Golden Mussel - *Limnoperna fortunei*

The golden mussel, a macrofouling bivalve, was introduced into Argentina from Asia in 1991 and within a decade spread to four other South American countries. The invasion of the zebra mussel (a morphologically similar bivalve) into North American waters demonstrated the vulnerability of industrial water conduits to macrofouling species. Although these two species share some of the physical characteristics, the golden mussel exhibits a wider tolerance of ecological parameters than the zebra mussel. Therefore, if introduced into North American waters, the golden mussel is expected to invade a broader range of habitats.

Taxonomy

Phylum	▪ Mollusca
Class	▪ Bivalvia (Pelecypoda)
Order	▪ Mytiloida
Family	▪ Mytilidae

General Biology

Juvenile Morphology

- Mean shell length 2-8 mm
- Use byssal threads to attach to substrates

Adult Morphology

- Mussels are considered adults when they become sexually mature at about 1 year of age
- Shell appears golden or yellowish in color
- Shell length of 20 mm is common; maximum shell length of about 40 mm and 60 mm, respectively, in some South American and Asian populations
- Umbones very nearly terminal, dorsal ligament margin is nearly straight
- Does not posses hinge teeth or byssal notch
- Mantle fusion occurs dorsally
- Females typically comprise two-thirds of population

Behavior

- Ecological tolerances and parameters vary widely by geographical location; populations are capable of adapting to suit various habitats
- Attach byssally to available substrates, forming dense aggregations (often establishing colonies with densities >80,000/m^2)

Identification

Distinguishing Characteristics

- The shell of *L. fortunei* often has a distinctive golden coloration
- North American biofouling mussel species which are similar in shape and size to the golden mussel (Fig. 1) are:
    - *Mytilopsis leucophaeata* (typically inhabits brackish water habits) (Fig. 2)
    - *Dreissena polymorpha* (typically inhabits fresh water habits) (Fig. 2)
    - *Dreissena bugensis* (typically inhabits fresh water habits) (Fig. 2)
- The presence of a nacreous layer within the shell of *L. fortunei* (Fig. 1) distinguishes it from all bivalves in the superfamily Dreissenacea, including species in the genera *Dreissena* and *Mytilopsis* (see Morton 1973)

Fig. 1 *Limnoperna fortunei* typically have yellowish or golden shells (A), but some populations can be dark (B), but they typically have a nacreous layer on the interior of the shell (C).[1]

[1] http://www.way.com.ar/~invasion/English/Mejillon.htm

Mytilopsis leucophaeata
false dark mussel

- Typically solid coloration, not striped
- Adult shell length of 1-2 cm common
- Has projection on the lateral margin of its myophore plate
- Dorsally tapered shell valves
- Umbone located anteriorly
- Bottom of organism convex and lacking an acute angle

Dreissena polymorpha
zebra mussel

- Tan, brown, and black striped shell pattern
- Adult shell length of 1-2 cm common
- Lacks projection on the lateral margin of its myophore plate
- Dorsally tapered shell valves
- Umbone located anteriorly
- Bottom of shell flat or concave
- Acutely angled ventral shell margin

Dreissena bugensis
quagga mussel

- Tan, brown, and black striped shell pattern
- Adult shell length of 1-2 cm common
- Lacks projection on the lateral margin of its myophore plate
- Umbone located anteriorly
- Bottom of shell convex, not flat
- Ventral shell margin lacking an acute angle

Fig. 2 Characteristics of three similar epifaunal bivalves already located in North American waters.[2]

Life Cycle

Geographical variations exist for reproduction, growth, and longevity. The following information pertains mainly to populations existing in South America.

Veligers
- External fertilization produces clam-shaped free-swimming veligers (Fig. 3)
- Larval stage duration of 30-70 days

Juveniles
- Typically remain immature for 1 year and grow to about 8 mm in length

Maturity
- Sexual maturity reached by 1 yr. (Fig. 4)
- Gonads of both sexes begin developing in May, maturing in June, and degenerating in October
- Life cycle of South American populations rarely exceeds 2-3 years; 5 and 10 years maximum, respectively, in Korea and China.

Spawning
- Occurs at temperatures between 16-28°C (June-September)
- Spawning occurs 1-2 times per year
- Dioecious, gametes are discharged into the water where external fertilization occurs
- Temperature appears to be a major factor in initiating gamete release

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[2] Jerrine Nichols and Glen Black (U.S. Geological Survey)

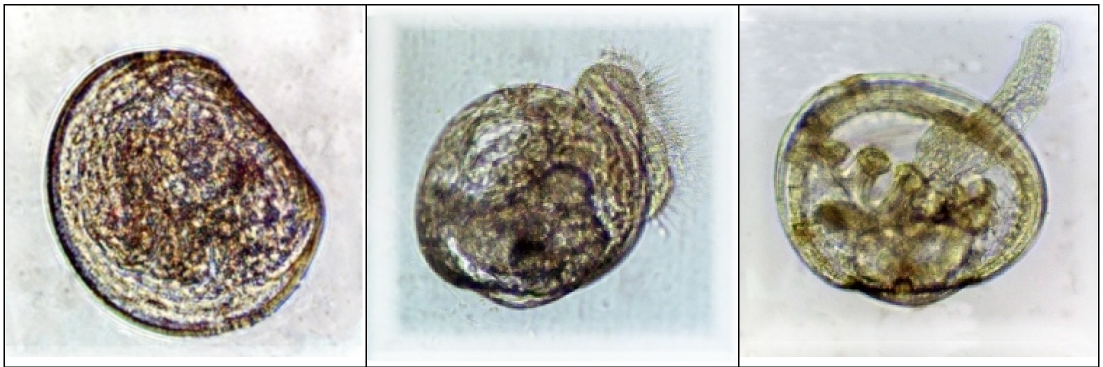

Fig. 3 Veliger stages of *L. fortunei*.[3]

Fig. 4 Adult *Limnoperna fortunei*.[4]

Habitat Characteristics

Preferred Environment
- Freshwater lakes and rivers and estuaries
- Attaches byssally to hard substrates

Temperature
- Between 8-32°C in Asia, confirmed occurrences up to 35°C
- Based upon its thermal tolerances, the golden mussel appears to be capable of colonizing waters from South America to the lower North American Great Lakes Region

Oxygen
- Intolerant of extended anaerobic conditions
- Maximum growth and reproductive output occur at oxygen conditions above saturation
- Requires ≥1.0 mg/L (Table 1)

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[3] http://biolo.bg.fcen.uba.ar/primerapagina.htm
[4] http://biolo.bg.fcen.uba.ar/primerapagina.htm

Salinity

- Euryhaline freshwater species (primarily a freshwater species, capable of tolerating brackish waters and maintaining substantial populations in estuarine habitats) (Table 1)

Water Quality

- Tolerant of polluted and contaminated water conditions
- Capable of inhabiting waters with relatively low calcium and pH levels (Table 1), heated waters, and organically-enriched waters subject to periodic hypoxia

	L. fortunei	***D. polymorpha***
Salinity	0-12‰	0-5‰
Calcium	≥3.0 mg/L	≥12.0 mg/L
pH	≥6.4	≥7.4
Temperature		
Larval Development	16-28°C	12-24°C
Adult Survival	8-35°C*	2-30°C
Oxygen	≥1.0 mg/L	≥1.8 mg/L

Table 1 Tolerance limits of *L. fortunei* compared to those of *D. polymorpha* (*based on confirmed occurrences).[5]

Distribution

Native Range

- China and southeastern Asia

Distribution in the Americas

- Established in South America (Fig. 5)
- Status of North American introduction: Predicted

Probable Means of Introduction

- In ship ballast, and as a contaminant of shipments of live Asian clams
- The most likely mode of introduction into North American waters is the release of larvae in discharged ballast water from:
    - Asian freighters visiting Pacific American ports
    - South American freighters visiting ports along the Gulf of Mexico

[5] Adapted from Ricciardi (1998).

Fig. 5 Continuous sampling of the Plata Basin has indicated that the golden mussel was introduced into Argentina, South America in 1991 and spread upriver at a rate of 240 km per year. The golden mussel is currently established in five South American countries.[6]

Diet

Adults

- Filter feed on planktonic algae (phytoplankton) and zooplankton

Impacts

Negative

- High filtration rates indicate that suspension feeding may:
    - Reduce phytoplankton standing stocks and biomass
    - Suppress zooplankton populations
    - Outcompete native species for available food
    - Increase sedimentation rates
    - Alter contaminant and nutrient cycling
- Has the potential to affect the diversity of native molluscan communities (e.g., can overgrow and possibly kill native mollusks; impacts may be similar to *Dreissena*)
- Adhere byssally to gauges and valves causing them to malfunction
- Dead mussels can accumulate on intake screens, strainers, trash racks, and cooling pipes and cause clogging

[6] http://www.way.com.ar/~invasion/English/HisDistr.htm

- Although strainers and screens may be able to filter out mussels of adequate size, larvae pass through, settle on interior surfaces, detach, and accumulate on intake screens, strainers, trash racks, and cooling pipes causing clogging
- Dead mussels have clogged small diameter pipes (e.g., water quality piping, sampling lines, cooling pipes) transmitting raw water which causes, in some situations, a complete shutdown of the plant
- Grit chambers and flocculators clog heavily with sediment of broken shell and tissue material
- Decaying shell and tissue material give off noxious odor
- Increased operational costs (complete shutdown of plant; clogging of mussels, shell material, and sediment may need to manually removed)

Positive

- Food source for fish, particularly individuals >30 cm total length

Management

Control Measures

- Desiccation (see Morton 1974)
- Predation by the fish, *Leporinus obtusidens*, may assist in decreasing the densities of golden mussel populations (see Penchaszadeh et al. 2000)
- Many chemicals, including chlorine (see Morton et al. 1976), are effective in controlling larvae of the golden mussel within facilities, but are not often used due to resulting complications with their use (e.g., interference with function of nitrification in pipelines, formation of trihalomethanes)
- Physical removal

Literature

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Web Sites

http://www.way.com/ar/~invasion/English/
Control and Prevention of Invasive Bivalves - *Limnoperna fortunei*, the "golden mussel"

http://www.sgnis.org/publicat/96iccia.htm
Sea Grant Nonindigenous Species

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