ISSN: 2687-8089
DOI: 10.33552/AOMB.2021.03.000553
Advances in Oceanography & Marine Biology
Iris Publishers

Short Communication

Why There are Almost no Reports on Non-Indigenous Lobsters?

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Received Date: November 08, 2021

Published Date: November 29, 2021

Abstract

Introduction of non-indigenous marine species to new areas have been enhanced in the recent years due mainly to transport of life stages in ballast water of ships and man-made canals. Crustaceans, and especially Decapoda, is one of the most successful taxonomic group that demonstrate migration between biogeographic provinces. Yet there is almost no report on alien lobsters despite their large geographic and ecological dispersal and the economic importance of many lobsters' species. What is the reason for this scarcity? An exception of this shortage of reports is found in the American clawed lobsters. Adults are imported, mainly by flight transport for human consumptions, from North America to the European countries. Some of these alien lobsters were released/escaped and recorded in north European waters. The Mediterranean and especially its south-eastern Levant basin, is considered a hot spot of bio-invasions. Dozens of Red Sea and Indian Ocean decapod crustacean's species have migrated to the Mediterranean through the Suez Canal in a process termed "Lessepsian migration" and many have established viable populations. Yet there are only 2 reports of a single record each, of 2 Indo-pacific spiny lobsters' species in the coast of Israel. It is suggested that passage of lobsters' sensitive propagules in ballast waters of ships is less probable due to the long and complex life history of these crustaceans. It is also doubtful if the delicate planktonic early stages of lobsters can survive and complete their life cycle in the environmental conditions of the regions of destination.

Keywords: Bio-invasions; Shipping, Ballast water; Decapod crustaceans; Live import; Anthropogenic effects; Lessepsian migration; Life cycle; Environmental conditions

In the recent centuries human activities in the sea, and especially during the present era of globalization, have enhanced the introduction of non-indigenous marine species (NIMS) into new habitats, sometimes in other biogeographical provinces. Shipping, via ballast water, is considered the most important marine invasion pathway, but other anthropogenic factors, such as man-made canals between previously separated biogeographic marine provinces, transport of marine species in aquaculture, research projects and aquarium trade, fishing activities and global warming also have important roles in invasion processes [1]. Adult marine organisms may pass actively through man-made canals, by swimming or walking. Eggs, larvae, and juveniles may be drifted passively in currents in artificial canals. Propagules, juvenile and adults may be carried in ballast water of ships over natural barriers of salinity, temperatures and other a-biotic and biotic obstacles. Modern ships are larger and faster and hence carry larger volume of ballast water and make the travel time shorter which increase the probability of the NIMS to survive in the unfavorable conditions of the ballast tanks during the trip. Biofouling on the outer part of marine vessels is another pathway for NIMS. Other vectors of introductions are equipment of the energy, fishing and maricultural industries and floating debris to which potential NIMS adhere. Such equipment and debris may be transferred to other geographic regions with the potential live NIMS attached to them. Deliberate and accidental transfer of NIMS can be done also by scientists and aquaria hobbyists. Live import of marine organisms as food for humans may be another vector of introduction if some of these live animals are released/escape to the sea in the countries of destination, either legally or illegally. Some of the NIMS have managed to overcome competition, predations and pathogens in the new habitats and were able to establish perma-

nent successful reproductive populations.

One of the most successful taxonomic group that demonstrate global dispersal is the crustaceans with many successful NIMS especially decapod crustaceans [2]. Among the decapods there are five families of lobsters the species of which can be found in many marine habitats around the world. Three of these families - clawed lobsters, Nephropidae, Spiny lobsters, Palinuridae, and slipper lobsters, Scyllaridae, include dozens of species, some of which are fished worldwide (annual yield of hundreds of thousands metric tons) and are a highly valuable resource [3]. Yet despite their wide geographic and ecological distribution and abundance and their commercial importance there are almost no reports on NIMS. What is the reason for this scarcity?

All lobsters have a complex life cycle with long and sensitive planktonic larvae, stages that can span in duration 4-8 weeks in clawed lobsters, 26-44 weeks in spiny lobsters [4] and 2-9 months in slipper lobsters [5]. Thus, it is unlikely that early life stages of lobsters are transferred in ballast water. An exception of this shortage of reports on NIMS can be found in clawed lobsters. About 13 thousand metric tons of live adult American Lobsters, *Homarus americanus,* are yearly imported, mainly by flight transport, for human consumptions, from North America to the European countries. Despite prohibitions to release or hold *H. americanus* in net cages, there have been recorded findings of live *H. americanus* in Sweden as well as in a number of other European countries including Denmark, Ireland, Norway and Great Britain [6-8]. *H. americanus* has likely established populations in the water of northern Europe and can hybridize with the indigenous European Lobster, *H. gammarus*, leading to fertile or sterile offspring. The hybrids might be fast growing and viable and thus potentially increase the competition for food, habitat and mates. The relative success of the American Lobsters in northern Europe may be due to similarity of the North European habitats and environmental conditions to the American one and its rather short life cycle [9]. Also, a single live specimen of *H. americanus*, was caught off Croatia, north Adriatic Sea [10]. This is the first record of this species wild-caught in the Mediterranean. The origin of the caught specimen is unknown, but its presence is likely due to live seafood importation to markets in the northern Adriatic Sea. Deliberate introduction of *H. gammarus* in New Zealand early in the 20th century was unsuccessful [11].

The Mediterranean Sea, and especially its south-eastern Levant basin, is considered a hot spot of bio-invasions [12, 13]. Several hundred alien metazoan species have been recorded in the Mediterranean Sea. The majority of NIMS in the eastern Mediterranean entered from the Red Sea and the Indian Ocean through the Suez Canal in a process termed "Lessepsian migration" [14]. More than one hundred alien marine crustacean species have been recorded in the Mediterranean and many have established viable populations [15]. Indigenous decapods and stomatopods of the soft sediments of the upper shelf in the Levant basin have been substituted by Lessepsian (or "Erythrean") NIMS and form the majority of the NIMS in the eastern Mediterranean. The rising of sea water temperature, due to the global warming, seems to favor the reproduction, growth and survival of these thermophilic NIMS over the indigenous taxa. The continuous warming trend of the Mediterranean water tends to enhance the establishment and dispersal of these crustaceans NIMS also in other parts of the Mediterranean [15, 16].

Yet one important group of decapod crustaceans is misrepresented in this list of NIMS. Only two single records of non-native lobsters were reported from the Levant. A single adult Ornate Spiny Lobster, *Panulirus ornatus*, was caught on January 31st , 1988 by a trammel net, at 8 m depth, near the outer base of the breakwater of Haifa Port, Haifa Bay, northern Mediterranean coast of Israel [17]. This species is widely distributed in the Indo-West Pacific region but has been collected only twice in the Red Sea [3]. Specimens of this species were recorded walking across the seabed for 2-3 months, at an average speed of 6.1 km/day to a distance of 511 km [18]. *P. ornatus* inhabits shallow coastal water and adults prefer turbid water [3], conditions that can be found also in the vicinity of the Haifa Port. The second record of a Lessepsian lobster in the Mediterranean is of a seemingly fresh intact exuvia of an adult colorful female Indo-pacific Long-Legged Spiny Lobster, *Panulirus longipes longipes.* It was found on April 11th, 2018 at a depth of 15 m under a rocky shelf approximately 3 m inside this ledge in a dark area. This location is approximately 7.8 km from the opening (head of the breakwater) of the nearby Haifa Port [19]. It was assumed that this lobster molted under a ledge leaving behind an intact exuvia. However, this species, as other colorful spiny lobsters, are used in the aquaria trade [20]. Thus, one cannot reject the possibility that the exuvia had been disposed of from an aquarium of a slow moving (so that it would have remained fully intact and undamaged) passing cruise-ship or a pleasure yacht entering or exiting the close-by Haifa Port. Intensive and repetitive SCUBA diving searches in the general location of the find since April 2018, as well as widespread inquiry among professional and sport fishermen in the area have been, so far, fruitless.

The environmental conditions of the southeastern Mediterranean may be suitable for adults of some Indo-Pacific species of lobsters but passage of propagules in ballast waters of ships seems less probable due to the long and complex life history of the members of the Infraorder Palinura which includes the spiny lobsters (Palinuridae) and slipper lobsters (Scyllaridae) [21]. It is also doubtful if the sensitive early stages of Indo-pacific Palinurids can survive and complete their life cycle in the environmental conditions of the Levant.

Two species of spiny lobsters were reported from the Mediterranean Sea, the Common/European Spiny Lobster, *Palinurus elephas* and the Pink Spiny Lobster, *Palinurus mauritanicus*, [3, 22]. They have only a westerly distribution as neither species appear to be found in the extreme eastern and south-eastern areas of the Mediterranean, probably due to unfavorable environmental conditions there. The water of the Levant is probably too warm also for Med-

iterranean clawed lobsters such as *H. gammarus,* and the Norway Lobster, *Nephropes norvegicus,* that inhabit the water of Central and Western Mediterranean [3]. It is interesting to note, however, that a mosaic from a Byzantine church from circa 6th century CE from Bet Guvrin, southern Israel, includes two figures of clawed lobsters that seem to be *H. gammarus.* This is peculiar because Israel is out of the present distribution range of this species [3, 23]. It was suggested that either the artist who created the mosaic was from the western part of the Byzantine Empire where *H. gammarus* was (and still is) common [3], or that the artist used a models' book that originated from the western region, a practice that was common in ancient Mediterranean cultures. Another hypothetical assumption postulated that during the Little Ice Age *H. gammarus* may have extended into the, then, colder southeastern Mediterranean [23, 24].

Acknowledgment

None.

Conflict of Interest

No conflict of interest.

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