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Rapid Communication

First record of the northern brown shrimp *Penaeus aztecus* Ives, 1891 (Crustacea, Decapoda, Penaeidae) from Libyan waters

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Abstract

The first record of the northern brown shrimp, *Penaeus aztecus* Ives, 1891, from Libyan nearshore waters is hereby documented. Thirteen individuals of the species were caught by artisanal fishers using a mixture of gill and trammel nets in September 2020 within the Umm-Hufayn Lagoon. This lagoon is situated within the Gulf of Bomba along the Libyan Cyrenaica coast, and this discovery extends the known Mediterranean distribution of this western Atlantic species.

Key words: allochthonous species, southern Mediterranean, artisanal fishers, lagoon

Introduction

Within the Mediterranean, the northern brown shrimp, *Penaeus aztecus* Ives, 1891, can be best described as a "sprinter" of an introduced species, given its pattern of prodigious expansion within the Mediterranean in the last decade. The species is native to the Western Atlantic coastline of the USA and Mexico, with its range extending from Massachusetts to the Yucatan (Cook and Lindner 1970). It has exhibited a very rapid range expansion within the Mediterranean since its first record from the basin in 2009 in the Bay of Antalya, Turkey as *Farfantepenaeus aztecus* (Deval et al. 2010). Subsequently, the species has been recorded from the Mediterranean coast of Turkey in 2013, from the Aegean Sea in 2013–2014, off Corfu in the Ionian Sea in 2014, off Montenegro in the Adriatic Sea in 2013 and in the Tyrrhenian Sea in the Strait of Sicily in 2015 (Galil et al. 2017; Scannella et al. 2017). Following this progressive spread to contiguous coastal areas *P. aztecus* was also recorded in disparate coastal regions in the Mediterranean, including the Gulf of Lions in France (Galil et al. 2017) and the southern coastal waters of the basin, from Egypt, including the Nile Delta in 2018, the coastal waters of Alexandria in 2019–2020 (Özcan et al. 2019; El-Deeb et al. 2020), and the Gulf of Gabes, Tunisia (Ben Jarray et al. 2019).

Figure 1. Small-scale deployment of trammel and gill nets at the Umm-Hufayn lagoon, eastern Libyan coast. Photos taken by Jaber Yahya.

Along with the white shrimp *Penaeus setiferus* (Linnaeus, 1767) and the pink shrimp (*Penaeus duorarum* (Burkenroad, 1939)), *P. aztecus* represents one of the three most important commercial fisheries in its native region in the Gulf of Mexico. These fisheries, which are based on the premise that all individuals spawn, grow, reproduce and die within one year (NOAA 1992), are considered to be in a state of complete exploitation (O'Connor and Matlock 2005). Spawning of *P. aztecus* occurs offshore, after which post-larval stages are carried passively by advection to estuaries, where they develop into sub-adults which migrate offshore to spawn (NOAA 1992).

This study represents the first record of *P. aztecus* within Libyan coastal waters, thus further extending the known distribution of this western Atlantic species within the Mediterranean.

Materials and methods

In the first week of September 2020, one of the authors (AA) was alerted by artisanal fishers of the capture of thirteen (13) "unfamiliar" shrimps. The shrimp individuals were collected through the small-scale deployment of a mixture of trammel and gill nets (Figure 1) within the Umm-Hufayn Lagoon

Figure 2. The banks of Umm-Hufayn lagoon support halophytic vegetation dominated by *Salicornia fruticosa* (L.) L., *Juncus acutus* L. and *Phragmites australis* (Cav.) Trin. ex Steud. Photo: Abdulghani Abdulghani.

(coordinates: 32°33′13.5″N, 23°05′57.2″E), situated within the Gulf of Bomba along the Libyan Cyrenaica coast, approximately 50 km south-east of the city of Derna.

The Umm-Hufayn lagoon covers an area of approximately 2 km^2, with water depth ranging between 0.5 m and 3.0 m. It is connected to the sea via a narrow channel, through which tidal incursions occur. The lagoon is also fed by submarine springs, which discharge low-salinity (11 psu) water into its innermost regions. The banks of lagoon support halophytic vegetation dominated by *Salicornia arabica L.* synonym *Salicornia fruticosa* (L.) L., *Juncus acutus* L. and *Phragmites australis* (Cav.) Trin. ex Steud. (Figure 2), whilst the benthic community at the mouth of the lagoon is mainly dominated by seagrasses (i.e., *Cymodocea nodosa* (Ucria) Ascherson and *Posidonia oceanica* (L.) Delile). The lagoon and the fringing sandy beach are considered important fish nurseries and seabird and marine turtle nesting sites.

Shrimp specimens were weighed and the following measurements were taken in cm using a vernier caliper: Total Length (TL), Ocular Length (OL) and Cephalothorax Length (CL – measured as the distance between the rear margin of orbit to the mid-dorsal posterior margin of the cephalothorax). The sex of the individuals could not be determined given their juvenile status.

Results

The shrimp specimens were assigned to *P. aztecus*, according to the description provided in Perez-Farfante (1988), namely (1) a long and deep median sulcus along the entire length and a broad dorso-lateral sulcus; (2) the ratio of the keel height to the sulcus width inferior to 3; (3) the distal

Figure 3. A specimen of *Penaeus aztecus* recorded in the Umm-Hufayn lagoon. Scale is in cm. Photo: Abdulghani Abdulghani.

Table 1. Selected morphometric attributes and weight of the 13 *Penaeus aztecus* individuals recorded in the current study.

P. aztecus individual reference number	Total length (cm)	Ocular length (cm)	Cephalothorax length (cm)	Total weight (g)
1	18.6	15.4	5.2	35.5
2	18	15	4.5	34
3	17.5	15	5	30.8
4	18	15.5	5.1	32.6
5	17	14.5	4.3	31
6	17.4	14	4.5	35
7	15.5	13.7	4	29.8
8	17.2	15.5	5.5	31.5
9	16.5	13.7	4.5	33
10	17.4	15.5	4.4	34.2
11	16.3	14.2	4.3	30.2
12	15.2	13.7	4	32.8
13	16.8	14.7	5.1	31.4

part of the petasma's ventral costa tapered to a point, arc-shaped and armed with an elongate patch of closely-set small teeth on attached border; and (4) the thelycum featured relatively broad anterior and posterior processes (Figure 3).

The TL ranged between 15.2 cm and 18.6 cm and the CL between 4 cm and 5.5 cm, while the weight from 29.8 g to 35.5 g (Table 1). The thirteen *P. aztecus* specimens have been retained in an ethanol solution in a private collection by one of us (AA) and have, to date, not been catalogued. It is to be remarked that, upon being interviewed, the fishers making the catch explained that they had started observing *P. aztecus* within the lagoon approximately seven years ago, but had never to date reported this finding to scientists. Figure 4 gives the latest, updated distribution of *P. aztecus* within the Mediterranean basin, including the record reported within this study.

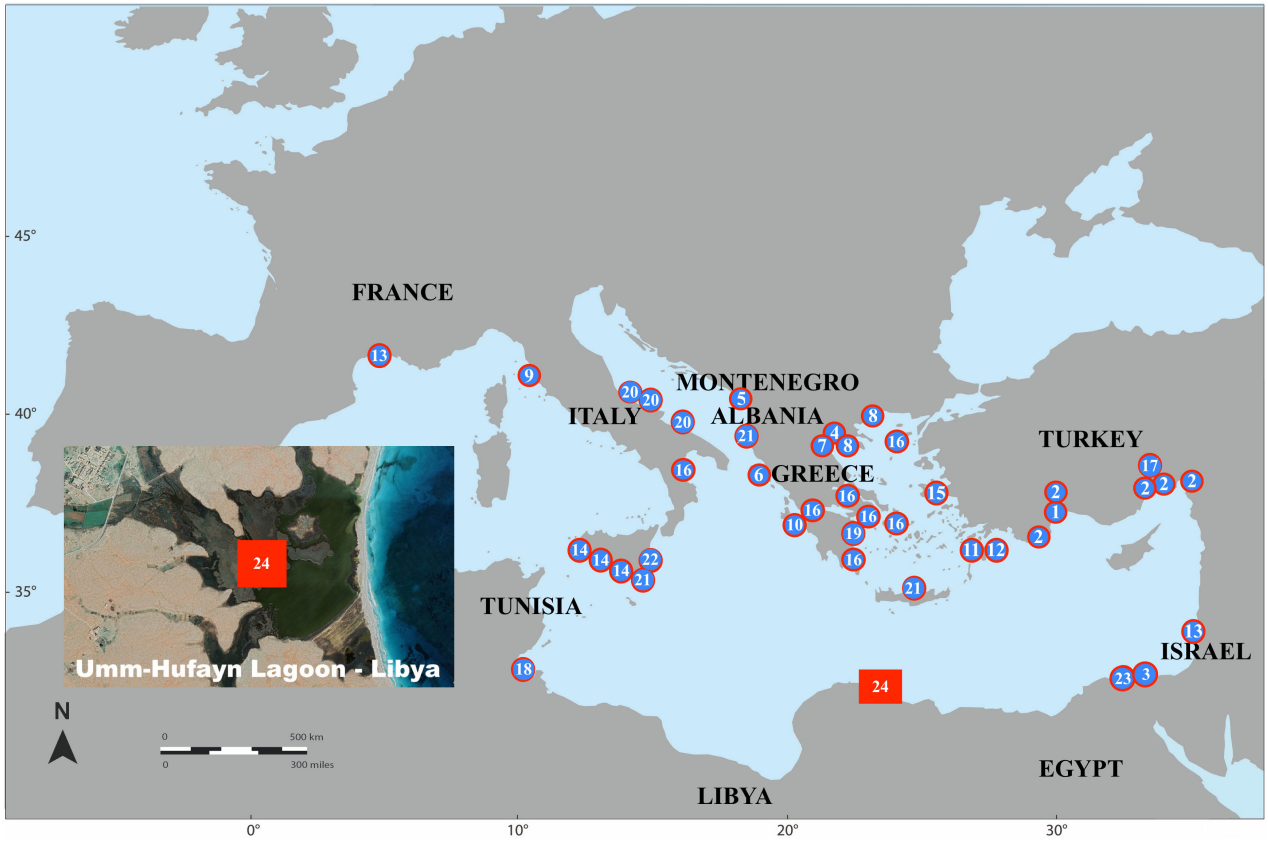

Figure 4. Updated distribution map of all the published records of *Penaeus aztecus* in the Mediterranean Sea, in chronological order: 1 – Antalya, Turkey, (Deval et al. 2010); 2 – Finike, Antalya, Adama, Mersin, Iskenderun Turkey (Bilecenoglu et al. 2013); 3 – Damietta, Egypt, (Sadek et al. 2018); 4 – Thermaikos Gulf, Greece (Nikolopoulou et al. 2013); 5 – Boka Kotorska, Montenegro (Marković et al. 2014); 6 – Corfu Island, Greece (Kapiris et al. 2014); 7 – Thermaikos Gulf, Greece (Kevrekidis 2014); 8 – Thermaikos Gulf, Nestos river estuaries, Greece (Minos et al. 2015); 9 – Castiglione, Italy (Cruscanti et al. 2015); 10 – Kyllini, Greece (Crocetta et al. 2015); 11 – Chalki Island, Greece (Kondylatos and Corsini-Foka 2015); 12 – Faliraki Rhodes, Greece (Kondylatos et al. 2020); 13 – Gulf of Lion, France and Palmahim, Israel (Galil et al. 2017); 14 – Mazara del Vallo, Porto Empedocle e Gela, Italy (Scannella et al. 2017); 15 – Ildır Bay, Turkey (Bakır and Aydin 2016); 16 – Golfo di Corigliano, Italy, Kerkyraikos Gulf, Maliakos Gulf, North Ionian Sea, Patraikos Gulf, Saronikos Gulf, South Ionian, Thracian-Limnos, Lakonikos Gulf, Kyklades (Syros Island), Greece (Mytilineou et al. 2016); 17 – Mersin Bay-Iskenderun, Turkey (Özcan et al. 2019); 18 – Gulf of Gabes, Tunisia (Ben Jarray et al. 2019); 19 – Central Aegean Sea, Greece (Kapiris and Minos 2017); 20 – Termoli and Mola di Bari, Italy (Zava et al. 2018); 21 – Marzamemi, Italy, Albania, Erakleion Crete, Greece (Kampouris et al. 2018a); 22 – Augusta, Italy (Stern et al. 2019); 23 – Alexandria, Egypt (El Deeb et al. 2020); 24 – Umm-Ufayn, Libya (present study).

Discussion

The total length measured for the *P. aztecus* specimens recorded in the current study suggests that they belonged to sub-adult stages, given that the maximum reported corresponding measurements are 19.5 cm and 23.6 cm for males and females, respectively (FAO 2020). This observation is consistent with the location of capture of the *P. aztecus* individuals reported in this study, with lagoons and estuarine habitats representing the type locality for juveniles of the species (Fry et al. 2003).

The first reported occurrence of *P. aztecus* along the Libyan coast is significant for three main reasons. Firstly, the species represents a useful fisheries resource, with annual global catches fluctuating between 50,000 and 80,000 tons (FAO 2020). Secondly, the species is known to spread quickly once introduced. For instance, shortly after it was introduced, *P. aztecus* was commercially exploited through trammel and gill nets in the

Gulf of Izmir in Turkey (Aydin et al. 2013) and through bottom trawling and trammel nets in the Gulf of Antalya in Turkey and in the Gulf of Gabes in Tunisia (Bilecenoglu et al. 2013; Ben Jarray et al. 2019, respectively). Thirdly, the species' introduction and spread in the Mediterranean constitutes a matter of ecological concern, given that it has been hypothesized to compete with the native *Penaeus kerathurus* (Forskal, 1775) (Kevrekidis 2014) and is known to host non-indigenous pathogens and parasites (Galil et al. 2017), such as the Indo-Pacific isopod *Epipenaeon ingens* Nobili, 1906 (Korun et al. 2013).

Whilst a number of studies on the occurrence of *P. aztecus* in the Mediterranean (e.g. Deval et al. 2010; Kevrekidis 2014; Kampouris et al. 2018a) speculate that its introduction into the basin was most likely attributable to ballast water-mediated transport, other studies (e.g. Cruscanti et al. 2015; Galil et al. 2017) attribute this phenomenon to a more direct anthropogenic intervention – i.e. a deliberate introduction for mariculture purposes. The latter hypothesis has been mainly supported by the proximity of these introduced *P. aztecus* populations to a number of operational fish and shellfish farms and by the rapidity at which the species (which presents limited dispersal abilities) has been spreading. The current population status of *P. aztecus* in Libyan coastal waters is still largely unknown. Due to limited research resources, the biological exploration of the Libyan waters is still partial, although the study of non-indigenous species has been intensified in recent years (Bazairi et al. 2013; Shakman et al. 2019; Al Mabruk et al. 2018; Al Mabruk and Rizgalla 2019; Osca et al. 2020; Bariche et al. 2020; Abdulghani et al. 2021; Al Mabruk et al. *in press*). In addition to this, the considerable time-lag of seven years between the first sighting and the first report of *P. aztecus* from the Umm-Hufayn Lagoon, combined with the widespread distribution of *P. aztecus* in the contiguous Tunisian and Egyptian coastal areas, suggest that the species is probably already established along additional stretches of the Libyan coastline.

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