Aquatic Invasions (2009) Volume 4, Issue 4: 715-718
DOI 10.3391/ai.2009.4.4.22

Short communication

The crab that came in from the cold: first record of *Paralithodes camtschaticus* (Tilesius, 1815) in the Mediterranean Sea

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Received 1 June 2009; accepted in revised form 31 August 2009; published online 23 September 2009

Abstract

On August 2008, a single individual of the red king crab *Paralithodes camtschaticus*, a boreal species indigenous to the North Pacific, was caught by a gill net in the Ionian Sea, Central Mediterranean. The crab weighed 4 kg and it is estimated it was ten years old. Transport in ballast water seems the most likely way of introduction. If true, the implication is that this cold-water species is capable of surviving and growing to adulthood in a warm-temperate sea.

Key words: Crustacea, Decapoda, Lithodidae, *Paralithodes camtschaticus*, red king crab, alien species, Ionian Sea

The spreading of alien marine species is a growing phenomenon world-wide and plays today a significant role in the global change of marine ecosystems (Ruiz et al. 1999; Occhipinti-Ambrogi 2007). Due to its geographic position and the intensity of its maritime traffic, the Mediterranean Sea is a major recipient of alien species (Zenetos et al. 2008). Most alien species entering the Mediterranean come from the Red Sea through the Suez Canal (Galil 2008), but other anthropogenic causes, either intentional or unintentional, have been invoked, including ship fouling, ballast waters, aquaculture, trade of living bait, wrapping of fresh seafood with living algae, aquariology, and even scientific research (Zibrowius 1992; Bianchi and Morri 2000).

Whatever the way of introduction, alien species in the Mediterranean Sea are typically of tropical or subtropical origin (Bianchi 2007). Present sea-water warming is thought to facilitate the establishment of warm-water species in the Mediterranean Sea, which has been said to be undergoing a process of 'tropicalization' (Bianchi and Morri 2003). As an example, 58 out of the 64 alien decapods and stomatopods listed for the Mediterranean by Galil et al. (2002) are of tropical origin, and only 6 of (warm) temperate origin.

Based on these premises, finding the boreal crab *Paralithodes camtschaticus* (Tilesius, 1815) in the Mediterranean Sea came totally unexpected. *P. camtschaticus*, or red king crab, is native of the North Pacific, from the Gulf of Alaska and the Aleutines to the Okhotsk Sea and the Bering Sea (Pavlov 2003). During the 1960s (with further additions in the late 1970s), it was purposely introduced into the Barents Sea for its high commercial value (Orlov and Ivanov 1978). Within four decades, the released stock of a little more than 15,000 adults grew to a naturalized population estimated at about 12 millions individuals (Berenboym 2003). The species has since expanded its range to Norwegian waters by 1992 (Petryashov et al. 2002; Jørgensen 2006), pointing at the potentiality of invasive behaviour (Figure 1).

The present paper reports the recent discovery of this species in the Mediterranean Sea, and discusses the hypothetical ways of introduction.

In August 2008, a large lithodid crab (Figure 2) was accidentally caught in a gill net laid over a sandy-rocky bottom at about 20 m depth off Le Cannella, within the Marine Protected Area of Capo Rizzuto on the Ionian Sea, central Mediterranean (Latitude 38°55.935' N, Longitude 17°08.900' E). Based on the diagnostic keys of Dawson and Yaldwin (1985), the crab belonged to the genus *Paralithodes*. It was classified as *Paralithodes camtschaticus* because of the presence of six spines on the cardiac region (Figure 2) instead of four, as in the other two species of the genus, *P. platypus* and *P. brevipes* (Pavlov 2003).

The crab weighed 4 kg, and exhibited a carapace width of 15 cm and a maximal size (legs included) of ca. 75 cm. This size corresponds to a ten-year old male (Berenboym 2003).

We are greatly puzzled by this finding and cannot determine a possible way of introduction with certainty. Six potential ways may be considered: the first two take into account natural mechanisms, the remaining four human introductions.

1. Adult migration - migration is part of the normal life cycle of *Paralithodes camtschaticus*, and travels 426 km long have been recorded (Jewett and Onuf 1988); adults from overcrowded populations have even been shown to migrate over longer distances (Jørgensen 2006). The distance between the central Mediterranean and the closest area of the established range (i.e., the Barents Sea) is anyway more than 7000 km, and along the Atlantic coasts of Europe the crab has not been recorded yet.
2. Larval transport by currents - larvae of red king crab can be transported over 200 km from hatching to metamorphosis (Jewett and Onuf 1988), a distance that is anyway much shorter than that between the Barents Sea and the Mediterranean. In addition, current pattern in the NE Atlantic would not facilitate passive transport in that direction.
3. Intentional introduction - we are unaware of attempts to introduce *P. camtschaticus* to the Mediterranean Sea. Based on climatic reasons, an intentional introduction should have privileged the cool northern Adriatic Sea (Bianchi et al. 2004) rather than the distinctly warmer Ionian Sea.
4. Escape from an aquarium, aquaculture installation or scientific laboratory - red king crabs are displayed in public aquaria in both N. America (e.g., http://www.alaskasealife.org and http://www.aquarium.org) and Europe (e.g., http://www.polaria.no). Successful rearing tests for the aquaculture industry have been carried

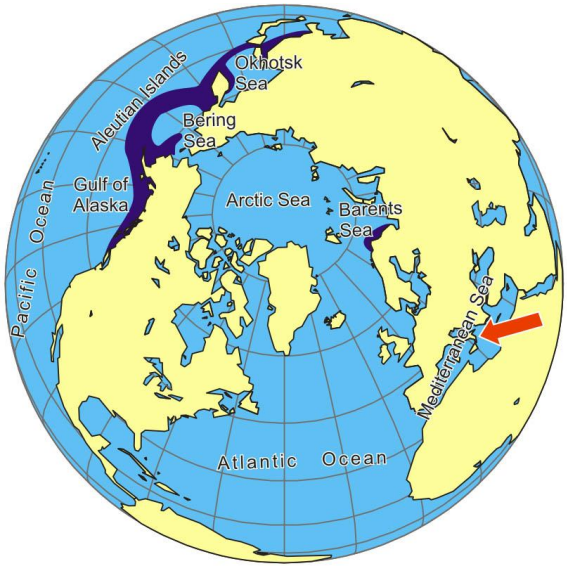

Figure 1. World distribution of the red king crab *Paralithodes camtschaticus*: the blue shadings indicate the native northern Pacific range and the non-native Russian and Norwegian Barents Sea range; the red arrow points at the present record in the central Mediterranean Sea

Figure 2. The individual of *Paralithodes camtschaticus* caught at Le Cannella (Ionian Sea, central Mediterranean) on August 2008. Photograph by F. Astorino

out in Japan, USA, Russia and Norway (Berenboym 2003; Pavlov 2003). We found no information about *P. camtschaticus* kept in captivity in Mediterranean countries.

5. Loss from a vessel – no such living sea food are shipped to this area, and we can hardly imagine commercial or military vessels to transport living crabs for the crew's refectory. Recreational ships cruise far off the coast to reach Greece.

6. Larval transport in ballast water - larval life of *P. camtschaticus* lasts 3 to 4.5 months (Jewett and Onuf 1988), a span long enough for them to be transported over long distances. Most of the inbound ship traffic arrives to the Mediterranean from the NE Atlantic (Galil et al. 2008), so that transport of larvae from the Barents Sea seems plausible.

If the entering of red king crab larvae by ballast transport looks plausible, it is difficult to understand how they have been able to survive, metamorphose and grow to the adult phase in warm waters. Average surface temperatures in the Ionian Sea range from 14°C in February to 26°C in August (Brasseur et al. 1996), whereas the temperature tolerance of *Paralithodes camtschaticus* has been estimated between -2°C and 18°C (Pavlov 2003). Survival in winter would thus have been possible, but how did the crab withstand summer temperatures for about ten years?

Perhaps the individual caught in August 2008 at a depth of 20 m was just the tip of an iceberg, other animals thriving in the cooler water below the summer thermocline. Extensive fishing, recreational diving and a program of seafloor investigation with ROV in search of ancient wrecks have however failed to detect other individuals. The alternative is that we had the chance to come across the only individual that survived to adulthood, but it seems equally unlikely.

The presence of *P. camtschaticus* in the area should be closely monitored with purposely adopted methods. The long life span, the great fecundity (Jørgensen 2006) and the apparently wide thermal tolerance suggested by the present finding point to the possibility of adaptation and rapid expansion within the Mediterranean Sea. Its large size and potential predatory behaviour upon benthic species, included some of interest to fishery (Jørgensen 2005), might cause both economic and ecological concern in the years to come.

Acknowledgements

We thank F. Astorino (Isola di Capo Rizzuto) for photo of king crab. For C. N. Bianchi, the study of the penetration of alien species into the Mediterranean Sea falls within the scope of the project 'The impacts of biological invasions and climate change on the biodiversity of the Mediterranean Sea' (Italy–Israel Co-operation on environment, research and development) funded by MATTM (the Italian Ministry for the environment). Comments by two anonymous reviewers improved the final presentation of the ms.

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