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Identity

Panulirus homarus  Linnaeus, 1758  [Palinuridae]

FAO Names: En - Scalloped spiny lobster,  Fr - Langouste festonné,  Es - Langosta festoneada

Biological features

Note: the two species Panulirus homarus and P. ornatus are treated together in a single fact sheet for reasons explained in the Historical background section below.

Body cylindrical comprising cephalothorax, heavily spined and conspicuously marked by two frontal supraorbital horns; abdomen smoother, having six somites; no distinct rostrum. Large antennae particularly large; basal segments well developed and spined; flagellum stiff, robust and longer than body.

P. ornatus brightly coloured, thus the name ‘ornate’ or ‘painted’; carapace broadly blue-green with contrasting
yellow-red spines, often highlighted with intricate streaks and spots of varying colour; frontal horns, walking legs and abdomen have contrasting dark and light colouration resulting in banded or marbled appearance. Abdomen brownish or greenish grey sometimes with minute indistinct speckles, without transverse whitish bands. Large anterior eyespot near base of pleura accompanied by oblique pale streak. Pleura with white tips, sometimes extending slightly up anterior and posterior margins. Antennal flagella distinctly ringed. Antennular plate with 4 spines, without additional scattered small spinules in between. Third maxilliped without exopod. Abdominal somites smooth and naked, without transverse groove. *P. homarus* less colourful with more uniform darkish green to reddish brown carapace colour, finely spotted with white. No distinct abdominal bands of light and dark colour; legs uniform darkish green like the carapace. Light anterior spot present at base of abdominal pleura. Antennules banded. Legs rather uniform in colour, sometimes with faint, longitudinal streaks. Antennular plate with four equal, large, well separated spines, arranged in square with additional very small spinules scattered in between. Exopod of third maxilliped absent. Anterior margin of transverse groove of abdominal somites crenulated. Groove itself either complete or interrupted in the middle.

**Images gallery**

![Late stage phyllosoma](image1)

![Juvenile P. homarus](image2)

![Juvenile P. ornatus](image3)

![Nursery cages in Viet Nam](image4)
Of the various tropical spiny lobster species in the Indo-West Pacific region, *Panulirus ornatus* and *P. homarus* are emerging as the favoured species for aquaculture. This is based on a number of factors including market demand and pricing, availability of naturally settling seed (for on-growing), development of hatchery technology, suitability for captive grow-out and adaptability to a variety of production systems. Production to date is based only on naturally settled pueruli, which in some areas of Vietnam and Indonesia are particularly abundant and easily caught. In Vietnam, more than 1,500 tonnes of *P. ornatus* are farmed each year in sea cages, while in Indonesia lobster farming has begun in Lombok, where large numbers of *P. homarus* seed settle each year. Further seed resources are likely to be identified elsewhere in the archipelago. In Australia, exploitation of wild pueruli is uneconomic and the focus has been on hatchery technology which is now poised for commercialisation. Aquaculture production of lobsters is an attractive proposition worldwide, as the species are generally of high value and in great demand, and fishery production cannot be increased. Active research and development programmes throughout the world have sought to develop this sector, but to date none have been successful, beyond the developments referred to in this fact sheet. Tropical species of spiny lobsters are likely to remain at the forefront of aquaculture production development because of the availability of wild seed, the development of commercially viable hatcheries, and their highly economic grow-out characteristics.

The development of spiny lobster culture has been actively pursued for many decades, although advances have been slow to realise because of the protracted larval phase. To date the only significant established lobster aquaculture industry is that of Vietnam, based on the grow-out of wild caught juveniles. Its development was entirely market driven and dates back to the late 1970s and early 1980s, when demand for lobsters from China grew rapidly. Prior to that a small lobster fishery of less than a hundred tonnes of annual catch operated along the coast of Vietnam, operated by divers and supplying a local market only. *Panulirus ornatus* was part of the supply but demand was only moderate as this species was of less value than others because its eating quality was less revered. However, Chinese consumers were specifically interested in *P. ornatus* as a sashimi product, served as a centrepiece for celebratory banquet dining. Only *P. ornatus*, with its colourful shell satisfied the visual appeal, was large enough (>1 kg) for such presentation and possessed the flesh characteristics (pearly
lustre, sweet taste and firm texture) required for sashimi. Increasing demand from China heralded increased fishing effort throughout the South China Sea and beyond.

In Vietnam, fishing effort increased through the use of larger vessels equipped with trawl nets that could operate further offshore and spiny lobster yields increased to >700 tonnes. For several years much of the catch was of large lobsters, namely *P. ornatus* of up to 5 kg per individual, *P. homarus* of over 1 kg per lobster and *P. longipes* and *P. stimpsoni* of up to 1 kg each. By the 1990s, fishing pressure and lack of any regulatory management led to decreasing catch and diminishing mean size. For *P. ornatus*, the Chinese demand was for larger lobsters, and the price paid for those less than 1 kg was lower. Vietnamese fishers were adaptive and inventive and soon began holding the smaller lobsters to fatten them to the preferred market size. Although the initial methods and equipment to do this was necessarily rudimentary, *P. ornatus* in particular demonstrated to them it was well suited to captivity. Growth rates and survival of lobsters held in simple enclosures staked into the seafloor in shallow waters off the beach and fed low value trash fish were excellent and the practice proved to be very profitable. By 2004 over 30 000 net cages had been established along the south central coastline producing more than 2 000 tonnes of farmed lobsters, primarily *P. ornatus*. In less than a decade a small but valuable fishery for market sized lobsters in Vietnam had been decimated. The catch of smaller lobsters destined for fattening farms decreased in volume but increased numerically as the mean size of lobsters caught continued to drop. By the mid 1990s Vietnamese fishers had developed techniques and identified locations to capture lobsters at the swimming (puerulus) stage; since 1996 the bulk of lobsters marketed from Vietnam have been farmed from an initial capture size of less than 5 g.

### Main producer countries

No farmed production of *Panulirus* spp. has yet been reported in the last years to FAO, nevertheless in Vietnam, Indonesia, Malaysia and Philippines the species are currently cultured. (Information provided by the author: Clive, 2011)

### Habitat and biology

Both *P. ornatus* and *P. homarus* are reef dwelling species, most abundant on coral and coastal fringing rocky reefs and the areas surrounding them. Both are less commonly found in inshore areas of a sedimentary nature, indicating their broad environmental tolerances that make them suitable for aquaculture. They are found in depths of 1 to 50 m. The juvenile and adult stages of both species are omnivorous, grazing primarily on small crustaceans, molluscs, worms and algae. They are generally nocturnal, most active from dusk through to dawn. Both are highly social, preferring to congregate in groups in hollows, caves and crevices within and beneath the reef structures. This social nature also confers a distinct advantage for aquaculture.

*P. ornatus* matures in its second year post puerulus (see definition below), when the size is >1 kg, while *P. homarus* matures at around 12 months post puerulus when the size is about 300 to 500 g. In both species mating involves the deposition by the male of a white spermatophore, released from gonopores at the base of the fifth walking legs (pereiopods), onto the sternum of the female. This spermatophore may persist for several days, and when the female is ready the spermatophore is scratched open with the posterior pereiopods to release non-motile sperm, which are drawn into a temporary breeding chamber formed by the tightly curled abdomen. Eggs are released at the same time from gonopores at the base of the third pereiopods and also drawn into the breeding chamber by a current created by the beating abdominal appendages (pleopods). Fertilisation occurs in the mix and fertilised eggs become attached to long ovigerous setae on the pleopods. Each female can produce several hundred thousand eggs per spawning, well over a million in larger individuals, and may spawn more than once during summer. *P. ornatus* have been known to undergo spawning migrations to locate themselves on the edge of the continental shelf to release larvae. Egg incubation takes ~3 to 4 weeks.

Hatching occurs at night, and the first stage phyllosoma larvae (<2 mm carapace length) are released. The planktonic phyllosoma larvae are capable of moving vertically to a preferred depth, but are otherwise at the
whim of ocean currents. In both *P. ornatus* and *P. homarus* the phyllosoma develop through 11 distinct stages involving up to 20 successive moults (instars) until the final stage which may have a carapace length of >25 mm. The final stage phyllosoma metamorphoses into the puerulus, which is a free-swimming and initially transparent stage that looks like a lobster and lasts for 2-3 weeks, seeking suitable habitat on or near coral reefs. The puerulus is a non-feeding stage that lives off accumulated energy reserves. Once suitable habitat is located, the puerulus, which is now pigmented, settles to the bottom, moults to the first juvenile stage and takes on a benthic habit.

**Production**

![Production cycle of Panulirus homarus](image)

**Production systems**

Seed supply

Lobster farming is currently reliant on a natural supply of wild pueruli, which in Vietnam comprises a fishery that employs a range of gear and methods to attract and capture the swimming pueruli as they move inshore after their oceanic larval stage. Two to three million pueruli are caught each year between October and March, of which around 70 per cent are *P. ornatus* and 25 per cent *P. homarus*. The only other developed fishery for spiny lobster pueruli is in southeast Lombok, Indonesia, where around 500 000 pueruli are captured each year. In this fishery, 90 per cent of the pueruli caught are *P. homarus* and the rest are primarily *P. ornatus*.

Hatchery production

Hatchery production of lobster larvae (phyllosoma) is technically challenging because of the protracted duration of larval development, the large number of moults involved and the delicate nature of the larvae. Japanese research and development of hatchery technology is the most long-standing at over 100 years, but in recent times the most significant developments have come from Australia and New Zealand. Small numbers of...
Pueruli have been produced in research hatcheries and several groups (government and private) are now commercialising their technology. Commercial hatchery production of spiny lobster juveniles is expected to become existent over the next 10 years, which is expected to enable significant expansion of the grow-out industry.

**Nursery**

The captured pueruli are very delicate and mortality can be very high (>50 percent). In Vietnam, pueruli are purchased from the fishers by dealers, who hold and transport them to nursery farmers. The bulk of pueruli are transported in small styrofoam boxes by motorbike over distances of up to several hundred kilometres. The nursery phase typically involves stocking the pueruli at 50-100/m² into submerged cages, consisting of mesh surrounding a steel frame. Each cage is placed on the sea floor at 2-5 m depth and a feeding tube from the surface to the cage provides the means to feed the baby lobsters. Finely chopped trash fish, crustaceans and molluscs are used as food. The nursery phase lasts for 3-6 months, during which the lobsters grow to 10-30 g. They are then harvested and moved to grow-out cages. Mortality during the nursery phase may be as high as 40 per cent but under optimal conditions is usually less than 10 per cent.

In contrast, the nursing of lobsters in Lombok (Indonesia) typically involves floating nursery cages which also serve as the attachment point for habitat traps used to capture the pueruli. Thus captured pueruli are simply and quickly moved from the trap directly into the nursery cage. This approach is believed to result in much lower puerulus mortality than the Vietnamese method. Floating nursery cages are 3 m x 3 m x 2 m deep, consisting of fine mesh, suspended from a floating bamboo frame. The cages are furnished with seaweed (Gracillaria sp.); this provides shelter for the small lobsters. They are fed with chopped fish flesh and on-grown for 1-3 months until attaining 5-10 g.

**Ongrowing techniques**

Grow-out of tropical spiny lobsters is performed in sea cages.

In Vietnam these were originally simple frames of netting staked into the seafloor in shallow water (<3 m) just off the beach. As the industry developed the materials, design and approach improved, and most cages are now deployed in deep water from floating frames that are moored to the bottom. Grow-out cages are typically square in cross-section 3 to 4 m along each side and from 3 to 5 m deep. Individual farms vary in size from 10 to over 80 cages housed within one inter-linked floating framework, with narrow walkways between the cages for access. Each farm includes a small house for the farmer which is manned continually to ensure security of stock and to perform routine feeding, cleaning, harvesting and re-stocking. Most lobster farms have some cages stocked with other species including groupers. A farm is typically owned by a family and different members of the family will alternately stay at the farm to perform the farming duties.

In Lombok Indonesia, grow-out is performed in floating sea cages that have been adapted from grouper cages. They are typically a little smaller than those in Vietnam, 2 to 3 m along each side and 2 m deep. Here a typical lobster farmer will have 5 to 10 cages for grow-out of *P. homarus*, while in Vietnam a typical farmer has 40 to 60 cages for production of *P. ornatus*.

Lobsters are typically stocked for on-growing at 10-50 g each. These smaller lobsters may be stocked into cages with a smaller mesh size to ensure they do not escape. Stocking density may be up to 30/m². As lobsters grow, they are periodically harvested and manually graded to minimise the size variation within each cage. Larger lobsters are stocked at lower densities, typically around 5/m² at 200 g and 2/m² at 500 g.

Cages may become fouled with algae and various surface colonising bio-fouling organisms. To some extent the lobsters will consume this material, but periodically the cages require cleaning. Uneaten food and moulted shells also accumulate on the cage floor. Farmers may dive into the cage by free-diving or with compressed air, to clean waste and bio-fouling by hand. From time to time, the lobsters are moved from heavily fouled cages to clean ones, and the dirty cages are dried and cleaned on-shore.
*P. ornatus* is usually on-grown to 1 kg which achieves the best price for export to China. This typically takes 18-20 months. In Indonesia, where *P. homarus* is most commonly farmed, the desired market size is 100-300 g, which takes ~9 months.

**Feed supply**

Farmed lobsters are traditionally fed a mixture of fish, crustaceans and molluscs which come from the fish markets nearby. This so-called ‘trash fish’ can be highly nutritious if fresh and handled appropriately. In Vietnam, there is typically a broad variety of trash fish species available and farmers will provide a customised mixture to suit their budget and their preference for what they believe generates the best growth. Unfortunately, the trash fish is often of poor quality because of inappropriate handling and the long delay between capture and feeding. Thus, food conversion ratios are often poor and considerable pollution occurs in the vicinity of the cages. Manufactured pellet diets are available, although there has been little uptake to date. In Lombok, Indonesia the diversity of equivalent trash fish is much lower and the nutritional value of trash fish feeding is poor. It is likely that farmers will embrace pellet feeding once a reliable supply is secured.

**Harvesting techniques**

Lobsters are easily harvested from the sea cages by pulling the net cage to the surface and retrieving the lobsters by hand. Lobsters ready for market are placed in styrofoam boxes and returned to shore to processing / export facilities. The farmer typically sells the lobsters at this point and the wholesaler takes on the responsibility for further handling and transport to market. Many wholesalers will travel to the farm at harvest to pay the farmer and take possession of the lobsters for market.

**Handling and processing**

Wholesalers and exporters of farmed spiny lobsters employ live holding systems, consisting of tanks with clean seawater that usually involve recirculation technology to maintain high water quality. Lobsters purchased from the farmers are held only briefly for 1 or 2 days to maximise their quality and are generally not fed. They may be cooled to 10-15 ºC to slow their metabolism and improve survivability during transport. Individual lobsters are normally wrapped in newspaper and placed in styrofoam boxes before being air freighted to market.

**Production costs**

Tropical spiny lobster farming is currently (2010) a profitable business with moderate to high establishment and operating costs and high returns. In Vietnam the cost-benefit ratio is around 1.4 and average net revenue around USD 15 000/yr per farm. Because of diseases, there is moderate risk involved, but when production is unaffected by disease or other major problems (e.g. storm damage), the standard of living of the farmer is relatively high compared with other farming or fishing activities. The most significant operating cost is feed, which accounts for more than 60 per cent. The cost of lobster seed is also significant (22 percent). A single puerulus of *P. ornatus* in Vietnam, for example, will sell for USD 5-10 and a larger juvenile (up to 10 g) for more than USD 15. Pueruli of *P. homarus* in Indonesia sell for about USD 0.50-1.00 each. Trash fish has an average cost to the farmer of USD 1/kg. *P. ornatus* harvested at 1 kg are sold at about USD 45-60/kg in Vietnam. In Indonesia, *P. homarus* harvested at 100-300 g fetch USD 30-40/kg.

**Diseases and control measures**

Disease problems in Vietnam have been a significant issue for farmed lobsters, which came to a head in 2008/2009, when production fell by more than 50 per cent due primarily to milky disease. Although the cause is not confirmed, the localised pollution of the environment around lobster farms is a likely contributing factor. To a large extent this pollution is caused by the high farming density and the feeding of trash fish. The uptake of pelleted feeds may help to alleviate this situation. Production in Vietnam since 2009 has improved, since the incidence of milky disease abated. This was a result of preventative or treatment measures (e.g. the use of antibiotics) and a reduction in farming intensity as failed farms from previous disease outbreaks were not re-activated. Unfortunately, disease is likely to continue to be a major constraint.

Milky disease has been observed in Indonesia farm stocks of *P. homarus* although it has not yet caused any major mortality. It is hoped that information arising from Vietnam will be used to mitigate disease in the developing Indonesian industry.
In some cases antibiotics and other pharmaceuticals have been used in treatment but their inclusion in this table does not imply an FAO recommendation.

<table>
<thead>
<tr>
<th>DISEASE</th>
<th>AGENT</th>
<th>TYPE</th>
<th>SYNDROME</th>
<th>MEASURES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milky Disease; Milky Haemolymph Disease (MHD)</td>
<td>Rickettsia like bacterium</td>
<td>Bacteria</td>
<td>Milky appearance in tail muscle; lethargy; poor feed response; low growth rate; significant mortality</td>
<td>Oxytetracycline 10 % (3-7 g/kg feed) for 5-7 days; quinolones effective but not recommended; shorter cropping period; prophylactic antibiotics in feed; use of vitamins, immunostimulants &amp; probiotics in feed</td>
</tr>
<tr>
<td>Red Body</td>
<td><em>Vibrio</em> spp., often <em>V. alginolyticus</em>, reported</td>
<td>Bacteria</td>
<td>Body has distinct reddish coloration; lethargy; poor feed response; low growth rate; some mortality</td>
<td>Oxytetracycline 10 % (3-7 g/kg feed) for 5-7 days; maintain good hygiene</td>
</tr>
<tr>
<td>Black Gill</td>
<td>Unknown, consistent with <em>Fusarium</em> spp</td>
<td>Fungi</td>
<td>Gills become black; lethargy; poor feed response; low growth rate; some mortality</td>
<td>Formalin; clean cage; move to clean site</td>
</tr>
<tr>
<td>Tail rot</td>
<td>Non-specific</td>
<td>Various</td>
<td>Blister's &amp; lesions on margins of telson &amp; uropods; reduced growth rate; low mortality</td>
<td>Formalin; lower stocking density; maintain good cage hygiene</td>
</tr>
<tr>
<td>Loose head</td>
<td>No pathogen</td>
<td>Environmental</td>
<td>Head loose</td>
<td>Maintain cages in salinity &gt;28 ‰</td>
</tr>
<tr>
<td>Soft shell</td>
<td>No pathogen</td>
<td>Nutritional</td>
<td>Thin shell</td>
<td>Improved nutrition</td>
</tr>
</tbody>
</table>

**Suppliers of pathology expertise**

In Viet Nam farmers can contact Nha Trang University Faculty of Aquaculture (No 02 Nguyen Dinh Chieu, Nha Trang, Khanh Hoa, Viet Nam) or the Regional Institute for Aquaculture No. 3 in Nha Trang for advice on disease issues.

**Statistics**

**Production statistics**

The graph above refers to Palinurid spiny lobsters nei. No farmed production of *P. homarus* or *P. ornatus* has yet been reported by national authorities to FAO. Estimates are that production from Vietnam is currently (2010) around 1 500 tonnes, primarily of *P. ornatus*. Production from Indonesia is currently (2010) around 200 tonnes of *P. homarus*.

**Market and trade**

Tropical spiny lobster farming benefits from, and is in fact driven by strong and increasing market demand. Unsatisfied demand exists worldwide; however, the strongest demand and highest prices are in China. In particular the Chinese seek *P. ornatus* for celebration dining. This species is unique in meeting the specification they prefer for sashimi (uncooked) lobster, served whole as the centre-piece for banquet dining. Most Vietnamese production of *P. ornatus* is sold live into China via Hong Kong.
**P. homarus** is preferred by the Chinese and Taiwanese markets at a size of 100-300 g. This species may be served as sashimi but more commonly is cooked.

### Status and trends

Lobster farming is a new industry and to date is only established in any substantial way in Vietnam and Indonesia. Although hatchery technology for spiny lobsters has been mooted for commercial production for some time, there is as yet no hatchery supply available. Consequently, the industry is based on the natural availability of lobster seed.

In Vietnam, the seed resource appears to be fully exploited and provides a catch of 2-3 million lobster seeds per year. The only opportunity to increase Vietnamese production is through improved survival and productivity, both of which are subject of on-going R&D efforts (see Main issues). There are strong concerns about the sustainability of an industry based on a natural supply of seed; until a hatchery supply is secured, these concerns will persist. Nevertheless, over the 15 years that the industry has existed, the catch of seed has remained reasonably stable.

In Indonesia, the spiny lobster farming industry is much smaller but exists so far only on the island of Lombok, where a natural seed resource has similarly been exploited. Research efforts are underway to identify seed resources in other parts of the archipelago. There would appear to be some optimism that the Indonesian industry can expand, given the broad expanse of the country and the likelihood of other exploitable seed resources. Furthermore, Indonesia possesses many excellent sites for sea cage farming.

Because of the success of Vietnam and Indonesia, there is great interest in the south-east Asian region to establish spiny lobster farming. There is some regional trade in pueruli and juveniles to support grow-out and some efforts to identify natural seed resources in other countries including the Philippines, Malaysia and India.

### Main issues

The primary constraint to industry expansion is the availability of seed. Reliance on wild seed is risky, and while the Vietnamese have made great use of a natural seed resource to establish the industry, its long term future can only be secured with a hatchery supply. Fortunately, research efforts (in Australia) in tropical spiny lobster hatchery technology are nearing a commercialisation phase, so it is likely that by 2015-2020, the expansion of spiny lobster farming will no longer be constrained by the seed supply.

Disease is also a major constraint and spiny lobster farming in Vietnam has already experienced the severity of a disease outbreak. The positive effect of this has been that spiny lobster diseases are better understood, and prevention and treatments have improved. Hopefully the Vietnamese experience will be instructive to other countries in planning and managing the development of the industry.

To a large extent, the disease issue is probably related to the feeding of trash fish, which involves large inputs of organic materials and consequential pollution. Feed conversion ratios for trash fish fed to lobsters range from 25 to 50:1. Thus 25-50 kg of food enters the farm environment for every kilogram of lobster produced. The substitution of trash fish with manufactured diets will be a positive move in this regard and will probably also improve profitability.

Lobster farm surveys have revealed that the primary constraint is access to credit. In Vietnam, most farmers borrow money from agricultural banks for each crop and many have difficulty in securing the loans. In Indonesia where the industry is nascent, credit is even more difficult to obtain and is mostly arranged with family or neighbours at exorbitant rates.

### Responsible aquaculture practices

Farming of spiny lobsters in Vietnam has had a significant positive impact on livelihoods in impoverished coastal communities, with almost all the economic development occurring within family businesses.
Environmentally, the industry has suffered from lack of management, which allowed unchecked development of sea cage farms, particularly in coastal and island bays and lagoons protected from severe weather events. Localised pollution has occurred due to the high density of lobster farms and the practice of feeding trash fish. This climaxed in 2009 when lobster diseases caused a 50 per cent reduction in production. Since then, provincial government planning and development restrictions have been effective in containing the number of cages within given areas, and the return of production to pre-2009 levels suggests that the industry is now more sustainable. Environmental impact will be further reduced with the uptake of manufactured feeds and improved feeding practices.

Unrestricted fishing of naturally settling lobster seed is concerning as it may impact on breeding populations and cause the puerulus fishery to collapse. Although in Vietnam there is no evidence of this, any management of the resources would need to take a regional perspective, given the broad dispersal of the oceanic larvae. In Vietnam there are minimal populations of adult lobsters (due to over-fishing) and yet the pueruli settle in large numbers each year. Clearly the source of these pueruli is elsewhere in the region. The advent of hatchery supply is expected to alleviate pressure on wild seed resources, and in the long term this will prove to be the most sustainable basis for the expansion of lobster farming.

In Indonesia, the Vietnamese model of lobster farming is being applied with a focus on poverty alleviation for the coastal communities of eastern Indonesia. In 2010, the only substantial development was in Lombok where a suitable resource of naturally settling seed had been identified. Other resources of wild pueruli are likely to be found elsewhere that could support expansion of lobster grow-out. The Indonesian government is motivated to establish a sustainable industry and is expected to apply planning and regulation to the puerulus fishing and grow-out sectors.

References


Related links

Australian Centre for International Agricultural Research
FAO FishStatJ – Universal software for fishery statistical time series
Globefish