SEED PRODUCTION AND THE PRAWN INDUSTRY IN THE PHILIPPINES

J.H. Primavera
Researcher
SEAFDEC Aquaculture Department

INTRODUCTION

In any aquaculture system, the major components are seed and feed. The same is true for *Penaeus monodon* known locally as sugpo, lukon, pansat or by its trade/export name "black tiger." (The present discussion will refer to *P. monodon* unless otherwise specified). This paper is an attempt to give a state-of-the art of prawn hatchery technology and wild fry collection in the country, focus on technical and non-technical problems, and offer solutions and policy recommendations.

First, a brief review of the natural and production cycles of sugpo. The life cycle of sugpo starts with the spawning of the gravid female in offshore waters with an average of 500,000 eggs/spawning (Fig. 1). They hatch after 12-15 hours into the first larval stage or nauplii, it takes another 10-12 days for them to pass through two more stages -- protozoea and mysis. Only a small fraction of the larvae survive predators and the vagaries of nature to metamorphose into the postlarval stage.

The young postlarvae or fry move shorewards and start appearing in coastal waters on the 14th day of their postlarval life (PL_{14}). They continue migration towards the estuarine areas such as mangroves which serve as their nurseries or feeding grounds, growing to larger juveniles, postjuveniles and subadults.[1]

First mating of subadults occurs at 4-5 months of age in the inshore areas (Motoh 1981). However, it is only during or after migration back to the offshore areas that full maturation of the ovaries and first spawning take place at around 10 months to complete the natural cycle. The bottom-dwelling *P. monodon* remain in the ocean up to a ripe age reaching sizes of 500 grams or more unless they die earlier of disease or predation.

The larval rearing phase which starts from spawning of the ripe females to production of the young postlarvae is the basic concern of the hatchery (Fig. 1b). However, the young postlarvae (PL_5 to PL_{10}) harvested from the hatchery tank are fragile and need to go through a nursery phase, whether in tanks or earthen ponds. After 1-2 months in the nursery, the so-called juveniles (PL_{35} to PL_{60}) measuring the width of a matchstick are hardly enough to be stocked in extensive or semi-extensive grow-out ponds. Younger PL_{15} to PL_{20} may be stocked in intensive ponds. After 3-6 months, the prawns are harvested at marketable sizes of 30-80 grams.

[1]The policy of increasing production from already existing fishponds rather than opening new mangrove areas has helped preserve natural population of crustaceans and finfish by protecting their nurseries.

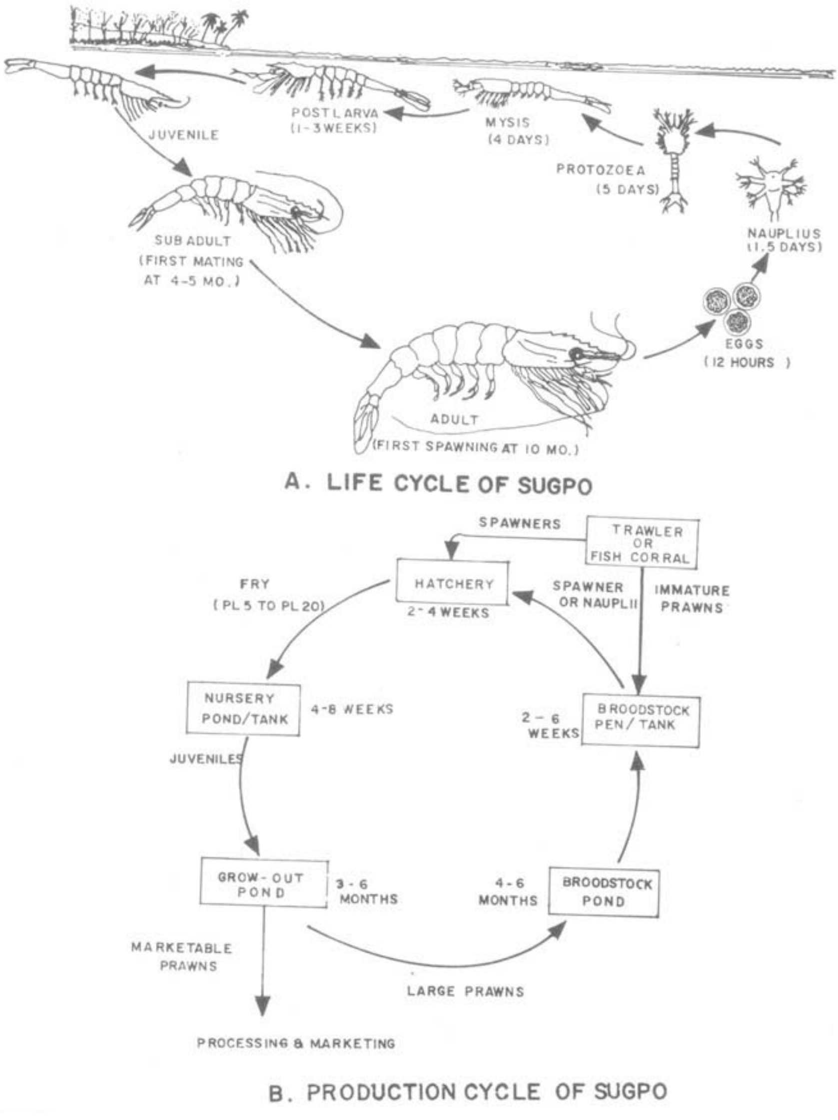

Fig. 1. Parallels in the (A) life cycle and (B) production cycle of sugpo *Penaeus monodon.*

In addition to the larval rearing and nursery phases, a hatchery may also go backwards and incorporate a broodstock as an alternative to wild spawners. Maturation and subsequent spawning of the female closes the cycle in captivity.

WILD FRY

Prawn culture in the Philippine has evolved from the harvest of sugpo and other prawns as by-products of milkfish ponds from wild fry that enter with tidal flushing to the intentional stocking, first of wild-caught fry and later of hatchery-reared fry (Fig. 2).

	SOURCE OF FRY	SPAWNERS	
First Stage	Wild fry	-	Accidental entry with tide
Second Stage	Wild fry from coastal gatherers	-	Intentional stocking in pond
Third Stage	Hatchery fry	Wild spawners (MSU-IFRD, 1970)	Stocked in pond
Fourth Stage	Hatchery fry	Captive/ablated spawners from broodstock (SEAFDEC AQD, 1976)	Stocked in pond

Fig. 2. Evolution of fry supply in pond culture of prawn.

Wild fry are caught by different collecting gears according to habitat: fry lures made of grass and twigs for mangrove areas, filter net and fry raft (saplad) for fry migrating in rivers, and filter net (tangab), fry seine (sagyap or sayod) and scissors net (sakag) for shorewaters (Motoh 1981).

Compared to other penaeid species, sugpo fry are not so abundant in our coastal and estuarine waters. In a two-year survey, sugpo constituted only 5.5% of all penaeid fry compared to 85% for putian (Motoh, 1981). With milkfish, on the other hand, it can be assumed that some 900 million fry stocked in ponds from a yearly catch of 1.15 billion given 78.4% survival before stocking in ponds (Villaluz et al 1982). If best industry estimates show 15 million prawn fry stocked in ponds in 1982 (Primavera 1983b), this means a ratio of 60 milkfish to every prawn fry stocked in ponds.

Even with such low population, wild fry still constitute a significant seed source in areas of abundance and in places where prawn farming is new and at the extensive, low-stocking level.

PHILIPPINE HATCHERIES

a. History

A 1969 ecological survey by the Mindanao State University Institute of Fisheries Research and Development (MSU-IFRD) (Villaluz et al 1972) marked the first scientific study of *P. monodon* in the country. This was followed by the first experimental hatchery established by MSU-IFRD in 1973. After two years, the SEAFDEC Aquaculture Department started large-tank hatchery operations in Tigbauan, Iloilo followed by the small-scale hatchery in 1977.

On the industry side, the first two commercial hatcheries were established in the late 1960 followed by a third one established in Lanao del Norte by the Panguil Bay Fishpond Owners Association in 1972. These early hatcheries eventually closed largely due to the immature state of hatchery technology at the time. Most of our private hatcheries were built after 1975.

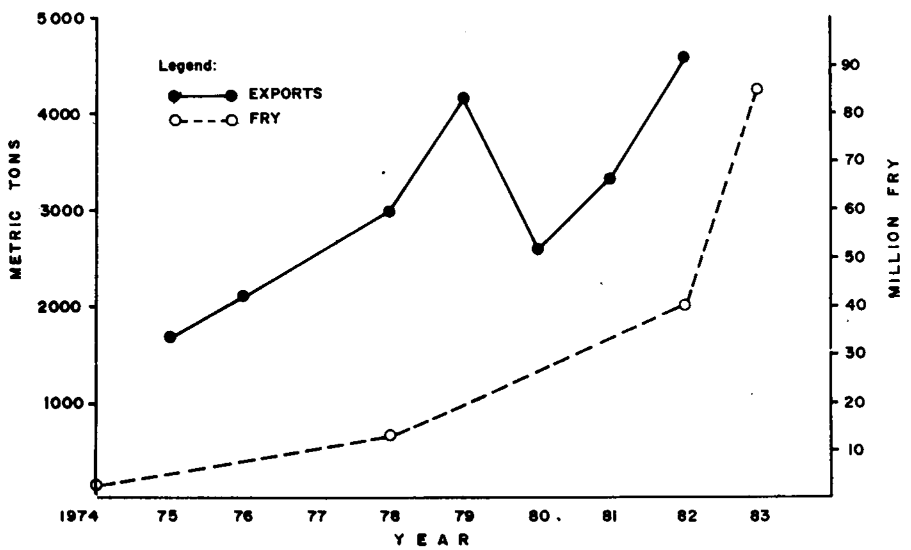

Fig. 3. Total prawn exports and hatchery fry production in the Philippines, 1974-1983.

Fig. 3 shows the gradual but steady increase in hatchery fry production from less than 3 million in 1974 to around 85 million last year (J. Lim personal communication). A rough parallel may be noted in the yearly total prawn exports.

b. Classification

There are some 60 hatcheries in the country today. A majority (85%) are private owned. The government-operated hatcheries include SEAFDEC AQD hatcheries in Iloilo and Aklan the MSU-southern Philippines Development Authority hatchery in Naawan, Mis. Or., and the Ministry of Human Settlements hatcheries in Mindoro Occ. and Agusan del Norte. More than half (56%) of the hatcheries are located in the Visayas with 24 in Panay Island alone, 21 (36%) are in Luzon and 5 (8%) are in Mindanao.

According to total larval rearing tank capacity in tons and total investment costs, these hatcheries may also be classified into small-scale (less than 30 T tank capacity and less than (P50,000 capitalization), medium-scale (30-100 T capacity and less than P1 million capitalization), and large-scale (above 100 T capacity and at least P1 million capitalization). Based on this classification criterion 10 (17%) are small-scale, 23 (39%) are medium-scale, 12 (20%) are large-scale and the remaining 14 hatcheries are probably small to medium-scale (Fig. 4).

All of these hatcheries rear sugpo but a few have also reared fry of *putian (P. indicus / P. merguiensis).*

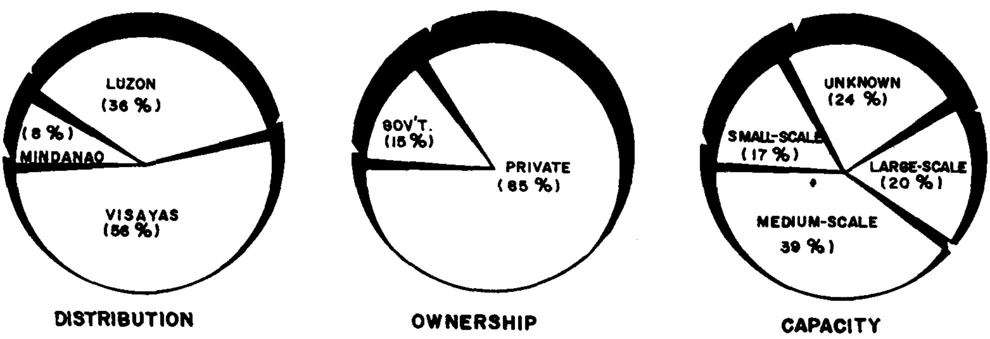

Fig. 4. Classification of prawn hatcheries in the Philippines according to distribution, ownership and capacity (small-scale = 30T and < P50,000; medium-scale = 30-100T and <P1 million capital; large-scale > 100T and >P1 million capital).

c. *Site selection and facilities*

Clean seawater of 28-35 ppt salinity is a primary consideration in locating a hatchery. Seawater supply may be pumped directly from the sea or from a sump pit, an inshore well or seabed using perforated PVC pipes (Quinitio et al 1984).

However, at least two hatcheries are built away from the coastline and had to lay down a few hundred meters of expensive pipeline. A hatchery located in Northern Mindanao that has not produced a single PL in a year of operation was constructed in a mangrove area where salinity drops to 4 ppt.

The case of two hatcheries located inside residential subdivision is noteworthy. Both haul seawater. The owner of one frugally recycles his water while the other claims to have written off a P250,000 tanker he uses for hauling water from the sales of a few million fry.

Besides nearness to seawater, other criteria in site selection include proximity to spawner and broodstock sources, transportation and communications, power supply and freshwater.

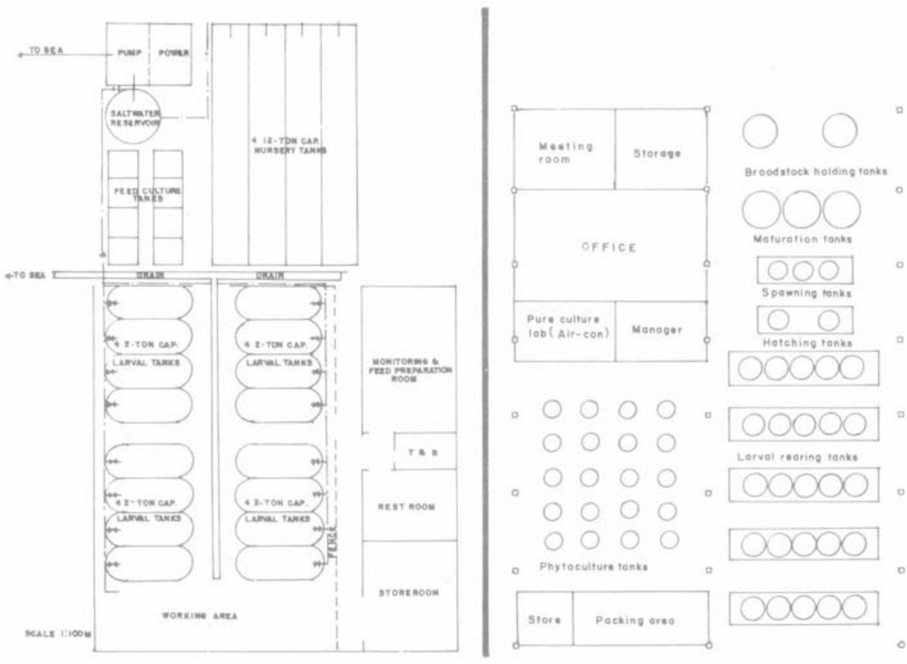

Fig. 5. Layout of two prawn hatcheries.

Basic physical facilities include a seawater reservoir, larval rearing tanks, algal tanks and spawning tanks inside a roofed structure (Fig. 5). Optional are an algal room, broodstock tanks, nursery tanks for juvenile rearing and living quarters for live-in staff.

Most hatcheries have their larval tanks and building made of concrete. A cheaper alternative is to use bamboo, plastic sheets and other local materials (Quinitio et al 1984). For the same water capacity, the bamboo hatchery would cost less than P100,000 to build.

d. *Wild spawners and broodstock*

The closing of the life cycle of ***P. monodon*** and the first rematuration of a spent spawner were achieved in 1975, both by eyestalk ablation (Santiago 1977). In the eyestalk of the prawn are located the production and storage sites of a goad-inhibiting hormone which prevents ripening of the ovaries. In nature, some environmental factors cause the decrease of this substance as the animals migrate from the estuaries back to the offshore areas. Ablation by pinching, cutting or tying of either eyestalk reduces the hormone level so that maturation can proceed (Fig. 6). Continuing produc-

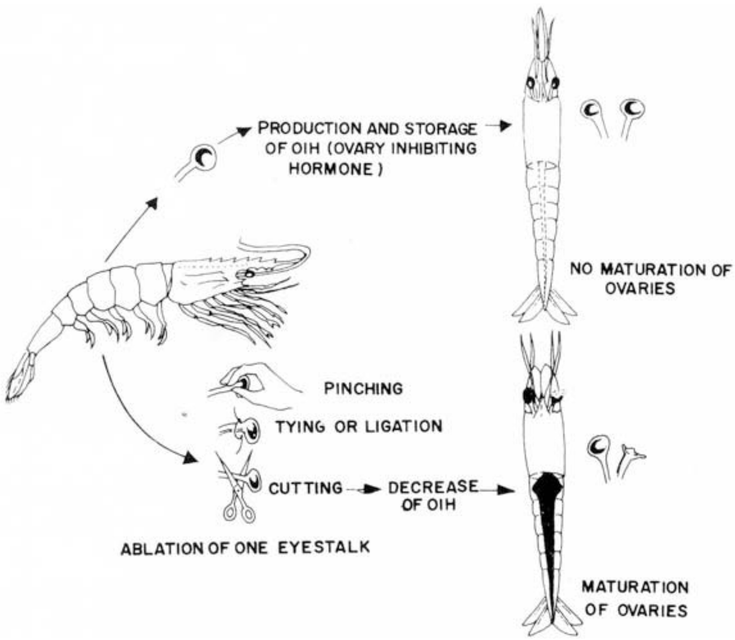

Fig. 6. Ovarian maturation by eyestalk ablation in sugpo and other prawns.

tion of the hormone by the remaining unablated eyestalk may explain the reduced fecundity of ablated females (ave. of 300,000 eggs/spawning) compared to wild spawners (ave. 500,000 eggs/spawning).

Hatcheries may use ***P. monodon*** spawners that are obtained directly from the wild or from captive broodstock with ablated females. Broodstock, in turn, may be pond-reared or wild. Both wild spawners and wild (immature) broodstock are caught by fish traps and filter nets in mangrove areas or by trawler or gill net in offshore areas.

The regular use of pond-reared animals for broodstock to eliminate dependence on wild stock is the ideal target in aquaculture. However, studies at SEAFDEC AQD and observations by private hatchery operators show that 4 - to 6-month old pond-reared females produce larvae of poor quality after ablation. In contrast, larvae from pond broodstock ablated at 1 to 2 years of age gave relatively higher survival rates (Primavera and Yap 1979).

Given the same body size wild females are older and probably more receptive to induced maturation than normal harvest-age females (Primavera and Yap 1979). In nature. ***P. monodon*** attains full maturation and spawns for the first time at 10 months (Motoh 1981). Current practice m both research and private hatcheries is the use of wild broodstock for ablation in the meantime that one-year old pond animals are not available on a regular basis.

Once the females are ablated, ***P. monodon*** broodstock may be maintained in tanks, marine pens, cages or earthen ponds; the latter two systems are still experimental. Land-based tanks may be circular or rectangular, made of concrete or ferrocement, and with water volume of 10-15 m^3. Salinity, temperature and other environmental parameters are generally dependent on the seawater supply. Maintenance of good water quality whether in a flow-through system or by regular water change in a static system is essential for maturation. A private hatchery controls photoperiod to obtain better maturation results.

The prawns are stocked in batches of 30-40 ablated females and an equal number of unablated males per tank. Sampling for gravid females is undertaken every night using an underwater light. One batch can yield 2 to 10 million nauplii or larvae from six to thirty spawnings over 2 to 6 weeks.

The maturation pen requires a cove for protection against wind and wave action. Seawater should be relatively free from industrial and agricultural pollution. The SEAFDEC model measures 16 x 16 x 4 m and consists of bamboo posts, braces and catwalks enclosed by bamboo mattings. Approximately 150 male and 150 ablated female broodstock are kept in an inner polypropylene net resting on the sea bottom.

Feeding is given once to thrice daily at 2-5% of total body weight. Feeds include squid, mussel, marine worms and other items rich in lipids, particularly in certain polyunsaturated fatty acids. Preliminary findings show high levels of those fatty acids in mature ovaries and spawned eggs of wild ***P. monodon*** spawners and ablated wild broodstock (O. Millamena personal communication). Other details on broodstock tank and pen procedures have been described elsewhere (Primavera 1983a).

All Philippine hatcheries with broodstock maintain them in land-based tanks; the offshore pen is found only in the AQD stations in Batan, Aklan and Igang, Guimaras. This preference may be due to the following advantages of the tank; (a) versatility because it is not site-specific, (b) security against poachers, (c) ease and higher frequency of retrieval of gravid females, (d) convenience in cleaning, and (e) minimal depreciation of concrete tanks compared to bamboo pens (Primavera and Gabasa 1981).

Larval supply of AQD's hatchery tanks has moved from total dependence on wild spawners (1975-76) to the use of females ablated in maturation pens and ferrocement tanks (1977 to present). However, it was only in 1980 that two hatcheries in Mindoro started to operate their own broodstock. Today, 20-25% of all hatcheries in the country depend to some extent on ablated spawners.

In 1975, the year the first sugpo was ablated in the Philippines, one wild spawner cost only P5. Less than a decade later, a wild spawner now fetches P100-700 locally and P15,000-20,000 when smuggled to Taiwan. With the dissemination of SEAFDEC ablation and maturation technology to commercial hatcheries here and abroad, wild broodstock provide a cheaper alternative -- at P20-40 apiece locally and P4,000-6,000 in Taiwan.

The 1983 monthly operating expenses of a hatchery in Roxas City of P30.000 (P9,000 for spawners alone) was reduced by 50% (to P15,000) with a shift to wild broodstock. The availability of ablated females has released the pressure on wild spawners in certain areas like Roxas City. Nevertheless, claiming poor larval quality from ablated spawners, some hatcheries insist on wild ones. A SEAFDEC study this year sets out to prove or disprove this claim.

Transport of nauplii, rather than spawners, in simple, unoxygenated plastic containers from collecting grounds to the hatchery is another AQD-generated technology adopted by the private sector (Primavera 1983c). This method is also used by hatcheries that would rather sell nauplii to other hatcheries instead of rearing them because of high larval mortalities.

e. *Larval rearing*

Larval stocking density falls within a high range of 50-100 nauplii/liter in small tanks with a volume of 2-20 tons and a low range of less than 50 nauplii/liter in larger tanks of more than 20 to 200 tons volume.

Hatchery feeding technology may be classified into the fertilized or ecological system and the unfertilized or feeding system (Platon 1979). Developed in Japan, the fertilized method involves the culture of both the larvae and phytoplankton or algal food in the same tank with the latter induced to bloom by the addition of inorganic fertilizer. In the other system, algal food is grown separately and fed at predetermined amounts to the larvae in the feeding system, largely an American innovation. Most Philippine hatcheries shift from one system to the other depending on the quality and quantity of seawater flora which is seasonal.

The kind and amount of food and frequency of feeding varies with the larval stage. Basically however, larval food consists of two items, algae and the brine shrimp *Artemia*. Algae are given from early protozoea up to mysis or even at early postlarvae. These are diatoms *(Chaetoceros calcitrans* and *Skeletonema costatum* and phytoflagellates *(Tetraselmis chuii* and *T. tetrahele).*

Newly hatched brine shrimp nauplii are fed starting mysis up to early postlarvae or even all the way to harvest at PL_{20}. An alternative to the natural method of hatching which is cyst decapsulation by sodium hypochlorite or calcium hypochlorite offers the advantages of cysts disinfection, no more separation of nauplii from empty and unhatched cysts, and possible direct feeding of prawn larvae on decapsulated cysts (Sorgeloos 1977). Nevertheless, private hatcheries prefer natural hatching to decapsulation because the latter involves added processing and fear, whether unfounded or not, of chlorine contamination in the larval rearing tank.

Some hatcheries feed the rotifer ***Brachionus plicatilis*** during mysis. Early experiments at AQD on the use of frozen, dried or otherwise preserved forms of algae, and rotifers aimed to simplify hatchery operation by concentrating the natural food culture to a single period instead of being a daily activity. Although results showed high survival rates of larvae fed with preserved algae (Millamena and Aujero 1978), the technology has not been picked up by the private sector. In contrast, the use of hard-cooked chicken egg yolk for larval feeding is another Department-generated technology that has been successfully applied by a dozen hatcheries in the country (Gabasa 1982). Egg yolk feeding significantly reduces the live algal food requirement thereby simplifying hatchery technology. Aside from egg yolk, other non-live or processed foods used by government and private hatcheries are yeast, ***Artemia*** flakes, and the "artificial plankton" B.P. (50-100 mu particles) as a supplement to or substitute for brine shrimp cysts and A.S. (200-800 mu particles) for prawn postlarvae. Along this line, Japanese and British companies are developing microcapsulates that range from 50 to 200 mu in size as partial or complete substitutes for algae, rotifer and brine shrimp.

Water management in larval rearing consists of changing 30% of total volume daily or as the need arises starting from protozoea. All hatcheries have an open water system except for a few that recirculate water through mechanical-biological filters. Most hatcheries operate from March to December when water temperature ranges from 26 to 30°C. When it becomes too cold, some hatcheries seal off the rearing area with plastic sheets to conserve heat and/or use improved 2-kw coil heaters. Other hatcheries have installed thermostatically controlled heaters so they can operate during the cold months when temperature drops to as low as 20°C.

Disease of ***P. monodon*** larvae and postlarvae are caused by viruses (Baculovirus group), bacteria ***(Vibrio, Pseudomonas, Aeromonas),*** fungi *(Lagenidium, Haliphthorus)* and ectocommensals ***(Zoothamnium, Epistylis)*** (Lio-Po et al 1981). Disease prevention is through maintenance of good water quality, proper seawater filtration, minimizing of stress, and treatment of spawner with treflan of formalin. Treatment is through the use of tetracyclin, oxytetracyclin, formalin, malachite green, treflan and furanace. Only one private hatchery is known to use antibiotics. This same hatchery also routinely spawns gravid females in seawater with EDIA (ethylenedinitrotetracetic acid), a chelating agent.

Postlarval/nursery rearing

In response to the high mortality rates of PL_{15} to PL_{20} in extensive ponds as experienced in the AQD Cooperators Program in 1974, research was initiated to develop a nursery system in ponds and later in tanks. The earthen nursery pond and the nursery tank system have since been adopted by the private sector. The bamboo slat (banata) substrates first tested in Tigbauan tanks in 1980 are now used by many private nurseries.

Stocking prawn juveniles means higher survival rates and a shorter cropping period in extensive ponds in Northern Panay. With the preference for sturdier juveniles, commercial nurseries using tanks were first established in Roxas City either as independent systems or as part of a hatchery. Many small-scale hatcheries have incorporated the nursery phase within the hatchery complex so that they can sell postlarvae to farmers at the juvenile stage.

Nursery tanks range from 1 to 20 m^3 in capacity. Fry of PL_5 to PL_{20} are stocked at 1,000-5,000/m^3 and reared from 2-6 weeks. The postlarvae are fed with Artemia nauplii, mussel meat, trash fish and others. Substrates made of bamboo slats, polypropylene net, nylon material or plastic sheets are installed to provide increased surface area. In addition to shelter from predation and cannibalism, the substrates grow benthic algae and associated animals which become additional food for the prawns. Survival of prawn postlarvae with different substrates was significantly higher than those reared without substrates (Martosudarmo 1983).

In general, survival rates in nurseries are higher than in larval rearing tanks because rearing beyond PL_5 is more predictable than the larval stages of protozoea and mysis.

g. Harvest, transport and marketing

Hatcheries in Cebu, Mindoro and elsewhere that fly their fry to other island do not harvest beyond the PL_{25} stage. At this size, the fry are small enough to be packed at high densities with minimal risk compared to juveniles with a greater biomass. Moreover, intensive and semi-intensive ponds with more efficient methods of predator control than in extensive ponds may stock young PL_{25}.

Packing procedures depends on the size or age of fry and duration of transport. Fry transported by air are packed et 5,000-10,000 PL_{20}/bag, each polythylene bag containing 8-10 liters of seawater with oxygen added and temperature decreased to 21-24 C. The plastic bags are placed inside styrofoam boxes with or without an outer G.I. container.

Juveniles transported overland to prawn ponds are packed at 500-2,000/bag which in turn is placed in a styrofoam box or buri bag. If transported for a short period during early morning or at night when it is cool, no temperature lowering and oxygenation are needed. Longer transport time requires oxygen, temperature decrease and lower stocking densities.

A growing trend among hatcheries and nurseries is to acclimate the fry prior to transport to salinity levels close to those of the receiving pond. This minimizes the acclimation period in the ponds so that the postlarvae or juveniles can be stocked soon after arrival.

While hatchery fry may travel directly from hatchery to grow-out pond the route of wild fry is longer; it goes through a concessionaire sub-dealer and dealer before reaching the farmer (Fig. 7). The additional steps mean

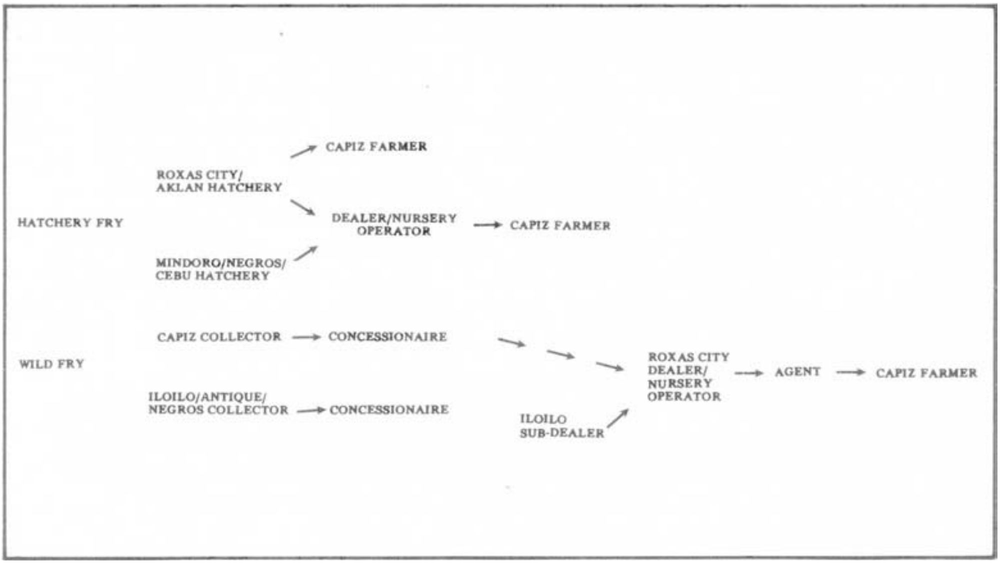

Fig. 7. Marketing channels of sugpo (*Penaeus monodon*) fry.

From: Primavera, J.H. 1983. ***Prawn Hatcheries in the Philippines.*** **Asian Aquaculture, May June 1983.**

greater stress for the fry. Such stress coupled with the availability in limited quantities and varied sizes of wild fry account for the growing preference among farmers for hatchery-reared fry.

Although prawn ponds are generally supplied by hatcheries within the same area, the relative shortage has led to a movement of fry towards the two major prawn-growing areas: Northern Panay and Central Luzon. Cebu has few prawn ponds and most of its hatchery production goes to other islands facilitated by the numerous flights out of Mactan Airport.

PROBLEMS

If we assume: (a) density of 50 larvae/liter, (b) 30% survival from larvae to PL_5, (c) 50% survival from PL_5 to juveniles, (d) 10 operational months/year, (e) 2 larval rearing runs/month, (f) average larval rearing capacity of 20 tons (20,000 liters), 50 tons and 400 tons for small, medium and large-scale hatcheries, respectively and (g) operational capacity of 75% for small-and medium-scale and 50% for large-scale hatcheries, what is the total potential hatchery production?

Based on these, we come up with 2.2 million, 5.6 million and 30 million juveniles each that could be produced annually by the small, medium, and large-scale hatcheries, respectively. Multiplying this by the number of hatcheries, we should have a total potential production of over 500 million juveniles. Without including the 14 unclassified hatcheries, it is clear that the reported 1983 hatchery production of around 35 million was way below this estimated potential.

What problems plague our hatcheries to account for underproduction? Among the non-technical problems, two are foremost: lack of spawners and lack of technicians. In a sense, as long as larval survival is unpredictable, spawners will always be in short supply.

The export of sugpo spawners to Taiwan is a yearly multimillion peso industry. With numerous hatcheries (500 of one count) and not enough spawners, Taiwan must look to her Southeast Asian neighbors with their abundant natural stocks of ***P. monodon.*** The Philippines, in particular, has been a favorite collecting ground because of its proximity. An hour's flight from Taiwan by private plane, Aparri in the North is a major exit point aside from the international airports in Manila, Cebu and Zamboanga.

Some Philippine hatcheries started out as holding stations for wild spawners en route to Taiwan. Only later did these stations undertake serious larval rearing activities. Aware of the massive outflow of spawners (as many as 200-300 in one day), researchers at SEAFDEC AQD recommended that the government ban spawner export in order to protect our own infant hatchery industry. In December 1982, Fisheries Administrative Order No. 141 "banning the export of live gravid shrimps of the genus ***Penaeus***" was jointly issued by the Ministry of Natural Resources and the Bureau of Fisheries and Aquatic Resources finally making the export illegal. Even then, the trade continued, branching out into wild broodstock. This promoted the MNR to issue F.A.O. No. 143 a year later extending the ban to "all live prawns of the species ***Penaeus monodon***". Still the smuggling goes on.

The technician is the most important resource in a hatchery as long as larval rearing remains more an art than science and fry survival hinges on the skill of the technician. The spectrum of hatchery manpower in the Philippines starts from zero technician (hatchery not operating) to second and third-rate technicians (hatcheries under-productive) to first-rate technicians (hatchery successful, given the other requirements). Recently, salaries have ranged from P2,000 to P6,000 for Filipino technicians and P10,000 or more for Taiwanese technicians. Nevertheless, not even a high salary can keep a good technician nor assure the success of a hatchery. Many successful Taiwanese hatcheries are run as family affairs with the larval rearing techniques, the secrets of the trade, so to speak, handed from one generation to the next.

It is this "state-of-the-art" status, the lack of definition of water quality, and other rearing parameters that make erratic survival rates unexplainable. Among the few factors that have so far been quantified are salinity and temperature - eggs will not hatch and larvae will not molt below 28 ppt (Reyes 1981). This explains the non-production of the hatcheries in Northern Mindoro located in a low-salinity mangrove area. The remaining variables need further experimental work. Other industry problems include the scarce supply and prohibitive prices (P1,200/tin of 400 grams) of ***Artemia*** cysts and lack of capital or subsidy.

POLICY RECOMMENDATIONS

a. Resource survey

Although the basic technology in ablation of wild broodstock, larval rearing, and nursery has been extended to the private sector, the following areas for experimental work remain:

1. Maturation of pond-reared broodstock as long-range solution to the problem of spawner supply.
2. Development of alternatives to ablation, e.g. hormones and nutrition to induce ovarian maturation.
3. Studies on larval quality, algal feeds, disease and other factors that may affect survival rates.
4. Refinement and/or development of egg yolk feeding, microcapsules, etc. to reduce if not eliminate live algal food requirements.
5. Local production of *Artemia* cysts in salt ponds.
6. Development of *Artemia* substitutes in larval rearing such as *Moina* and other zooplankton species
7. Refinement of nursery tank techniques.

b. **Conservation of wild spawners**

Smuggling of spawners can be minimized by:

1. More strict enforcement of F.A.O. No. 143. Corollary to this is the training of BFAR and other personnel assigned to international airports in the identification of different prawn species, spawners vs. broodstock, and fry vs. nauplii.
2. Extension of the coverage of the ban to include all species as well as nauplii transport.
3. Requirement of government licenses or permits for buying wild spawners with accreditation from local fishfarmers' associations to monitor wild spawner catches and movements.

c. **Research directions**

To maximize utilization of wild fry, broodstock and spawners, BFAR and other government agencies should undertake surveys to identify collecting grounds all over the country. Once these areas are mapped out, local fishermen should be trained in the collection, identification, holding, packing and transport of wild prawn fry, broodstock and spawners. (An example of such a training was the April 26-27, 1984 symposium in Zamboanga City sponsored by SEAFDEC, BFAR and the Zamboanga Fry Dealers Association.)

d. **Training of technicians**

Increase in the number and improvement of the quality of prawn hatchery technicians can be achieved through:

1. Extension of hatchery training programs to at least 6-10 months to cover larval rearing runs.
2. Development of a system of accreditation of qualified technicians to protect unsuspecting hatchery owners from "charlatans" of the industry.
3. Offering of refresher courses for technicians who are operating hatche-

ries continuously beset by problems of larval mortalities, etc.

4. Providing extension services to hatcheries in the form of algal starters, disease diagnosis. An experienced SEAFDEC AQD hatchery specialist has been assigned the fulltime job of troubleshooting problem hatcheries.
5. Recruitment of a greater number of technicians by SEAFDEC, MSU and other government hatcheries to allow for pirating of technicians by industry.

e. **Other recommendations**

1. Soft loans TRC, ADB, World Bank-IFC, etc. to subsidize construction and operating expenses of prawn hatcheries.
2. Tax exemption of ***Artemia*** cysts and other imported hatchery supplies and equipment and their classification as basic raw material.
3. Clearinghouse for prawn fry buyers and producers. Lastly, we must diversify markets and diversify species to include white shrimps locally known as putian ***(Penaeus indicus*** and ***P. merguiensis).*** Lighter-colored white, pink and brown prawns and shrimps have an unlimited market abroad, constituting 60-80% of total consumption in Japan and the USA, and an assured local market. Spawner supply and larval rearing of these species are easier than for sugpo but production of export-sized prawns (at least 20 g or 50 pcs to a kilo heads-on) from grow-out remains an area for further research.

REFERENCES

Gabasa, P.G. 1982. Recent developments in design and management of small-scale hatchery for *Penaeus monodon* in the Philippines. SCS/GEN/82:40, pp. 77-86.

Lio-Po, G., Tamse, C.T., Baticados, M.C.L. and E.R. Cruz. 1981. Prawn disease prevention and control. Small-Scale Prawn Hatchery Management Training, SEAFDEC Aquaculture Dept., Tigbauan, Iloilo (mimeo).

Martosudarmo, B. 1983. Effects of different substrates and selected feeds on the growth and survival of hatchery-produced ***Penaeus monodon*** postlarvae. U.P. Visayas. Unpub. M.S Thesis 83 pp.

Millamena, O. and E. Aujero. 1978. Preserved algae as food for ***Penaeus monodon*** larvae. SEAFDEC Aquaculture Dept. Quarterly Report 2:15-16.

Motoh, H. 1981. Studies on the fisheries biology of the giant tiger prawn, Aquaculture Dept., Iloilo, Philippines, 128 pp.

Platon, R. 1978. Design, operation and economics of small-scale hatchery for larval rearing of sugpo, ***Penaeus monodon*** Fabricius. Extension Manual No. 1, SEAFDEC Aquaculture Dept., Iloilo, Philippines. 330 pp.

Platon, R. 1979. Prawn hatchery technology in the Philippines. Technical Consultation on Available Aquaculture Technology, Tigbauan, Iloilo 8-11 Feb. 1979, pp. 128-138.

Primavera, J.H. 1983. Broodstock of sugpo ***(Penaeus monodon*** Fabricius). Extention Manual No. 7, SEAFDEC Aquaculture Dept., Iloilo, Philippines, 25 pp.

Primavera, J.H. 1983b. Broodstock technology and the prawn industry. Greenfields 13:21-23.

Primavera, J.H. 1983c. Prawn hatcheries in the Philippines. Asian Aquaculture 5:1-4,6:5-8.

Primavera, J.H. and P. Gabasa Jr. 1981. A comparison of two prawn ***(Penaeus monodon)*** broodstock systems -- land-based tanks and marine pens. J. World Maricul. Soc., 12:345-356.

Primavera, J.H. and W.G Yap. 1979. Status and problems of broodstock and hatchery management of sugpo ***(Penaeus monodon)*** and other penaeids. PCARR Symposium on Fish Hatchery Nursery Management, Metro Manila, 27-28 Sept. 1979 (mimeo).

Quinitio, E., P. Gabasa, Jr., F. Sunaz, D. de la Peña, Jr., D. E. Reyes, and R.

Rivera. 1984. A guide to prawn hatchery and operation. Extension Manual No. 9, SEAFDEC Aquaculture Department. (in press).

Santiago, A.C. Jr. 1977. Successful spawning of cultured *Penaeus monodon* Fabricius after eyestalk ablation. Aquaculture 11:185-196.

Sorgeloos, P., et al. 1977. Decapsulation of *Artemia* cysts: A simple technique for the improvement of the use of brine shrimp in aquaculture. Aquaculture 12:311-316.

Villaluz, D.K., Villaluz. A., Ladrera, B., Sheik, M. and A. Gonzago. 1972. Reproduction, larval development and cultivation of sugpo *(Penaeus monodon* Fabricius). Philipp. J. Sci, 98:205-234.

Villaluz, A.C., U.R. Villaver, and R.S. Salde. 1982. Milkfish fry and fingerling industry of the Philippines: Methods and practices. SEAFDEC Aquaculture Department Technical Report No. 9, 84 pp.

PENAEID PRAWN HATCHERIES IN THE PHILIPPINES

Enterprise/Owner	Location	Management	Capacity[a/]	Remarks
1. Cagayan State University (CIADP)	Aparri, Cagayan	Govt.	SS	Not operating
2. Taggat Industries Mr. Alfonso Lim	Claveria, Cagayan	Pvt.	MS	
3. Vice Gov. Godofredo Reyes	Sta. Maria Ilocus Sur	Pvt.	MS	
4. Vice Mayor Samuel Bautista	Binmaley Pangasinan	Pvt.		
5. Mr. Romualdo Mascarinas	Limay Bataan	Pvt.		
6. Mayor Serafin Roman	Orani, Bataan	Pvt.	SS	Not operating
7. Naic Aqua Corp/ Mr. Richard Ty	Naic, Cavite	Pvt.	MS	
8. Yoshimine Aquatic Dev. Corp/Marcos Andrin	San Juan Batangas	Pvt.		
9. Mr. Earl Kennedy	Parañaque Rizal	Pvt.		Hauls seawater
10. Mr Angel Virri	Parañaque	Pvt.		
11. Min. Human Settlements	Mamburac, Mindoro Occ.	Govt.	MS	
12. Masaganang Sakahan, Inc.	Magsaysay, Mindoro Occ.	Govt.	LS	
13. Aquafil/Tabacalera	San Jose Mindoro Occ.	Pvt.	LS	
14. San Jose Aquaculture Dev. Corp/Mr. Alfonso Lim	San Jose Mindoro Occ.	Pvt.	LS	
15.	Masbate, Masbate	Pvt.	SS	

a/ SS — small scale: MS - medium scale; LS — large scale

16. Suarez Agro Ind. Corp/ Mr. Danilo Suarez	Catanawan Quezon	Pvt.	MS	
17. Licup, Ian & Co.	Pagbilao, Quezon	Pvt.	-	Not operating
18. Mr. Vicente Go	Gumaca, Quezon	Pvt.		Not operating
19. LYL Marine Ind. Corp./ Mr. A. Lim Yuc Long	Daet, Camarines Norte	Pvt.		
20. River, Land & Sea Dev. Corp./Mr. Rolando Sianghio	Paracale, Camarines Norte	Pvt.		Not operating
21. Fiesta Hatchery/Messrs. de Guzman & Enrile	Tinambak, Naga, Camarines Sur	Pvt.		Not operating
22. SEAFDEC AQD	Batan, Aklan	Govt.	MS	
23. Mega Hatchery	Batan, Aklan	Pvt.	MS	
24. Reyes Backyard Hatchery Mr. Reynaldo Reyes	Batan, Aklan	Pvt.	MS	
25. Rojas Prawn Hatchery Mr. Luis Rojas, Jr.	Obob, Batan, Aklan	Pvt.	MS	
26. Rojas Prawn Hatchery Mr. Luis Rojas, Jr.	Batan, Aklan	Pvt.	MS	
27. Aquamarin Hatchery Co.	Dumaguit, Aklan	Pvt.	MS	
28. Pacific Aqua Dev. Corp. Mr. Mike Ho	Makato Aklan	Pvt.	LS	
29. AA Export Aqua Dev. Corp. Mr. R. del Rosario	Makato Aklan	Pvt.	LS	
30. Shrimpy's Hatchery Ms. Nilda Bermejo	Baybay, Roxas City	Pvt.	LS	
31. Atty. Antonio Ortiz	Baybay, Roxas City	Pvt.	SS	

32. Anvil Hatchery/Mr. Vicente Andaya	Baybay, Roxas	Pvt.	MS	
33. Mr. Santiago Bermejo, Jr.	Roxas City	Pvt.		
34. TV Fish Marketing Mr. Antonio Tan	Punta Tabok, Roxas City	Pvt.	MS	
35. Mr. Hock Sing	Baybay, Roxas City	Pvt.	SS	
36. San Rafael Aquaculture Atty. Rafael Dinglasan	Baybay, Roxas City	Pvt.	MS	
37. Cogor Aquafarms Atty. Rafael Dinglasan	Cogon, Roxas City	Pvt.	MS	
38. JBL Corp./Mr. John Whang	Cogon Roxas City	Pvt.	MS	
39. Venus Hatchery Mr. Dam Arches	Cogon, Roxas City	Pvt.	MS	
40. Mercury Hatchery Mr. Dam Arches	Dumalag, Roxas	Pvt.	MS	
41. Emma Hatchery Maj. & Mrs. Manuel Soriano	Carles, Iloilo	Pvt.	MS	
42. SEAFDEC AQD	Tigbauan, Iloilo	Govt.	LS&SS	
43. SEAFDEC AQD	Leganes, Iloilo	Govt.	MS	
44. Mr. D. Villaluz	Leganes, Iloilo	Pvt.	MS	Not operating
45. Mr. Nelson Jamandre	Oton, Iloilo	Pvt.	MS	
46. Ms. Dawn Jamandre	Oton, Iloilo	Pvt.	MS	Not operating
47. Seascape Hatchery Mr. Te Bon Eng	Villa, Iloilo	Pvt.		
48. Blue Crest Aquafarms Mr. Te Bon Eng.	Dumangas	Pvt.		

48. Blue Crest Aquafarms Mr. Ricardo Gulanes	Dumangas	Pvt.		
49. Phil. Marisco Corp.	Calumangan Bago City	Pvt.		
50. Pioneer Hatchery Mr. Franklin Yung	Punta Taytay Bacolod City	Pvt.		
51. Macopa Fry Resources Mr. Gerardo Lopez, Jr.	Sto. Clara Subdv. Bacolod City	Pvt.		
52. San Miguel Corp.	Calatrava Negros Occ.	Pvt.	LS	
53. HJR Fishing Ind. Mr. Jerry Lim	Banilad Cebu City	Pvt	LS	Hauls seawater
54. HJR Fishing, Inc. Mr. Jerry Lim	Liloan Cebu	Pvt.	LS	
55. Premier (Ocean Life) Matchery/Mr. Jimmy Uy	Talisay Cebu	Pvt.	LS	
57. St. Paul's Farms Mr. Francisco Tan	Ormoc Leyte	Pvt.	MS	
58. Min. Human Settlements	Cabadbaran, Agusan	Govt.	SS	Not operating
59. MSU-Southern Phil. Dev. Authority	Naawan, Govt.	LS		
60. Mr. Pedrito Bombeo	Panaon Misamis Occ.	Pvt.	MS	
61. Mr. Luciano Puyod	Davao City	Pvt.	SS	Not operating
62. Zamboanga Regional Inst. Fish. Tech.	Zamboanga City	Govt.	MS	