Perna viridis 正體中文 **System:** Marine

Kingdom	Phylum	Class	Order	Family
Animalia	Mollusca	Bivalvia	Mytiloida	Mytilidae

Common name Asian green mussel (English), green mussel (English)

Synonym
Chloromya viridis , Dodge, 1952
Mytilus (Chloromya) smaragdinus , Jukes-Browne, 1905
Mytilus opalus , Lamarck, 1819
Mytilus (Chloromya) viridis , Lamy, 1936
Mytilus smaragdinus , Chemnitz, 1785
Mytilus viridis , Linnaeus, 1758
Perna viridis , Ahmed, 1974

Similar species *Perna canaliculus, Perna perna, Mytilus spp.*

Summary Perna viridis is a bivalve mussel native to the Asia-Pacific region where it is widely distributed. It has been introduced elsewhere around the world through ship ballast, hull fouling and the experimental introduction for farming. Perna viridis can quickly form dense colonies in a range of environmental conditions. Impacts include; causing blockage in intake pipes of industrial plants, clogging crab traps and clam culture bags and impeding commercial harvest. Fouling creates a need for increased maintenance and if not carried out regularly can cause decreases in fuel efficiency. Perna viridis is also able to out-compete many other fouling species, causing changes in community structure and trophic relationships.

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Species Description
Perna viridis is a large mussel, 80-100mm in length, occasionally reaching 165mm (Rajagopal *et al.* 2005). The shell has a smooth exterior surface characterised by concentric growth lines and slightly concave ventral margin. The shell is covered with greenish (variable in older mussels) periostracum; periostracum is generally intact in young ones and with patches peeled off in older ones.The colour of the perostracum is bright green in juveniles, fading to brown with green edges as it matures. The inner shell surface is smooth and iridescent with a bluish green hue. The ridge which supports the ligament connecting the two shell valves is finely pitted. The beak has interlocking teeth: one in the right valve and two in the left. Wavy posterior end of the pallial line and the large kidney-shaped retractor muscle scar are characteristic features. Anterior adductor muscle absent in this species. The foot is generally laterally compressed with no operculum. The family Mytilidae, to which this species belongs, is characterized by narrow, elliptical, fan-shaped, thin valves which are of the same size; the absence of prominent hinge teeth; anterior adductor muscle reduced or absent; and often the presence of byssal threads for anchoring to hard substrates (DeVictor and Knott, UNDATED; NIMPIS, 2002).

Lifecycle Stages
Hayes *et al.* (2005) state that, \"The life cycle of *Perna viridis* follows this type of pattern: adults sexually reproduce by releasing gametes into the water column where fertilisation takes place. Fertilised eggs develop into free swimming larvae after 7 or 8 h. Larvae remain in the water column for 2-3 weeks after which they settle and attach onto hard substrate using a byssus (Yap *et al.* 2002). Spawning normally occurs once or twice a year, with a peak during monsoonal periods, and may entail multiple spawning with rapid recovery (weeks) over a prolonged period of time (Rajagopal *et al.* 1998a and Rajagopal *et al.* 1998b). During their planktonic period, larvae will be widely dispersed by physical processes, but may aggregate periodically at certain depths through a variety of biological processes, most notably diel vertical migration (Folt and Burns, 1999). Juveniles may be able to reach sexual maturity within 2-3 months, and may live as long as 3 years. Adult populations may reach densities of 35,000 individuals per square metre (Ingrao *et al.* 2001).\"

Uses
DeVictor and Knott (UNDATED) state that, \"*Perna viridis* is harvested commercially in the Indo-Pacific as a human food resource due to its dense and fast growth. It is not recommended for consumption when found in areas like Tampa Bay because of its potential to harbor toxins, parasites and other health risks.\"
The Gulf States Marine Fisheries Commission (2003) reports that, *P. viridis* has also been used as an indicator of biopollution of heavy metals, organochlorines, and petroleum hydrocarbons and that *P. viridis* is one of the best mussel species to test for biopollution.

Habitat Description
DeVictor and Knott (UNDATED) state that, \"*Perna viridis* generally inhabit intertidal, subtidal and estuarine environments with high salinity. *P. viridis* attaches to hard substrata but is capable of relocating. Dense colonies can develop in optimal temperature and salinity conditions, sometimes with thousands of individuals per square metre. *Perna* species appear to thrive in intake pipes of industrial plants, where they may interfere with operation.\"
NIMPIS (2002) reports that, \"*P. viridis* forms dense populations (up to 35,000 individuals per square metre) on a variety of structures including vessels, wharves, mariculture equipment, buoys and other hard substrata. It is susceptible to overgrowth from other fouling organisms that make it difficult to detect despite its vivid green appearance. Primarily found in estuarine habitats with salinities ranging from 18-38 ppt and temperatures from 11-32 deg C, *P. viridis* has a broad salinity and temperature tolerance.

Reproduction
NIMPIS (2002) reports that, \"Sexes in this species are separate and fertilization is external. Spawning generally occurs twice a year between early spring and late autumn, however in the Philippines and Thailand spawning occurs year round. Fertilized eggs develop into larvae and remain in the water column for two weeks before settling as juveniles. Sexual maturity typically occurs at 15-30mm shell length (corresponding to 2-3 months age). The life span of *P. viridis* is typically 2-3 years. Growth rates are influenced by environmental factors such as temperature, food availability and water movement (Rajagopal *et al.* 1998). First year growth rates vary between locations and range from 49.7mm/yr in Hong Kong to 120mm/yr in India\" Rajagopal *et al* 1991).

Nutrition
NIMPIS (2002) reports that, \"*P. viridis* is an efficient filter/suspension feeder, feeding on small zooplankton, phytoplankton and other suspended fine organic material.\"

General Impacts

DeVictor and Knott (UNDATED) state that, \"Because of its dispersed spawning nature, lack of local predators, fast growth, and high tolerance of environmental conditions, the mussel population is expected to expand in Atlantic habitats until it reaches its thermal limits. *P. viridis* clog water pipes (restricting flow) and accumulate on boat hulls, pilings, buoys and other man-made structures. In the same manner, the mussels may clog crab traps and clam culture bags, making the commercial harvest of these native species more difficult. There are conflicting views on the potential impact on local oyster species. Green mussels and oysters generally occupy different habitats, but it is likely that their populations may overlap.\"
NIMPIS (2002) reports that, \"*P. viridis* can have economic, ecological and human health impacts. Economically, it can cause problems with water systems of industrial complexes by clogging pipes, increasing corrosion and reducing efficiency. It is also a problem for vessels: fouling can raise costs for owners due to increased maintenance, decreased fuel efficiency and blocked or damaged internal pipes. Fouling on mariculture equipment alters maintenance routines, harvest times and may restrict water flow thus effecting product quality. Ecologically, *P. viridis* is able to outcompete many other fouling species, causing changes in community structure and trophic relationships. *P. viridis* has also been recorded with high levels of accumulated toxins and heavy metals and is linked to shellfish poisoning in humans.\"

Management Info
Preventative measures: A two year study undertaken for the Department of Environment and Heritage, Australia by CSIRO (Commonwealth Scientific and Industrial Research Organisation) Marine Research, was designed to identify and rank introduced marine species found within Australian waters (potential domestic target species) and those that are not found within Australian waters (potential international target species). Potential domestic target species, in this context are defined as ship-vectored, established, non-native (or cryptogenic) species that have demonstrated significant impact on human health, economic interests or environmental values in the Australian marine environment. Potential international target species are similarly defined as ship vectored, non-native (or cryptogenic) species that have demonstrated significant impacts outside of Australia. All of the non-native potential target species identified in the independent report published are ranked as high, medium and low priority, based on their invasion potential and impact potential.
The invasion potential of a species is expressed as the weighted sum of commercial ship movements, recreational vessel movements (international yachts) and ballast discharge from all 'infected' bioregions around the world to any Australian location. The environmental similarity between the donor and recipient ports, measured in terms of latitudinal difference, has a relatively marked effect on their invasion potential (as compared to the invasion potential of domestic target species). *P. viridis* has been categorised as one of ten most likely invaders, calculated using the most influential measure of environmental similarity.
The impact potential of a species is expressed in terms of their actual (or potential) human health, economic and environmental impacts. *P. viridis* has been categorised as one of ten potentially most damaging species.
The potential international target species are prioritised by their location in the invasion potential/impact potential space. *P. viridis* has been categorised as 'High priority'. (Hayes *et al.* 2005)
The Queensland Environmental Protection Agency (2002) offers a number of different preventative measures boat owners can take to prevent the spread of *P. viridis*. The authors state that, \"Effective antifouling protection not only protects your own boat from the potential damage from marine pests, but also reduces the chance of the pest being spread to other boats and other locations. A range of antifouling products is available and it is important to make sure you are using the right type of antifouling protection for your vessel. For example, an infrequently used boat will need a different product from a boat that travels at high speeds everyday. Regularly clean propellers and other underwater fittings that cannot be coated by antifouling paint. Regularly flush internal seawater systems with freshwater to kill newly settled pests. Remove all pests as you find them. Do not clean your boat on the beach or at the boat ramp where any pests you remove can get back into the water. To minimize the chance of spreading pests to other locations, ensure your boat is clean before traveling to other areas.\"
Chemical: Low levels of constant chlorination near the conduits and high water velocities effectively detach or kill green mussels. However, not all mussels are killed and significant numbers are left behind to reproduce and increase the density again. Continuous high-level chlorination of the intake tunnels effectively detaches and kills the green mussels (Rajagopal *et al.* 1991, 1996b).

Pathway
The introductions of the mussels *P. viridis* from the Indo-Pacific, into the Gulf of Mexico are attributed to fouling on boat hulls or ballast-water traffic (Chapman *et al.* 2003).

Principal source: DeVictor and Knott, Undated. The Asian Green Mussel: Recent Introduction to the South Atlantic Bight
NIMPIS, 2002 Asian Green Mussel: *Perna viridis*

Compiler: National Biological Information Infrastructure (NBII) & IUCN/SSC Invasive Species Specialist Group (ISSG)

Review: Dr. S. Rajagopal Institute for Water and Wetland Research Radboud University Nijmegen The Netherlands and Dr. V. P. Venugopalan, BARC Facilities, Kalpakkam, India.

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ALIEN RANGE

[1] ATLANTIC COAST (NORTH AMERICA)
[2] ATLANTIC - WESTERN CENTRAL
[4] AUSTRALIA
[2] JAMAICA
[1] TRINIDAD AND TOBAGO
[3] UNITED STATES
[2] VENEZUELA

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Summary: The electronic tool kits made available on the Cefas page for free download are Crown Copyright (2007-2008). As such, these are freeware and may be freely distributed provided this notice is retained. No warranty, expressed or implied, is made and users should satisfy themselves as to the applicability of the results in any given circumstance. Toolkits available include 1) FISK- Freshwater Fish Invasiveness Scoring Kit (English and Spanish language version); 2) MFISK- Marine Fish Invasiveness Scoring Kit; 3) MI-ISK- Marine invertebrate Invasiveness Scoring Kit; 4) FI-ISK- Freshwater Invertebrate Invasiveness Scoring Kit and AmphISK- Amphibian Invasiveness Scoring Kit. These tool kits were developed by Cefas, with new VisualBasic and computational programming by Lorenzo Vilizzi, David Cooper, Andy South and Gordon H. Copp, based on VisualBasic code in the original Weed Risk Assessment (WRA) tool kit of P.C. Pheloung, P.A. Williams & S.R. Halloy (1999).
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