

First records of *Eriocheir sinensis* H. Milne Edwards, 1853 (Crustacea: Brachyura: Varunidae) for Chesapeake Bay and the mid-Atlantic coast of North America

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Abstract

We report here the first Chinese mitten crabs, *Eriocheir sinensis* H. Milne Edwards, 1853, found in the Chesapeake Bay, USA. Two male specimens were caught, retained, and identified from the mouth of the Patapsco River, near Baltimore, Maryland. The first crab to be reported was captured on 9 June 2006. Surprisingly, the second reported crab was captured at least one year earlier, probably in May 2005. Another two specimens of *E. sinensis* were reported up to 90km south of this location in April-June 2006, but the identity of these latter crabs could not be confirmed, because the specimens were not kept. Environmental conditions in Chesapeake Bay appear suitable for colonization by *E. sinensis*, and it is presently not known whether mitten crabs are reproducing or established in the region.

Key words: *Eriocheir sinensis*, Chesapeake Bay, North America. nonindigenous species

Introduction

The Chinese mitten crab, *Eriocheir sinensis* H. Milne Edwards, 1853, was introduced to northern Europe, where it is now widespread and considered established from Finland to southern France, including England (Herborg et al. 2003,

Panov 2006, Robbins et al. 2006). The crab also has been recorded in Ireland, the Mediterranean Sea, Black Sea, Sea of Azov, Caspian Sea (northern Iran), and southern Iraq, although it is not clear whether established populations are present in any of these areas (Petit 1960, Petit and Mizoule 1973, Clark et al. 2006, Robbins et al. 2006, Minchin in press).

In North America, *E. sinensis* is only known to have established a single population that is very restricted geographically on the west coast, occurring in the San Francisco Bay Delta of central California (Cohen and Carlton 1997, U.S. National Management Plan 2003, Rudnick et al. 2003, 2005). One other confirmed occurrence of a mitten crab along this coast was a single specimen reported from the Columbia River, at the border between Oregon and Washington, and was described as *E. japonicus* (De Haan, 1835), originating from a different geographic source than the California crabs (Jensen and Armstrong 2004; see also McLaughlin et al. 2005).

Mitten crabs have also been reported in eastern North America, occurring in two different regions, but are not thought to be established. Since 1965, at least eleven different specimens have been reported as *E. sinensis* from the Laurentian Great Lakes and St. Lawrence River (Annex), along the border between Canada and the United States. This includes eight specimens from Lake Superior to Lake Erie (including the Detroit River), and three specimens collected near Quebec, Canada. In addition to these northern records, a single mitten crab was reported in 1987 from the Mississippi River delta, Louisiana, in the southeastern United States and along the Gulf of Mexico. In total, at least three of the mitten crabs collected from eastern North America have been preserved and deposited in museums (Annex).

Here, we report the first records of the Chinese mitten crab for the Chesapeake Bay, Maryland, USA. To our knowledge, this is the first confirmed occurrence of *E. sinensis* for the U.S. Atlantic coast between the Gulf of Mexico (Louisiana) and the U.S.-Canadian border. The Chesapeake specimens were collected at least 1,000km by contiguous waterways from prior records in the Gulf of Mexico, Great Lakes and St. Lawrence River, and the U.S. Pacific coast.

Collection Records and Description

The first reported mitten crab was captured 9 June 2006 at the mouth of the Patapsco River, Maryland in the Chesapeake Bay (39°09'25"N, 76°24'13"W) by J. Delp. The mitten crab was caught in a baited crab trap at approximately 5m depth along with several individuals of the native blue crab *Callinectes sapidus* Rathbun, 1896 (J. Delp, personal communication). This first mitten

crab was frozen and delivered to us for examination on 21 July 2006. The specimen is male, 63mm carapace width (Figure 1).

Following announcements and media coverage of this initial crab (e.g., Maryland Department of Natural Resources 2006, Williamson and Fahrenthold 2006), a second specimen was reported from the same approximate location, at the mouth of the Patapsco River, Maryland, and was also captured in a baited crab trap (J. Foltz, personal communication). This second crab was apparently captured at least one year prior to the first reported crab, probably in May 2005, although there is some uncertainty about the exact date. The crab was maintained live for several months in captivity and then frozen (S. Takos, personal communication), being delivered to us in August 2006. The second specimen is also a male, 62mm carapace width.

To date, we have received two additional reports of mitten crabs in the Chesapeake Bay that appear credible, although the specimens were not retained and identification cannot be confirmed. A third crab was reported from the mouth of the Patuxent River, Maryland in Chesapeake Bay (38°18'N, 76°25'W). This crab was captured in a crab trap in late April 2006 (M. Wolfe, personal communication) and fits the general description of a Chinese mitten crab. This specimen was reported to be approximately 60mm in carapace width. A fourth specimen was reported from a crab trap in the vicinity of Chesapeake Beach, Maryland (38°41'10"N, 76°32'05"W; E. O'Brien, personal communication). The fourth crab was reported to be of similar size and captured in June 2006. Because other known crab species in this size range and vicinity are not easily confused with the mitten crab, these appear credible records, occurring up to ~90km south of the first two specimens.

In summary, we report at least two different specimens of *E. sinensis* captured in Chesapeake Bay in two different years, and both were deposited in collections of the National Museum of Natural History, Smithsonian Institution, Washington DC (USNM 1092253; second number pending). The two specimens, as well as the other two unconfirmed reports, were from low salinity (5-15 psu) waters of the upper Chesapeake Bay. No specific environmental measures were taken at the specific time and place of these collections.

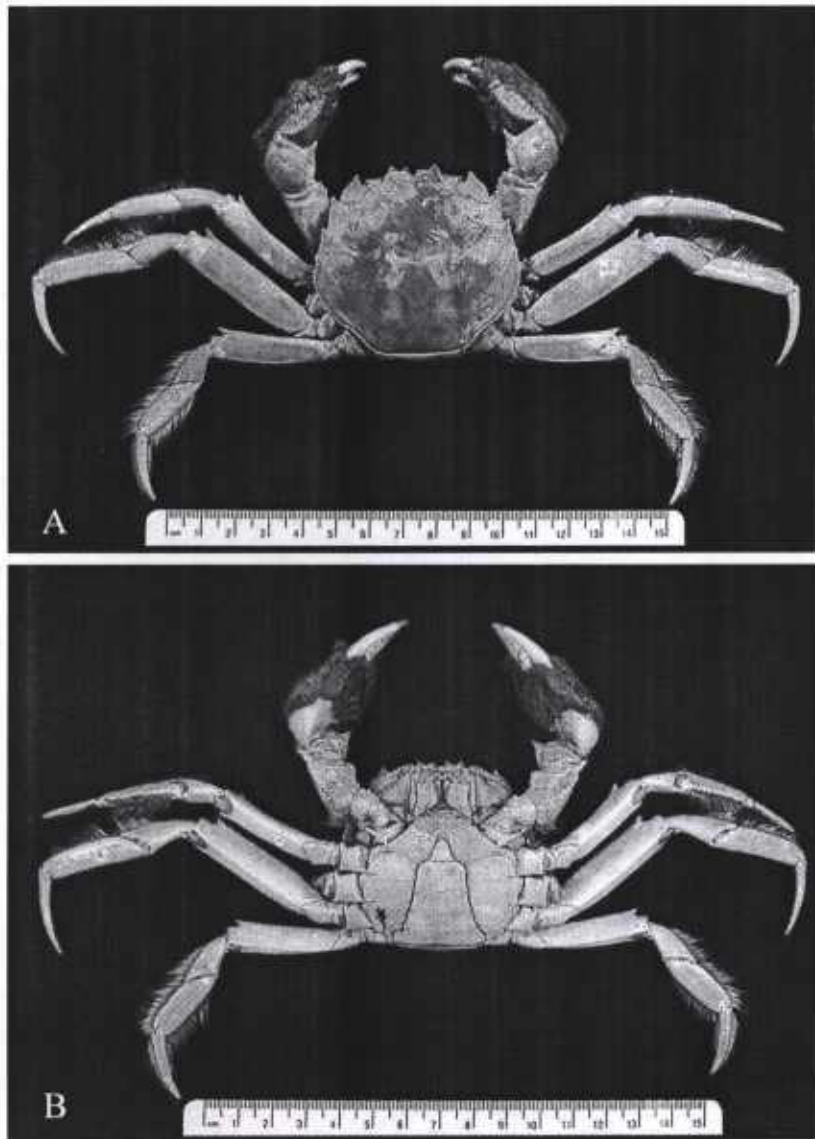


Figure 1. *Eriocheir sinensis* H. Milne Edwards, 1853, male specimen 63mm carapace width (third pereopods missing), captured 9 June 2006 at mouth of Patapsco River, Maryland, Chesapeake Bay (39°09'25"N, 76°24'13"W), by J. Delp: A, dorsal view; B, ventral view.

Discussion

At the present time, we do not know whether additional mitten crabs occur in the Chesapeake Bay watershed or whether reproduction is occurring here. It is possible that (a) only a small number of crabs were present in the Chesapeake

and (b) the existing crabs could have originated by transfer instead of local reproduction.

There are at least two likely mechanisms for the initial transfer of mitten crabs to the Chesapeake. Commercial ships are known to transfer marine organisms across ocean basins in their ballast tanks and associated sea chests (Carlton and Geller 1993, Coutts et al. 2003). This

mechanism can deliver larval and postlarval crabs to the Chesapeake from anywhere in the world. It is noteworthy that northern Europe is a dominant source for overseas ships arriving and discharging ballast water to ports of the Chesapeake Bay (Carlton et al. 1995, Smith et al. 1999). Not only do incoming ships often originate from within the known European range of *E. sinensis*, but they also arrive to the Port of Baltimore in the Patapsco River, where the mitten crabs were found. Ships also arrive from Pacific ports where mitten crabs occur, and could deliver *E. sinensis* to the Chesapeake, but the reported volume of ballast water discharged locally from this region in recent years (1999-2004) was < 1% of that from the northern European ports where this species occurs (NBIC 2005).

In addition to shipping, mitten crabs could have been imported to the Chesapeake region for food and released. Mitten crabs are eaten in Asia and Europe, and production of mitten crabs in China alone was estimated at 380,000 tons/year in 2003, increasing more than 40 times that in 1991 (China Fisheries Yearbook 2004). Given the magnitude and continuing growth of mitten crab production (Cheng, personal observation), and that crabs are sold and sometimes kept live for days to weeks before consumption, importation of live crabs cannot be ruled out as a possible transfer mechanism (e.g., see Cohen and Carlton 1997). In the USA, it has been illegal to import live mitten crabs from overseas or across states since 1989 (U.S. Fish and Wildlife Service 1989). Nonetheless, importation could have occurred before or after this ban, and we have no estimate of the extent to which this has occurred.

Either transfer mechanism could account for recent delivery of the observed crabs to the Chesapeake, but we also cannot exclude the possibility that reproduction is occurring or that the mitten crab is established. Unlike the Great Lakes, which lack ready access to saline waters required for successful reproduction, environmental conditions in the Chesapeake Bay and its extensive tributaries appear very suitable for population establishment. A recent analysis by Herborg et al. (2006) suggested the Chesapeake ports of Baltimore and Norfolk were "most vulnerable to introduction and establishment of Chinese mitten crabs" among major U.S. ports, based upon a combination of environmental parameters and shipping patterns.

Although a long-term presence of reproductive crabs in the Chesapeake may seem remote, *E. sinensis* populations often exhibit low abundance

for many years, with crabs being observed primarily during occasional high abundance "outbreaks" (Herborg et al. 2003, U.S. National Management Plan 2003, Rudnick 2003, 2005). Moreover, the crabs' occurrence in freshwater may avoid detection, if it is not yet abundant, due to relatively low sampling effort in appropriate habitats of the extensive freshwater tributaries surrounding the Chesapeake.

The mitten crab is considered to pose a significant risk of ecological and economic impacts in North America. As reviewed in the U.S. National Management Plan (2003), there is evidence that *E. sinensis* can (a) impact water supply and management, (b) increase erosion and slumping of banks and levees, (c) impact fisheries by interference with gear, and (d) cause damage to aquatic vegetation by feeding. Although the crab may also have significant effects at population, community, and ecosystem levels, these are not well documented. Based upon existing knowledge, the United States listed species of the genus *Eriocheir* as injurious wildlife, prohibiting the importation of these crabs into the country or across state boundaries (U.S. Fish and Wildlife Service 1989).

The Chinese mitten crab is a potential threat to resources in the Chesapeake Bay and its extensive watershed, given current knowledge about the crab's ecology (impacts as above), habitat breadth that includes reported inland migration in excess of 1,000km from saltwater, and occasional population outbreaks (U.S. National Management Plan 2003, Herborg et al. 2006). Yet, should an *E. sinensis* invasion occur here, it is difficult to predict the actual effects, since the crab would be interacting with a novel regional biota and environmental regime. Predicting such interactive effects when faced with new conditions remains a key challenge in invasion ecology.

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Annex

Eastern North American reports of *Eriocheir sinensis*. Shown chronologically for the reported occurrences in eastern North America are: (a) Region (Great Lakes, St. Lawrence River, Gulf of Mexico) and specific location of collection, (b) Record coordinates (estimated latitude and longitude), (c) Date of record, (d) Number, size (carapace width (CW) in mm), sex, and presence of museum deposition (dash indicates information not available for category), and (e) source of record. Not all reports have been confirmed with species identification. [Museum Abbreviations: CMN = Canadian Museum of Nature; ULLZ = University of Louisiana at Lafayette, Museum Zoological Collection. References: (1) Nepszy and Leach 1973; (2) U.S. Geological Survey 2006; (3) de LaFontaine 2005; (4) Environment Canada. St. Lawrence Centre 2006; (5) This report.]

Region/Location	Record coordinates		Record date	Number; Size; Sex; [Museum deposition]	Reference (Collector)
	Latitude, °N	Longitude, °W			
Great Lakes, Detroit River (water intake pipe, Windsor, Ontario)	42°20'	83°02'	October 1965	1; 57-64; male; [CMN]	1,2
Great Lakes, Lake Erie (gillnets, Erieau, Ontario)	42°15'	81°05'	April 1973	3; 57-64; 2 males, 1 female. [CMN]	1,2
Great Lakes, Lake Erie (gillnets, Port Stanley, Ontario)	42°40'	81°13'	May 1973	1; 60; -; [CMN]	1,2
Gulf of Mexico, Bay Gardene, Mississippi River delta (Plaquemines Parish, Louisiana)	29°27'	89°42'	March 1987	1; -; -; [ULLZ 3684]	2
Great Lakes, Lake Erie (fishing net, Ontario)	42°00'	81°00'	March 2004	1; 70; male; -	2,4
St. Lawrence River (eel fishing weir, near Lévis, Quebec)	46°48'	71°10'	September 2004	1; 46; female; -	2, 3, 4
St. Lawrence River (near Sainte- Angèle-de-Laval, Quebec)	45°36'	73°44'	Fall 2004	1; -; -; -	4
Great Lakes, Lake Erie offshore of Port Alma, Ontario)	42°10'54"	82°14'36"	March 2005	1; 74; female; -	2, 4
Chesapeake Bay, Patapsco River, Maryland	39°09'25"	76°24'13"	May 2005	1; 62; male; -	5 (J. Foltz)
St Lawrence River (Lake Saint- Pierre, fyke net, Quebec)	46°12'15"	72°49'58"	September 2005	1; 38; male; -	4
Great Lakes, Lake Superior (power station, Mission Island, Thunder Bay, Ontario)	48°24'05"	89°16'04"	December 2005	1; 65; male; -	2, 4
Chesapeake Bay, Patuxent River, Maryland	38°18'	76°25'	April 2006	1; ~ 60; -; -	5 (M. Wolfe)
Chesapeake Bay, Patapsco River, Maryland	39°09'25"	76°24'13"	June 2006	1; 63; male; -	5 (J. Delp)
Chesapeake Bay, Chesapeake Beach, Maryland	38°41'10"	76°32'05"	June 2006	1, ~60; -; -	5 (W. O'Brien)