

Mitten Crabs: Oriental Invaders of the River Thames

Editor's Introduction | Throughout the past ninety years, the Chinese mitten crab has invaded European and American waterways in an extraordinary fashion, burrowing into riverbanks, carrying out mass migrations, threatening native flora and fauna, frustrating anglers and interfering with commercial fishing. Roni Robbins, Paul Clark and Phil Rainbow, of the department of zoology at The Natural History Museum, have tracked the Chinese mitten crab through its journeys up and down the River Thames in England. They have charted its survival and discovered how the crab has been able to travel so far from its native territory in the Far East.

The Chinese mitten crab (*Eriocheir sinensis*) is so named because of one of its most obvious features, its "mittens", which are actually setae (soft bristles) that cover its claws. It is an extremely large crab with a carapace (shell) width of approximately 80 millimetres and legs that are one and a half times this in length. Identifying the gender of this species is relatively simple, as the male features a V-shaped abdomen whilst the female's abdomen is U-shaped. The crab is considered a delicacy in the Far East, where it is eaten raw. This, however, can cause health problems as the mitten crab is a secondary host to the parasitic lung fluke, *Paragonimus westerii*, which completes its lifecycle in mammals, developing in the chest and causing symptoms similar to those of tuberculosis.



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An adult *Eriocheir sinensis*.

These crabs have an unusual life history because they spend four or five years upstream in fresh water, before migrating down the river in order to reproduce. They migrate in large numbers and can cause major problems by crawling into properties located near rivers, including hospitals. After mating, the male will usually die, leaving the female to brood the eggs. The female aerates the eggs continuously in order to provide a steady flow of oxygen, and the larvae feed on yolk she produces within each egg. She releases the larvae in the brackish water of estuaries. The first phase is known as zoea, which barely resembles the adult crab form. It possesses a long dorsal spine, two lateral spines, and a rostral spine. The filamentous appendages on the side aid passage through the water, but in later development they will be used for feeding.



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Embryo of a crab ready to hatch as a zoea (not *Eriocheir sinensis*). The developing eye can be seen towards the centre of the egg. The stalk is used to attach the egg to the abdominal appendages of the female.

After six zoeal stages, there is a dramatic metamorphosis from zoeal to megalopal phase, and many zoeae die during this period. At megalopal phase the larvae begin to have a crab-like appearance but the abdomen still protrudes from behind, giving it the appearance of a lobster. During this phase the megalop leaves its planktonic life in the water column and begins a benthic existence on the seabed. At this phase the swimming appendages it once used as zoea have developed into external mouth parts for feeding, abdominal appendages are used for swimming and legs have now developed aiding the crab in its new benthic existence. After about seven days the megalops will moult and become crabs with the abdomen tucked under the body. The juvenile crabs begin the long migration upriver where they will begin the lifecycles again.



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Zoeal stage of *Eriocheir sinensis*.

The mitten crab's native habitat is found from Fukien province in China to the western coastal regions of Korea. This temperate environment has enabled this species to adapt to similar conditions in Europe. The first record of this species in Europe was in 1912 when a large male was captured from the River Aller, a tributary of the River Weser, in Germany. During the 1920s and 1930s, the mitten crab spread rapidly throughout Europe invading all of the major rivers including the Oder, the Elbe, the Vistula and the Rhine. It is thought that the Chinese mitten crab reached Europe in the ballast tanks of commercial vessels. The crabs would have entered these tanks as larvae (zoeas), developed en route, and were then liberated into the destination harbour when these tanks were emptied.



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A first crab stage.

Mitten crabs are known to migrate vast distances and in China they have been found up to 1500km upstream in the Yangtze River. In Europe, they have been found in Prague, some 750km from the sea and far north as Sweden and Finland. It is not known whether the occurrence of this species in countries surrounding the Baltic Sea is an established population as the low salinities of these waters may not allow for the development the eggs.

In the 1940s the migrating crabs became a major problem in the Netherlands where, during the autumn migration period, up to a tonne of these animals were caught on a daily basis. This impeded fisheries, as their sharp claws destroy the nets and damage fish caught within them. In the 1950s rumours were rife surrounding this species, and one in particular accused this animal of causing major flooding incidents due to its burrowing activities into the dykes. This rumour was later dispelled. Elsewhere in Europe the mitten crab population was increasing in numbers as well in distribution. In France, substantial numbers of crabs were captured from the River Seine up until around ten years ago when scientists noticed a great decline in specimens caught.

A variety of theories have been put forward regarding the causes of this sudden decrease, including increasing levels of pollution, and a very plausible theory suggesting that as France experienced a number of extremely cold winters, these low temperatures may have contributed to large numbers of larvae to dying. In 1959, Chinese mitten crabs were first captured from the Languedoc lagoons in southern France, having reached the region by following the Garonne canal system

(Languedoc-Roussillon). In 1967 and 1968 further specimens were captured from this area, but the present day status of this population has not been reported. During the late 1980s, local fishermen reported capturing mitten crabs from the Tagus estuary, Portugal. This represents the southernmost Atlantic coast record to date. From 1988 to 1990, the crab was abundant within this estuary and was found up to eighty kilometres upstream from sea. Since then, however, this population has decreased.

In the United States, the mitten crab was first recorded in the Detroit River at Windsor, Ontario in October 1965. There were no further sightings until 1973, when two males and one female were caught in Lake Erie by commercial fishermen using gillnets. There are no other records of this crab in North America until 1987, when a single specimen was captured from the Mississippi River delta, near Louisiana. In 1992, commercial shrimp trawlers in the southern San Francisco Bay area reported catching Chinese mitten crabs occasionally, many of which were egg-bearing, and by the summer of 1994 they had spread to the northern San Francisco Bay (San Pablo Bay) area. As important locations for the fishing industry, the sudden increase in the crab populations was considered a major threat. During the late 1980s, all mitten crab imports into the USA were banned and the law was enforced with tough penalties; however, the population in the San Francisco Bay region is still increasing.

The first record of the Chinese mitten crab in Great Britain was in 1935, and the presence of this animal was widely debated within zoological circles at the time. A single specimen was captured on the band screens of Lots Road power station, situated on the River Thames in Chelsea. The original specimen disappeared unfortunately, and with research drying up in the 1940s, there were few records until 1949 when a second specimen was found in South Fields Reservoir near Castleford, Yorkshire. The reservoir tops up the canal system and it is likely that the crab was introduced through shipping on the Humber River. In 1973, further records were collected from the River Thames when three crabs were captured at West Thurrock power station. These specimens were donated to The Natural History Museum and are now held in the Zoology reference collection. It is not known why Britain did not experience the same population explosion that had swept through Europe in the early part of last century, but a steady increase in numbers is being witnessed today.

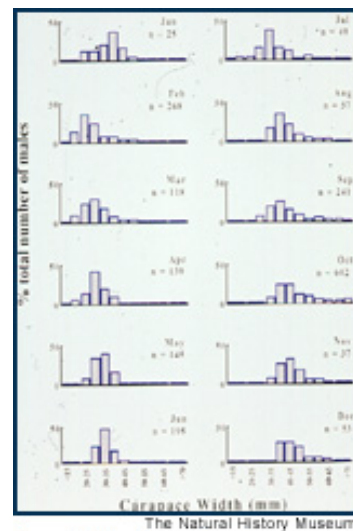
The mitten crab is known to have spread up the River Thames as far as Staines, a mere 63km from the sea, but records from both Europe and China have shown that the entire Thames catchment is at risk from invasion. A preliminary project was carried out on behalf of The Environment Agency to assess this risk. Using historical records from the Environment Agency alongside reference material held in The Natural History Museum's reference collection, past distributions have been mapped. Updating this with new information from a public telephone "hotline" on the distribution of the 1997 species, the preliminary study showed clear evidence of an increase in the distribution of mitten crabs within the Thames catchment area.

A more intensive programme was subsequently set up by the Museum to investigate the patterns of increase. This involved frequent sampling from a variety of power stations situated along the River Thames, including Lots Road, Barking and Tilbury. Lots Road is an old Victorian coal-fired power station and, like the others, requires vast quantities of river water to cool the power stations generators when electricity is being produced. The water is gravity-fed into wells, rising and lowering with the tide, before being filtered through rotating band screens on which fish, crabs and other debris accumulate. These band screens are then cleaned either by water jets or by a series of rotating brushes, and the filtered material, including the crabs, are collected into a trash pit below.

On the other hand, Barking power station, at less than ten years old, is gas fired. In order to correspond to the requirements of recent environmental regulations, a fish-return system is employed here. This system uses rotating screens and a low-pressure water jet to filter out any fish debris, or crabs for that matter, into a channel that returns the animals back to the River Thames

intact. The band screen is then washed with a high-pressure jet of water to remove the remaining debris.

Data from Lots Road revealed that crabs of the smallest size range (twenty to twenty-five millimetres in carapace width) appear in April and May each year. This peak size increased over time, until it reached a maximum modal size of about forty to forty-five millimetres in carapace width by the following autumn. In January 1998, only twenty-five large male crabs (crabs above forty-five millimetres width) were collected on an ebbing tide, whereas a total of 602 were collected in October at the same state of the tide. A similar pattern was established with the females. This indicates that large numbers of sexually mature crabs are moving downstream in the autumn months. In contrast to this, large numbers of small crabs are caught in the spring and summer months on a rising tide, which may be inferred as upstream migration. Very little data were collected on the size distribution of juvenile crabs, largely due to an equipment bias as the mesh size of the band screens allows the juveniles to simply fall through.



Size distribution of male *Eriocheir sinensis* at Lots Road in 1938.

In addition to the data already obtained, the researchers undertook a tagging programme in order to monitor the migratory movements of the crabs. Previous reports have indicated that these animals can migrate at a rate of between nine to twelve kilometres per day. Tags were inserted in the suture line at the back of the crab, where it moults, to avoid inhibiting the growth process, and surveys began to try and recapture the animals.



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A bucketful of mitten crabs.

In the spring, another project examined the development of the zoeas, the location of females in the estuary, their egg-bearing times, and the areas for hatching zoeae within the River Thames. Egg-bearing females were collected from Tilbury power station and maintained in seawater, where zoeas were then hatched. This allowed for the individual stages of the zoea and megalopa to be described accurately. In order to discover their exact locations in the river, plankton was sampled at all power stations and additional sites (Mucking Flats, Holehaven, Chapman Sands and Southend-on-Sea) for special study. Whilst the power stations were sampled throughout the year, these additional sites were sampled fortnightly over three to four months in the spring and summer around a high tide. Chinese mitten crab larvae were located around Holehaven over a two-year period, but not found at any of the other sites.

The studies carried out by The Natural History Museum team were also important for looking at human health issues, particularly the analysis of their heavy metal content because of their potential use as a food resource. There are very significant environmental implications of an explosion of the mitten crab in the Thames--it is an omnivorous predator and will devour anything, including native freshwater crayfish. Mitten crabs also burrow, and in large numbers can cause substantial damage to unprotected riverbanks.

Although the arrival of a non-native species may have a negative effect on an aquatic community,

a number of benefits have also been attributed. They can provide a food source for humans or even increase productivity in previously uncolonised environments. Being so highly prized in the Far East, the Chinese mitten crab may provide a new source of exploitable species in the West in the future. This would provide the effective means of control, so necessary for this fast-developing non-native species.

[The Chinese Mitten Crab \(www.nhm.ac.uk/zoology/crab\)](http://www.nhm.ac.uk/zoology/crab)

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