AQUACULTURE EXTENSION MANUAL NO. 24 JUNE 1998

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For comments and inquiries: Training and Information Division
SEAFDEC Aquaculture Department
Tigbauan, Iloilo 5021, Philippines
Fax (63-33) 335 1008, 336 2891
E-mail tid@i-iloilo.com.ph/
tvp@aqd.seafdec.org.ph/
AQD website http//www.seafdec.org.ph/

FOREWORD

This volume is the first of AQD's manuals resulting from the Technology Verification Project (TVP) launched in mid-1996. TVP aims to field-test specific culture systems in selected farm sites, and to package technologies that are found to enhance productivity and/or profitability. These verification studies consider site-specific conditions such as socio-economic, environmental, biological, anthropological and other related aspects. An important feature is the active participation of fishfarmers, fisherfolk and the local government units.

TVP marked the change in our thrusts in that AQD is going into production-oriented research followed by vigorous technology verification, technology demonstration and technology transfer activities. TVP can bridge the gap between AQD's considerable research output in the last 25 years and the aquaculture industry's continuous need for sustainable technologies.

We are very appreciative of the fishfarm owners who answered our call for sites where we can conduct our verification studies. Mr. Bobby Sanson collaborated with AQD on grouper culture in his farm in Sum-ag, Bacolod City from whence the techniques in this manual were verified. His farm can now be considered a demonstration site for grouper culture in brackishwater ponds. His experiences can attest to the success of grouper farming.

We hope this manual will be of use to fishfarmers and aquaculturists, extensionists, and students of aquaculture.

ROLANDO R. PLATON, PhD
Chief, SEAFDEC Aquaculture Department

Contents

A sampling of delicious grouper recipes

Grouper culture in brackishwater ponds

Groupers are cultured in the Philippines using tiny fry and juveniles caught from the wild. Fishfarmers grow them in netcages and in ponds. To help fishfarmers, SEAFDEC Aquaculture Department conducts research and verification studies on broodstock management, seed production, and grow-out.

The recent SEAFDEC / AQD technology verification study on grouper pond grow-out culture resulted in high productivity and profitability. Grouper farming could therefore become another dollar earner for the country as live marketable size grouper have strong export potentials. Grouper farming likewise could offer a ready alternative to shrimp farming, the industry of which is presently beset by problems of diseases and environmental degradation.

The demand for grouper in the international market is fast growing, particularly in Hong Kong, Japan, and Singapore. Its export price is expected to increase in the near future.

This aquaculture extension manual is a guide for fishfarmers. We encourage its users to contribute to its refinement and when necessary, provide inputs to enhance its usefulness.

What are groupers?

Groupers, *Epinephelus* spp., popularly known as "lapu-lapu" in some Philippine dialects are important marine fishes belonging to the Family Serranidae. They are characterized by thick-set or stout bodies, slightly elongate with brown spots or blotches. They also have very large mouths and normally protruding lower jaw. It is, however, difficult to differentiate one species from another due to the fishes' ability to change colors. Groupers may assume varied colors under certain environmental conditions and physiological slates. But the general pattern of spots, stripes and blotches remain the same.

Males are slightly longer than females. Sexual maturity is obtained in 4 to 6 years. Maximum body length reaches up to 200 cm. Marketable sizes in commercial production vary depending on requirements of different live grouper importing countries: 400-700 g in the Philippines, 600-900 g in Singapore, more than 1 kg in Kuwait.

GEOGRAPHIC DISTRIBUTION: Indo-West Pacific; East Africa, Red Sea to the Philippines, southern Japan, Hawaii

HABITAT: Coastal water area, rocky shore, coral reef

FOOD HABIT: Carnivorous; feeds on fishes, crabs, squids, etc

LIFE CYCLE:

Spawning season June to September and November to December (INDONESIA), August (SINGAPORE), April to

July (KUWAIT), year-round except May in tanks and July-October in floating netcages (PHILIPPINES)

Spawning habit Grouper start spawning before sunset. Distinct courtship behaviour is observed: the male and female are found pairing closely with one another and swim swiftly in a counter-clock wise direction.

In the Philippines, the onset of monthly spawning cycle in tanks and floating netcages has been observed over a period of 3 days before and after the last quarter moon.

Fecundity From 400,000 to 700,000 eggs per kg female. Live, fertilized eggs are pelagic, and measure about 0.8 mm in diameter with a single oil globule of 0.19 mm.

Incubation period Fertilized eggs hatch after 18 to 20 hours at 27 to 29 °C.

Larvae The size of hatched larvae is 1.7 mm. Newly hatched larvae become free-swimming larvae (2.7 mm) after 3 days, start feeding, then metamorphose into juveniles (25 mm) after 35 to 50 days.

Young and adult Young groupers (about 16 cm in total length) are found in shallow waters during the peak season from October to December in Malaysia. They move to off-shore areas as they grow. Biological minimum size is 45-50 cm in body length at 2 years of age. Grouper reverse sex (from female to male) when they attain 65-75 cm in body length.

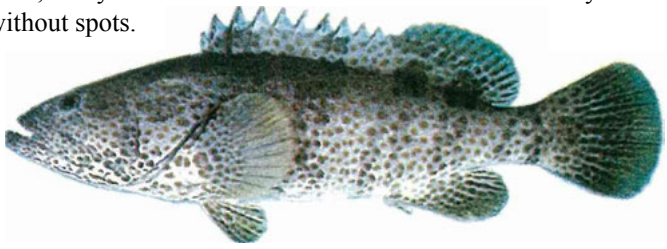
Commercially important groupers

There are around 40 species of groupers distributed in tropical waters, but so far, only two are popularly cultured commercially:

1 The orange-spotted grouper *Epinephelus coioides* (Hamilton 1822)

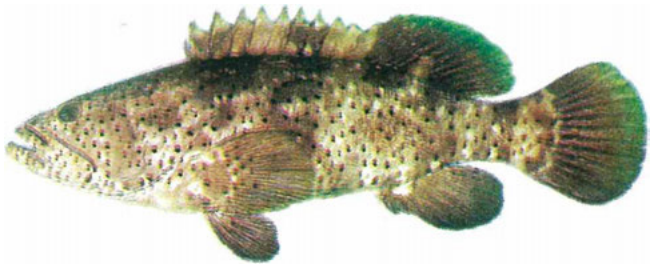
Also known as "inid" or "lapu-lapu" in central Philippines

Body color is light yellowish-brown dorsally, shading to whitish on the side and belly, numerous brownish-orange or brownish-yellow unequal spots scattered on head, body and on fins. Underside of head and belly whitish or creamy white without spots.



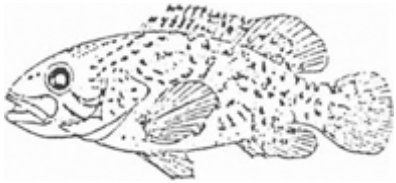
2 The black-spotted grouper *Epinephelus malabaricus* (Bloch and Schneider 1891)
Also known as "inid" or "lapu-lapu" in central Philippines

Body color is light brown on the upper part of the body; belly and ventral side light grey; body with five distinct broad dark brown oblique bars which tend to branch to two ventrally. Head and body with numerous small well-separated blackish spots especially on the underside of the head; fins scattered with small black spots.



Source of fry or fingerlings

At present, grouper fry or "tiny" for commercial cage and pond production are still wild-caught. Grouper fry are collected in nominal quantities using various devices, e.g., rock mounds, brush piles, brush lures, fish trap. The size of the fry (tiny) varies from 5 to 50 mm. Fry are usually collected from coastal waters near mangrove areas.



Grouper fry (30 mm)

In the Philippines, the major sources of grouper fry include waters off Pangasinan, Cavite, Mindoro, Quezon, Ormoc, Masbate, Bulacan, Cagayan, Dadiangas, Negros Occidental, and Capiz. But fry or fingerling supply from these sources is seasonal and unreliable. R & D institutions like SEAFDEC/AQD and some progressive fish hatchery operators have therefore developed, or are developing, captive broodstock and seed production techniques. The fish breeding association in Taiwan has been known to produce fry in hatcheries in commercial quantities.

SEAFDEC / AQD's journal publications on grouper (mainly on broodstock management and seed production) appear at the end of this manual (page 18).

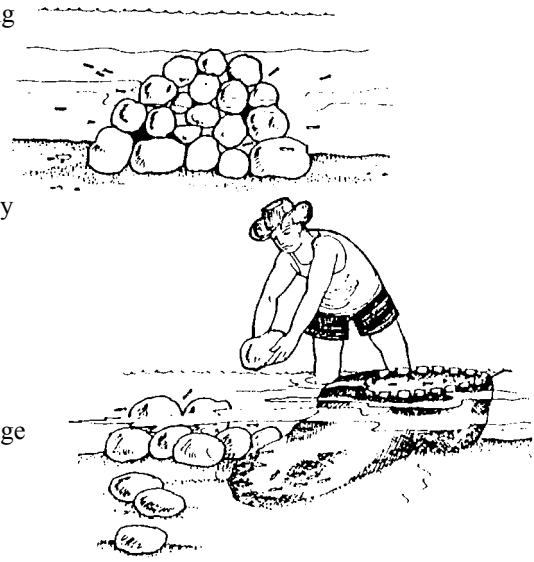
Common collection gears for fry / juveniles

BRUSH LURES

Locally called *bonbon* or *pagungpong* in the Visayas, brush lures are devices made of twigs, grass or palm leaves and set in shallow estuarine or mangrove areas. These attract grouper and sea bass fry / juveniles which are then collected using scoop nets.

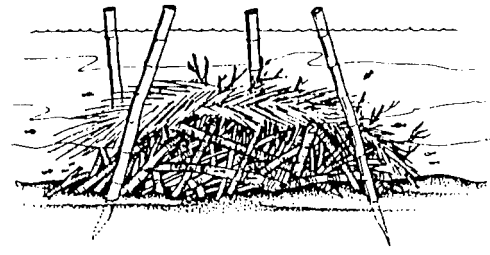
ROCK MOUNDS

Locally called *gango,* the rock mound is a conical pile of rocks or dead corals set along depressed portions of intertidal areas, seagrass beds, and mangrove tidal pools. This method has been in use for more than 50 years and considered the most ecologically sustainable collection gear for grouper juvenile. The rock mound is usually 0.5 to 1.3 meter high (depending on water depth at lowest tide). It is generally colonized by fishes from the immediate vicinity. Harvesting is carried out with the use of an encircling net during low tide. After the net has been set up, the rocks are taken out one by one while fishes take refuge inside the pouch of the net. When the last rock has been taken out and the last fish collected, the rocks are returned to its original place.



BRUSH PILES

Locally called *padugmon* or *padum-ok*, brush piles are similar to rock mounds but are made of tree branches, twigs, and palm leaves. They are set on soft bottom areas like mudflats. Harvesting is similar to rock mounds.



Other fry collection gears include bamboo fish traps, and scoop or dip nets.

Brackishwater pond culture

POND SPECIFICATION: Groupers may be raised in brackishwater ponds that are --

- earthen or concrete of size 500 m^2 to 1 ha
- usually rectangular in shape with pond depth of 1-2 m and a level pond bottom to allow easy harvest
- preferably with double gate system made of concrete or wood and with separate supply and drainage to facilitate good water exchange
- preferably equipped with life support systems, e.g., axial or centrifugal water pump, paddlewheel aerators, which are necessary in emergency water change and aeration especially during neap tides, windless days or nights, or when water condition so requires.

A *grouper farm in Bacolod City.*

SITE SELECTION: To attain maximum production, the farm site must have --

- sufficient source of seawater or brackishwater
- water salinity and temperature that range 18-32 ppt and 27-30°C, respectively.
- not less than 3 ppm dissolved oxygen of the water
- sufficient source of live tilapia fingerlings and/or trashfish throughout the year
- reliable supply of electricity

The site must also be free from any source of pollution (industrial, agricultural and domestic) and easily accessible.

POND PREPARATION: The protocol is similar to milkfish pond preparation --

1 Drain the pond completely and sun-dry for a week or two or until the soil cracks.

Drying the pond bottom.

2 Apply teaseed powder at the rate of 15-30 ppm, depending on water salinity, to eradicate pests and predators. Alternatively, apply a combination of hydrated lime [$Ca(OH)_2$] and ammonium sulfate fertilizer (21-0-0) at the ratio of 1:3. Other environment-friendly organic pesticides such as tobacco dust, denis root extracts may also be used.

3 Apply organic fertilizer (chicken manure) at a rate of 1 ton per ha, and increase the water level gradually to allow growth of natural food (*lab-lab* or *lumut*). A basal application of inorganic fertilizers -- for example, di-ammonium phosphate (16-20-0) at 50 kg per ha -- would bolster growth of natural food.

Natural food (above) *is grown for tilapia* (below) *which in turn serve as prey of the carnivorous grouper.*

4 Stock tilapia adults (5,000-10,000 pieces per ha). Once these reproduce in the ponds, the fingerlings will serve as natural food or prey for grouper.

NURSERY OPERATION: Nursing grouper is necessary only if 2-3 cm fry are the only ones available for stocking the grow-out pond.

5 Install rectangular netcages inside the pond and attach these to bamboo or wooden poles that are staked to the bottom. Cage size varies from 4 x 2 x 1.5 m to 8 x 4 x 1.5 m. Net mesh size is 0.5 cm. Stocking density is 60 fry per m^3. Inside the cage, the fry are "trained" for a week or two to feed on finely-chopped trashfish and/or mysid shrimps ("alamang" or *Acetes* spp.).

6 Install 50-watt incandescent, hover-type lamp in every cage, about a foot above the waterline, to attract mysids, copepods and other young fishes and crustaceans at night. These are live food for the grouper fry.

Netcages for nursery phase

7 Sort and grade the fry weekly, to minimize competition for space and food and to prevent cannibalism. Extra net cages would be needed to accommodate the separated or graded stocks.

Constantly monitor the water parameters.

	Range
Water depth	1.0 to 1.3 m
Water temperature	27 to 28.5°C
Salinity	19-24 ppt
Dissolved oxygen	4.5-8.2 ppm

Values are from SEAFDEC / AQD's TVP run in Bacolod City, 1997

Sorting and grading grouper fry

8 Transfer the grouper fry to the grow-out pond when these reach fingerling stage (5-10 cm total length). This is usually after 30-45 days of culture.

GROW-OUT CULTURE: The grow-out phase involves rearing the grouper from juvenile (5-10 cm TL) to marketable size (400 to 1,000 g average body weight).

Transfer of juveniles to grow-out pond

9 Stock grouper fingerlings in grow-out ponds at least one month after the release of adult tilapia when tilapia have reproduced and fingerlings are abundant. The stocking rate of grouper is 5,000 juveniles per hectare.

10 Aside from the live food available in the pond, give chopped trash fish every other day at the rate of 5% of total grouper biomass. Give half of the daily feed requirement in the morning and the other half in the afternoon. Place one part of the feed onto a feeding tray for monitoring purposes and broadcast the rest.

Trash fish for grouper

11 Determine the biomass and daily feed requirement of the grouper stock by monthly stock sampling. To do this, measure and record the length and weight of grouper caught by a cast net. Return the sampled stock to the pond.

Stock sampling

12 Change water by taking advantage of the tidal cycle or use a pump. Water exchange is done at least twice a week depending on the water quality monitored daily.

Constantly monitor the water parameters.

	Range
Water depth	0.6 to 1.3 m
Water temperature	24 to 31°C
Salinity	21-41 ppt
Dissolved oxygen	4.9-9.3 ppm

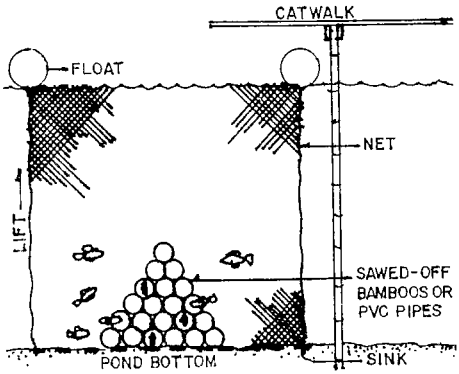
Values are from SEAFDEC / AQD's TVP run in Bacolod City, 1997

13 Groupers take 5 to 7 months to attain the marketable size of 400 to 800 g, depending on the initial size at stocking:

Marketable grouper

HARVEST: As soon as majority of the grouper slock reach the size of 400 g or more, selective harvesting can be initiated.

14 To harvest grouper, install modified liftnets and sink these at strategic feeding locations in the pond. Hides made Of sawed-off bamboos or PVC pipes tied in bundles are placed inside the net to serve as hiding places.



15 In early morning, while the groupers are inside the hides, slowly lift the modified net and get the fish weighing 400 g or more. Transfer directly to pre-installed production net cages (measuring 4 x 8 x 1.5 m with mesh size 1-2 cm) within the pond. Stocking density is about 20 fish per m^3.

16 Keep the grouper for a maximum period of one week in the production netcages. Feed with trashfish at 5% of biomass every other day while waiting for buyers.

POST-HARVEST: Groupers are marketed live, hence these must be kept in good condition.

17 Hold harvested grouper temporarily in an aerated conditioning tank for about an hour.

Hides or shelters for grouper

Production netcages

Feeding trashfish in netcages

CLOCKWISE:
Temporary conditioning tank; packing grouper in plastic bags; shipment of live grouper

Adjust water temperature by adding packed ice gradually. Lower the temperature to about 18°C.

18 Weigh 3-5 fish and place inside double-sheeted plastic bags with enough water to cover the nostrils of the grouper. Close the bags and pack in square styrofoam box (30 x 30 x 20 cm) for shipment. Place crushed ice on top of the plastic bags to maintain coolness of water during transport.

Growth, survival, and feed efficiency performance of grouper reared in brackishwater ponds

A series of verification runs were conducted at Sanson Farm in Sum-ag, Bacolod City (Tables 1 and 2, Figures 1 and 2).

In the nursery phase, grouper fry or tiny (initial ave. body weight: 3.8 g) were held in netcages inside the pond for 30 days. Survival was 93.33 % and final average body weight was 14.9 g. Total feed consumed was 225 kg, giving an FCR of 3.59. The mean relative growth increment is 0.365 g per day per fish.

In grow-out culture, total production was 1,512.3 kg of live grouper after 210 days of culture using a 0.9 ha grow-out pond. The survival rate was 80% and the average body

weight was 450.3 g per fish. Total feed consumed during the grow-out period is 5,783 kg resulting to an FCR of 3.82. The mean relative growth increment of stock was 2.04 g per day per fish.

TABLE 1 Nursery pond production, SEAFDEC / AQD's TVP trials, Bacolod City, 1997

Days of culture	Survival (%)	Ave. body weight (g)		Total biomass (kg)	Total feed consumed (kg)	Feed conversion ratio
		Initial	Final			
0-15	100	3.8	7.5	33.7	75	2.2
16-30	93	7.5	14.9	62.6	225	3.6

TABLE 2 Grow-out pond production (total stock: 4,200 pieces) SEAFDEC / AQD's TVP trials, Bacolod City, 1997

Days of culture	Survival (%)	Ave. body weight (g)		Total biomass (kg)	Total feed consumed (kg)	Feed conversion ratio
		Initial	Final			
0-15	100	14.9	30.3	62.6	342	2.7
16-30	-	30.3	49.1	-	797	-
31-45	-	49.1	63.2	-	1.352	-
46-60	-	63.2	82.0	-	1,872	-
60-75	-	82.0	113.9	-	2,212	-
76-90	-	113.9	136.4	-	2,562	-
91-105	-	136.4	161.6	-	2,912	-
106-120	-	161.6	202.5	-	3,242	-
121-135	-	202.5	254.6	-	3,511	-
136-150	-	254.6	285.4	-	3,903	-
151-165	-	285.4	321.4	-	4,323	-
166-180	-	321.4	363.6	-	4,803	-
181-195	-	363.6	408.6	-	5,293	-
195-210	80	408.6	450.2	1,512.6	5,783	3.8

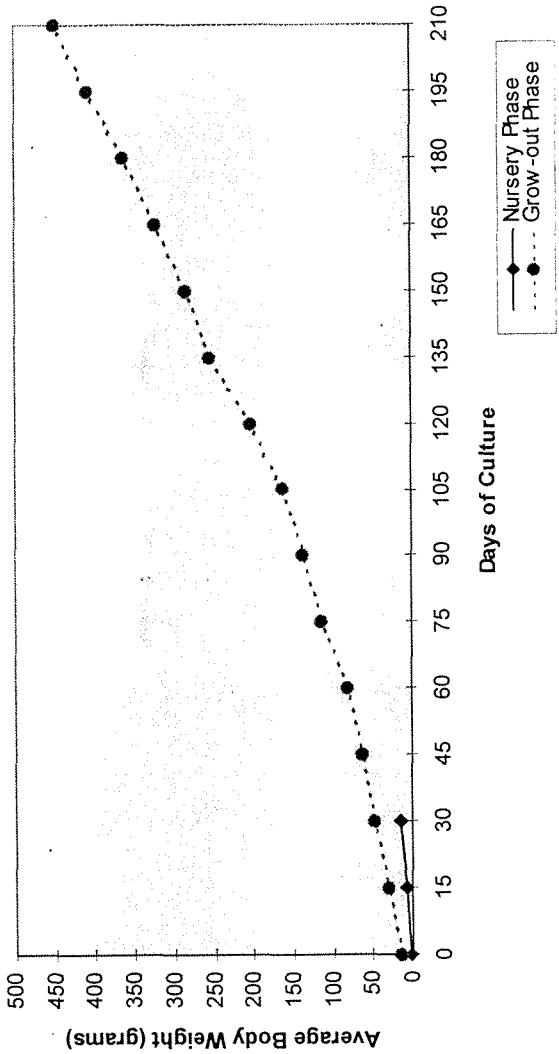


FIGURE 1 Growth of grouper reared in brackishwater pond
SEAFDEC / AQD's TVP trials, Bacolod City, 1997

Economics

COSTS-AND-RETURNS OF GROUPER CULTURE IN BRACKISHWATER POND

Production (grow-out pond)			
Pond area	0.9 ha		
Number of stock	4,500 pcs		
Survival rate	80%		
Culture period	5 to 7 months		
Number of croppings per year	1		
Total harvest	1,512kg		
Ave. body weight at harvest	450 g		
Selling price	₱ 280.00 per kg		
Gross income			₱ 423,360.00
Variable costs	**Quantity**	**Unit cost (₱)**	**Total cost (₱)**
For natural food production			
Chicken manure	1,000 kg	₱ 1.00 per kg	1,000.00
For predator eradication			
Hydrated lime	200 kg	1.50	300.00
Ammonium sulfate (21-0-0)	40 kg	5.00	200.00
Netcages for tiny (2 units, 4 x 2 x 1.5 m)			
Nylon nets	60 m	30.00	1,800.00
Net cages for harvesting			
(4 units, 8 x 4 x l.5m)			
Nylon nets ('A' size)	224 m	30.00	6,720.00
Bamboo (whole length) for			
horizontal and vertical bracing	4 pcs	50.00	200.00
Monofilament # 180	2 kilos	50.00	100.00
Tilapia (100 g)	4,500 pcs	4.00	18,000.00
Grouper tiny (1 inch)	4,500 pcs	8.00	36,000.00
Trash fish	5,783 kg	10 .00	57,830.00
Technician's salary	8 months	4,000.00	32,000.00
Power (lights, pump, standby aeration)			20,000.00
Subtotal			₱ 174,150.00
Fixed cost			
Depreciation of paddlewheel aerator			5,000.00
Total cost			₱ 179,150.00
Capital outlay			
Paddlewheel aerator (1 unit plus accessories)			15,000.00
Total investment (variable costs + capital outlay)			₱ 194,150.00
Net profit before tax			₱ 244,210.00
Income tax (35%)			₱ 85,473.50
Net profit after tax			₱ 158,736.50
Return on investment			**82 %**
Payback period			**1.22 years**

Marketing and transport

Grouper is more expensive than most other fishes grown in the region. So the local demand is rather limited. At present, production from Thailand, Philippines, Malaysia and Indonesia is exported live by air. Within Asia, Japan is the single most important market for live fish. Live fish is also popular in Hongkong, Taiwan, Korea, and Singapore. The demand is year-round, and the live fish trade is expanding.

During Christmas and the Chinese New Year, prices of grouper usually shoot up. Chinese New Year is celebrated in February of each year, and is the time of least and festivity for the largely ethnic Chinese populations in Hongkong, Taiwan, Singapore and Malaysia. During this time, even modest households spend lavishly on ceremonial food regardless of price. Any live fish is popular during this season as it is a common belief that fish brings prosperity to the family.

Grouper sell at an average wholesale price of US$9 to 24 per kg even way back 1995. In the Philippines, the current local market price for live grouper ranges between ₱270-310 per kg.

Transporting live fish to markets, sometimes several hundred miles away, is stressful to fish and deserves special attention. The following are basic considerations for efficient transport and marketing of live groupers:

- The operation should be properly planned to minimize delays in transit.
- Select only healthy animals for live marketing.
- It is important to keep animals well-aerated. Only clean air or oxygen, free from oil or dust particles, is used for aeration. The higher the stocking density (fish per unit volume), the higher the need for oxygen.
- Condition the fish prior to transport over long distances to reduce stress. This can be done by starving the fish and reducing water temperature in the holding tank. Adult fish should be starved for at least 24 hours prior to transport; the larger the fish, the longer it needs to clear its gut. Temperature reduction is done by addition of ice to holding tank. The rate of temperature drop should be ideally less than 5°C per hour and should be brought down to 18°C. Ice should be contained in a plastic bag to prevent dilution of seawater when it melts.
- Use only sealed double polyethylene bags for packing live groupers. Place just enough water inside each bag to avoid extra weight during transport. Place these bags inside insulated styrofoam box where sufficient ice are added to control rise in temperature.
- Determine airline requirements for shipping or air-freighting live groupers. Generally, the gross weight of the pack should not exceed 20 kg.
- It is important that labels -- **LIVE ANIMAL, THIS SIDE UP** -- are attached properly to all packages

Diseases

DISEASES CAUSED BY PROTOZOA

Parasitic protozoa cause severe losses in fry and juvenile grouper. Fish suffer from skin irritation and scrape their bodies on the side of the net or bottom of the pond. Diseased fish refuse food and gather near the surface of the water. Tail rot and skin damage with loss of mucus and scales are typical clinical signs. Common parasites are *Trichodina* spp. and *Cryptocaryon irritans*. A report from Malaysia indicates that the trophont of the protozoa *Amyloodinium* also causes high mortalities in grouper fry.

DISEASES CAUSED BY MONOGENEA

Monogenean trematode parasites are often found on the body and gills of cage-cultured grouper. Fish with severe infections have small focal haemorrhages on the body, which often result in secondary bacterial infection. Two monogenic parasites have been identified -- *Megalocotyloides epinepheli* reported in Malaysia and *Pseudoorhabdosynochus epinepheli* reported in Malaysia, Thailand and Philippines. *Dactylogyrus* sp. and *Benedenia* sp. have also been reported in cultured grouper.

DISEASES CAUSED BY DIGENEA

Digenean trematode parasites are frequently observed in the intestinal tract of cultured and wild grouper. These included *Cardicola* sp., *Aphanurus* sp. *Ectenurus* sp., *Lecithochirium neopacificum*, *Prosorhynchus pacificus*, *Prosorhynchus* sp., *Pseudometadena celebesensis*, *Allopodoccoryle serrani*, and *Stephanostomum* sp.

DISEASES CAUSED BY BACTERIA

Pathogenic bacteria cause severe losses in hatchery and grow-out cage culture systems and are usually related to poor management and poor water quality. Fish are easily damaged and stressed by improper handling and can become infected with *Flexibacteria* and *Vibrio,* leading to skin damage and tail rot. Gram-negative bacteria, especially *Vibrio parahaemolyticus* and *V. alginolyticus*, cause haemorrhagic septicemia in grouper in nursery and grow-out cage systems. The gram-positive bacteria. *Streptococcus* also cause systemic infection in grouper. Affected fish exhibit signs of weakness, abnormal swimming and occasionally comeal haemorrhage.

DISEASES CAUSED BY VIRUSES

Two viruses have been associated with major problems at the fry and fingerling stages of grouper culture in southern Thailand.

The first virus was identified in grouper with paralytic syndrome. The affected fish exhibited dark coloration, anorexia, loss of equilibrium and corkscrew-like swimming motion; mortality was heavy. *A. picorna*-like virus has been confirmed as the etiological agent. Viral particles were isolated from moribund specimens and tissue extracts from the brain of diseased grouper induced similar clinical signs.

The second virus was isolated from diseased grouper exhibiting lethargy, dark coloration of the tail and fins, and loss of balance. The virus was partially characterized as an iridovirus.

DISEASE AND STRESS

It is generally recognized that many of the disease problems in fish culture are often associated with stress. Stressed fish are more easily infected by native pathogens, and this affects growth.

To minimize stress on fish and prevent disease outbreak in the farm, fishfarmers should:

- Avoid stocking grouper fry or juvenile beyond the suggested stocking rate.
- Do not underfeed the stock during the culture period.
- Maintain good water quality by providing good aeration as well as constant water change.
- Take special care in handling grouper stock to avoid physical damage.
- Ensure proper disposal of fish that die on the farm. This is to reduce risk of the disease spreading to healthy stock.

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- The Authors

SEAFDEC / AQD research publications on grouper

FOR INQUIRIES, E-MAIL

aqdlib@i-iloilo.com.ph

or FAX

(63-33) 335 1008, 336 2891

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SEAFDEC Aquaculture Department
Tigbauan, Iloilo, Philippines
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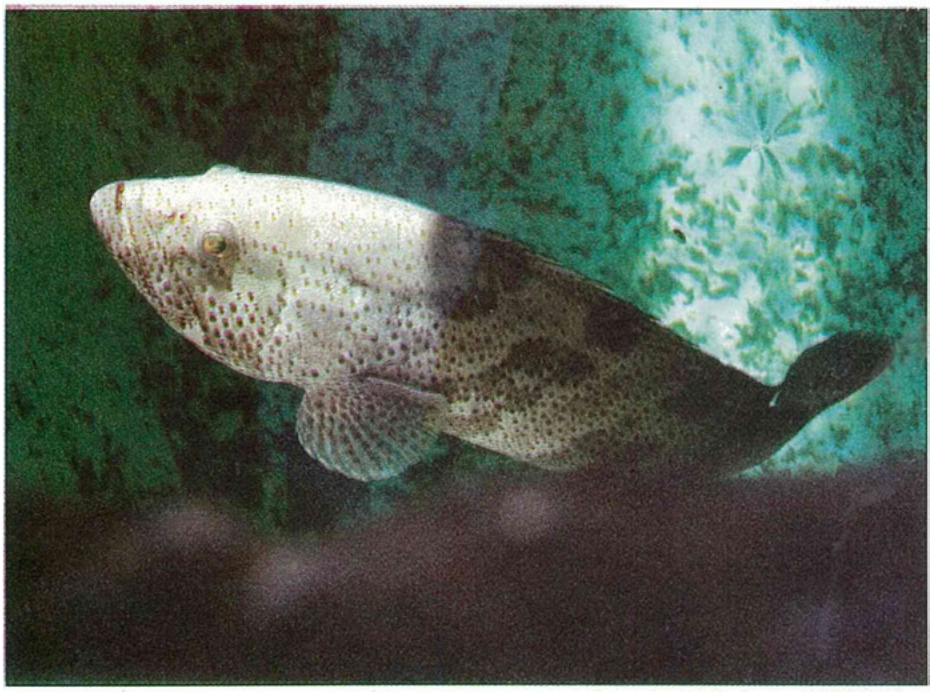

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- The **Aquaculture Department** (AQD) in Tigbauan, Iloilo. Philippines, established in July 1973 for aquaculture research and development
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