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# 67

# Review of grow-out techniques under tropical conditions : experience of Thailand on Seabass *(Lates calcarifer)* and Grouper *(Epinephelus malabaricus)*

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**Abstract** — *Seabass and grouper have been reared in cages coastal waters in Thailand for 10 years. The fingerlings are nursed for a month in nylon nursing cages. Then, the juvenile fish are reared in culture cage which can be stationary or floating. The cage is usually 5 × 5 × 2 metres. The stocking density is around 500 to 2000 fish per cage. The survival rate is approximately 80 percent. The selling price at the culture site is 80 baht and 250 baht per kg for sea bass and grouper respectively. The culture method and economics of culture are explained.*

## INTRODUCTION

Marine fish culture in Thailand has been practised in ponds and cages. Seabass can be cultured in a pond or a cage. In comparison, grouper can be cultured only in a cage. This is due to the water salinity and other habitat requirements of the species.

From the fisheries census of 1985, some 1579 families engage in marine fish culture in an area of 3698 rai (592 ha) with around 17920 cages (Table 1). Some 87 percent of the marine fish culture is in the south (Table 2). The 1985 total production of seabass was about 512 tonnes, more than the combined production of grouper and mullet (Table 3) (Anon, 1987).

## SOME GENERAL CHARACTERISTICS OF SEABASS AND GROUPER

### Seabass

Seabass, *Lates calcarifer* (Bloch), is widely distributed in tropical and sub-tropical areas of the Western Pacific and Indian Ocean, between longitude 50°E-160°W, latitude 24°N-35°S (Kungvankij et *al.*, 1986). It is found throughout the northern part of Asia, southward to Queensland (Australia), westward to East Africa.

Seabass is a euryhaline and catadromous species (Sirimontaporn, 1988). Sexually mature fish are found in the river mouths and lagoons where the salinity and depth range between 30-32 ppt and 10-15 m, respectively. The newly-hatched larvae (15-20 days old or 0.4-0.7 cm) are distributed along the coastline in brackishwater estuaries while the 1 cm size larvae can be found in freshwater bodies (Kungvankij et *al.*, 1986; Sirimontaporn, 1988).

### Grouper

The grouper which has been cultured in Thailand is estuarine grouper (*Epinephelus malabaricus* Bloch et Schneider) (Tunvilai, 1986). It is a marine fish which is mostly distributed in coastal and marine waters, especially along coral reefs. Grouper is a protogynous hermaphrodite; it matures as a female but transforms into a male when it grows bigger and older (Chen et *al.*, 1977).

### Selecting a suitable site for cage culture

Cage culture V.S. pond culture

At present, brackishwater fish are mostly cultured in cages. Cage culture is quite well developed in South East Asia. The advantages of cage culture to pond are as follows :

- cages are usually set in sites with better aquatic environmental conditions. Therefore, cages can be stocked with more fish than ponds,
- the cost of cage preparation is much cheaper than the cost of pond construction,
- during culture period, cage culture would not need water changing and pond preparation, which means cage culture operation would cost less.

### Selection criteria

Criteria for selecting a suitable site for cage culture of seabass and grouper are the following (Tookwinas and Charearnrid, 1988).

- Salinity : would range from 10-32 ppt for seabass and from 20-32 ppt for grouper.
- Tide and water depth : water depth should be more than 2-3 metres.

This is due to the usual size of culture cage which is 5 m × 5 m and 2 m deep. The tidal fluctuation should allow the water depth to be at least 2 m at the low water of spring tide.

- Current and waves : area should be protected from strong winds, waves and current; an ideal area would be in protected bays, sheltered coves and inland sea.
- Water quality : the site should be relatively free from domestic, industrial and agricultural wastes and other environmental hazards.
- Water circulation : the site should have enough water circulation to improve poor water quality that could occur at some period in the culture due to the decomposition of waste materials which often accumulate at the bottom under the net-cage.

The water quality parameters which are considered of minimum range for cage culture are shown in Table 4.

## CAGE PREPARATION

There are two types of cages used in seabass culture in Thailand (Tookwinas and Charearnrid, 1988) :

### Floating cages

The net-cages are hung on GI pipe, wooden or bamboo frames. The cage is kept afloat by styrofoam drum, plastic carbuoy or bamboo. The most convenient dimension for a cage is a rectangular and volume of 50 $m^3$ (5 m × 5 m × 2 m). The cage unit is stabilized with concrete weights at each bottom corner. The cage unit has to be anchored to the bottom. The cages might be rocked a little by strong wind and current. Floating cages can be set on coastal waters where tidal fluctuation is wide.

### Stationary cages

This type is fastened to wooden poles installed at its four corners. Stationary cages are usually set in shallow bays where the tidal fluctuation is low. The size is the same as the floating cages.

### Cost

Floating cages are more popular than stationary cages. This is because floating cages are usually set in sites with better aquatic environmental condition such as deeper water, narrow fluctuations of water salinity, more rapid circulation and farther distance from sources of pollution. Therefore, floating cages can be stocked with more fish than stationary cages. In Thailand, the floating cages are mostly used on the west coast (Andaman sea), east side and some area in southeast, while the stationary cages are used in Songkhla lagoon and some areas in southeast.

The type of floating cages can be divided into two :
a) standard which is made of GI pipe frames,
b) ordinary which makes use of wooden frames.

The total cost is 12,700 baht per standard cage and 4,400 baht per ordinary cage. The cost per year is 4,051 baht and 1,575 baht respectively (Table 5 and 6) (1 US $ = 25 baht).

The cost of a stationary cage can be estimated by the method described in Table 5 and 6.

## NURSERY

### Seabass

Seabass fry and fingerlings should be reared in concrete tanks up to the size 2.5 cm or 1 inch. After that, they can be transferred for rearing in nylon net-cages until they attain 25 cm in about 2 to 3 months of culture period.

The most convenient cage design is a rectangular cage made of synthetic netting attached to wooden, GI pipe or bamboo frames. It is either a) kept afloat by styrofoam, plastic carbuoy or b) stationary by fastening to a wooden or bamboo pole at each corner. The size of cage varies from 0.9 × 2 m to 1.0 × 2.0 m and a depth of 1.0 m. The mesh size of the nylon net is 1.0 mm. However, after a month of nursing, they can be transferred to cages with nylon net with mesh size of 0.5 cm.This would allow water to pass through the cages more freely (Table 6).

The stocking density is approximately 1000 fingerlings per cage. Grading of fingerlings has to be done at least once a week during the nursery period. Stocking is done separetely for each size group. This would minimize losses from cannibalism. Fingerlings of 2.5-5.0 cm should be fed with ground trash fish at 8-10 percent of body weight daily or about 4 to 5 times a day. After that, they can be fed with finely chopped trash fish.

The net cage should be checked daily to ensure that it is not damaged by crabs of clogged with fouling organisms. The cage should be cleaned every other day by soft brushing in order to allow water circulation in the cage.

The survival rate for the nursery period would be 50 to 80 percent. This would depend on feeding, aquatic environmental conditions and the expertise of the fish farmers.

### *Grouper*

At present, grouper fry have been collected from the wild for culture in net cage in Thailand and other countries in Southeast Asia. The fry of size of 3-4 inches, 7.5-10 cm are usually collected by fish traps set in coastal waters near mangrove areas. The fry can be normally collected the year round. However, the peak season is from May to December.

The fish farmers have to collect grouper fry or buy from the collector everyday until they have enough stock for culture. Before stocking, the fry

would be dipped in a formalin solution at a concentration of 100-250 ppm for 1 hour.

The fry can be stocked in nursery cages as mentioned previously. Stocking is done separately for each size group. This is due to the cannibalistic behaviour. First, the ground trash fish is fed 3-4 times a day. The fish farmers should give the feed slowly and watch the fish. Feeding should be stopped when the fish no longer come up to the surface; it shows that the amount of feed is enough for them. The grouper fry get used to manual feeding after one week of stocking. Then, the feeding can be done about two times a day, in the morning and afternoon. The fry can be stocked in nursery cage for about 15-30 days before transferring to marketable cages.

## REARING MARKETABLE FISH

### Seabass

Seabass are reared from juvenile to marketable size for another 5 to 20 months. The marketable size requirements of the seabass are between 700-900 g and 2000-3000 g (Tookwinas and Charearnrid, 1988). However, the 700-900 g fish is prefered by the local market as consumers in neighbouring countries.

Stocking density for marketable fish culture varies from 12-300/$m^3$ (Table 8) : depending on water quality and the environmental conditions of the culture site. Floating cages can be stocked more than stationary cages. This is because floating cages are usually set in sites with better aquatic environmental conditions such as deeper water, smaller fluctuation of water salinity, more rapid circulation and further away from sources of pollution.

Trash fish is the main feed for seabass culture. Trash fish should be fresh and clean. Trash fish used in Thailand are sardines and other small marine fish. The trash fish should be chopped and fed twice a day, in the morning and afternoon. The size must be suitable for the size of the mouth of the fish. The farmers should feed fish slowly and watch them. Feeding should be stopped when the fish no longer come up to the surface which indicates that the amount of feed is enough for them.

Food conversion rates of seabass culture in Thailand range from 4.0 to 10.0 : 1 (Tookwinas and Charearnrid, 1988). It also depends on the quality and quantity of trash fish. Normally, seabass can grow at an average of 1 kg/yr.

Survival rates for marketable fish culture are about 80-95 percent in normal culture conditions.

The cages should be checked once or twice a month to ensure that they are not damaged by fouling organisms, crabs or flotsam. The cages should be cleaned or changed every month. Therefore, fish farmers should have spare nylon net cages. Changing cages also allows the farmer to check on the number and health of the fish.

Cover nets can be used to prevent fish from jumping out especially when sea is rough. Cover nets are also used to prevent the fish from predators such as sea otter. The cover net is essentially another net panel which is placed onto the top edges of a cage.

### Grouper

The fish are reared in cages until they attain marketable size in about 10-18 months (Table 9). The marketable size requirement of the grouper are between 700-900 g and 1200-1400 g. The fish are mostly exported live by air to Hong Kong and Taiwan.

Stocking density for marketable fish culture varies from 12-100/$m^3$, depending on water quality and the environmental conditions of the culture site.

Trash fish is also the main feed for grouper culture in Thailand. From the experiment, grouper can be fed with artificial diets easier than sea bass. Feeding and cage maintenance should be the same as in sea bass culture.

Food conversion rates (FCR) of grouper culture varies with stocking density. They range from 6.0 to 7.5 (Tanomkiat et *al.*, 1987; Sakaras and Kumpang, 1988). At a high stocking density, FCR is lower than at the low stocking density which is the same as in sea bass culture (Table 10). This is due to the following factors :

- metabolic rate is decreased at high stocking density. This is because of the fish in big group do not have to swim against a strong current in cages,
- high stocking density stimulates feeding. The feeding per fish would be better than at low stocking density (Sakaras et *al*, 1988).

## FEEDS AND FEEDING

Feed is the major constraint to seabass and grouper culture. At present, trash fish is the only known feed stuff used on the first two months of culture, 10 percent of body weight is the feeding rate. After that, it can be reduced to about 5 percent of body weight (Kungvankij et *al.*, 1986). Since the supply of trash fish is insufficient and expensive, trials on moist feed or artificial diets have been conducted. The feed composition recommended for grouper is presented in Table 11. The artificial diet for seabass culture are still at an experimental stage.

## WATER QUALITY AND AQUATIC ENVIRONMENT

The physico-chemical properties of coastal aquaculture and grouper cage culture in lower south of Thailand (Krabi, Trang and Satul Provinces) were surveyed between July 1980 and August 1982 in 19 survey stations. The methodology for water analysis was set along the standard line of Apha (1975), Lind (1974) and Strickland and Parsons (1969), as temperature, visibility, dissolved oxygen, pH, salinity, ammonia-nitrogen,

nitrate-nitrogen, phosphate and silicate(Tookwinas et *al.*, 1985; Tookwinas, 1988a).

The water quality then is indicated in Table 12.

The major aquaculture is Songkhla Lake for seabass culture in net cages. It was introduced in 1972 by the Department of Fisheries. In 1986, seabass production from the 300 net cages of some 115 farmers in the lake was approx. 98.5 tonnes.

Songkhla Lake is the largest lagoon in Thailand and in Southeast Asia, as well. It is located at latitude 7°08 -7°50 N and longitude 100°07 -100°37 E. Total area is approximately. 89,680 ha. The eastern side of the lake (Thale Sap Tonnok) opens into the Gulf of Thailand).

The physico-chemical parameters of water in the lake are given in Table 13.

Other culture areas were also investigated. The bottom sediment under the net cage contained a high level of waste organic matter as shown by the chemical oxygen demand (COD) value. The benthic organism found was a polychaete which can bloom in polluted condition. It can be noted that the decomposition process occurs in the bottom sediment, which consumes a lot of dissolved oxygen in the water column.

Seabass culture in Songkhla Outer lake has been going on for 8 to 10 years. The waste material from cage culture is directly deposited at the bottom. The cages are also set very close to each other so that the number of culture cages could have been more than the carrying capacity of the area. The fish farmers have stocked up to 42.8 kg/$m^3$. The investigations suggest that the aquatic environment at the culture site must be improved by the following measures; (Tookwinas et *al.*, 1986; Tookwinas 1988 a).

a) The maximum stocking density of fish should be 300 fish per cage (cage size 7 × 8 × 2 m).

b) The dissolved oxygen can be increased by air pump, especially at night from 0200-0800 hours.

c) For a long term improvement measure :

- the culture cages should be moved farther away from one another and from the village (about 300 m). This would avoid the effect of excretory waste materials,
- the bottom sediment should be dredged. This would decrease the decomposition of waste materials.

## DISEASE AND PREVENTION

Since the cages are floating in estuarine water, there are frequent changes in water quality. As a result of environmental problems, the fish are subject to stress and their resistance to infectious diseases is lowered. Diseases may therefore result in significant losses (Chonchuenchob, 1986; Ruangpan 1988). Diagnosis and treatment of fish disease, especially for subtropical and tropical species, have not been well established. Therefore, the most important preventive measure for disease is to grow strong fish, which can withstand pathogenic agents, through proper provision of fresh,

high-quality feed, appropriate stocking density, and suitable water quality at culture site.

Numerous diseases of seabass and grouper have been reported in Thailand (Ruangpan, 1988). The causative agents of these diseases are parasitic organisms, bacteria, viroses, malnutrition and environmental stresses. Some disease and parasites associated with seabass and grouper culture are presented in Table 14 and 15.

## MARKETING AND ECONOMICS

Grouper and seabass are more expensive than most other fish species. The demand is therefore rather limited. The supply for the local market is already adequate and the prospect for markets abroad is being developed by local producers (Tookwinas, 1988b). For seabass, the demand for specific processed types and various sizes of marketable fish will also influence the expansion of the industry and its foreign market.

At present, seabass is usually sold in the local markets. The product is also exported to neighbouring countries. For grouper, the live product is mostly exported to Hong Kong by air (Fig. 1).

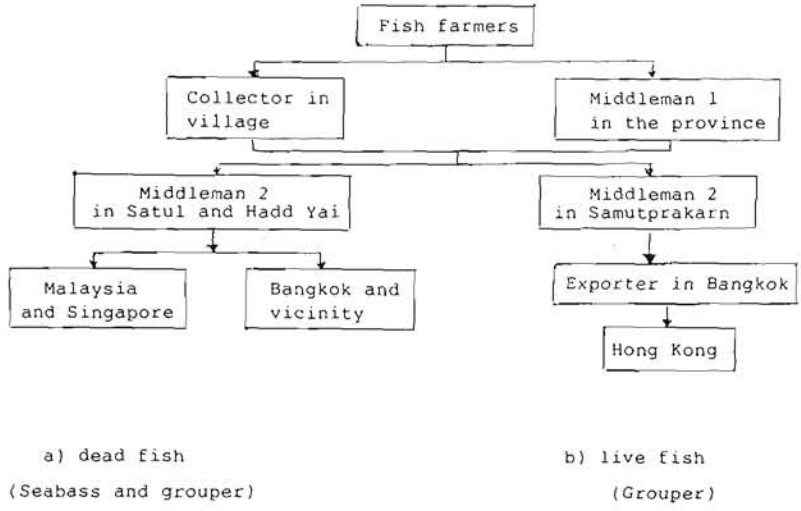


**Fig. 1.** — Marketing of Seabass and Grouper.

The income from grouper culture is much more higher than from seabass culture one's. At present, the demand is continuous the year round. The net income of grouper and seabass culture in normal conditions per cage and per year are 62,849 and 3,849 baht respectively (Table 16).

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**Tab. 1.** — Coastal aquaculture in Thailand, 1985.
(From Anon. 1987)

| Type of culture | No. of families | Area (rai)* | Percent by area |
|---|---|---|---|
| 1. Fish culture | 1 579 | 3 698 | 1.58 |
| — Pond | 289 | 3 418 | 1.46 |
| — Cage | 1 290 | 280** | 0.12 |
| 2. Shrimp culture | 4 480 | 217 574 | 92.98 |
| 3. Crab culture | 122 | 369 | 0.16 |
| 4. Oyster culture | 1 170 | 3 924 | 1.67 |
| 5. Mussel culture | 257 | 1 456 | 0.62 |
| 6. Cockle culture | 112 | 6 956 | 2.97 |
| 7. Horse mussel culture | 6 | 13 | 0.005 |
| 8. Others | 3 | 3 | 0.001 |
| Total | 7 720 | 233 993 | 100 |

* 1 Rai = 1600 $m^2$
** 280 Rai = 17 920 cages (5 × 5 × 2 m)

**Tab. 2.** — Marine fish culture in Thailand, 1985
(From Anon. 1987)

| Zone | No. of | Percent |
|---|---|---|
| Eastern part | 94 | 5.9 |
| Central part | 222 | 7.03 |
| Southern part | 1 374 | 87.02 |
| Total | 1 579 | 100.00 |

**Tab. 3.** — Production from fish culture, 1981-1985 (tonnes)
(From Anon. 1987)

| Species | 1981 | 1982 | 1983 | 1984 | 1985 |
|---|---|---|---|---|---|
| Seabass | 215 | 145 | 1 059 | 473 | 512 |
| Grouper | — | — | 176 | 149 | 117 |
| Mullet | — | 1 | — | 4 | — |
| Total | 215 | 146 | 1 235 | 626 | 629 |

**Tab. 4.** — The suitable water quality for cage culture of seabass and grouper

| Parameters | Ranges |
|---|---|
| pH | 7.5 - 8.3 |
| Dissolved Oxygen | 4.0 - 8.0 mg/l |
| Salinity | 10 - 32 ppt. (seabass)<br>20 - 32 ppt. (grouper) |
| Water temperature | 25 - 32°C |
| Ammonia - nitrogen | less than 0.02 mg/l |
| Hydrogen sulfide | none |
| Current | normal |

**Tab. 5.** — Cost of investment for standard floating cages (5 x 5 x 2 m)
(Tookwinas and Charernrid, 1988)

| Material | N° | Duration (yr) | Total cost (Baht) | Cost per year (Baht) |
|---|---|---|---|---|
| 1. GI pipe frame | 4 | 5-8 | 2 800 | 623 |
| 2. Nursing net | 3 | 1-2 | 900 | 600 |
| 3. Marketable net | | | | |
| — mesh size 2.0 cm | 1 | 3-5 | 3 600 | 1 028 |
| — mesh size 4.0 cm | 1 | 3-5 | 2 000 | 500 |
| 4. Styrofoam drum | 1 | 3-5 | 2 000 | 500 |
| 5. Other mareials | — | — | 1 000 | 500 |
| Total | | | 12 700 | 3 751 |

**Tab. 6.** — Cost of investment for ordinary floating cages (5 x 5 x 2 m)
(From Tookwinas and Charernrid, 1988)

| Material | N° | Duration (yr) | Total cost (Baht) | Cost per year (Baht) |
|---|---|---|---|---|
| 1. Wooden frames | 4 | 2 | 800 | 400 |
| 2. Styrofoam drum | 4 | 2-4 | 1 200 | 400 |
| 3. Nursing net | 1 | 3-5 | 1 000 | 250 |
| 4. Marketable net | 1 | 3-5 | 900 | 225 |
| 5. Other material | — | — | 500 | 300 |
| Total | | | 4 400 | 1 575 |

**Tab. 7.** — The suitable netting mesh size for various size group of fish.
(From Tookwinas and Charernrid, 1988)

| Mesh size (cm) | size of fish (cm) |
|---|---|
| 0.5 | 1-4 |
| 1.0 | 5-19 |
| 2.0 | 20-30 |
| 4.0 | 30 and up |

**Tab. 8.** — Growth of seabass at different stocking densities in cages. (From Sakaras, 1985)

| Culture period (days) | Stocking density (/m³) | | | | |
|---|---|---|---|---|---|
| | 100 | 150 | 200 | 250 | 300 |
| 30 | 119.7 g | 115.6 g | 116.7 g | 117.7 g | 117.8 g |
| 60 | 222.7 | 218.4 | 206.6 | 212.4 | 208.1 |
| 90 | 309.0 | 306.4 | 294.4 | 293.1 | 285.1 |
| 120 | 380.0 | 361.2 | 368.0 | 353.0 | 345.7 |
| 150 | 448.0 | 420.5 | 418.0 | 410.9 | 379.4 |
| 180 | 523.4 | 495.8 | 463.3 | 449.9 | 436.5 |
| 210 | 573.3 | 569.9 | 551.4 | 527.9 | 505.4 |

**Tab. 9.** — Growth of grouper at different stocking densities in cages

| Cultured period (days) | Stocking density | |
|---|---|---|
| | 58/m³ *a | 100/m³ *b |
| 0 | 83.7 | 26.9 |
| 30 | 158.7 | 45.6 |
| 60 | 186.5 | 65.9 |
| 90 | 243.9 | 98.7 |
| 120 | 283.7 | 137.0 |
| 150 | 296.8 | 217.1 |
| 180 | 355.8 | 312.4 |
| 210 | 443.9 | 387.6 |
| 250 | — | 586.6 |

*a fed with trash fish
*b fed with artificial diets

**Tab. 10.** — Food conversion ratio (FCR) of Seabass and Grouper culture at various stocking densities

| Species | Stocking density (/m³) | | | | | |
|---|---|---|---|---|---|---|
| | 58 | 100 | 150 | 200 | 250 | 300 |
| Seabass | — | 7.79 | 5.78 | 5.38 | 5.02 | 4.64 |
| Grouper | 7.48 | 6.36 | — | — | — | — |

**Tab. 11.** — Artificial diets for grouper culture

| Composition | Weight (kg) |
|---|---|
| Fish meal | 75 |
| Rice bran | 20 |
| Soy bean oil | 0.5 |
| Vitamin and mineral | 0.2 |
| Banana | 20-30 pieces |

**Tab. 12.** — Water quality in coastal aquaculture area in Krabi, Trang and Satul Provinces, lower and south of Thailand, monthly average from 19 surveyed stations, July 1980 to August 1982

| Parameters | Mean | S.D. |
|---|---|---|
| Depth, m. | 2.10 | 1.348 |
| Visibility, m. | 0.87 | 0.324 |
| D.O., mg/l | 5.24 | 0.495 |
| pH | 7.80 | 0.170 |
| Salinity, ppt | 26.10 | 3.923 |
| $NH_3$-N, mgN/l | 0.01 | 0.01 |
| $NO_2$-N, mgN/l | 0.0039 | 0.004 |
| $PO_4$, mg$PO_4$/l | 0.04 | 0.018 |
| Si, mgSi/l | 2.50 | 0.279 |

**Tab. 13.** — Physico-chemical properties of water in Songkhla Lake (Thale Sap Tonnak) (1984-1985)

| Parameters | Mean (av. annual) | Ranges |
|---|---|---|
| Temperature (°C) | 30.17 | 24.0-34.0 |
| Turbidity (FTU/NTU) | 19.34 | 6.90-33.50 |
| Conductivity (mmhos/cm) | 22.24 | 0.10-58.70 |
| Salinity (ppt) | 13.68 | 0-34.00 |
| pH | 7.89 | 6.40-8.55 |
| Dissolved oxygen (mg/l) | 7.19 | 3.10-9.95 |
| COD. (mg/l) | 2.46 | 0-9.50 |
| Orthophosphate (mgP/l) | 0.27 | 0-1.60 |
| Nitrate-nitrogen (mgN/l) | 0.01 | 0-0.09 |
| Alkalinity (mg/l) | 56.24 | 21.43-95.00 |
| Acidity (mg/l) | 2.79 | 0-5.96 |

**Tab. 14.** — Parasite of Seabass culture in Thailand

| Parasite | Attacked position | Mortality (%) | Treatment |
|---|---|---|---|
| *Protozoa* | | | |
| Blastodimidae | Gill | — | formalin 250 ppm |
| Epistylis sp | Gill, body, eye, fin | 5-80 | 30 minutes or |
| Henneouva sp | Gill | 5-80 | formalin 50 ppm 24 h |
| Opistonectus sp | Gill, body, skin | 5-80 | 3-4 times/3 day |
| Trichodina sp | Gill, body, skin | 50-100 | |
| *Helminths* | | | |
| Deplectanum latesi | Gill | 2-5 every day | |
| *Crustacean* | | | |
| Aega sp | Gill | 5 | formalin 50 ppm 3-6 h. |
| Gnathis sp | Gill, mouth cavity | > 20 % | or dipterex 0.25-0.5 ppm |
| Caligus sp | Gill, mouth cavity | 10-80 in small size fish | or NaCl 3-5 % for 5 mn |
| *Lernanthropies* sp | Gill | | |

**Tab. 15.** — Some parasites and diseases associated with culture of grouper in Thailand

| Disease or Parasite | Attacked position | Mortality (%) | Treatment |
|---|---|---|---|
| 1. Monogenetic trematode | Skin, gill | | Dipterex 0.3 ppm 24-48 hrs |
| 2. Cryptocaryon sp (Ich.) | Skin, gill | | Malachite green 0.1 ppm + formalin 25 ppm, 24-48 hrs |
| 3. Trichodina sp | Skin, gill | | Formalin 250 ppm 30 '(twice) |
| 4. Bacteria | | | Oxytetracycline 1.5 g/1 kg of feeds, feeding 7 days |

**Tab. 16.** — Economic of Seabass and grouper culture per year in Thailand. (unit : Baht; 1 US$=25 Baht)

| | Seabass | Grouper |
|---|---|---|
| 1. Cages (standard) | 4 051 | 4 051 |
| Seed | 2 500 | 10 000 |
| Feed | 7 000 | 7 000 |
| Labour | 3 600 | 3 600 |
| Total cost | 17 151 | 24 651 |
| 2. Production (kg) | 350 | 350 |
| 3. Income | 21 000 | 87 500 |
| 4. Net income | 3 849 | 62 849 |
| 5. Net Income over cost | 18.3 % | 71.8 % |