

Rapid Communication

The barnacle *Amphibalanus improvisus* (Darwin, 1854), and the mitten crab *Eriocheir*: one invasive species getting off on another!

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Abstract

The balanoid barnacle, *Amphibalanus improvisus* (Darwin, 1854), was found on the carapaces of two invasive species of mitten crabs: *Eriocheir sinensis* H. Milne Edwards, 1853 and *E. hepuensis* Dai, 1991. The first instance was from a female mitten crab captured from the River Thames estuary, Kent, England, where *A. improvisus* is common. However, the second record, on a Hepu mitten crab from Iraq is the first record of *A. improvisus* from the Persian Gulf.

Key words: *Eriocheir sinensis* H. Milne Edwards, 1853, *E. hepuensis* Dai, 1991, invasive species, England, Iraq, barnacles, mitten crabs

Introduction

“Hairy” (Southeast and East Asia) or “mitten” (Europe) crabs are currently assigned to *Eriocheir* De Haan, 1835 (Brachyura: Grapsoidea: Varunidae). These crabs are catadromous spending most of their life (four to five years) in freshwater, but migrating to higher salinity water to reproduce and for the females to hatch zoea larvae (Panning 1939; Clark et al. 1998; Naser et al. 2012). After the mating period, the adults die off (semelparous), and the juveniles migrate upstream to start the life cycle again. Reproductive adult crabs do not moult during their ca. 8–10 months in higher salinity and, consequently, their carapaces can become fouled with barnacles (Figures 1, 2).

The barnacle *Amphibalanus improvisus* (Darwin, 1854) is considered native to the eastern coasts of the Americas, but this species was known to Darwin (1854) from both sides of the Atlantic, and from the Pacific in tropical South America. The present distribution of *A. improvisus* includes:

the eastern and western North Atlantic; Baltic Sea; west coast of Africa (to the Cape of Good Hope); Mediterranean Sea; Black Sea; Caspian Sea; Red Sea; Straits of Malacca; Singapore; Australia; New Zealand; China; Bohai Sea; Japan; Pacific coast of USA from Washington to San Francisco; Mexico; Columbia; Ecuador; and Peru. *Amphibalanus improvisus* continues to spread through vessel fouling (Jones 1991, 1992, 2012; Leppäkoski 1999; Olenin 2006).

In its native and invasive ranges, *A. improvisus* occurs from the littoral to the shallow subtidal being found in mesohaline regions of estuaries world-wide, but it is euryhaline and tolerates brackish to fully marine waters. The species attaches to hard substrates including rocks and wood, and also fouls animate surfaces, e.g. macroalgae, crustaceans and molluscs (Olenin 2006). It also fouls artificial hard surfaces such as ships’ hulls, dock and bridge pylons, and other marine infrastructures (Leppäkoski et al. 2002; Katsanevakis et al. 2014).

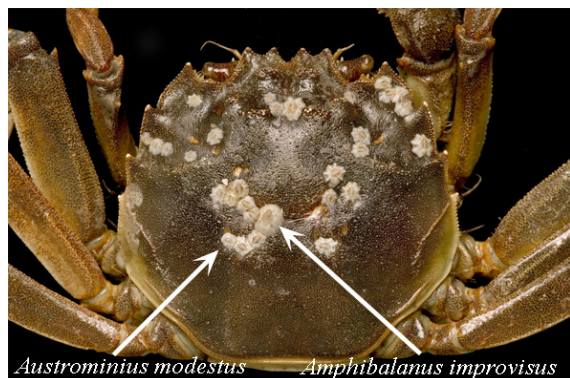


Figure 1. *Eriocheir sinensis* H. Milne Edwards, 1853, ♀ (47.9×44.2 mm) captured at Greenhithe, Kent, River Thames, 51°27.626'N 000°18.062'E, NHM reg. 2011.8673-8675, with barnacles on the dorsal surface of the carapace. Taken by Harry Taylor, NHM Photo Unit.



Figure 2. *Eriocheir hepuensis* Dai, 1991, ♀ ovi. (68.6×65.9mm), NHM reg. 2011.8035-8037, Shatt Al-Basrah canal near the dam at 30°24'33.75"N 47°46'32.32"E, Iraq, coll. M. Naser, 30 Nov. 2010. Dorsal carapace with *Amphibalanus improvisus* (Darwin, 1854). Taken by Harry Taylor, NHM Photo Unit.

Abbreviations used: collected = coll.; Natural History Museum, London = NHM; registration number = reg.

In this study, we document the balanoid barnacle, *Amphibalanus improvisus* (Darwin, 1854) attached to the carapaces of *Eriocheir sinensis* H. Milne Edwards, 1853 collected from the estuary of the River Thames, London, England, and on *E. hepuensis* Dai, 1991 collected from the Shatt Al-Basrah canal, Iraq. The latter represents a first record of *A. improvisus* for the Persian Gulf.



Figure 3. *Amphibalanus improvisus* (Darwin, 1854) from *Eriocheir hepuensis* Dai, 1991, ♀ ovi. (68.6×65.9mm), NHM reg. 2011.8035-8037, Shatt Al-Basrah canal near the dam at 30°24'33.75"N 47°46'32.32"E, Iraq, coll. M. Naser, 30 Nov. 2010. Scale bar in mm. Taken by Harry Taylor, NHM Photo Unit.

Collection of specimens and diagnosis

Specimens of mitten crabs carrying barnacles were collected opportunistically. Each was measured (carapace width × length in millimetres) and barnacles collected and identified to species. The specimens of *Amphibalanus* collected in the present study were identified using Henry and McLaughlin (1975). They were compared to all other *Amphibalanus* species that could be expected to occur in the area: *A. amphitrite* (Darwin, 1854); *A. eburneus* (Gould, 1841); *A. improvisus*, *A. subaldidus* (Henry, 1973); and *A. venustus* (Darwin, 1854). Five distinguishing features were examined (Table 1).

Eriocheir sinensis H. Milne Edwards, 1853 (Figure 1)

Material examined: Two males (45.9×41.4, 50.0×42.0 mm) and one female (47.9×44.2 mm) mitten crab were collected at Greenhithe, Kent, south bank of the River Thames (51°27.626'N; 000°18.062'E) on 27 July 2006. The barnacles found on the carapace were identified as *Amphibalanus improvisus* and *Austrominius modestus* (Darwin, 1854).

Eriocheir hepuensis Dai, 1991 (Figure 2, 3)

Material examined: One male (66.6×62.6 mm) and one female (68.6×65.9mm) mitten crab were collected in the Shatt Al-Basrah canal, Iraq, near the dam (30°24'33.75"N; 47°46'32.32"E) on 30 November 2010. The barnacles found on the carapace were identified as *Amphibalanus improvisus*, which had not previously been recorded in the Persian Gulf.

Table 1. Distinguishing features of *Amphibalanus* species found in the region. CR = carino-rostral.

	<i>amphitrite</i>	<i>eburneus</i>	<i>improvisus</i>	<i>subaldidus</i>	<i>venustus</i>
Shell	conic to sub-cylindrical; parietes white with longitudinal lavender or purple vertical striping with broad medial and lateral interspaces	conic to nearly cylindrical; parietes white	conic to sub-cylindrical; parietes white with hyaline longitudinal lines	conic to nearly cylindrical; parietes white	conic; parietes purple with horizontal and vertical white lines
Epicuticle	thin, usually not persistent	pale yellow, thin, usually persistent except on radii	pale yellow, usually persistent only on radii	thick, usually persistent, sometimes only basally	thin, sometimes persistent
Scutal growth lines	low, fine, approximate, often crenulate; longitudinal striae sometimes present	strongly crenulate, longitudinal striae strong	low, occasionally finely crenulate, occasionally with fine longitudinal striae	usually not crenulate, with fine longitudinal striae	growth lines low, longitudinal striae fine or absent
Orifice	entire or slightly toothed	toothed	entire or slightly toothed	toothed or slightly toothed	toothed
Orifice width	usually >1/2 CR diameter	usually <1/2 CR diameter	usually >1/2 CR diameter	usually >1/2 CR diameter	equal to or >1/2 CR diameter

Discussion

To date, 43 thoracican barnacles species are known from the waters of the Persian Gulf (33 species) and the Gulf of Oman (26 species) (Shahdadi et al. 2014). Records indicate that three amphibalanine balanids (*Amphibalanus amphitrite*, *A. subaldidus* and *A. venustus*) are recorded from these waters. All three species are considered to be foulers: two species are cryptogenic and one is regarded as an introduction.

Amphibalanus amphitrite is a cryptogenic, cosmopolitan species that is recorded from the Persian Gulf by Nilsson-Cantell (1938, as *Balanus amphitrite hawaiiensis* Broch, 1922, locality unknown); Stubbings (1961, as *Balanus amphitrite* var. *communis* Darwin, 1854; and *Balanus amphitrite* var. *hawaiiensis*, from Kuwait); Utinomi (1969, as *Balanus amphitrite*, from Hormoz Island); Jones (1986, as *Balanus amphitrite* var. *communis*, from Kuwait); and Shahdadi et al. (2014, as *Amphibalanus amphitrite*, from various localities along the Iranian coast, salinities ranging from 5–43 psu). The species is also recorded from the Gulf of Oman by Utinomi (1969, as *Balanus amphitrite*, locality unknown); and Shahdadi et al. (2014, as *Amphibalanus amphitrite*, from various localities along the Iranian coast).

Although *Amphibalanus subaldidus* has not been recorded from the Gulf of Oman, it was recorded for the first time along all river banks

in the northern Persian Gulf, from a variety of animate and inanimate substrates by Shahdadi et al. (2014), as *Amphibalanus subaldidus*, from the Arvandroud River (salinity 17.8), the Karoon River (salinity 1.6), the Bahmanshir River, and the Zohre River. The native range of this species is the Western Atlantic Ocean and Gulf of Mexico (Henry and McLaughlin 1975); therefore, *A. subaldidus* is considered to be an introduction into the waters of the Persian Gulf.

Amphibalanus venustus is a cryptogenic, mainly subtidal, species that occurs on both sides of the Atlantic Ocean, in the Indian Ocean, and in the western Pacific Ocean. The species is recorded from the Persian Gulf by Nilsson-Cantell (1938, as *Balanus amphitrite niveus* Darwin 1854, locality unknown); Utinomi (1969, as *Balanus venustus venustus* Darwin 1854, from Bahrain, Bushehr, Kish Island, and as *Balanus venustus niveus*, from Bahrain and Kish Island); Basson et al. (1977, as *Balanus venustus*, from Saudi Arabia); and Shahdadi et al. (2014, as *Amphibalanus venustus*, from Mahshahr, Nayband, Parsian, Bandar-Lengeh and Chabahar Bay). The species is also recorded from the Gulf of Oman by Utinomi (1969, as *Balanus venustus venustus*, locality unknown).

Herein, we present the first record of the Atlantic brackish-water species, *Amphibalanus improvisus* from the Persian Gulf thus bringing the number of amphibalanines known from this area to four.

Amphibalanus improvisus is now recognized as a widely distributed species, indicating its ability to become established in warm temperate to tropical regions of the world. The species is recognized as a nuisance fouler in estuaries, and is reported to have a high impact on ecosystem services and biodiversity (Leppäkoski 1999; Zaiko et al. 2007; Katsanevakis et al. 2014). Vulnerable habitats are brackish water bays and estuaries to shallow marine habitats (to ~6 m depth). Such foulers have the propensity for habitat modification and harmful impacts on other biota through competition for space and food resources, including on commercial species (e.g., fouling of mussels and oysters in aquaculture cages). They can also be harmful to human health, for example by fouling water intake pipes and heat exchangers. As well, the fouling of boat and ships' hulls and man-made constructions, such as navigational constructions, breakwaters, etc., impacts highly on transport efficiency.

High marine traffic is experienced in the Persian Gulf due to oil-related industries. The northern part of the Gulf has the highest number of oil terminals and the largest ports, with an estimated 25,000 tankers transporting crude oil across the Strait of Hormuz annually (Haapkylai et al. 2007; Shahdadi et al. 2014). Barnacles are known to successfully cross biological barriers as hull foulers or via ballast water (Yamaguchi et al. 2009; Tottrup et al. 2010). Therefore, with high ship traffic, the area is vulnerable to establishment of alien invasive marine species (Naser et al. 2012).

Recently, Shahdadi et al. (2014) reported the introduction and establishment of *Amphibalanus subaldidus* in the Persian Gulf, in the lower catchments of the Karoon, Tigris and Euphrates rivers, the first records of this species outside its native range (Western Atlantic Ocean). These authors also documented the first record of the megabalanine, *Megabalanus coccopoma* (Darwin, 1854) in the waters of the Persian Gulf and the Gulf of Oman, and stressed the need for a monitoring program to detect newly-arrived exotic species. The subsequent detection of *Amphibalanus improvisus* on the invasive Hepu mitten crab, *E. hepuensis*, in the Persian Gulf further supports the case for the monitoring for exotic species.

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