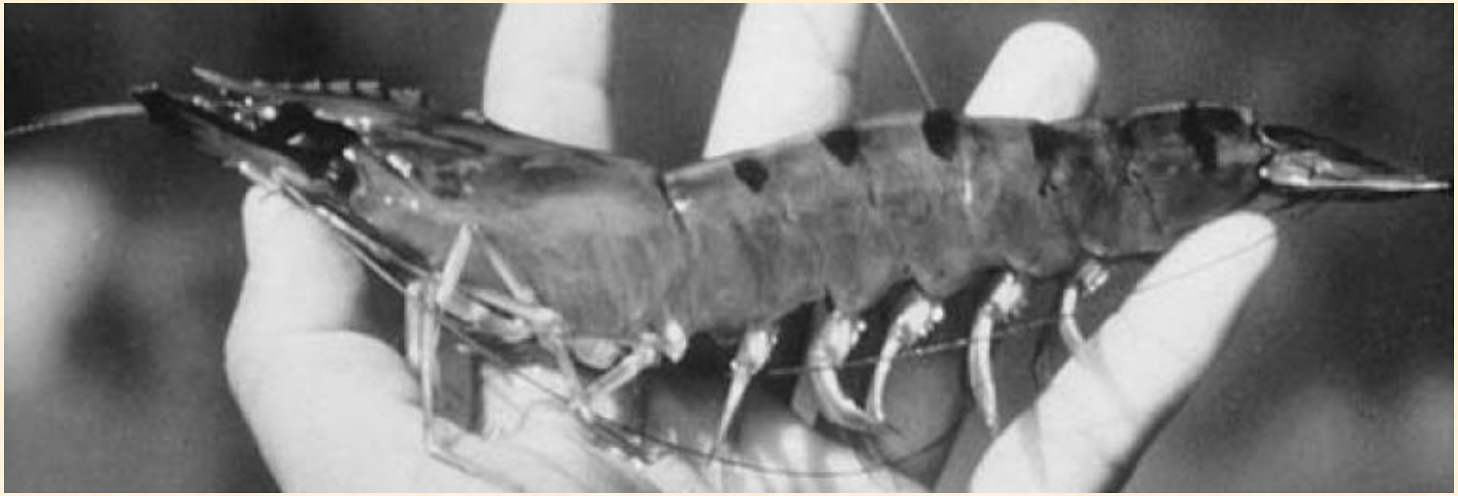
Marine Aquaculture 8

PhD. student
Dr.A.Y.Al-Dubakel



White-leg shrimp, *Penaeus vannamei*.

Intensive systems of shrimp and prawn culture are generally practised in tank farms. Water in the tanks is frequently exchanged to maintain high oxygen levels and to discharge metabolic products. When the water exchange is low, heavy aeration is adopted to keep organic particles in suspension. These suspended particles serve as biological filters because of the dense colonies of nitrifying bacteria that grow on them. Circular tanks, up to 2000 m^2 surface area, with adequate water circulation and drainage facilities are in use. Raceway systems with a total exchange of water several times a day (sometimes built under greenhouses for better environmental control) have proved particularly efficient for certain species like *P. stylirostris*.

The traditional system of shrimp production in rice fields on the west coast of India is described in Chapter 30. On the east coast of India, in the Gangetic delta, many farmers now raise crops of shrimps in rotation with rice. Similar practices have developed in Bangladesh and in the Mekong delta area in Vietnam. After the shrimps have been harvested, the fields are stocked with carp during the rainy season, when the salinity in the fields is low.

Open-water stocking of shrimps carried out in Japan to enhance natural populations is referred to in Chapter 31. It is reported that at least 300 million post-larvae are released every year, and this is claimed to have formed the basis for new 'sea ranching fisheries' (Uno, 1985). Open-water stocking of the fresh-water prawn *M. rosenbergii* has been carried out in lakes and reservoirs in Thailand, and is reported to have become a source of food and revenue to local fishermen. Small-scale stocking of a river and of dams (reservoirs) has also been attempted in Taiwan (Chao, 1979).

Production of seed stock

Though hatchery techniques have been developed for the main species of shrimps farmed commercially, only a small proportion of the global requirement of seed-stock is presently produced in hatcheries. There are, of course, countries like Japan and Taiwan, where virtually all the required seed are produced in hatcheries. Other major shrimp-culturing countries have depended on the collection of naturally occurring post-larvae and juveniles when available, rather than waiting for hatchery systems of production to be established. However, the collection of wild seed stock is not devoid of problems. There are considerable difficulties in sorting out the required species from the mixed collections, which may contain the larvae of slow-growing, undesirable species of shrimps and also of predatory or weed-fish. Secondly, there may be marked fluctuations in their availability. Thirdly, the shrimp fishermen in the area are more than likely to ascribe poor commercial catches of shrimps to the fishing of the larvae and juveniles for farming, and this can cause social conflicts.

Collection of wild seed stock

The traditional system of stocking ponds with post-larvae and fry brought in by incoming tidal water is still practised in many Asian countries. To eliminate unwanted fish larvae and fry and to estimate the number of shrimp post-larvae and fry stocked, an improved system of stocking has been proposed. This starts by filling nursery ponds with as many larvae and fry as possible by manipulation of the tidal flow. After about a month the nurseries are treated with tea-seed cake (containing 10–15 per cent saponin) at a rate of 10–25 ppm, to kill all the fish without affecting the shrimps. The shrimps can then be transferred to the rearing or production ponds.

Wild shrimp fry can be collected with different types of nets and lure lines. Push nets and scissor nets (fig. 25.7) are probably the most common equipment used. Lure lines, very much like the ones used for milkfish fry collection, are used to gather the fry, which are then removed using scoop nets. Fine-meshed bag nets (similar to the shooting nets used for carp spawn collection in India), with a receptacle at the cod-end, are also placed against tidal currents at high tides in creeks, canals or in sluice gates for catching incoming fry. The fry collect in the cod-end receptacle and are removed at frequent intervals.

The sorting of shrimp fry according to species requires considerable experience. The nature and location of pigmentation, body shape and mode of locomotion are some of the main identifying characters. ASEAN (1978) gives some distinguishing features for identification of the post-larvae and quotes a provisional key for *P. indicus*, *P. semisulcatus* and *P. monodon*.

Collection of shrimp fry with a scissor net.

Hatchery production of seed stock

Following on the early success of hatchery production of post-larval *P. japonicus*, considerable research effort has been directed towards the controlled maturation, spawning and larval rearing of a number of shrimps and of the fresh-water prawn *M. rosenbergii*. Though initial attempts were directed towards mass production with gravid females caught from the fishing grounds, success has since been achieved in the maturation and mating of shrimps in captivity.

Berried females of fresh-water prawns can be obtained from natural habitats or from pond farms. Alternatively, breeding stock maintained in tanks and aquaria can be mated after the mature female undergoes prenuptial moulting. Though the basic principles of seed-stock production for shrimps and the freshwater prawn are similar in many respects, there are some differences in detailed procedures and so they are summarized here separately. Detailed descriptions of seed-stock production can be found in McVey (1983), Huner and Brown (1985) and New and Singholka (1985)

Reproduction and larval rearing of shrimps

The controlled spawning and larval rearing of shrimps was initiated by Hudinaga (1942) with wild spawners of *P. japonicus* caught from fishing grounds. Since then, as many as 24 *Penaeus* species and seven *Metapenaeus* species are reported to have been fully or partially propagated artificially. Among these, the more important species for which methods of commercial-scale propagation are available are *P. aztecus*, *P. duorarum*, *P. indicus*, *P. japonicus*, *P. kerathurus*, *P. merguiensis*, *P. monodon*, *P. orientalis*, *P. setiferus*, *P. stylirostris*, *P. vannamei* and *M. ensis*.

1 Brood stock

Spawners of *P. japonicus*, *P. aztecus*, *P. duorarum* and *P. setiferus* can be collected in large numbers, whereas spawners of species like *P. monodon* are more difficult to obtain. Therefore, maturation of captive stock of wild-caught or pond-reared adults is necessary for large-scale hatchery production of adequate numbers of larvae of these species.

Some species, like *P. merguiensis* and *P. japonicus*, mature, mate and spawn freely in response to controlled environmental conditions. Unilateral eye-stalk ablation (see Chapter 8) is adopted for species which otherwise do not mature in captivity, like *P. aztecus*, *P. duorarum*, *P. monodon* and *P. orientalis*. Even for species that would mature without such treatment, ablation helps speedy maturation and better spawning rates. By eye-stalk ablation it is possible to reduce the interval between spawnings to 3–15 days, from the normal interval of 10–67 days.

The technique of ablation or extirpation involves the removal of either eye and the partial or total removal of the eye stalk by cutting with surgical scissors, cautery (using a soldering iron or clamps or by electrocautery), ligation, squeezing or crushing the eye stalk tissue, or manual pinching. It is important to prevent excessive loss of eye fluids and infection. The interval between ablation and the onset of maturation and subsequent spawning varies from three days to more than two months, depending on a number of factors including the age of the shrimp and the stage of the moulting cycle. It is considered best to undertake ablation during the intermoult, for maturation to follow in less than a week. Ablation during the premoult period can lead to immediate moulting and a prolonged latency period. Maturation and viability of eggs seem to depend on the water quality (salinity, temperature and pH), light intensity and nutrition. Spawning stock is given high-quality feed, preferably natural foodstuffs like polychaete worms, squids, mussels, clams or cockle meat, at the rate of about 10 per cent of the biomass. A continuous flow of water is maintained in the maturation tanks and a daily exchange of 60–70 per cent of the water is recommended.

2 Hatchery systems

Spawning and larval rearing are generally carried out in tanks made of cement concrete, ferrocement, fibreglass, plastic, etc. (see Chapter 6) (fig. 24.8). Maturation cages and pens have been used on an experimental basis, but are seldom used on a commercial scale. The hatchery tanks used for spawning and larval rearing in Japan are large, ranging from 100 up to 2000 ton capacity. They are suitable for spawning a large number of spawners at a time and for rearing the resultant hatchlings by what is referred to as the 'community culture method' (see fig. 6.38). Larval foods are raised by fertilizing the tanks directly every day, producing diatoms and zooplankton, which form the food of larval shrimps. Spawning, larval rearing and fry nursing are all done in the same tank.

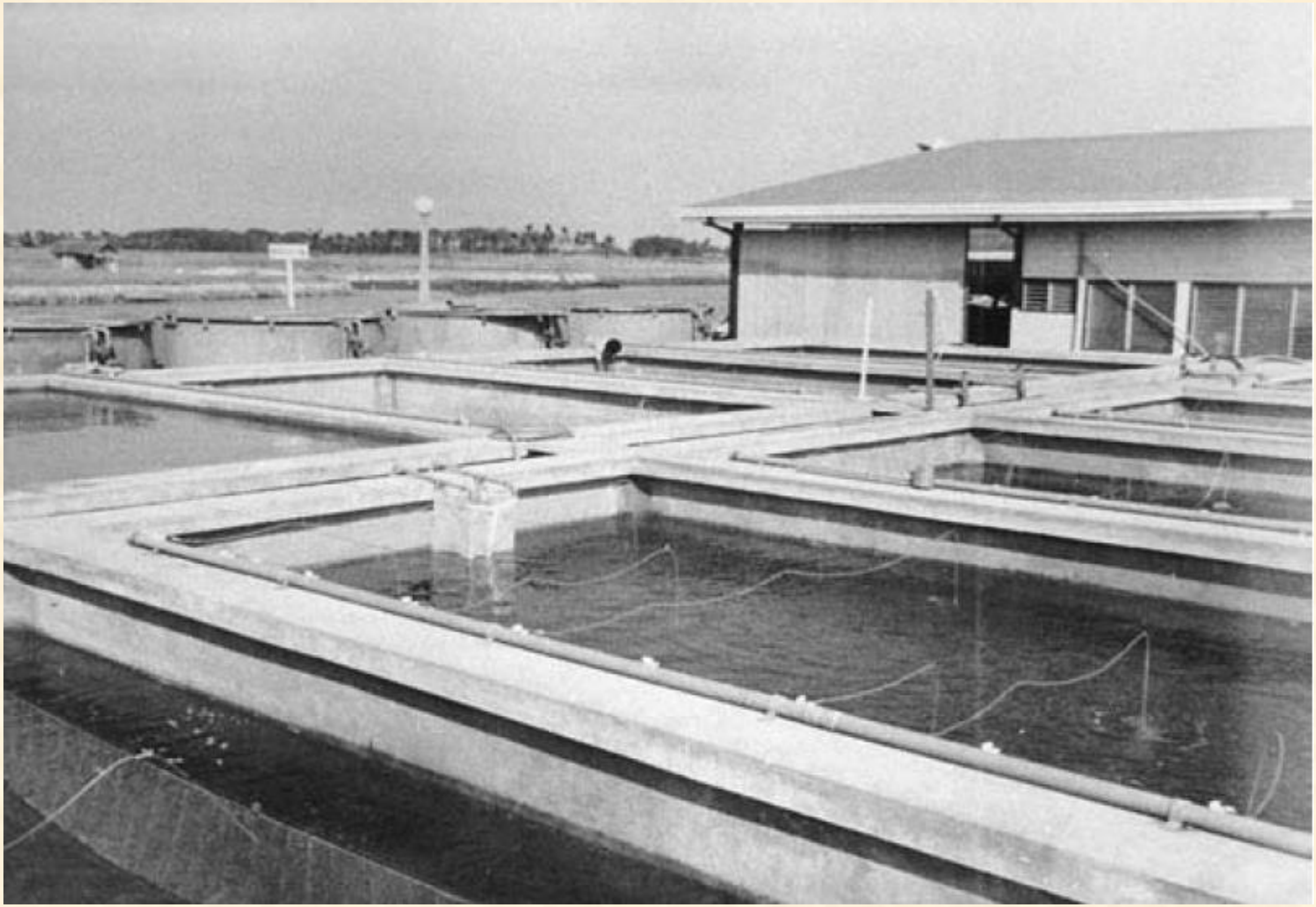
ponds, before grow-out. This type of hatchery system seems to be better suited for species like *P. monodon*, where the availability of spawners is very much limited and so community culture may not prove efficient.

Kungvankij (1982) described a third system, which combines the advantages of the above two systems. It includes spawning tanks with capacities of 1000–20001, larval rearing tanks of 1000–30001 capacity and nursery tanks with a capacity of 30–100 tons for rearing post-larvae to the P_{30} stage (fig. 25.10). This system is reported to maximize tank utilization in spawning and larval rearing of species like *P. monodon*.

Liao (1985) referred to a recently developed 'ladder system' hatchery (fig. 25.11), consisting of four interconnected tanks built on sloping ground, with the algal culture tank at the top, followed below by the rearing tank for nauplii and zoea larvae, then another rearing tank for mysis to the P_{1-5} stages and finally a larger tank for post-larvae, all built one below the other, with descending water levels.

An indoor hatchery system in Hawaii.

Culture of diatoms and *Artemia* for feeding shrimp larvae.



A hatchery system with spawning, nursery and rearing tanks.