

Lobster Fishery and aquaculture development in the North coast of Gulf of Oman: with emphasis on spiny lobster

Panulirus homarus

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Abstract:

Spiny lobsters are one of the most important commercial and highly priced crustaceans along the Southern coast of Iran (Sistan and Baluchistan Province). In the last three decades, the economy of a large part of the fishermen population has been directly dependent on it. The lobster fishing rate decreased from 42 t in 1989 to 1 t in 2004. This has been attributed to the effects of improper fishing methods and overfishing. Meanwhile, Oman, as a leading country in the fishing industry in the Gulf of Oman, produced 450 t of lobster in 2016, compared to 416 t in 2015. Little attention has been paid to lobsters by related organizations. This neglect in framing and enforcing fishing regulations has led to heavy fishing pressure on this vulnerable resource along the southern coast of Iran. For this reason, some efforts have been made by researchers at the Iranian fisheries science research institute, such as the Preliminary study of lobster biology, feeding biology and ecology, designing the appropriate lobster trap, designing an artificial reef as a shelter for lobster; and some experimental research is currently underway to assess population dynamics and maximum sustainable yield (MSY). Furthermore, the release of artificially raised lobster juveniles contributes to the re-establishment or enhancement of lobster stocks. However, one of the main problems for successful restock programs has been the lack of inexpensive methods for juvenile production.

Keywords: Scalloped spiny lobster, Stock enhancement, Gulf of Oman,

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Introduction

The family Palinuridae (Phylum Arthropoda: Class Crustacea), commonly known as spiny or rock lobster is a commercially important marine and brackish water group with a large number of genera (Jayakody, 1991). The scalloped spiny lobster *Panulirus homarus* is widespread in the tropical and subtropical waters of the Indo-West Pacific, from eastern South Africa to Somalia, along the Arabian Peninsula, and from India and Indonesia to Japan and Australia (Yellapu *et al.*, 2017). It extends into the Arabian Sea along the coasts of Yemen and Oman, continues to the southeastern coast of Iran in Gulf of Oman. Their habitat varies greatly among species and typically grows to a length of 20–25 cm and lives in shallow water, usually 1–5 meters deep, including among rocks in the surf zone, but occasionally up to 90 m (Suryandari *et al.*, 2018).

Little attention has been paid to lobsters by related organizations. This neglect in framing and enforcing fishing regulations has led to heavy fishing pressure on this vulnerable resource along the south coast of Iran. The most important reasons for declining lobster stocks are illegal fishing and the use of non-standard catching methods in catching this valuable aquatic species, destruction of lobster habitats, lack of culture technology, lack of knowledge in the field of ecology and low survival rate of puerulus. For this reason, some efforts have been made by researchers at the

Iranian fisheries science research institute in Sistan and Baluchestan province over the past two decades. The ultimate goal of these studies has been to provide a broader vision of the fisheries system, sustainable exploitation and improved stock enhancement. During these studies, the amount of catch, fishing gear, time of exploitation, annual catch rate, size at first maturity, minimum catch size of lobster for fishing and some biological aspects such as reproductive characteristics and growth parameters have been identified and introduced. In this regard, many management strategies are presented in the form of instructions and regulations. Up to now stock enhancement methods are useful fishery management tool to declines in lobster populations and given the current situation, the main focus should be on lobster stock enhancement.

Economic value of lobster

Lobsters are sold fresh, live, frozen, cooked frozen, smoked, salted and dried depending on the taste and needs of different countries (Venugopal, 2005). Lobster export trade is profitable in the world. The main exporting countries are; Canada, the United States, Australia, New Zealand, India and Vietnam. The average global price of lobster is \$ 42.59 per kg on July 2020. Its price in Europe was between \$ 40 and \$ 70 (at New Year's Eve) during the last year (Tridge, 2020). The main factors for the growth of the global lobster market are: seafood is superior to other types of animal meat, rich

sources of nutrition, and ultimately the development of the aquaculture growth process will further develop the market. With the increase in the use of packaged foods, restaurants have found a variety of lobster dishes, and changing consumer tastes will continue to drive the market. Currently, more than half of lobsters are produced in the United States. In addition, due to strong domestic consumer demand, the United States also imports lobster from other countries. As a result, by the end of 2025, the global lobster market is expected to exceed 400,000 tons (Research and Markets, 2020).

Lobster species in southern waters of Iran

At present three species of spiny lobster and two species of slipper lobster have been documented from the Gulf of Oman (Ajdari *et al.*, 2016). The scalloped spiny lobster, *Panulirus homarus* is the most widely distributed in this region and it is also the most important commercial species of spiny lobster in the North coast of Gulf of Oman. *Panulirus polyphagus*, a mud spiny lobster, is another species of spiny lobster on the North coast of the Gulf of Oman. It is a species of crustacean that lives on shallow rocky reefs and muddy substrates and usually found from 3 to 90 m depth. *Panulirus versicolor*, painted spiny lobster is one of the three most common varieties of spiny lobster in Iran. This species is found in shallow tropical waters, coral reef ecosystems and coral reef plateaus at depths of up to 15 m. *Thenus*

orientalis and *Scyllarides squammosus* are two other species of lobsters in the Gulf of Oman, belonging to the family of Scyllaridae. *Scyllarides squammosus* or blunt slipper lobster lives on soft substrate of sand or mud and is usually found at depths of 20 - 90 m. *Thenus orientalis* or flathead lobster prefers a mixture of sand or mud substrate in depth range of 8-100 m (Ezhdehakosh pour, 2016).

Statue of lobster in Gulf of Oman

Lobster is one of Iran's most valuable and expensive crustaceans and an important export product. Although it is distributed throughout the Iranian coast, the main fisheries are on the east (Ramin and Bris) and west (part and Pozm) coast of Sistan and Baluchestan province. Because of its economic value and its importance as a valuable export market, the economy of a part of the fishing community in this region was directly dependent on it in last three decades. Overexploitation and illegal fishing led to lobster stock depletion so that the lobster fishing rate decreased from 42 t in 1989 to 7 t and then 1 t in 2003 and 2004, respectively (Fig. 1).

Overall, due to destructive fishing practices, overfishing and illegal actions by some fishermen, lobster catches in Oman's coastal waters have declined in recent decades. Reported lobster catch from Oman coastal waters have declined from about 2000 tons in 1988 to only about 158 tons in 2011. In Pakistan, lobster fishing along the coast of Balochistan Province (Sindh region)

has practically stopped because the catch of these expensive marine crustaceans has been greatly reduced. Although lobster catches have been greatly reduced over the years, the species is still caught indiscriminately. The lobster catch per boat, according to

the marine fisheries department of Pakistan, has declined from 300 to 400 to three to four specimens over three decades, while the price has jumped from (minimum) Rs 30 to Rs 2,000 now for a single lobster (Pereira and Josupeit, 2017).

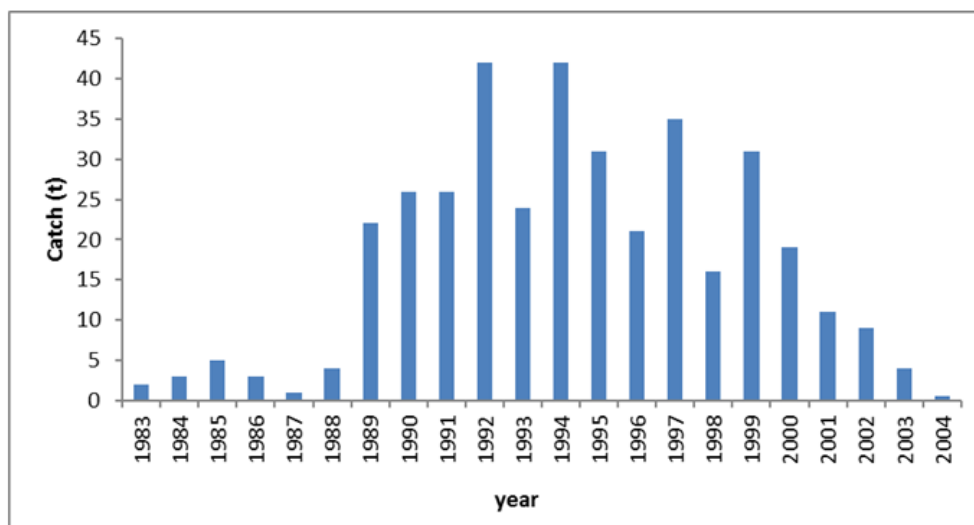


Figure 1: Historical catch of lobster over the years in North coast of Gulf of Oman (Sistan and Baluchestan Province).

While Oman has conducted extensive studies such as changing the fishing season to improve stocks. Fishing season of Oman along the Arabian Sea coast was shifted from 15 October-15 December (2003-2008) to March-April (2010-2014) by the decision of the Ministry of Fisheries. As a result, with a production of 430 tons in 2016 and 416 tons in 2015, compared to 302 tons in 2014, production has increased by 32 to 40 percent.

Due to the limited supply of other species in Iran, the scallop lobster *Panulirus homarus* is the only lobster species used in this area. All lobsters caught are exported and therefore play an important role in the fisheries of

Southeast of Sistan and Baluchistan province. In recent years, the biological and economic aspects of *P. homarus* lobster fishing in the waters of the Gulf of Oman in Iran have been studied. These include; biosystematics and biological characteristics (Sari, 1991), size and age composition of populations as dynamical systems (Fatemi, 1998), and fishing management (Mashaii and Rajabipour, 2003).

Ecological Characteristics of lobster habitat

Stock enhancement activities based on ecological characteristics of the lobster habitats must be considered due to the decreased lobster stocks. Water and

sediment samples of the lobster habitats in Ramin as a main important lobster habitat in southeastern Iran (Sistan and Baluchestan Province) were studied by Mashaii *et al.* (2013). The annual average values of water temperature, water salinity, dissolved oxygen; pH and turbidity were $25.56 \pm 2.8^\circ\text{C}$, 38.77 ± 1.71 g/lit, 6.07 ± 1.12 mg/lit, 8.22 ± 0.17 and 3.03 ± 2.98 , respectively. The annual frequency of macrobenthos was 133 individuals/m². The maximum and minimum abundances of macrobenthos were observed in May and November, respectively. The highest average number of macrobenthos belonged to cephalochordata, polychaeta, nematoda, ostracoda, gastropoda, bivalves and amphipoda.

Growth studies

Fishery resource assessment is the key to development and improvement of management methods for exploited stocks. Analysis of specific parameters provides information regarding the state of the stock and indicators of exploitation levels. Some biological characteristics such as length frequency, peak of spawning time and carapace length at first maturity were investigated by Rastiannassab *et al.* (2002) during spring and autumn in the North coast of Gulf of Oman. These qualitative parameters along with quantitative features in catch composition (such as egged and unegged females and undersized individuals) in autumn and spring were compared. Based on the results, carapace length of

the biggest and smallest lobster was 34 and 112 mm, respectively.

Differences in reproductive size were observed of the entire study area, with a range of 55 mm CL for the smallest berried females and a range of 64-69 mm CL in the 50% maturity size.

The maximum spawning rate was observed in spring (March and April) and individuals in this season were bigger than autumn, but a lot of autumnal catch were undersized individuals (59% undersize) and this shows seasonal migration in different length groups. Therefore, seasonal behavior such as the time of maximum spawning rate is important in order to catch season determination. A Comparison of the total catch in the sea and landing site shows that illegal catch in spring is larger than autumn. Furthermore, they suggested management measures include prohibition on possession of eggbearing females, shift of the fishing season, minimum legal size of carapace (70 mm).

The carapace length (Lm50%) is used to determine the minimum legal size for commercial fishing; in fact, it is the length of the carapace that at least 50% of the lobsters are mature during the spawning season. In 2009, Azhir *et al.* (2009) reported that the minimum legal size in North coast of Sistan and Baluchestan province is 69-71 mm of carapace length. Detailed examination on some biological parameters in catch composition of lobster by Rastiannasab and Hossaini (2015) showed that

minimum legal size was 70 cm carapace length.

Spiny lobster fishing methods and gear

Due to the increase in demand, lobster fishing activities have been extensively developed in the world and have led to high exploitation. But it is well known that the use of illegal fishing methods such as catch of berried females and undersized lobsters has caused serious problems in developing countries including Iran. Different countries use different methods and equipment such as traps, pots, and a type of anchor shaped hooks and gill nets to catch lobsters (Jayakody, 1991). In India lobsters caught in shallow waters using drop nets, whereas in deeper waters (>100m), they are caught by traps (pots), operated by powered vessels (Radhakrishnan *et al.*, 2019). Several methods were used to catch lobsters in Iran. Fishing activity with gillnets to capture the spiny lobster was a common method along the Iranian coastal water. Furthermore, the analysis of bycatch species from artisanal fishermen's gillnet recorded some lobster species. Some slipper lobsters that prefer soft substrates were recorded in trawl nets along the North coast of the Gulf of Oman. Lobster trap is another gear that used in lobster fishing in this area. The efficiency of traps and gillnet was studied by Zarshenas (1993) on the North coast of the Gulf of Oman. The results of this study showed that traps are much more efficient than gillnets. The existence of small escape vent for juvenile lobsters was another

advantage of using this type of trap in the North coast of Gulf of Oman. Furthermore, Azhdehakosh pour *et al.* (2013) modified the lobster trap by designing appropriate escape vents in terms of shape, position, and size to improve size selectivity by reducing the catch of immature and juvenile lobster in the North coast of Gulf of Oman.

Spiny lobster aquaculture

Both raising of wild-caught pueruli/juveniles and the propagation of larvae from egg to the puerulus stage were investigated by researchers in the North coast of the Gulf of Oman.

Hatchery

The culture of spiny lobsters from egg to the puerulus stage has now been achieved for spiny lobster species. Studies to bring these to the full commercial aquaculture level are currently under way in several countries. The early stages of the *Panulirus homarus* were hatched and reared in the laboratory by Balouch (2009). In this study, a new culture tank was designed for illustrating the early stages and instars of each stage in *P. homarus* in the laboratory. The females with eggs were captured from their habitat and carefully brought into the laboratory. The larvae were transferred to a tank of circulating water with a density of 10 larvae per liter. The first complete phyllosoma culture of *P. homarus* was accomplished in the laboratory. About 60 stages I phyllosoma were cultured at 27-30°C, being fed with nauplii of *Artemia* at the

initial stages. The phyllosoma did not grow beyond stage III, even though it survived up to 10 days. The survival of pueruli in this study was much higher at 83% in stage II and 100% in stage III. The larvae molted three times, once at stages I to II, two times at stage III. It is believed that the mortality rate is due to insufficient supply of nutrients at the phyllosoma stage to support energy consumption and development during the non-feeding puerulus stage. Anyway, the larvae (phyllosoma) phase involves several distinct morphological and molt stages. Although the the small number of phyllosoma have grown successfully to pueruli stage in Japan and New Zealand, but the development of hatcheries is far from commercial success.

Nursery phase

However, free-swimming larvae can be found and collected in the wild. In order to collect these post larvae, technology has been developed that enables post larvae to reach a commercial size and have a much higher survival rate than in the wild. When some artificially grown, mature lobsters are returned to the sea, the population can grow and recover. In a study by Aminrad *et al.* (2013) puerulus and post puerulus lobsters with an average weight of 0.77 and 11.8 g were collected by collectors at North coast of Gulf of Oman. The amount of larval requirement food was calculated based on 15% of their body weight and feeding by trash fish, bivalve and squid. The nursery phase lasted for 3-6 months, during which the lobsters grow

to 10-30 g. Results of this study showed that post-pueruli survival was significantly higher and the growth rate in post puerulus was much faster than the growth rate of puerulus.

Fattening

There is no recorded literature on the initiation of the lobster culture on a commercial basis in Iran. The study of lobster culture in concrete ponds was carried out by (Haghpanah *et al.*, 2016) during four months with the goal of economic and sustainable development of the lobster culture system. The lobsters were fed by trash fish at the rate of 5% body weight per day. The average weight growth of lobsters and the average length growth of carapace were equal to 81 ± 8.76 g and 7.2 ± 2.6 mm, respectively. Results of this study showed the average weight growth (\pm SE) of male *P. homarus* reared at different stocking densities of the existing body.

Conclusion

In summary, lobster seems to have been extensively exploited, and current regulations are not sufficient to recover from years of overfishing of lobster and protect the population from the collapse in Gulf of Oman. The sharp decline of lobster fisheries along the coast of Sistan and Balochistan is still a major problem, and other management measures are urgently needed, such as reducing the pressure on the fishery, especially the illegal fishery of spawner females and juvenile lobsters, conservation of critical habitat such as

spawning and nursery areas, a reliable fishery statistics database needs to be established in order to make more accurate estimates of stocks, improve fishing gear and control illegal, unreported and unregulated catches, establish and enforce strict rules for offending fishermen, banning the use of gillnets on the entire Northern coast of the Gulf of Oman and replacing them with traps may prevent the exploitation of juvenile lobster, which account for a large part of the catch. Finally, it is important to establish some form of cooperation among fishers, scientists, and government agencies for implementing sustainable management programs.

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