many narrow segments, with a pair of eyes.

Affected organ	Signs	Effects
gills	loss of appetite	respiratory problems
body surface	fish rub body against objects	mortality



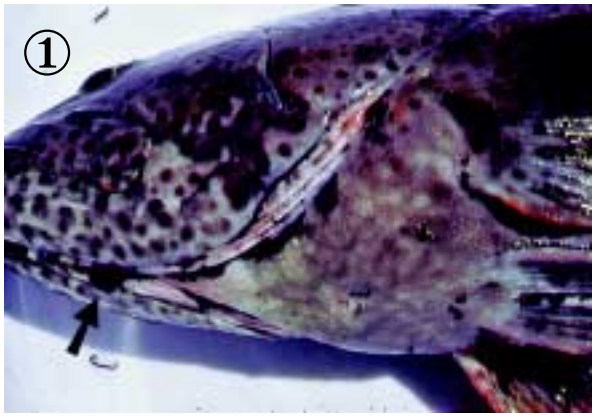
Isopod infections set in when there is:

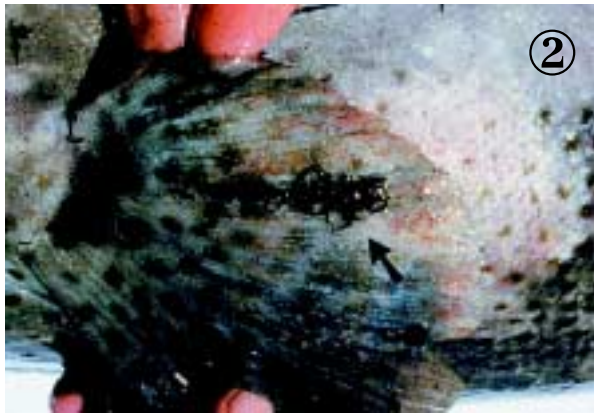
- High stocking density

- Remove and kill parasites by crushing or other physical means
- Short bath treatment with **200 ppm formalin** (200 ml formalin in 1 ton of water) for 30-60 minutes, with strong aeration
- Transfer treated fish to clean, parasite-free tank

Leeches are external parasites with pseudo-segmented bodies, 8-12 mm long, and with anterior and posterior suckers used for feeding and movement.

Affected organ	Signs	Effects
body surface **fins** **mouth** **eyes**	brownish-black parasites attached in patches in affected areas ① and ②	feeding and attachment sites of parasite are sometimes hemorrhagic secondary bacterial infection





Leech infections set in when there is:

- Poor maintenance of facilities
- Poor water quality

Treatment

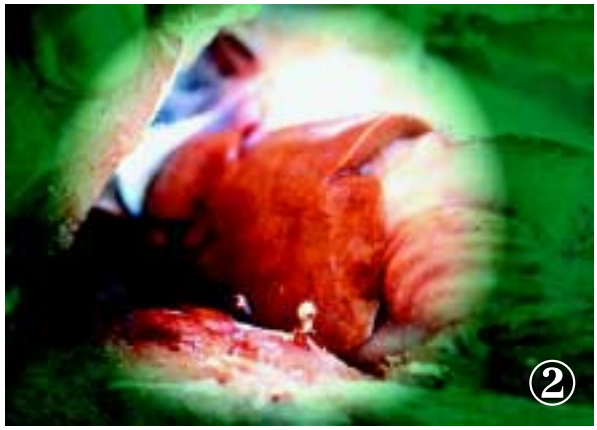
- Manual removal using wet cloth ③
- Short bath treatment with **50-100 ppm formalin** for 1 hour, with strong aeration
- Transfer treated fish to clean, parasite-free tank

Nutritional diseases

Lipodosis

Affected organ	Signs	Effects
liver	pale liver ② lethargy eye opacity body deformity	poor growth low survival

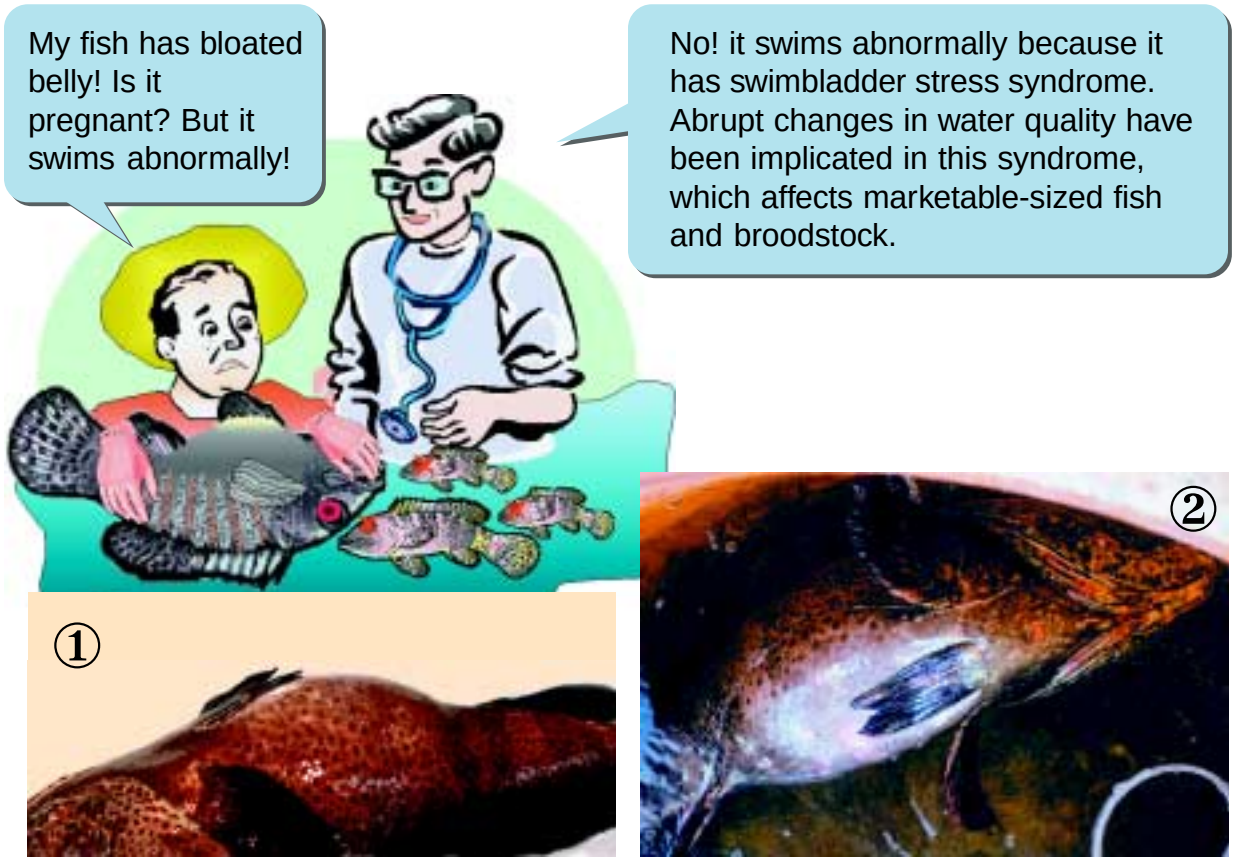
Normal color of liver



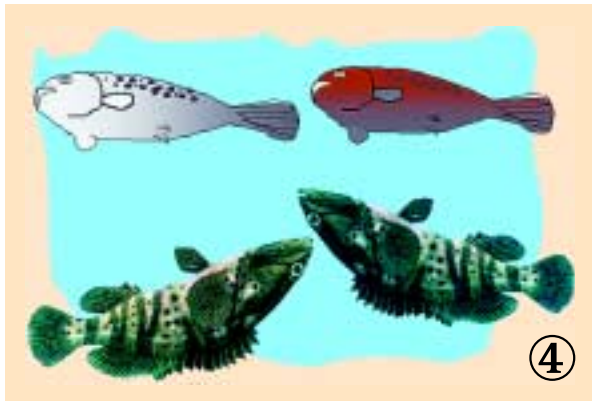
Pale liver

- Avoid feeding fish with spoiled and rancid trash fish
- Avoid giving moldy artificial feeds

Environmental diseases



Affected organ	Signs	Effects
swimbladder **gills**	excessive distention of fish "belly" ①, ② and ③ fish swim in a head-down or sideward position near the surface ④ bubbles in the gill lamellae	positive buoyancy sunburn death



The rearing environment affects fish health. Rainfall run-off may carry nutrients triggering a plankton bloom. For fish in cages, net fouling slows down water circulation and contributes to deterioration of water parameters.

For marketable size fish:

- Harvest and sell
- Do not allow secondary bacterial infection to set in, which may lead to mortalities

For broodstock:

- Puncture the abdomen with a sterile hypodermic needle
- Gently return the fish into the water and press lightly to release gas.
- Once excess air in the swimbladder has been expelled, remove the needle and dab the punctured site with **0.1% acriflavin or antibiotic ointment**
- Return the fish to the tank or cage
- Recovery time takes from **3-6 days** with a success rate of **50%**.

Appendix I.

Local names of cultured grouper species in the Asia-Pacific

Grouper Species	English name	Local names	
		Indonesia	Malaysia
Epinephelus coioides	Orange spotted grouper Green grouper	Kerapu lumpur	Kerapu
Epinephelus malabaricus	Malabar rockcod	Kerapu malabar	Kerapu hitam
Epinephelus fuscoguttatus	Flowery cod Blotchy rockcod Brown marled grouper	Kerapu macan	Kerapu hitam
Epinephelus bleekeri	Dusky tail gouper	Kerapu bintik	Kerapu
Plectropomus leopardus	Leopard coral trout Blue spotted seabass	Kerapu sunu Kerapu lodi	Kerapu merah Kerapu sunoh
Plectropomus maculatus	Barred-cheek coral trout Spotted coral trout	Kerapu sunu Kerapu lodi	Senderong Kerapu sunoh
Cromileptis altivelis	High-finned grouper Hump back rockcod Barramundi cod Polka-dot grouper	Kerapu bebek Kerapu tikus Sunu tikus	Kerapu tikus Kerapu sunoh
Epinephelus fario	Three spot grouper	Kerapu	
Epinephelus fasciatus	Black tip grouper	Kerapu batu	Kerapu bara Kerapu merah
Epinephelus septemfasciatus		Kerapu	
Epinephelus lanceolatus	Giant grouper	Kerapu ketang	Kerapu
Epinephelus moara		Kerapu merra	

Local names			
Philippines	**Singapore**	**Thailand**	**Vietnam**
Lapu-lapu		Pla karang-jud-namtal	
Lapu-lapu	Chi hou Hua tun hou	Pla karang-dum	Ca song diem dai
Lapu-lapu	Lao hu ban	Pla karang-lai-hin-on	Ca song hoa nau
Lapu-lapu	Hua hou Jia zhi hou	Pla karang-hang-tud Pla karang-jut leang	Ca song bolekori
Lapu-lapu	Hong hou	Pla karang lai seau Pla kudsalak-lai-sae	Ca mucham nho
Lapu-lapu	Jin hou	Pla kudsalak Pla oon roon	Ca mucham to
Lapu-lapung senorita	Lao shu hou Nuo mi hou	Pla karang-naa-ngon	Ca lu heo Ca mu det
Lapu-lapu			Ca mu song
Lapu-lapu		Pla karang-leong-fa Pla karang seua keeb yao	Ca mu bong Ca song soc ngang
Lapu-lapu	Long dan	Pla moh-ta-le	Ca muk hoang Ca mu song

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Husbandry and Health Management of Grouper

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