PACIFIC ISLANDERS GAIN SPECIFIC KNOW-HOW ON GROUPER HATCHERY TECHNIQUES

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Marine finfish hatchery training for Pacific Islanders

Six Pacific Islanders received training in marine finfish hatchery techniques in Thailand between 12 May and 2 June 2007. Organisation and sponsorship was mostly provided by the Secretariat of the Pacific Community (SPC) with local support provided by the Network of Aquaculture Centres in Asia-Pacific (NACA). Participants were from New Caledonia, Papua New Guinea, French Polynesia, and Fiji. Training was held at the Krabi Coastal Fisheries Research and Development Center (KCFRDC) on Thailand's Andaman coast, and included field trips to the provinces of Satun, Songkla, Phuket and Phang-nga.

Groupers were the focus of the hatchery training. Tiger groupers (*Epinephelus fuscoguttatus*) were induced to spawn and participants followed up on larval rearing and larvae development for the duration of their three-week stay in Krabi. The training included hands-on work, lectures on all topics relevant to grouper/tropical marine finfish aquaculture, and field visits to governmental and commercial ventures in southern Thailand.

Researchers from aquaculture centres around southern Thailand gave 15 lectures on various topics including health and disease, feeds and nutrition, specific grouper culture, and broodstock management.

Overall, participants were given a broad perspective of the constraints in and potential for developing marine finfish and grouper aquaculture in the Pacific. This was made possible by a daily exposure to the successes and achievements in this type of venture.

Thanks to the very knowledgeable and helpful staff of KCFRDC, the SPC/NACA participants gained tremendous practical knowledge on techniques of grouper culture, larvae handling and rearing, which will have direct application to the development of finfish aquaculture in their respective island countries.

KCFRDC, a prime training centre

KCFRDC was identified as a suitable facility for the SPC/NACA training because of its ability to mass produce tropical fish species (mostly grouper species, seabass and cobia) in a hatchery environment. KCFRDC was also chosen because of its:

- accessibility (there are direct flights to Krabi from Bangkok),
- large size and available space for training purposes (both theoretical and practical), and
- skilled staff who are able to communicate in English.

KCFRDC was also ideal because of the variety of tropical finfish that are cultured there and the number of relevant commercial and governmental aquaculture facilities that are close by.

KCFRDC has several fish hatcheries and nursery rooms: a food fish hatchery (grouper species, seabass and cobia), nursery room and broodstock areas area; a shrimp hatchery and nursery room; and an ornamental fish hatchery and grow-out area.

Several earthen ponds are also used for holding broodstock of large fish species (e.g. *E. lanceolatus*). Cage culture systems are placed in some of the ponds for holding broodstock and juvenile fish.

Hands-on training for technical participants

The main aim of the training was for participants to observe the spawning of grouper species and the early days of larval rearing — the life stages that present the most difficulties when culturing these fish.

Hormone stimulation and spawning induction were performed by all six participants at the beginning of the training. A mix of Superfact® and Motilim-M® was used to induce the fish to spawn. Before injection, *Epinephelus fuscoguttatus* broodstock were anaesthetized using quinaldine, and checked for gonad ripeness by stripping or cannulation for females. Then, several mature broodstock were injected with the hormone preparation.

Forty-eight hours after induction, the fish spawned and participants were invited to collect the eggs using a seine net. Good quality eggs were collected, disinfected, and placed into a 200 L incubator for 24 hours, until hatching. Each participant was assigned to a 4-t tank that was

thoroughly cleaned with iodine and domestic detergent, and then rinsed with fresh water.

Once the larvae hatched, they were gently transferred to the larval rearing tanks, at a density of 80 larvae per liter. Each tank was stocked with 250,000–300,000 larvae. Participants observed the larvae under microscopes and then calculated yolk size, lipidic globule size and total length. For two days, larvae were fed on yolk so that no external feeding was needed at that stage.

In Thailand, a green water technique is used for grouper culture. Green micro-algae are mass produced (e.g. *Tetraselmis* sp. or *Nannochloropsis* sp.) and then used for feeding zooplankton (rotifer). The algae tint the water in the larval rearing tank, which reduces visibility and diminishes the brightness of incoming light. The result is that stress levels in the fish are reduced. To keep the algae and rotifer populations balanced in a larval tank, fresh algae must be inoculated every day. A small strain of rotifers is used for feeding small grouper larvae. For the first few days of the grouper larvae feeding, only the smallest portion of the rotifer population is harvested through a 100 µm mesh. Smaller rotifers and rotifer eggs are used for the first feedings of the grouper larvae.

The very early stages of grouper larval development require little care and attention. The larvae are lecithotrophic. It takes around two days for the larvae to absorb the yolk and for their mouths to open. For the first two days of larval rearing, participants measured the volume of the yolk sac and the size of the lipidic globule in order to evaluate the absorption of the yolk sac and estimate the time the mouth opens.

After day 3, larvae were fed daily by maintaining the algae population in the tank. On day 4, grouper larvae entered a critical developmental stage (days 4, 5 and 6) and many larvae died or were trapped in the surface. During these three days, fresh algae were inoculated daily and the rotifer population maintained at around 10 rotifers/ml.

On day 6 of the larval rearing, the first dorsal spine appeared. Tanks were cleaned to remove waste products and to increase the water quality. For the following five days, routine feeding and larval observation took place. On day 12, tanks were harvested and larvae were counted and restocked into new tanks that were filled with algae and rotifers.

Usually, after day 12, grouper larval survival is more than 10–12%. Larval rearing from day 14 up to the weaning stages is not as problematic as during the early stages, and mortality decreases during the second half of grouper larval life. Basically, routine feeding with chlorella and rotifers continues until days 15–20, after which larvae are fed *Artemia* nauplii.

Top: Injecting a tiger grouper broodstock (photo Sih Yang Sim)

Bottom: Participant checking the quality of the eggs after spawning (photo Sih Yang Sim)

Once the nauplii have hatched, they are enriched with highly unsaturated fatty acids (HUFA), which are essential to grouper larval survival.

Rearing juvenile groupers to market size

Although nursery techniques were not the main focus of this course, participants were exposed daily to nursery practices, including grading and sorting for deformities, feeding, culture methods and culture tanks, packaging and transporting. While at KCFRDC, numerous *Cromileptes altivelis* of around 5 g were stocked in the nursery tanks and participants observed and assisted in all handling activities.

Thai grow-out techniques were observed during the numerous field trips around Krabi and in the other provinces. Participants studied single floating or multiple floating cages in ponds or at sea. Participants also participated in daily feedings of adult fish held in KCFRDC facilities.

It takes about six months to two years to rear groupers to commercial size, depending on the species and the culture methods used.

A study tour through southern Thailand

In addition to the routine daily hatchery training, participants made numerous field visits

Floating farms

Participants visited floating farms in Koh Ya Noi, an island between Krabi and Phuket, and another one in the mouth of the Krabi River. The floating set ups were similar and each farm had around 50–60 nets measuring 3 m x 3 m x 2 m. Most of the fish grown in these cages (*Epinephelus areolatus*, *E. coioides*) were collected from the wild as juveniles, but others, such cobia or sea bass, were purchased from hatcheries. Also, lobsters (*Panulirus ornatus*) were generating most of the interest of these cage farmers.

In Phuket Province, participants visited a floating cobia farm comprising three large (10 m in diameter) circular cages stock with 4–5 kg fish. Cobias were fed artificial feed and were ready for sale (filet and export) in approximately one year. It takes about 15 people to lift the nets or to proceed with any major operations (e.g. harvesting, changing the net). This particular cobia farm buys fingerlings from the government hatcheries in Krabi, Phuket and Phang Nga. Near the cobia farm, there is a co-owned Thai-Taiwanese floating grouper farm that operates approximately 200 square cages 5 m x 5 m x 2 m and one large floating work house. Fingerlings are mostly imported from Taiwanese and Indonesian hatcheries. Once the fish reach market size, most of them are exported live to Taiwan. This cage farm mostly focuses on high value species such as coral trout (*P. leopardus*), gold spot grouper, giant grouper, mouse grouper, and aereolated grouper.

Top: Cobia in a floating cage in Satun area
Middle: Floating cages in the mouth of the Krabi river
Bottom: Grading and treating fish with fresh water on a floating cage set up in Phuket area

throughout southern Thailand to the provinces of Satun, Songkhla, Krabi, Phang Nga and Phuket. Private floating fish farms, an abalone hatchery and grow-out facility, a prawn hatchery and prawn farms were visited. Participants also had the opportunity to visit government aquaculture centres in Satun, Songkhla, Phuket and Phang Nga, all of which had hatcheries and large finfish areas available for research and development or production work. Food fish and ornamental fish are commonly cultured and technologies transferred to the private sector.

Global characteristics of grouper farming and their application for the Pacific region

Marine fish farming in Southeast Asia has been developing at a rapid pace, especially in Indonesia, Malaysia and Vietnam. This is the result of improved farming techniques (hatchery) and the inclusion of aquaculture in all government strategic plans. International markets are still healthy and most of the production is aimed at exports.

The marine finfish sector and especially grouper production face particular problems relating to seed production (i.e. some species have low survival, supply can be inconsistent and seasonal, seed supply still rely a lot on wild caught juveniles), feed availability (whether it's trash fish or artificial feed), and fluctuating market prices (i.e. excess supply, price fluctuation, niche markets, seasonality).

The training at KCFRDC in Thailand was highly relevant to Pacific Islanders because:

- Systems used in Thailand are simple and do not involve high-tech equipment. Most set ups are made of concrete, PVC and fairly simple piece of equipment that are readily available throughout the Pacific.
- Techniques used in Thailand base their success on low input, low output. Survival rates of some delicate species remains low but the costs of producing them are also low.
- Mechanization of aquaculture facilities in Thailand is at a minimum and many stages of aquaculture production are done by hand. As a result, the processes are more labour intensive but costs and risks are kept low.
- There are numerous local markets in Thailand for finfish species. Thai producers seem to be targeting the domestic market rather than export market, where they would otherwise place themselves in competition with other countries (e.g. Vietnam, China).

In the Pacific Islands, marine finfish production should primarily be oriented towards the domestic market for local consumption. Increasing human populations and a stable demand for fish will help reduce the risks associated with export markets.

Because the demand for high quality products remains high, exporting might also be considered for Pacific Island countries. However, higher production

Table 1: Comparison of hatchery and farming practices among three countries.

Country	Hatchery practices	Farming practices
Indonesia	Small-scale low investment & low cost backyard hatcheries	Mainly floating cages
	Fast return	Medium- to large-scale
	Increasingly capital intensive: medium- & large-scale hatcheries established	Concrete tank culture
	Groupers (humpback, tiger, orange-spotted, coral & coral trout), milkfish, trevally, snappers, etc.	Capital intensive & high investment
		Mix of trash fish & artificial diets
Malaysia	Capital intensive	Floating cages & ponds
	Medium- & large-scale	Medium- to large-scale
	Mix of tank & pond systems	Relatively capital intensive
	Limited species produced	Mix of trash fish, artificial diets, bakery products,
	Majority of marine finfish species farmed rely on imported fingerlings	
Thailand	Commercial production limited to seabass	Mix of floating cages & ponds
	Grouper species from government stations	Small- to medium-scale
	Many marine fish species farmed in Thailand	Low investment capital
	Still rely on imports or wild seeds	Mainly trash fish

and shipping costs in the Pacific (vs those in Southeast Asian countries) will make competition difficult for Pacific region.

Good water quality, availability of land and sea area for farming, availability of labour and (relatively) low labour costs, and availability of broodstock from valuable species are assets to the Pacific Islands region and developing marine finfish aquaculture seems a viable option for the near future.

Farming aquarium fish

Eleven species of anemone fish are successfully being reared at KCFRDC using traditional larval rearing protocols. These include *Amphiprion ocellaris*, *A. percula*, *A. ephippium*, *A. sebae*, *A. polymnus*, *A. clarkii*, *A. frenatus*, *A. melanopus*, *A. akallopsios* and *A. perideraion* and *Premnas biaculateus*. Most of the fish are sold to small-scale Thai ornamental operators before they are exported.

Three species of seahorses are also cultured and larval rearing protocols are being developed for other species such as damsel fish (*Chrysiptera* sp.) and blue ring angel (*Pomacanthus annularis*), as well as silver angel (*Monodactylus argenteus*) and batfish (*Platax orbicularis*).

***Premnas biaculateus* broodstock at KCFRDC**

Diversified aquaculture

Participants of the KCFRDC training also visited two abalone hatcheries and grow-out farms, one in Phuket and the other one in the Krabi area. The abalone species that is cultured is *Haliotis diversicolor*, which is relatively fast growing and has a high market value in Taiwan. Abalone broodstock are fed *Gracilaria* sp. for maturation and then induced to spawn. Larvae are lecitotrophic, and at settlement they are fed artificial feed. After incubation, larvae are stocked directly in grow-out tanks with corrugated tiles and harvested when they reach commercial size.

The Lookmee prawn hatchery in the Krabi area uses highly hygienic practices to achieve a production of 200 million post larvae per year. A commercial grow-out farm rearing *Litopenaeus vanamei* was also visited. Productivity from this farm was high: seven ponds, each 1 ha, could produce around 400 t/harvest. Most Thai farms are very cautious of environmental issues. Use of settlement ponds and large buffer ponds is common. No antibiotics are used during the culture cycles.

Top: Juvenile abalone ready to export to a grow-out farm
Bottom: Intensive white shrimp farm in the Krabi area