Chinese Mystery Snail (*Bellamya chinensis*) Review *

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*** Note that the images and figures in this report were not available during formatting due to Mac/PC compatibility issues, so in text references to figures and maps are missing**

Diagnostic information

Scientific name

(Order/Family/Genus/Species)
Order: Architaennioglossa
Family: Viviparidae (Gray, 1847)
Genus: Bellamya (Jousseaume, 1886)
Genus: Cipangopaludina (Hannibal, 1912)
Species: chinensis
Sub-species: chinensis chinensis
Sub-species: chinensis malleata

Common name(s)

Chinese mystery snail (CMS) , Chinese vivipara, tanisha, rice snail, Chinese apple snail, Asian apple snail (http://nis.gsmfc.org/nis_factsheet.php?toc_id=125)

Basic identification key

Clench and Fuller (1965) describe this species as follows: Chinese mystery snails have a shell which is smooth, globose [rounded] in outline, and thin in structure, but strong. Color is uniform, light to dark olive-green, without any color bands. The small, round umbilicus [Fig. 3: I] is covered in part by the reflected, slightly thickened parietal lip. The outer lip is only slightly reflected and forms a round-to-oval aperture. Black pigmentation rims the entire lip and somewhat within the aperture. The columnella [Fig. 3: G] is narrow and arched. Whorls [Fig. 3: E] are strongly convex, with a very slight shoulder, and the suture [Fig. 3: D] is deeply indented. Shell sculpture consists of fine growth lines, spiral lines and fine to moderate malleations over the entire surface. In some individuals, older lip reflections will appear as fairly strong axial ridges. In others there may be one or more spiral threads forming slight carinae (prominent, sharp-edged ridges). The operculum is corneous, thin, with concentric growth lines, and a submarginal (located nearer the outer lip) nucleus [Fig 2].

Life-history and basic ecology

Feeding habits

Bellamya is a filter feeder and detritivore, but also browses on microalgae. In aquaria, and presumably in nature as well, *Bellamya* eats carrion when available. It does not feed on macrophytes, making it popular with aquarists and water gardeners (Fox 2005).
Individual CMS size is related to food quality. A sample of snails from three habitats showed that larger and heavier snails lived in areas with higher concentrations of algae and diatoms in the sediment (Jokinen 1982; Calow, 1975).

Life Cycle and Reproductive strategies

CMS are viviparous and gonochoric; Male and female CMS sexually reproduce and females give birth to live offspring. Females are believed to be able to produce at least 169 embryos over a lifetime (Jokinen 1982; Stanczkowska 1971), but individuals have been observed carrying 102 embryos at once (Jokinen

1982; Crabb 1929). This would suggest that, because females live for 5 years, 4 of which a reproductive, female CMS may be capable of producing 408 embryos over a lifetime. This number may be high because older females are more fecund (Jokinen 1982). Once embryos reach a juvenile state they are released from the uterus. This release occurs between June and October. At the end of this reproductive cycle, CMS migrate to deeper waters for the winter (Jokinen 1982).

Environmental optima and tolerances

-Habitat: CMS can be found in larger lakes or ponds with sandy to muddy substrates (Jokinen 1982). CMS also inhabit slow moving streams (Abbot 1950; Jokinen 1982; Schmeck 1942; Stanczykowksa et al. 1971), rice paddies, irrigation canals, and roadside ditches (Pace, 1973). The one theme common to all of these available habitats is the required presence of rooted aquatic vegetation (Cordiero).

-Non-terrestrial; CMS do not have a lung and cannot survive outside of freshwater (Fox 2005).

-Calcium requirements: possibly above 5ppm (Jokinen 1982).

-Thermal tolerances: unknown

-pH: CMS are not found in acidic waters (Cordiero).

Biotic associations (pathogens, parasites, and commensals)

Parasites: First described as a new species by Ando and Ozaki (1923), *Echinostoma cinetorchis*, a human intestinal fluke found in Japan, Korea and several other asian countries (Miki 1923; Hirasawa 1926), was not heavily studied until after 1980, when a human case of infection was reported. Since that case was reported, six other people had been infected by the intestinal fluke prior to 1999. Chung and Jung 1999 were first to determine the extent of natural infection of *E. cinetorchis* from viviparid snails and their study was the first to report that CMS do serve as the second intermediate host of *E. cinetorchis* and is a potential source of human infection in Korea (Chung and Jung 1999). Humans may become infected after ingesting host snails.

CMS is also a vector for other parasites and diseases including: *Angiostronbylus contonensis*, *Aspidogaster conchicola*, *Echinocasmus elongates*, *E. redioduplicatus*, *E. rugosus*, *Echinostoma macrorchis*, *E. metacercariae*, *Eupariphium ilocanum*, and *E. recurvatum* (Cordiero)

CMS also play host to parasites for unionid bivalves. This parasite, *Aspidogaster conchicola* (Bury et al. 2007; Huehner and Elges 1977), has been known to reduce reproductive output and the physiological condition of the mussel *Pyganodon grandis* in SE Alabama USA (Gangloff et al. 2008).

Current geographic distribution: Unknown

Point occurrences or distribution in the PNW

(map)

Thanks to anecdotal reports, researchers in the Pacific Northwest believe that *Cipangopaludina chinensis malleata (aka Viviparus malleatus)*, or the Chinese mystery snail, is more common than previously reported. The Center for Lakes and Reservoirs is launching a new project to map the distribution of this snail in Oregon and Washington. http://www.clr.pdx.edu/report.php

United States distribution (map)

I use the sub-species, *B. chinensis malleata*, distribution provided by USGS rather than the *B. chinensis* distribution because their *B. chinensis* distribution portrays a deceivingly small range. The usage of this sub-species distribution is acceptable only because subspecific status is normally maintained through geographic, not genetic, separation, and [because] several populations of interbreeding *B. chinensis* have been introduced into North America, the features that define any particular sub-species have most likely been obliterated (Smith 2000).

History of invasiveness

(In the United States)**:** Map from James (Jay) R. Cordiero's, 'Range Expansion of the Chinese and Japanese Mystery Snails of the Genus *Cipangopaludina* (Gastropoda: Viviparidae) Across North America.'

Invasion process

Pathways, vectors and routes of introduction

CMS are native to Burma, Thailand, South Vietnam, China, Korea, and Asiatic Russia in the Amur region, Japan, the Philippines, and Java (Pace, 1973).

CMS were initially imported to the United States alive from Japan to the Chinese markets of San Francisco in 1891 for food purposes (Abbot 1950). Three years later, it was reported that CMS were also being sold in a Chinese market in Victoria, British Columbia (Jokinen 1982). It is believed that the snail was imported into the United States by Chinese immigrants and then intentionally released to create a local food source. Additionally, snails are often released from aquariums into the wild (Cordiero 2005). After these intentional introductions, subsequent spread, once established in lakes, may occur in part because upstream lake populations serve as sources for downstream colonization (Bury et al. 2007). Subsequent spread may also be facilitated by boater interactions between invaded and non-invaded lakes via bait-buckets, live wells, fishing gear, and the boat itself.

On the East coast, CMS was initially discovered in Massachusetts in September of 1917 (Abbot 1950). It is hypothesized that this introduction may be attributed to biocontamination; CMS were introduced indirectly when goldfish were added to a stream for mosquito larvae control (Jokinen 1982; Johnson 1915).

Factors influencing establishment and spread

Size: CMS can grow to 65mm while snails native to the U.S. may only grow to 40mm. This size advantage may decrease predator vulnerability of CMS compared to native species (Johnson et al. 2008).

Feeding behavior: Freshwater snails are microphagous feeders (grazers) whose diet includes a variety of food items in the periphyton such as detritus and algae on submerged surfaces and decaying plant tissue. This food resource is shared with indigenous grazers such as other snails and some insects and when invasive snails reach high densities, they must surely reduce the food available to the indigenous grazing invertebrates (Appleton 2003). This direct competition for food items in the periphyton would give a competitive advantage to CMS because CMS is also capable of utilizing suspended food particles; In instances of low peryphiton abundance, CMS would have a competitive advantage over local, non-filter-feeding native snails thus facilitating further reproductive success and population spread by the non-native CMS.

Fecundity: The fact that a single gravid female is capable of founding a population helps explain their rapid dispersal (Fox 2005); Upon introduction, one fertilized female, capable of carrying up to 102 embryos, may release 102 juvenile CMS to a novel habitat thus creating a new population of invaders. If these new populations reach high enough densities, they may be able to out-compete native snails. For example Pointier (1999) details the effects of invasion by T. graniferain Puerto Rico, Cuba and Venezuela. In each case it reached high population densities and was associated with the disappearance of the indigenous species Biomphalaria glabrata (Planorbidae) in affected habitats in Puerto Rico and Venezuela and Pachychilus violaceus (Pleuroceridae) in Cuba (Appleton 2003).

Operculum: The trapdoor, or operculum, of *B. chinensis* are appreciated by aquarium hobbyists because when CMS close their trapdoor, it is a sign to the hobbyists that the CMS are protecting themselves from poor water quality. This physical attribute has increased the popularity of CMS amongst aquarium enthusiasts and therefore has increased the likelihood of introduction via aquarium release.

This trait, while it is enjoyed by aquarium hobbyists, it is not enjoyed by those that would try to eradicate CMS from their non-native range via biocides. Once a snail becomes an adult, it develops a hard shell, which it can close up tight with its trapdoor operculum, making it fairly impervious to biocides (Anon. 2003).

Potential ecological and/or economic impacts

Ecological impact: Although these species have received modest attention as non-native faunal elements in parts of North America, they generally have not been viewed as problem invasive species (Bury et al. 2007; Mackie 2000). According to Bury et al. 2007, this view may be flawed because CMS have shown the ability to reach high population densities and the risks associated with such high densities are largely unknown, although a couple of example do exist. For example, it has been shown that *V. georgianus*, a closely related species to CMS, can cause significant mortality of largemouth bass embryos when they invade nests (Bury et al. 2007; Eckblad & Shealy 1972). Another study, published after Bury et al 2007, showed that, in mesocosm experiments, CMS can alter the ecology of an ecosystem system by reducing periphyton biomass and by increasing the N:P ratio in the water column (Johnson et al. 2008).

Economic impact: As this snail species continues to increase in abundance and density across the landscape of the United States, management agencies will be forced to assess the economic costs of either dealing with, or ignoring this invasive species. One example of potential economic impact may come by way of the sport fisheries. CMS may exert a bottom-up control of some food webs, similar to the way *V. georgianus* did with largemouth bass, which may in turn reduce the amount of apex predators anglers love to fish for. This reduction in apex predators could eventually cost a state in lost revenue from reduced angler expenditures, or it could cost the state unknown sums of money to control the invasive CMS populations to a point at which fishing could still take place. Either scenerio would cost the state money.

The snails may need to be controlled for parasitism. Currently, no CMS within the united states have lead to infections…

Management strategies and control methods

In the state of Washington, the Dept of fish and wildlife recognize that CMS has invaded the state, most recently by introductions from aquarium fish, but they do not propose any direct action to cull the spread of CMS (Meacham and Pleus 2007).

It is interesting that, in spite of the admitted awareness of CMS invasion, management agencies in the Pacific Northwest do not view CMS as a huge threat; CMS is not listed as an aquatic nuisance species in Washington and it is not on Oregon’s 100 most dangerous invaders list. This lack of perceived threat by the management agencies of the PNW can most likely be attributed to the lack of knowledge about, or the lack of evidence for economic and ecological impacts associated with CMS invasion. Detailed studies identifying the types, gravity, and likelihood of impacts associated with CMS will need to be presented to managers before they will be willing to exert some form of control over the currently spreading populations of Invasive CMS.

Between the years of 2001 and 2007 little was done to stop the spread of aquarium released invasive species. The “Washington State Aquatic Nuisance Species Management Plan (Meacham 2001)” recognized the problem that accidental introductions occur through actions of the general public. It was recognized that this mode of introduction occurs via naive releases of nonnative aquarium plants and animals into natural waters and that the current state of public awareness of ANS issues is inadequate to address the problem. The actions proposed in this management plan were to:

Compile, develop, and coordinate the dissemination of educational materials on ANS that will increase general public awareness of the ANS problem.

Develop partnerships with media outlets and established publications to reach a broad range of the public with ANS messages through channels to which the public are already attuned. The constantly changing nature of new introductions and the spread of ANS make the media an excellent outlet to disseminate ANS information.

And finally, to increase the awareness of ANS issues and solutions for their control in the K-12 public schools system via school curricula and teacher training.

By 2007 the, "WDFW & WSP Aquatic Invasive Species Prevention and Enforcement Report" came out to report that:

- There has been a surge of public acquisition of exotic pets through store and internet sales.
- Enforcement is difficult and education outreach low.
- The national Habitattitude campaign is reaching more people as it continues to develop (Pleus et al. 2007).

The national Habitattitude campaign is a combined effort of multiple agencies, PIJAC (Pet Industry Joint Advisory Council), USFWS, and NOAA Sea Grant, to increase public awareness, particularly awareness amongst aquarium hobbyists, backyard pond owners, water gardeners and others who are concerned about aquatic resource conservation, about the associated threat of aquatic invasive species and the aquaria industry. This campaign employs multiple media types to gain public interest and is unique from previous management efforts because it has the support of PIJAC.

The website for Habitattitude may be viewed at http://www.habitattitude.net/.

Other management techniques

Fox 2005 reported that true mystery snails, *bellamya spp*, can no longer be purchased due to legislation. I was unable to find documentation for this claim.

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http://www.habitattitude.net/

Expert contact information in PNW

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Current research and management efforts

See Johnson's Pond Snail Round-Up at http://www.mass.gov/dcr/waterSupply/lakepond/hottopic/snailRoundup.pdf (as seen in 'PNW distribution' section) Thanks to anecdotal reports, researchers in the Pacific Northwest believe that *Cipangopaludina chinensis malleata (aka Viviparus malleatus)*, or the Chinese mystery snail, is more common than previously reported. The Center for Lakes and Reservoirs is launching a new project to map the distribution of this snail in Oregon and Washington. (http://www.clr.pdx.edu/report.php