

**Chinese Mitten Crab**

*(Eriocheir sinensis)*

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Fish 423: Aquatic Invasion Ecology



(Photo credit: [www.lancashireinvasives.org](http://www.lancashireinvasives.org))

## Diagnostic Information

Common Names: Chinese Mitten Crab, Moon Crab, the Hand Warmer

Order: Decapoda

Family: Grapsidoidea

Genus: *Eriocheir*

Species: *sinensis*



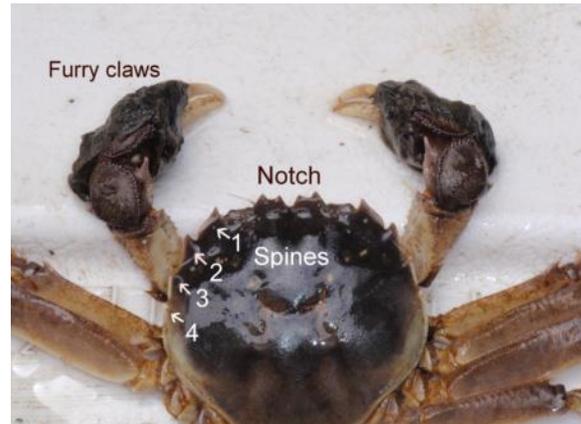
(Figure 1. A Chinese mitten crab out of water. Photo credit: newenglandboating.com)

## Basic Identification Key

### Adult

The most distinguishable feature of a Chinese Mitten crab is the mat of dense fine bristles, setae, typically apparent in males, along the claws with peaking white pincers giving the impression of wearing mittens hence the name. It's hypothesized that the extra amount of hair on the claws is a sign of male dominance (Robbins *et al.* 2003, Veldhuim 2001). The brown to light brown carapace is approximately three inches and has four protruding lateral spines, the fourth being very small. There is also a distinct notch in between the eyes. The light brown legs are over twice as long, with hair of their own, as the width of the carapace (Rudnick 2000). An adult can weigh up to two ounces (Elton 1958). Male crabs have a triangular abdomen with a pointed end while females have more of a rounded abdomen. Chinese Mitten crabs do not vary with seasons so there should

be no misidentifications with other species (GB Nonnative Species Secretariat).

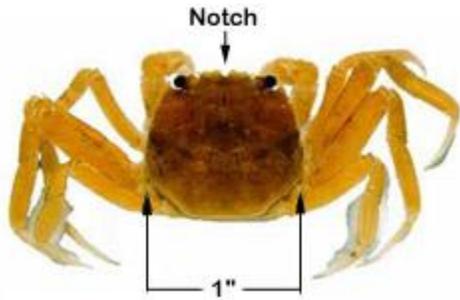


(Figure 2. An identification key of Chinese mitten crabs. Photo credit: Smithsonian Environmental Research Center)



(Figure 3. Male (bottom) and female crab (top). The crabs are small enough to fit in the palm of a hand. The hairs on the claws of the female crab are not as distinct as the claws on the male crab. Photo credit: Department of Fish & Game California State 1998)

## Juvenile



(Figure 4. An identification guide of a juvenile Chinese mitten crab. The carapace alone can be about the size of a quarter. Photo credit: Department of Fish & Game California State 1998)

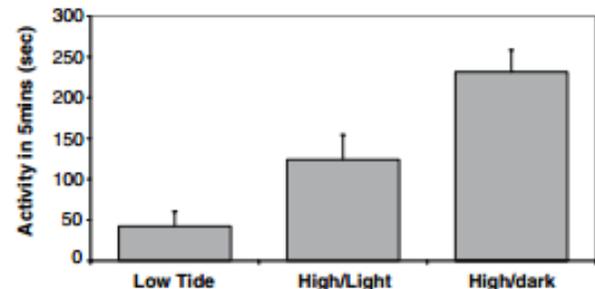
Juveniles are very light brown in color and do not have hairy claws if their rounded carapace is less than three-fourths of an inch. Bigger carapaced male crabs will show the beginnings of their hairy claws. Like the adults the legs are also twice as long as the carapace width (Department of Fish & Game California State 1998).

## Life-History and Basic Ecology

### Life Cycle

Chinese Mitten Crabs are catadromous meaning they live in freshwater and migrate to salt water for spawning. Majority of their life is spent in rivers until they migrate towards the ocean in estuaries in the mating season around late fall and winter. After reproduction both sexes die. The hatching larvae in estuaries are planktonic for a month or two (Department of Fish & Game California State 1998). The planktonic stage consists of five stage zoeal stages and one megalopa stage before the development of the juvenile chitin shell (Kim & Hwang 1995). There is a possibility that at this life stage larva can survive and swim up rivers given the right temperature (Anger 1991). Currently there are limited studies on larvae growth. The juveniles grow up in brackish water until late spring, March-July, when they start to

migrate towards fresh water rivers (Herborg *et al.* 2003) Studies have shown that juveniles have a tidal and diurnal endogenous rhythm to their migrational movements (Gilbey *et al.* 2007). Higher levels of movement occur during high tide intervals especially during night hours when predation by other animals is less likely. Low tide at night shows less activity, while low tide during daylight hours yields the lowest reported activity. It is hypothesized that juvenile mitten crabs ride the incoming flow of water upstream towards fresh water away from the estuary which allows them to cover great distances. When the tide ebbs away they seek refuge under boulders and such waiting for the next influx of water for transport (Gilbey *et al.* 2007). Depending on water temperatures juvenile Chinese Mitten crabs can range from one to five years to mature into adults. It has been reported that older juveniles are found higher up stream than the younger ones (Gilbey *et al.* 2007). The oldest crabs begin to enter channels from shallow areas in late summer to early fall, July-September, for their downstream migration (Herborg *et al.* 2003). Downstream migration rates have been recorded up to 400km/year (Panning 1939). By late fall and winter they reach salt waters to complete their life cycle (Department of Fish & Game California State 1998).



(Figure 5. A bar graph of juvenile activity in laboratory simulations of tide changes. Photo credit: Gilbey *et al.* 2007)

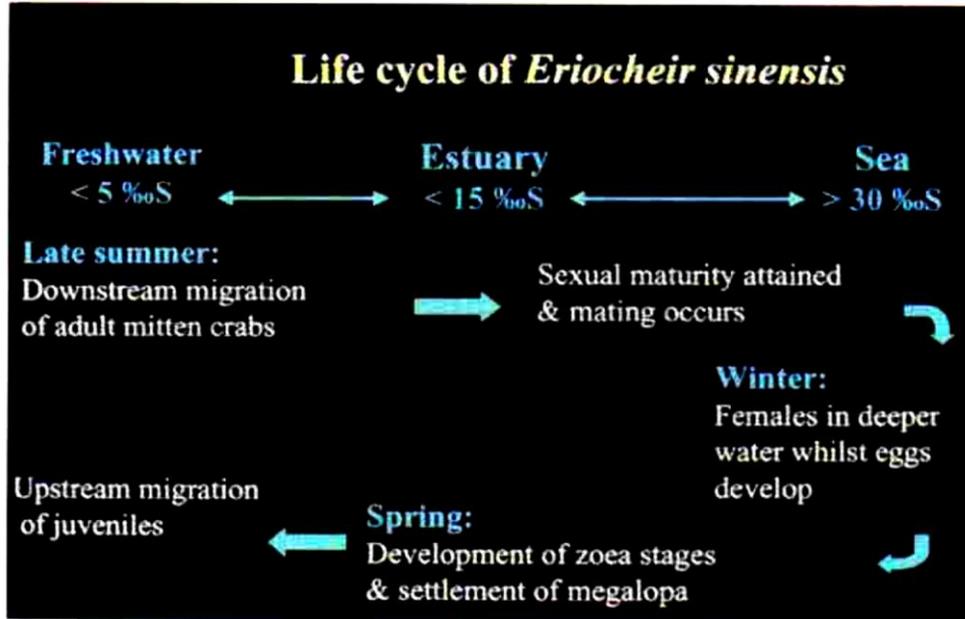
Duration and habitat of the life history stages of the mitten crab *Eriocheir sinensis*.

Stage	Duration	Habitat
Adult (non-reproductive stage)	2–4 years	Lakes, levees, rivers, streams
Adult (reproductive stage)	4–10 months	Brackish open waters
Zoea Larva (5 stages)	2–8 weeks	Estuarine/marine
Megalopa Larva (one stage)	3–6 weeks	Estuarine/marine
Early Juvenile	6–12 months	Brackish waters
Late Juvenile	12–24 months	Lakes, levees, rivers, streams

(Table 1. “Duration and habitat of the life history stages of the mitten crab *Eriocheir sinensis*. Credit: Dittel & Epifanio 2009)

### Feeding Habits

The diets of Chinese Mitten crabs mostly comprise of vegetation and detritus with a preference of macroinvertebrates over algae, detritus and shrimp (Rogers 2000). When macroinvertebrate abundance was low, a mitten crab’s stomach contents revealed that it comprised of 59.6% detritus, 10.7% of vascular plants and 10.4% of copepods and chironomid larvae (Czerniejewski *et al.* 2010). Fishermen have reported that invading mitten crabs have preyed upon their catch if crabs were caught alongside target fish by nets or other fishing gear (Panning 1939).



(Figure 6. The life cycle of the Chinese mitten crab starting at the juvenile stage downstream in rivers to estuaries and then the migration of recruits upstream. Photo credit: Robbins *et al.* 2003)

### *Reproductive strategies*

A single female has the capacity to carry a quarter of a million to a million eggs that hatch in estuary waters where larvae have plentiful available food to grow until the juvenile stage (Panning 1939). The male infraorder of this type of crab have been observed to deposit packets of sperm into the female seminal receptacles providing the ability to fertilize more batch of eggs (Epifanio 2007). Within 24 hours of mating, eggs are released and brooded for up to two months before hatching (Panning 1939, Lee & Yamazaki 1990 and Rudnick *et al.* 2005).

### *Environmental optima and tolerances*

They are a model species of osmoregulation due to their catadromous life-style (Péqueux 1995). Suitable habitats can range from freshwater of lakes, rivers and wetlands to brackish waters in estuaries. (Fisheries and Oceans Canada). Zoeal larvae have been found to with stand a wide range of saline concentrations, eurhaline. As the larvae develop into megalopa they tend to favor waters with salinities of 5-25‰ in brackish water (Rudnick 2000). Reproduction takes place generally in waters of >20‰ salinities. (Department of Fish & Game California State). Even though they were seen to have tolerate a wide range of temperatures but studies have shown that they may proliferate better in temperature colder than where they are usually found as cold as 7°C (Jakubowska 2011). In summer months, juveniles prefer 20-31 degrees Celsius (Rudnick 2000). In some cases where there is lack of vegetation crabs can be found under boulders (Gilbey *et al.* 2007). With that they can survive in polluted environments further expanding their range of potential habitats as long as they have access to higher salinity waters (Fisheries and Oceans Canada Rudnick *et al.* 2000).

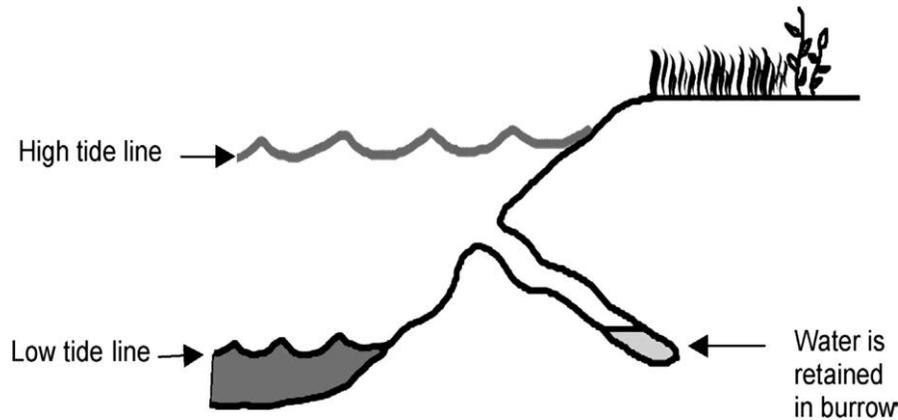
Juveniles seek out slow-moving water near bodies of water than swift moving rivers

(Rudnick 2000). They like to burrow themselves in between the water table of low and high tides in river banks and levees (Rudnick *et al.* 2005). Burrows can have more than one surface openings, multiple tunnels and terminal chambers (Rudnick *et al.* 2005). Mitten crabs try to avoid coarse material that may collapse and stick to fine-sediment or clay that are more stable to dig and live in (Rudnick *et al.* 2005). One cannot rule out coarse gravel as a potential host of mitten crabs since California has reported some populations in the hard substrate (Phillips & Kneeshaw 2002). At least some new burrows will be added by new juveniles each year as it takes a couple of years for a crab to reach maturity. The old burrows can be reused and added on to for multiple crab use with each crab maintaining its own chamber (Rudnick *et al.* 2005). The nature of each burrow depends on the complexity, population abundance and sediment composition for stability (Rudnick *et al.* 2005).

They are accomplished land walkers and have been spotted to bypass dams and other obstructions to continue on in their migration routes. Adventurist mitten crabs have even been sighted as far as 750 km inland (Department of Fish & Game California State 1998). How long a mitten crab can survive out of water is unknown or not reported.

### **Current geographic location**

The Chinese mitten crabs are native to coastal rivers and estuaries of the Yellow Sea in China where they are also farm raised and harvested for seasonal cultural delicacies (Robbins *et al.* 2003).



(Figure 7. An outline of burrows in substrates along the river beds relative to the highs and lows of the water table. The architectural design of the burrow allows the juveniles to have their own small body of water to live in that will prevent dehydration during low tide. Photo credit: Rudnick *et al.* 2005)



(Figure 8. A cast of a burrow showing how complex Chinese mitten crab burrows can be from one surface opening compared to a simple single burrow. Multiple crabs can live in complex burrows such as this. The study suggests that burrows on the gravel are restricted to fine-sediment top layer and avoided coarser sediment layers below. Photo credit: Rudnick *et al.* 2005)

#### *Biotic associations (pathogens, parasites, and bacteria)*

The ingestion of raw or undercooked Chinese Mitten crabs can pass on the oriental lung fluke, *Paragonimus wesrermani*, a parasitic flatworm that can infest humans (Robbins *et al.* 2003). The transfer of this parasite can only happen if crabs came from Eastern Asia since the primary intermediate freshwater snail host of the flatworm does not currently reside in California estuary waters or anywhere else in the United States. (Clark *et al.* 1998, Department of Fish & Game California State 1998).

Their hairy claws can serve as hubs for many kinds of bacteria and other microbials. Mitten crabs have been found to be infected with fungi, protozoans or oligochaets (Sobecka *et al.* 2011). Pesticides and heavy metals are well below detection level and FDA guidelines (Veldhuizen 2001). Little is known about what is actually housed in the hairy claws but recent discoveries have found a reovirus belonging to a possible new genus (Zhang & Banami 2012, Zhang *et al.* 2004).



(Figure 9. Map comparison of the recorded captures through the NAS database in the United States: 1965 (top) and 2014 (bottom). In a 50 year time span the Chinese mitten crab have spread to both coasts of the United States predominantly in New York, Maryland and in California. Photo credit: USGS)

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### *Distribution in the PNW and the United States*

It is the first freshwater crab species to exist in North America (Fisheries and Oceans Canada). By 1997, Cohen and Carlton have

gathered reports of sightings from both the Mississippi Delta and San Francisco Bay. Later years, observations of crabs have been accounted for in both the Atlantic and Pacific coasts (Rudnick *et al.* 2000, 2005). It was previously thought that the California population was directly from Asia, however, mt-DNA sequences have provided evidence that the population was founded by a European source instead (Hänfling *et al.* 2002).

## History of Invasiveness

In 1992, the Chinese Mitten crabs were first discovered in South San Francisco Bay, CA in the trawls of commercial shrimp trawlers. Since then they have rapidly spread all throughout the estuaries and up rivers (Department of Fish & Game California State 1998). No record of invasion in Washington State but a single straggler was caught in the Columbia River at the Port of Ilwaco in 1997 (Department of Fish & Wildlife Washington State). Isolated incidents such as this could be suspected of aquarium pet trade or escape from ethnic fish markets.

## Invasion Process

### *Pathways, vectors and routes of introduction*

The main vector of transporting marine species from one part of the world to another is through ballast water and hull fouling of international trade (Carlton 1985, Hopkins 2001). As a result of commonly found on a dinner plate in Asia it is a suspected possibility that these crabs can be imported live through smuggling on ship cargo or air packaging which would develop the risk of escapement towards establishment (Robbins *et al.* 2003). Some evidence supports those local citizens who wanted to a cheap source of a readily available food item in San Francisco Bay estuary (Weigle *et al.* 2005).

Aquarium pet trade is always welcomed by new strange creatures. Very few people who live in areas where mitten crabs have not already established might perceive these crabs as new creatures. Given that they are tolerant of a variety of salinities and temperatures as well as portable sized they may be a reasonable candidate for a fish tank. Although evidence may suggest that the mitten crab could be a new fad to the aquarium hobbyists the prohibition of live procession and concern of potential impacts will make the possibility unlikely but not impossible.



(Figure 10. A photo of a Chinese mitten crab in its planktonic zoea larval stage that can be found in ballast water of ships Photo credit: Robbins *et al.* 2003).

### *Factors influencing establishment and spread*

One ship of ballast water alone may not be enough to harbor an establishing population even though they are capable of surviving trips in their larvae stage if there is enough food (Rudnick 2000). Tons of ships travel every day to ports that serve as a hub of tons of other incoming ships. The number of ships docking and releasing their ballast water multiplies the chances of transporting sufficient amount of larvae to novel regions (Carlton 1985, Hopkins 2001). Escapement of predators in the native region allows the mitten crabs to reallocate their energy from defense purposes to reproductive means. The natural influx of rivers during high tide aid in transporting juvenile mitten crabs up stream far inland than what they would have on their own (Gilbey *et al.* 2007). Migrating mitten crabs have endurance on land and have the ability to find ways around obstacles in their way making them difficult to contain (Herborg *et al.* 2003).

### *Potential ecological and/or economic impacts*

They remove a substantial amount of sediment to make their homes by burrowing into river banks and levees which causes erosion of banks and damages to levees and other structures along the river (Rudnick 2000). In

Europe, crabs have been reported to burrow as deep as twenty inches with 2.7 crabs per foot squared. They effect commercial fishing catches by dominating the catch to bycatch ratio (Department of Fish & Game California State 1998). Gear selectivity is interfered by the presence of these crabs decreasing gear efficiency (Czerniejewski & Filipiak 2001). Tangled crabs have damaged many fishing nets (Veldhuizen & Hieb 1998).

In PG&E's Pittsburg Power Plant, mitten crabs have clogged pipes of cooling sytems (Veldhuizen & Hieb 1998). In states dependent of hydroelectric power, like the state of Washington, an invasion can greatly affect and damage dams and canals costing millions of dollars (Veldhuizen & Hieb 1998).

In Asia, juvenile crabs eat young rice shoots and burrow into rice levees damaging agricultural rice crops. In California, they have become a nuisance to fishermen removing them (~200) from nets and finding that their shrimp have been preyed upon rendering the target shrimp unsuitable for market. California has also suffered the loss of crayfish abundance valuable to the commercial fishery (Department of Fish & Game California State). In the state of Washington, mitten crabs can prey on salmon eggs and of trout and sturgeon threatening populations (Puget Sound Partnership).

Even though juveniles primarily eat vegetation they can still reduce population numbers of invertebrates by predation while their burrowing activities can change the deposition of sediment of estuaries additionally affecting wildlife communities that depend on these crucial sites for protecting and rearing recruits (Statzner *et al.* 2000). The decline of vegetation would also cause a negative relationship with benthic macroinvertebrates that serve as a food source for many of the native biota (Czerniejewski 2010).

## Management Strategies and Control Method

It is illegal of live possession, importation and transportation in the United States by legislation since 1987 (Robbins *et al.* 2003). Education and outreach are strategies used for the public by governmental departments and various awareness groups because spread of nonnatives are mostly human mediated (Department of Fish & Wildlife Washington State) Awareness efforts can be seen on other conservational based websites such as IUCN who have listed Chinese mitten crab on the top 100 list of the "World's worst invasive species".

Attempts have been made to set traps along the migration routes during juvenile migration upstream to prevent spread (Department of Fish & Game California State 1998). International cooperation may be needed to prevent invasion of new regions via ship's ballast water (Carlton 1985). Since ship's can uptake planktonic larvae in ballast water attempts of control involved open ocean water exchange or freshwater flushing though filtration of ballast water may be more effective (Hülsman & Galil 2001). However, any type of water exchange before the final destination of ships may not be economically favorable since trade rates will slow down.

## Other key sources of information and bibliographies

[www.nonnativespecies.org](http://www.nonnativespecies.org)

[www.dfg.ca.gov/delta/mittencrab](http://www.dfg.ca.gov/delta/mittencrab)

[www.nas.er.usgs.gov](http://www.nas.er.usgs.gov)

[www.anstaskforce.gov/spoc/mitten\\_crab.php](http://www.anstaskforce.gov/spoc/mitten_crab.php)

[online.sfsu.edu/bholzman/courses/Fall02%20projects/mitten.html](http://online.sfsu.edu/bholzman/courses/Fall02%20projects/mitten.html)

[www.psparchives.com/our\\_work/protect\\_habitat/ans/mittencrab.html](http://www.psparchives.com/our_work/protect_habitat/ans/mittencrab.html)

[wsg.washington.edu/mas/ecohealth/invasive\\_crabs/mitten\\_crab.html](http://wsg.washington.edu/mas/ecohealth/invasive_crabs/mitten_crab.html)

## Expert Contact information in PNW

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## Current Research and management efforts

The Puget Sound Partnership is calling for an early detection and rapid response program for the state of Washington. In 2000, the Washington's State's Aquatic Nuisance Species Committee developed a draft for early detection and rapid response. By 2007, the committee refined the plan and is currently waiting for agreements with responsible agencies (Puget Sound Partnership).

If a Chinese mitten crab has been found in the state of Washington, please call:

*Scott Smith*

Washington Department of Fish & Wildlife

Phone: 360.902.2724

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