สายอองกักยาม อก่ว่าก่ายสาย กอยู่มีการอยู่กากป

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The Chinese mitten crab was introduced as an alien invader into western Europe, probably initially in ballast water, in about 1912. Since the early 1990s, mitten crab numbers in the Thames catchment have risen dramatically. The crabs are ravenous omnivores, feeding on the indigenous freshwater fauna and flora, and outcompeting native crayfish.

The Chinese mitten crab, Eriocheir sinensis, is an alien invader of the rivers and estuaries of western and northern Europe. The mitten crab originates from the Far East, with a native distribution from the Province of Fukien in China northwards to the peninsula of Korea. Mitten crabs are catadromous, spending most of their life in freshwater. Males and females eventually migrate downstream in late summer to breed in estuaries (Panning, 1939; Anger, 1991). The egg-bearing females continue seaward after mating, spending the winter in deeper water at the bottom of the estuary, and return in the spring to brackish water to release their eggs (Panning, 1939). The spent adults are believed to die. The planktonic larvae develop in the lower estuary, then settle and metamorphose into juvenile crabs, which gradually move upstream to complete the life cycle (Panning, 1939).

The distances travelled upstream can be staggering, the crabs being reported as far as 1300 km from the sea in the Yangtze Kiang in China. After about four or five years, feeding and growing in rivers and streams, the adult crabs come into breeding condition and move downstream again in large numbers in the late summer, concentrating the crabs from the many tributaries of a river system together in the estuary to breed. It is during these mass migrations that they are at their most prominent. Mitten crabs can also cross dry land and are therefore capable of entering adjacent catchments.

Continental Europe

The Chinese mitten crab was introduced, probably in the ballast water of ships from the Far East, into Germany in 1912, where it was reported for the first time in Europe in the River Aller, a tributary of the River Weser (Panning, 1939). From Germany, it has spread throughout northern Europe from the Baltic to the Mediterranean. In the 1920s and 1930s, mitten crabs occurred in vast numbers through the estuaries and river systems of northern Europe, but population numbers fell from these peaks for the rest of the twentieth century. The crab is now found from Finland in the north, through to Sweden, Russia, Poland, Germany, the Czech Republic, the Netherlands, Belgium, England and France (Clark et al., 1998), and, recently, Portugal (Cabral and Costa, 1999). On the Atlantic coast of France the crab has reached the Golfe de Gascoigne, but it has also used the Garonne canal system to extend its range to a Mediterranean catchment, now occurring in southern France (Petit, 1960). The crabs migrate enormous

Title image. A mitten crab.



Figure 1. A mitten crab showing the mittens, composed of many fine bristles, on the claws. These mittens are particularly pronounced in large males and may play a role in intraspecific signalling of dominance.

distances and, in Europe, they have been found at Prague, about 750 km upstream in the Elbe.

North America

The mitten crab has also been reported from North America with records from the Detroit River at Windsor Ontario and Lake Erie, Canada, and from the Mississippi Delta and San Francisco Bay, United States (Cohen and Carlton, 1997). The only region where the crab appears to have taken hold, however, is San Francisco Bay, where it is particularly common. The American wildlife authorities are so concerned about the spread of this alien species and its burrowing behaviour that live mitten crab imports into California were banned by legislation in 1987, and subsequently the whole of the United States in 1989. It has generally been assumed that the San Francisco Bay population is the result of an invasion from the Far East. New research on mt-DNA sequences, however, showed that Californian crabs were fixed for a single haplotype, also found in European but not in Chinese populations sampled (Hänfling et al., 2002). This observation provides circumstantial evidence for the unexpected hypothesis that the San Francisco Bay populations were founded by a single introduction event from a European source (Hänfling et al., 2002).

England

The Chinese mitten crab was first recorded in Britain in England in 1935, when a single specimen was collected



Figure 2. The ventral view of a male mitten crab.

from Lots Road power station, Chelsea, on the Thames in London. The second recording was at Southfields Reservoir near Castleford, Yorkshire, in 1949. Sightings in England were rare until the 1970s when the crab appeared to become established in the Thames, apparently at a low population level (Ingle and Andrews 1976; Andrews *et al.*, 1982; Clark *et al.*, 1998). It is not known why Britain had remained essentially mitten crab-free during the continental European mitten crab population explosion of the 1930s and thereafter. Prevailing currents might have played a part, as might the polluted state of British rivers and estuaries at that period.

Records of mitten crabs in the Thames estuary remained relatively constant in the 1970s and 1980s (Clark *et al.*, 1998). Ingle and Andrews (1976) recorded three crabs from the intake screens of the West Thurrock power

station on the Essex (north) bank of the estuary. In 1979, an egg-bearing female was collected at Southend-on-Sea at the end of the Thames estuary, and a further 20 crabs were taken at West Thurrock (Andrews *et al.*, 1982).

In the 1990s, however, population levels of Eriocheir sinensis in the Thames escalated with huge increases in the numbers of crabs taken on the screens of West Thurrock, Tilbury and Lots Road (Chelsea) power stations (Clark et al., 1998; Robbins et al., 1999). By 1996, the crab had been reported upstream in the tributaries of the Thames catchment, from the River Colne at Staines in the west, the River Lee at Enfield in the north, and the Rivers Darent and Cray in the east, and all tributaries between (Clark et al., 1998). Against a background of increasing numbers through the 1990s, the numbers of crabs caught on power station screens do vary seasonally in reflection of the annual cycles of migration (Clark et al., 1998; Robbins et al., 1999). From 2002, mitten crabs have become so common in the Thames that it is not unusual to collect juvenile crabs (in the process of slowly migrating upstream) from beneath stones in the intertidal zone of the shore bordering the Embankment of central London.

In addition to the Thames, the mitten crab is present in the Medway and the Humber. It is clearly spreading in distribution. In 1999, a female crab was found in the River Teign in south Devon, and individual specimens have been collected since 1998 from the River Tyne in northern England. The rivers of Essex have now been colonised, with records from the Rivers Stour and Chelmer being reported to The Natural History Museum in 2002.



Figure 3. The life cycle of the mitten crab Eriocheir sinensis.

So what?

There is no doubt that the whole of the Thames catchment is accessible to mitten crabs as their numbers continue to rise. Similarly, it is likely that the crabs will continue to spread to other British estuaries. So what? We can expect the population explosion of this alien invader of our rivers and estuaries to have environmental consequences. In their time in freshwater, the crabs are active burrowers and can cause significant damage to banks and earthworks along river systems (as indeed was the case in western Europe in the 1930s). This burrowing habit was a crucial consideration in the banning of live mitten crab imports into California in 1987, and into the rest of USA in 1989. Remember that the crabs are not averse to crossing dry land and thereby invading adjacent river catchments. They have already made use of canals in France, and could well be estab-



Figure 4. The zoea larval stage of the Chinese mitten crab. These larvae are planktonic, living in the water column of an estuary for several weeks as they feed and grow larger via a series of moults before metamorphosing into the megalopa stage.

lished in the network of English canals already. Furthermore, mitten crabs are generalist omnivores, and they are large and aggressive. Their voracious omnivory threatens many members of the British freshwater fauna and flora, animal and vegetable, including the eggs of fish that are laid on the bottom. Mitten crabs also disturb fishermen, worrying bait off hooks, deterring fish and alarming anglers as they are pulled from the water.

Mitten crabs do not affect the native freshwater fauna by predation alone, for they also compete ecologically with crayfish, a member of our native fauna that can well do without any extra competition. The native (white-clawed) crayfish, Austropotamobius pallipes, is an inhabitant of hard (calcium-rich) freshwater systems in England, Wales and Ireland (only two small established populations are known from Scotland). Since the 1960s, foreign crayfish have been introduced for aquacultural, culinary and aquarist purposes. Now, in addition to the native white-clawed crayfish, Britain has wild populations of the Turkish narrow-clawed crayfish (Astacus leptodactylus), the Californian signal crayfish (Pacifastacus leniusculus), the Louisianan red swamp crayfish (Procambarus clarkii), the German noble crayfish (Astacus astacus) and the American spiny-cheek or striped crayfish (Orconectes *limosus*). (Incidentally, it is difficult to escape the conclusion that the spread of these alien crayfish may be 'helped' anthropogenically with an eye to a future harvesting opportunity.) The native crayfish is relatively docile, and is outcompeted by the alien crayfish, even



Figure 5. The megalopa of the Chinese mitten crab. The megalopa is the settlement stage of the life cycle marking the transition from a planktonic to a bottom-living way of life.

before the addition of the large mitten crab to any local freshwater fauna.

Lung fluke

In the Far East, the mitten crab, at a particular season of the year, is considered a culinary delicacy and large numbers of crabs are collected for the restaurant trade. Unfortunately, in its country of origin, the mitten crab is the second intermediate host of the oriental lung fluke, *Paragonimus westermani*, a parasitic flatworm that can infect humans if crabs are eaten without adequate cooking. The life cycle of the lung fluke involves freshwater snails of the family Thiaridae as well as the mitten crabs (Clark *et al.*, 1998). Fortunately, thiarid snails are warm-water species absent from northern Europe, and it appears unlikely that the lung fluke life cycle can be completed in Britain.

Control of alien mitten crabs

Prevention is the best method of controlling the invasion of exotic species into new regions and this requires international cooperation. One of the main methods of transportation of marine species around the world is in the ballast water of shipping (Carlton, 1985). Recent attempts at control have used open ocean water exchange or freshwater flushing of ship's ballast. Such methods may, however, not be effective to control bioinvasions and filtration of ballast water may be more appropriate (Hülsmann and Galil, 2001).



Figure 6. A mitten crab with a tag attached. Crabs were individually tagged in a study by The Natural History Museum on the migration patterns of mitten crabs in the Thames catchment.



Figure 7. Mitten crabs in season are considered a delicacy in chinese cooking, as exemplified in this poster outside a restaurant in Bangkok, Thailand.

For mitten crabs, however, there is little to be gained from shutting the stable door after the horse has bolted. Are there control methods for mitten crabs that might be appropriate now? Extensive trapping at a particular point (for example, during downstream migration) might be an option, but such attempts to control mitten crab populations in Germany in the 1930s met with no success.

The possible marketing of the crabs for the culinary trade might offer some salvation. There is considerable potential for commercial exploitation because of the high regard of mitten crabs as a gastronomic delicacy in the Far East. Restaurants in Hong Kong and Japan charge a high price for them. Mitten crabs flown in from the Far East may fetch up to £6 per pound in London when in season. An added attraction of exploiting the European mitten crab population for food is that the establishment of parasitic lung disease is thought unlikely. Firstly, the populations in Europe were probably established by planktonic stages transported in ballast water. Consequently, the adult population would probably be parasite-free. Furthermore, as mentioned above, the present climate in Northern Europe may be too cold for the thiarid snails that act as primary intermediate host for the lung fluke. However, before the commercial export of mitten crab can be sanctioned, tests for the presence of parasites in local mitten crabs should be undertaken. The Chinese mitten crab is probably here to stay - the culinary route may represent our best culling strategy if we are to limit its potentially damaging environmental effects in British freshwaters.

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Website

http://www.nhm.ac.uk/zoology/crab/ A Natural History Museum website providing details of chinese mitten crab biology, with contact details.

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