Seychelles Mariculture Master Plan

Aquaculture Fact Sheet

Black Tiger Prawn

Penaeus monodon

Compiled March 2019
By Advance Africa Management Services

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1. Background

Common Names

Black tiger prawn	*English*
Kanmaron	*Seychelles Creole*

Biology and ecology

The black tiger prawn (*Peneaus monodon*) is a crustacean belonging to the Penaeidae family. The species has a wide natural distribution in warm (17-38°C), tropical and subtropical waters of the Indo-Pacific, from the east coast of Africa to the Indo-Pacific islands and Australia, and latitudinally from 36°N to 33°S (Figure 1) (Duda Jr and Palumbi, 1999; Cheung *et al*., 2013; FAO, 2009; FAO, 2019a). They are benthic, occurring at depths of 0 to 150m (del Mundo, 2000), and inhabit a variety of habitat types throughout their lifecycle, with juveniles found in estuarine areas such as mangroves, and mature adults and larvae found offshore (Primavera, 1984).

Figure 1: Distribution of black tiger prawn (Source: FAO, 2019a).

Black tiger prawns reach a maximum age of three years, and a maximum size of 500g and 34cm, with females generally reaching a larger size than males (Holthuis, 1980; Primavera, 1984; Dall *et al*., 1990). The body is protected by a carapace (hard exoskeleton). Body colour depends on individuals' habitat and diet, and varies between green, brown, red, grey and blue, with transverse bands of blue, black and yellow (FAO, 2009). These prawns have five pairs each of swimming legs (pleopods) and walking legs (pereopods), and a well-developed rostrum and two eyestalks on the head (Figure 2) (FAO, 2009).

Figure 2: Black tiger prawn.

Males and females reach sexual maturity at a size of 35g and 70g respectively (Primavera, 1984). Mating takes place between male and female pairs shortly after a female has moulted her carapace and is soft-shelled. The first mating occurs between subadults in inshore areas, prior to females reaching maturity, at an age of 4 to 5 months and carapace length of 50mm (Motoh, 1981; Primavera, 1984; Hossain and Hasan, 2017). Females retain the sperm in a sperm sac (spermatophore) inside the sperm receptacle (thyelycum), and migrate offshore to areas with muddy or sandy bottoms, typically at 20 to 50m depth (Primavera, 1984; FAO, 2009). At about 10 months, the females' ovaries become mature, and she extrudes both mature eggs and sperm onto the sand where eggs are fertilised externally. Larvae hatch in offshore waters and undergo several moults to become fry or post larvae (PLs). PLs begin the migration back to coastal areas, and enter estuarine areas such as mangrove forests. These areas serve as nursery grounds for the species, where PLs, juveniles and subadults occur. Adults remain in the open ocean, where subsequent mating and spawning takes place; spawning can occur year-round, with each female spawning up to four times in her life cycle (Figure 3) (Primavera, 1984).

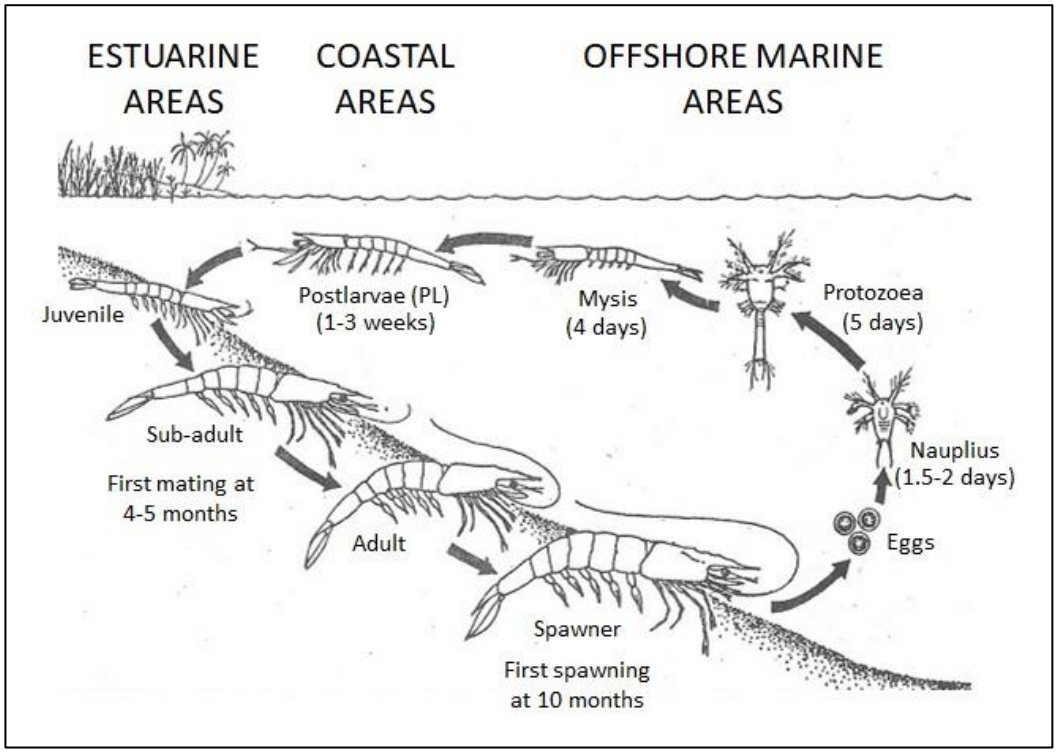

Figure 3: Life cycle of the black tiger prawn (Source: Rosenberry, 2009).

Black tiger prawns are nocturnal, with the majority of activity taking place at night including feeding, mating and spawning. During the day, the prawns burrow into the substrate. Larvae are filter feeders and consume plankton from the water column. From the PL stage onwards, black tiger prawns are benthic feeders, using the pereopods to pick up food from the ocean floor and transfer it to their mouths (Dall *et al*., 1990). They consume a diet that includes molluscs,

small crustaceans, polychaete worms and detritus, and are more predatory than other penaeid species (Primavera, 1984; Abu Hena and Hishamuddin, 2012).

Fisheries

Global fisheries production of black tiger prawn has increased since the early 1980s. It is harvested throughout its distribution using different gears depending on the habitat. In offshore environments, adult prawns are fished at depths of up to 150m using bottom trawling gear. These activities are typically associated with high levels of bycatch and damage to the seafloor. In coastal and estuarine environments, black tiger prawns are caught using gear such as beach seine nets, set bagnets and traps (Khan *et al.*, 1994; Hossain and Hasan, 2017).

Global fisheries production in 2016 was 237 334 tonnes, almost three times less than aquaculture production (701 000t) (Figure 4) (FAO, 2018). Production was dominated by India (84%) followed by Indonesia and Australia (12% and 3%, respectively) (FAO, 2018).

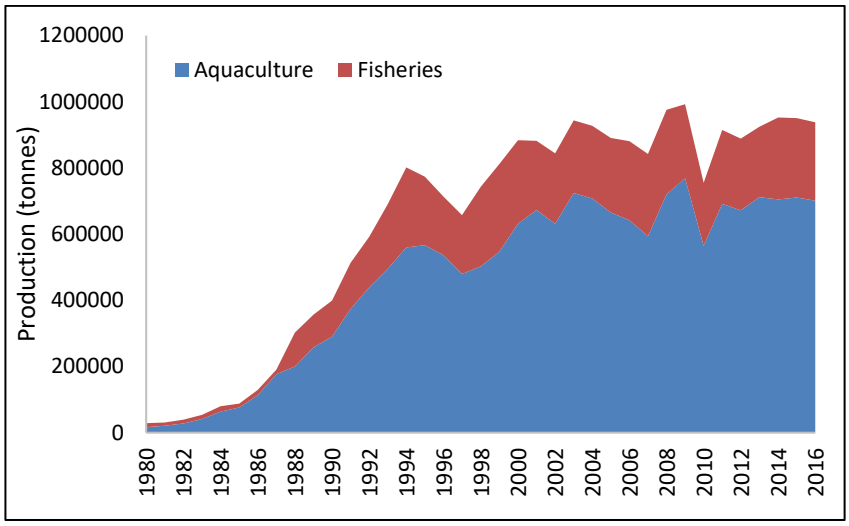

Figure 4: Black tiger prawn global production, 1980 to 2016 (Source: FAO, 2018).

Aquaculture

Approximately 55% of world prawn production is derived from aquaculture (WWF, 2016; Hossain and Hasan, 2017), and Asia accounts for more than 80% of farmed prawn production (FAO, 2009). Prawns have been farmed in Asia for more than 100 years, and use traditional farming methods of growing prawns to market size in extensive, semi-intensive or intensive ponds. This previously relied largely on the grow-out of wild caught PLs from coastal and estuarine environments (Hossain and Hasan, 2017). In the 1970s, research began into hatchery production of prawn PLs for grow-out, to increase production to meet the growing demand from Japanese, USA and European markets. Various countries, including Australia, Thailand, Taiwan and Bangladesh, have developed prawn hatcheries, and in 2002 there were more than 4 500 prawn hatcheries operating in Australia and Asia (FAO, 2009; Hossain and Hasan, 2017).

Black tiger prawn and Pacific white shrimp (*Litopeneaus vannamei*) together account for around 80% of global prawn aquaculture production (Shakir *et al*., 2014). Black tiger prawn is the largest farmed prawn species and thus has a high market demand. The species is well-suited to aquaculture due to its high growth rate, high tolerance of aquaculture conditions, and the fact that spawning is relatively simple in captivity (FAO, 2009). Global aquaculture production of black tiger prawn has remained relatively stable since 2000, with an average production of 677 330 tonnes per annum (tpa) (FAO, 2018). In 2016, 701 000 tonnes of black tiger prawn was produced by aquaculture, approximately 75% of global production of the species (Figure 4) (FAO, 2018). Thailand was the leading producer of black tiger prawn until 2004, with a peak production of 305 000 tonnes in 2000. Thai production has since been exceeded by Vietnam, China

and Indonesia; in 2016, Vietnam dominated aquaculture production of this species with 244 000 tonnes (Figure 5) (FAO, 2018).

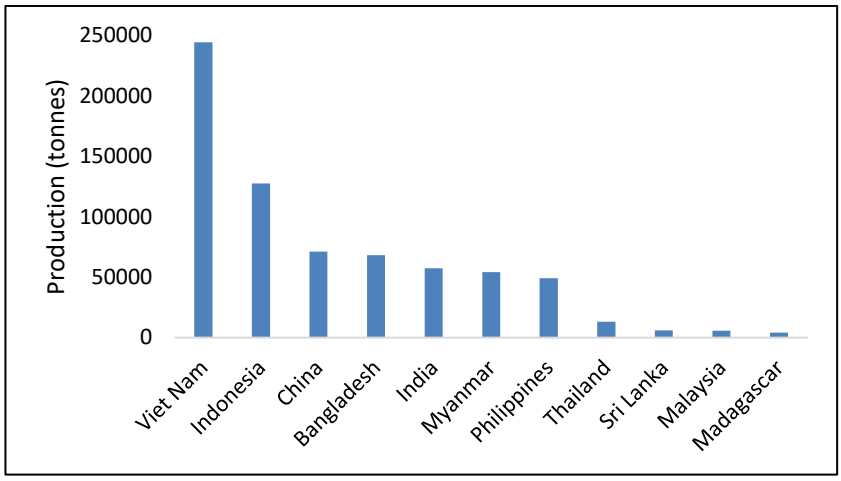

Figure 5: Aquaculture production per country in 2016 (FAO, 2018).

Seychelles began producing black tiger prawn in 1989 with the establishment of a prawn farm on Coëtivy. The operation consisted of two hatcheries and around 200 plastic-lined earthen ponds of 0.48 hectares each (Figure 6) (Hecht, 2013). Production peaked in 2004 at 1 175 tonnes, however this declined to less than 300 tonnes in 2007 and the farm was abandoned in 2008 due to factors such as falling international prawn prices, and technical issues including bottlenecks with larval survival (Figure 7) (Hecht, 2013; FAO, 2018). Nevertheless, the abandoned hatcheries and ponds on Coëtivy still offer significant opportunity for prawn farming in Seychelles.

Figure 6: Prawn ponds on Coëtivy Island, Seychelles (Source: Hecht, 2013).

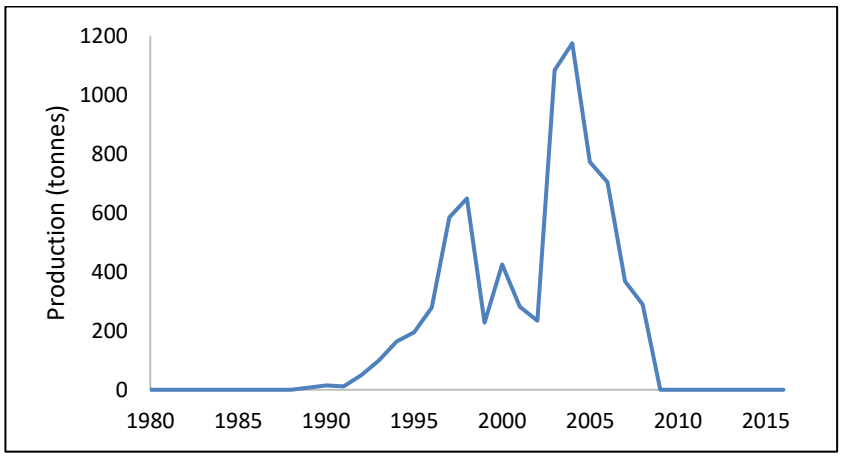

Figure 7: Seychelles aquaculture production of black tiger prawn, 1980 to 2016 (FAO, 2018).

2. Technical approach to aquaculture production

Production cycle

Farming of black tiger prawns takes place on land, in a combination of tank- and pond-based phases. Broodstock are induced to spawn in tanks, where larvae are reared until they reach PL15 or PL25 phase. They are then transferred to land-based earthen ponds for their nursery and grow-out phases (Figure 8) (FAO, 2009).

The land-based tank and pond systems are typically a combination of pump-ashore Recirculating Aquaculture Systems (RAS) and flow through systems. The water that is pumped ashore is filtered before entering the tanks to remove pathogens and to provide optimal water quality for the prawns. Similarly, effluent water leaving the tanks is cleaned in accordance with the relevant Seychelles Aquaculture Standard and global best practice.

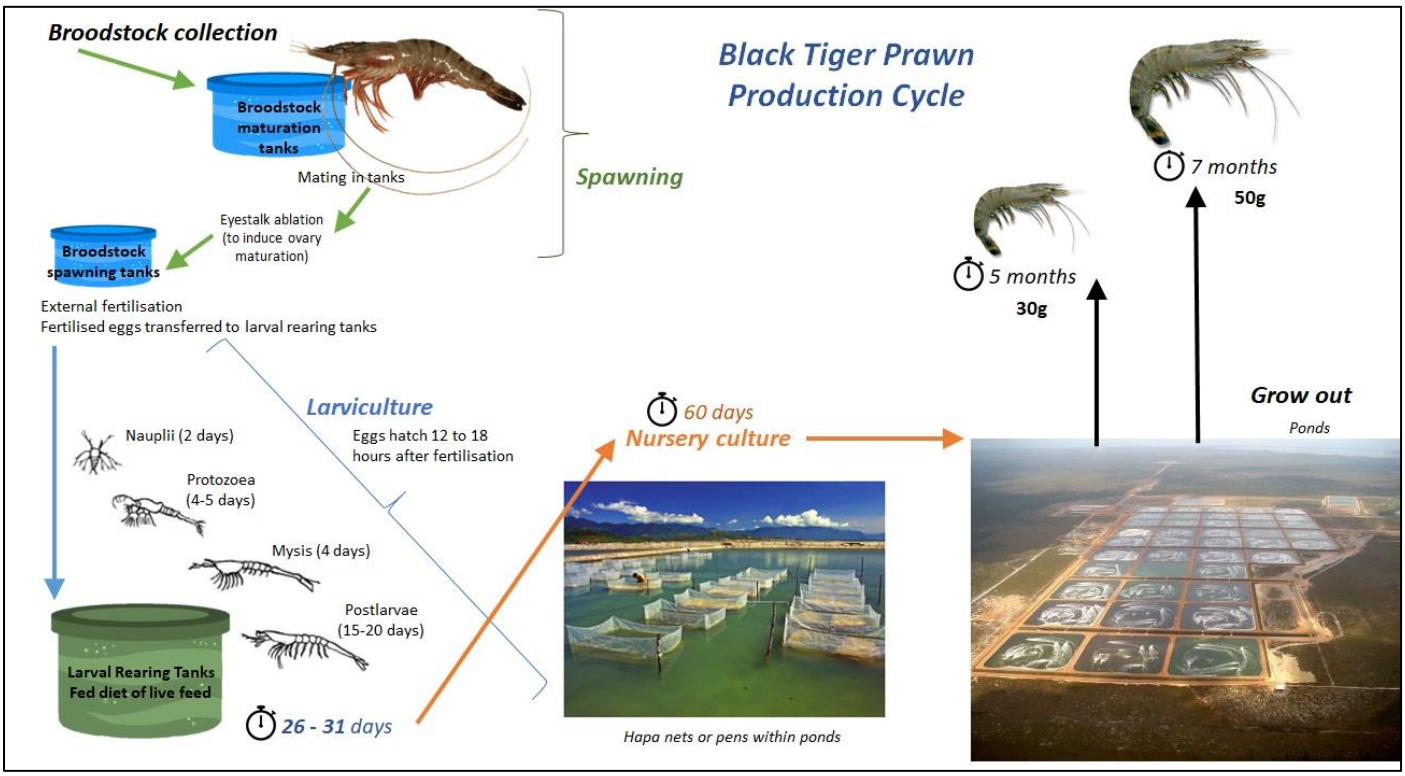

Figure 8: Production cycle of black tiger prawn.

Broodstock and spawning

Adult black tiger prawns (broodstock) are captured from the wild and transferred to a land-based broodstock facility. Broodstock are first placed in quarantine tanks, to prevent the potential spread of diseases to other prawns in the system (Nuruzzaman, 2002). Following quarantine and acclimation of up to three months, prawns are transferred to maturation tanks with an equal ratio of males to females (Figure 9). They are fed up to three times daily with a natural diet high in lipids, such as fish and mussels (FAO, 2009). The salinity is manipulated to induce female prawns to moult, and pairs mate after the female has moulted her carapace (FAO, 2009). Ovary inhibiting hormone (OIH) is produced and stored within the eyestalks. Once the carapace has hardened, eyestalk ablation (cutting, pinching or tying) is performed on females holding a spermatophore, to reduce levels of OIH and induce ovary maturation (in nature, this reduction in OIH is stimulated by offshore migration) (Primavera, 1984; FAO, 2009). When eggs are ripe, females are transferred to individual spawning tanks where they release both eggs and sperm. Fertilisation takes place externally and fertilised eggs (0.3mm diameter) are transferred to larval rearing tanks (FAO, 2009).

Figure 9: Black tiger prawn broodstock (Source: L. Evans; F. Poh; FAO, 2019b).

Larviculture and nursery phase

Nauplii, the first larval stage, hatch 12 to 15 hours after fertilisation. Prawn larvae moult through nauplii, protozoae and mysis stages before they become post larvae (PLs). Larval rearing lasts approximately one month, after which PL15s are transferred to nursery rearing facilities, which can be nursery tanks, or pens or hapa nets within land-based ponds. PLs are reared for one to two months until they are juveniles of around 10g, and are then transferred to grow-out facilities (Primavera, 1984).

Larvae and PLs are fed a variety of live feed in overlapping phases to meet their dietary requirements. They are initially fed diatoms and, at later development stages, rotifers and Artemia (Figure 10). Towards the end of the nursery phase, commercially formulated prawn pellets are introduced, and juveniles are weaned onto artificial feed before the grow-out stage (FAO, 2009).

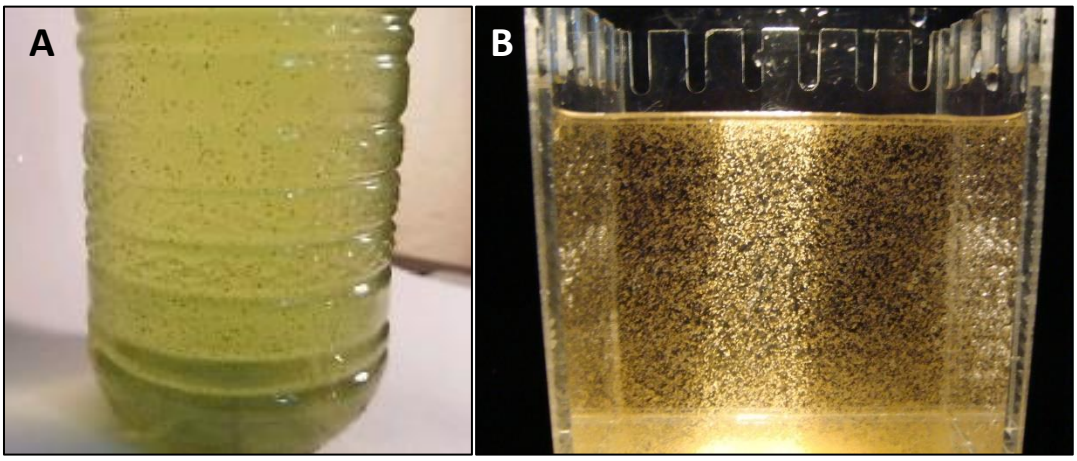

Figure 10: Live feed for larviculture rearing phase: A) Rotifers; and B) Artemia nauplii (Source: Aquaculture Nursery Farms).

Grow-out

Juvenile prawns of 10g are transferred to earthen ponds where they are grown for 2 to 7 months. These include intensive pond systems, which are earthen ponds of 0.1 to 2 hectares that can be stocked at relatively high stocking densities (>300 000 prawns per hectare) (Figure 11). Artificial pellet feed is added to these systems 4 to 8 times per day (Gowing and Ocampo-Thomason, 2007; FAO, 2009). Most of the daily feed ration is added to the system in the evening or at night when prawns are most active (Mandal and Dubey, 2015). Prawns are harvested throughout the year at market size which ranges from 30 to 70g (FAO, 2009).

Figure 11: Intensive earthen prawn ponds in Thailand (Source: Sustainable Seafood, 2017).

Prawns can be reared in ponds simultaneously with other species, such as sea cucumbers (e.g. sandfish, *Holothuria scabra*). Co-culture of prawns and sea cucumbers creates an Integrated Multi-Trophic Aquaculture (IMTA) system, whereby organic waste from prawn farming (such as uneaten feed and faeces) is used as feed by sea cucumbers. This increases the efficiency of production by providing feed for sea cucumbers, and bioremediates the prawn sludge, reducing the level of treatment needed for effluent water (Purcell *et al*., 2006; Chopin *et al*., 2012; Kodama *et al*., 2015; Buck *et al*., 2018)

Prawn health

Black tiger prawn is relatively hardy, and can tolerate a wide range of salinities, however, diseases have been reported in pond systems. It is important to provide clean and hygienic hatchery, nursery and grow-out environments, to prevent diseases, infections and parasites in hatchery-reared black tiger prawns. Maintaining optimal conditions, such as stocking densities, water quality and environmental parameters (e.g. water quality, salinity) in tanks and ponds can reduce stress and susceptibility to infections and disease (Mandal and Dubey, 2015). Sterilisation of ponds prior to stocking, for example using quicklime, reduces the likelihood of infections in pond systems (Mandal and Dubey, 2015).

Purchasing of broodstock and PLs from other hatcheries can also increase the chance of introducing diseases to the system; using wild-caught, quarantined broodstock and hatchery-reared PLs largely mitigates against this risk (Mandal and Dubey, 2015).

Black tiger prawn can be infected with viruses (e.g. White Spot Syndrome Virus), bacteria (e.g. *Vibrio*, *Pseudomonas*, *Aeromonas*) and fungi (e.g. *Lagenidium*, *Halipthorus*). Most bacterial and fungal infections can be treated using water treatments, such as terramycin, formalin and malachite green (Lio-Po *et al*., 1981; Primavera, 1984; FAO, 2009; Dieu *et al*., 2011; Mandal and Dubey, 2015).

3. Market for black tiger prawn products

There is a large and growing global demand for farmed prawn products (Gowing and Ocampo-Thomason, 2007). Black tiger prawn is highly valued due to its large size and its taste (Figure 12), and demand for this species is increasing (Mandal and Dubey, 2015). In Asia, black tiger prawn is considered to the the most important commodity in the trade of aquaculture products where Japan is the largest importer of farmed prawn products (FAO, 2009). However, there are also large and growing markets in the USA and Europe (FAO, 2009).

Figure 12: Prepared black tiger prawns (Source: MyFoodStory.com).

Black tiger prawns are processed by gutting and cleaning, and are then typically frozen with head and shell on shortly after harvesting to ensure a fresh quality product. They can also be frozen for markets as shelled product, or as value added products such as tempura battered prawns. For domestic consumption close to production facilities, prawns can also be marketed fresh and chilled rather than frozen (Figure 13).

Figure 13: Chilled black tiger prawns for sale at a market (Photo: Rudolph Furtado).

The international market for prawns is largely saturated by production from Asian farms, and the low price of Indian produced prawns makes it difficult to compete (Hecht, 2013). A high-quality product can, however, be produced in Seychelles to supply a domestic and tourist market.

Black tiger prawns from Coëtivy were highly regarded both locally and internationally, largely due to them being fully cultured in sea water (Hecht, 2013). The majority of production was exported; however, there was also a large domestic market for Coëtivy prawns, and prawn dishes were particularly popular among tourists visiting Seychelles (Figure 14). There is still significant potential to resume production of black tiger prawns for domestic markets in Seychelles, where they are likely to be well received as Seychelles was renowned as a prawn producing region in the past.

Figure 14: Creole prawn curry prepared in Seychelles using black tiger prawn (Source: thepeppercook.com).

4. Suitability for aquaculture in Seychelles

The species

Black tiger prawn is indigenous to Seychelles waters and is permitted by regulations for aquaculture production. The species has proven to be well-suited to aquaculture in land-based tank and pond systems; it is fast-growing and tolerant of culture conditions (Chen *et al.*, 1989). Culture technologies for this species are well-developed and understood (FAO, 2009). The species has a high market value, and an existing demand, particularly among tourists, in Seychelles.

Environmental and oceanographic conditions

Farming of black tiger prawns on Coëtivy, Seychelles did not succeed largely due to external factors (such as cheaper prawn production in India). Nevertheless, the project demonstrated that farming of the species in pond-based systems is both logistically and biologically feasible in seawater on the remote outer islands, provided that thorough financial and environmental planning is carried out (Hecht, 2013). IMTA, through co-culture of black tiger prawns and sea cucumbers, is also an option that could increase the efficiency of prawn farming operations (Purcell *et al.*, 2006).

Access to markets

Seychelles' level of transport infrastructure and its location in the middle of the western Indian Ocean makes it well-suited to aquaculture production for domestic markets. Prawns produced on the outer islands can be transported to local markets on the inner and outer islands. It is able to receive imports of supplies, such technical equipment and high-quality feed, from suppliers around the world via air and sea transport.

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