GLOBAL INVASIVE SPECIES DATABASE

FULL ACCOUNT FOR: ***Dreissena polymorpha***

Dreissena polymorpha 简体中文 正體中文 **System:** Marine

Kingdom	Phylum	Class	Order	Family
Animalia	Mollusca	Bivalvia	Veneroida	Dreissenidae

Common name Zebra-Muschel (German), moule zebra (French), racicznica zmienna (English, Poland), zebra mussel (English), dreisena (Lithuanian, Lithuania), svitraina gliemene (Latvian, Latvia), vaeltajasimpukka (Finnish, Finland), Zebramuschel (German, Germany), wandering mussel (English), tavaline ehk muutlik r�ndkarp (Estonian, Estonia), Dreikantmuschel (German, Germany), vandremusling (Danish, Denmark), Dreiecksmuschel (German, Germany), Schafklaumuschel (German, Germany), zebra mussel (Swedish, Sweden), vandringsmussla (Swedish, Sweden), Eurasian zebra mussel (English), Wandermuschel (German, Germany, Austria)

Synonym *Mytilus polymorpha* , Pallas 1771
Mytilus polymorphus , (Pallas)
Mytilus hagenii
Tichogonia chemnitzii , (Rossm.)

Similar species

Summary

view this species on IUCN Red List

Species Description
The shell of *D. polymorpha* is triangular (height makes 40-60 % of length) or triagonal with a sharply pointed shell hinge end (umbo). The maximum size of *D. polymorpha* can be 5 centimetres, though individuals rarely exceed 4 cm (Mackie *et al*. 1989). The prominent dark and light banding pattern on the shell is the most obvious characteristic of *D. polymorpha*. The outer covering of the shell (the periostracum) is generally well polished, a light tan in colour with a distinct series of broad, dark, transverse colour bands which may be either smooth or zigzag in shape.
\r\nThe mussel attaches itself to hard surfaces by byssal threads which are secreted from a byssal gland just posterior to the foot. The byssal threads emerge from the between the valves through a byssal notch along the posterior margin. This byssal hold-fast distinguishes the zebra mussel from all other similar-sized or larger North American freshwater bivalves (McMahon 1990; GSMFC 2005).

Notes
The rapid expansion of the zebra mussel has been linked to its possession of planktonic veliger larvae, byssal threads (for attachment to hard surfaces) and high rates of growth and recruitment (Stanczykowska 1977; Carlton 1993, in Ricciardi Serrouya & Whoriskey 1995b).
The specific name *polymorpha* derives from the many variations in shell colour, pattern and shape (Birnbaum 2006).

Lifecycle Stages
Fertilised eggs hatch into trocophores (40-60 microns, 1 to 2 days), which develop within a day into a free-swimming planktonic *veliger*. Veligers develop from a d-shaped to umbonal morphology, and remain planktonic for up to 4 weeks. Optimal temperature for larval development is 20 to 22oC (Benson & Raikow 2008). Larvae normally disperse by being passively carried downstream with water flow (Benson & Raikow 2008). The larvae develop into their juvenile stage once they have reached about 350 microns in size by settling to the bottom where they crawl about by means of a foot, searching for suitable substratum (Benson & Raikow 2008). They then attach themselves to substrates by means of a byssus, a cluster of threads produced by an external organ near their foot (Benson & Raikow 2008). They may mature within the first year of life under optimal conditions; maturity in the second year is more usual. Once attached, the life span of *D. polymorpha* is variable, but can range from 3 to 9 years (Benson & Raikow 2008). Adult mussels can voluntarily detach and move around the substrate to seek alternate locations.

Uses
Bioindicator: Due to its sensitivity to anthropogenic influences *Dreissena* is important as a bioindicator and biomonitoring organism (Franz 1992, in Birnbaum 2006), and quantitative assessments have been conducted regularly since the 1960s in the context of water quality surveys (e.g. in the Rhine) (Schiller 1990, in Birnbaum 2006).
Products: Crushed shells of the zebra mussel can be used as fertiliser and poultry feed (Birnbaum 2006). Zebra mussels have been used as fishing bait and for fish meal production (DAISIE 2006).

Habitat Description
Zebra mussel larvae are planktonic for 2-4 weeks, prior to beginning their juvenile phase by attaching themselves to substrates by means of byssal threads. Although the juveniles prefer a hard or rocky substrate, they have been known to attach to vegetation (Benson & Raikow 2008). In areas where hard substrates are lacking, such as a mud or sand, zebra mussels cluster on any hard surface available (Benson & Raikow 2008). Given a choice of hard substrates, zebra mussels do not show a preference. Zebra mussels attach to any stable substrate in the water column or benthos including rock, macrophytes, artificial surfaces (cement, steel, rope, etc.), crayfish, unionid clams and each other, forming dense colonies called *druses* (Benson & Raikow 2008). As adults, they have a difficult time staying attached when water velocities exceed two meters per second (Benson & Raikow 2008). Long-term stability of substrate affects population density and age distributions on those substrates. Within Polish lakes, perennial plants maintained larger populations than did annuals (Stanczykowska & Lewandowski 1993, in Benson & Raikow 2008). Populations on plants also were dominated by mussels less than a year old, as compared with benthic populations; as the mussel colonies grow they sink the macrophytes to which they are attached.
\r\nIn their native region zebra mussels will colonise surface standing waters, surface running waters, the littoral zone of inland surface waterbodies, estuaries, brackish coastal lagoons, large estuaries and inland waters, and hard and soft bottom habitats (DAISIE 2006). In their occupied invaded range they will colonise similar habitats with the most typical habitats colonised being lakes, rivers, and estuaries, particularly places where there are firm surfaces suitable for attachment (DAISIE 2006). Zebra mussels tolerate temperatures from -20°C to 40°C; the best growth is observed at 18-20°C (DAISIE 2006). They tolerate brackish waters with salinity up to 7 ppt (DAISIE 2006). They are, however, extremely sensitive to rapid fluctuations in salinity; in the northern Gulf of Mexico, where tidal fluctuations are not great, zebra mussels are found to invade areas with salinities up to 12 ppt, however, they appear unable to tolerate salinities above 12 ppt for any extended period (GSMFC 2005). Zebra mussels prefer moderately productive (mesotrophic) temperate water bodies and occur from the lower shore to depths of 12 m in brackish parts of seas and to 60 m in lakes (DAISIE 2006). They are able to tolerate low oxygen content in water for several days and to survive out of water under cool damp conditions for up to three weeks (DAISIE 2006). Zebra mussel are most abundant in hard waters (30-50 mg Ca L-1) but occur in water with Ca concentrations as low as 12 mg Ca L-1 (Cohen and Weinstein 2001).

Reproduction

Zebra mussels have separate sexes, usually with a 1:1 ratio; fertilisation takes place externally (DAISIE 2006). Synchronised spawning occurs once mussels are greater than 8 mm (or females in their second year) and is influenced by water temperatures (DAISIE 2006). A mature female may produce one million eggs per year (DAISIE 2006). Spawning begins at 12 to 15ºC and is optimal at 14 to 16ºC or 18 to 20ºC (depending on sources) and may take place over a period of three to five months (DAISIE 2006; Benson & Raikow 2008). In natural ecosystems oogenesis occurs in autumn, with eggs developing until release and fertilization in spring; in areas of warm water or where the thermal regime has been altered, reproduction can occur continually throughout the year (Benson & Raikow 2008). Eggs are expelled by the females and fertilized outside the body by the males; over 40 000 eggs can be spawned in a reproductive cycle and up to one million in a spawning season (Benson & Raikow 2008).

Nutrition

Zebra mussels filter a wide range of size particles, but select only algae and zooplankton between 15 and 400 microns. Larval stages of the mussel feed on bacteria.

General Impacts
For a detailed account of the environmental impacts of *Dreissena polymorpha* please read: *Dreissena polymorpha* Impacts Information. The information in this document is summarised below.
To date (2002) *D. polymorpha* has been the most aggressive freshwater invader worldwide (Karayayev *et al*. 2002). Once introduced, populations of zebra mussel can grow rapidly and the total biomass of a population can exceed 10 times that of all other native benthic invertebrates (Sokolova *et al*. 1980a; Karatayev *et al*. 1994a; Sinitsyna & Protasov 1994, in Karayayev *et al*. 2002)
Ecosystem Change: Most of the impacts of zebra mussels in freshwater systems are a direct result of their functioning as ecosystem engineers (Karayayev, *et al*. 2002). An individual zebra mussel can filter one to two liters of water each day; as a result high densities of zebra may cause major shifts in the plankton communities of lakes and rivers. Reductions in phytoplankton numbers and biomass also limit food to fish larvae and other consumers further up the food chain (Birnbaum 2006).
Modification of Natural Benthic Communities: The introduction of *Dreissena* is generally associated with increased benthic macroinvertebrate density and taxonomic richness (Ward & Ricciardi 2007). Biodeposition of organic wastes and dense colonization of the benthos by zebra mussels has also substantially altered benthic communities; many invertebrates benefit from the increased food resources and complex habitat, while benthic spawning and foraging fishes may be negatively impacted. Overall gastropod densities increased in the presence of *Dreissena*, but large-bodied snail taxa tended to decline (Ward & Ricciardi 2007).
Habitat Alteration: The high consumption of phytoplankton by zebra mussels results in increased water clarity, changing habitat characteristics and ecosystem functions (DAISIE 2006). The dense colonization of soft substrates can impede fish foraging (Beekey *et al*. 2004), and colonization of hard substrates affects spawning fishes (Marsden & Chotkowski 2001).
Predation: Zebra mussel populations significantly deplete plankton densities as a result of filter feeding.
Competition: Suspension-feeding species may experience increased competition for resources in the presence of high zebra mussel densities, as was reflected in the declines of sphaeriid clams in the Hudson River (Strayer, *et al*. 1998).
Modification of Nutrient Regime: Zebra mussels may influence ecosystem processes such as nitrogen (N) cycling by increasing denitrification rates (Bruesewitz *et al*. 2006).
Threat to Endangered Species: Freshwater mussels (Order Unionoida) are the most imperiled faunal group in North America with 60% of the species considered endangered or threatened (Ricciardi *et al*. 1998). The zebra mussel represents a new stress to populations of these native mussels as it is a biofouling organism that smothers the shells of other molluscs and competes with suspension feeders for food (Ricciardi, *et al*. 1998).
Biofouling: Other mussels serve as substrate for settlement by *Dreissena*, and are energetically stressed and eventually starve as filter feeding is disrupted (Böhmer *et al*. 2001, in Birnbaum 2006)
Economic Impact: Negative economic impacts caused by *D. polymorpha* include those caused by fouling of intake pipes, ship hulls, navigational constructions and aquaculture cages; the zebra mussel may also reduce angling catches (Gollasch & Leppäkoski 1999; Minchin *et al*. 2002, in Birnbaum 2006)
Bioaccumulation: Zebra mussels may bioaccumulate pollutants which may poison animals further up the food chain (DAISIE 2006).

Management Info
The following control methods for zebra mussel are potentially useful in certain circumstances (Benson and Raikow 2008):
• Chemical Molluscicides: Oxidizing (chlorine, chlorine dioxide) and non-oxidizing
• Manual removal (pigging, high pressure wash)
• Dewatering/desiccation (freezing, heated air)
• Thermal (steam injection, hot water 32oC)
• Acoustical vibration
• Electrical current
• Filters/screens
• Coatings: toxic (copper, zinc) and non-toxic (silicone-based)
• Toxic constructed piping (copper, brass, galvanized metals)
• CO2 injection
• Ultraviolet light
• Anoxia/hypoxia
• Flushing
• Biological (predators, parasites, diseases)
Preventative measures: Preventing overseas transfer can only be achieved by mid-ocean exchange or by suitable disinfection of ballast water (DAISIE 2006). Certain guidelines and regulatory instruments may be applied in areas where the species does not yet occur (Gollasch 2006). For further details see the Ballast Water Management Convention of the International Maritime Organization (www.imo.org) and the Code of Practice for the Introduction and Transfer of Marine organisms of the International Council for the Exploration of the Sea (www.ices.dk).
Appropriate control measures (inspection, removal of attached mussels, drying, etc.) should be taken to minimise risk of inoculation by transfer of boats, fishing gears, etc (DAISIE 2006). Applying copper based anti-foulant coatings in new facilities may offer protection from *Dreissena polymorpha*. The use of retrofitted screens can be effective but such screens are difficult to apply to existing pipelines (Aldridge *et al*. 2006).
Physical: Physical removal using high-pressure water jets is feasible on easily accessed industrial facilities (Aldridge *et al*. 2006). Larvae suffer total mortality after exposure to ultrasonic vibration (22 to 800 kHz) for 3 minutes (Schalekamp 1971, in Birnbaum 2006), but the technical effort involved is prohibitive.
Chemical: Many chemicals will kill zebra mussels but the suitability of a particular chemical is determined by considerations of effect on water quality, residual concentrations, byproducts, cost and practicality. Chemicals which have proven moderately successful include molluscicides (such as Bayer 73; Birnbaum 2006), chloramines, chlorine dioxide, ozone, hydrogen peroxide, potassium permanganate, pH adjustment, and inorganic salts. Chlorination remains the only widespread method used. It must be dosed continuously for up to 3 weeks to achieve complete elimination, though dosing for 2-3 days is sufficient to remove the majority of attached mussels.
Microencapsulation of toxins in particles that are edible to zebra mussels has the potential to overcome the rejection and valve-closing response generally seen when zebra mussels are exposed to toxic substances. The active ingredient used is potassium chloride, which is not lethal to most organisms, including fish, at low doses but which is particularly toxic to freshwater bivalves (Aldridge *et al*. 2006). Another emerging control for *D. polymorpha* is the use of endocannabinoids, anandamide and other compounds which have been tested to inhibit zebra mussel byssal attachment. These naturally occurring and synthetic cannabinoids can serve as non-toxic efficacious zebra mussel anti-foulants (Angarano *et al*. 2009).
Biological control: Large-bodied molluscivores such as common carp, freshwater drum, and channel catfish can limit zebra mussel numbers in coastal wetlands. Densities of other molluscs were not affected, suggesting that fish can have a greater impact on numbers of attached zebra mussels than other benthic molluscs (Bowers & DeSzalay, 2007). Known predators also include roach, eel, sturgeon, diving ducks, crayfish and muskrats (Molloy *et al*., 1997).

Pathway
The zebra mussel is possibly introduced into the wild by aquarium dumping.The main pathways of the expansion in the range of *D. polymorpha* are through oceanic shipping, in ballast water, and inland navigation, through solid ballast and other cargoes. Inland navigation transport increased since the opening of new waterwaZebra mussel adults routinely attach to boat hulls and floating objects and are thus anthropogenically transported to new locations (Benson & Raikow 2008). Humans may spread zebra mussels considerable distances upstream on the hulls of commercial barges (Keevin *et al*. 1992, in Ricciardi Serrouya & Whoriskey 1995b) and to isolated lakes and rivers through fishing and boating activity (Carlton 1993, McNabb 1993, in Ricciardi Serrouya & Whoriskey 1995b).*D. polymorpha* could be transported with timber or river gravel and overland transport (DAISIE 2006).

Principal source: Birnbaum, C. 2006. NOBANIS – Invasive Alien Species Fact Sheet – *Dreissena polymorpha*
Delivering Alien Invasive Species Inventories for Europe (DAISIE), 2006. *Dreissena polymorpha*

Compiler: IUCN/SSC Invasive Species Specialist Group (ISSG)

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ALIEN RANGE
[1] AUSTRIA
[1] BELARUS
[1] BELGIUM
[2] CANADA
[1] CROATIA
[1] CZECH REPUBLIC
[1] DENMARK
[1] ESTONIA
[1] EUPHRATES RIVER
[1] EUROPE
[1] FAROE ISLANDS
[1] FINLAND
[1] FRANCE
[1] GERMANY
[1] GREENLAND
[1] ICELAND
[1] IRELAND
[1] ITALY
[1] LAKE CHAMPLAIN
[1] LAKE CONSTANCE
[1] LAKE ERIE
[1] LAKE MICHIGAN
[1] LAKE ONTARIO
[1] LAKE ST. CLAIR
[1] LAKE SUPERIOR
[1] LATVIA
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[1] NETHERLANDS
[1] NORWAY
[1] POLAND
[1] RIVER RHINE
[1] RUSSIAN FEDERATION
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[1] ST. LAWRENCE RIVER
[1] SWEDEN
[1] SWITZERLAND
[4] UNITED KINGDOM
[29] UNITED STATES

Red List assessed species 1: CR = 1;

Anodonta pallaryi **CR**

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Summary: This database is of alien aquatic animals inhabiting waterbodies of the Republic of Belarus. It allows to search the species by scientific taxonomy and to get information on their origin, distribution and potential ecological impacts. The database was composed in result of the analysis of literature published during the last century and authors unpublished data. One can find some general information on Belarusian waterbodies, history of construction and functioning of the interbasin shipping canals, links to related sites, etc. The site is under testing and only an English version is available, a Russian version is expected shortly.
The database is available from: http://www.aliensinbelarus.com/content/view/12/28/.
This page is available from: http://www.aliensinbelarus.com/index.php?option=com_database&Itemid=27&id=35&task=one_dat [Accessed 28 May 2007]
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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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Summary: English:
The species list sheet for the Mexican information system on invasive species currently provides information related to Scientific names, family, group and common names, as well as habitat, status of invasion in Mexico, pathways of introduction and links to other specialised websites. Some of the higher risk species already have a direct link to the alert page. It is important to notice that these lists are constantly being updated, please refer to the main page (http://www.conabio.gob.mx/invasoras/index.php/Portada), under the section Novedades for information on updates.
Invasive species - Molluscs is available from: http://www.conabio.gob.mx/invasoras/index.php/Especies_invasoras_-_Moluscos[Accessed 30 July 2008]
Spanish:
La lista de especies del Sistema de informaci�n sobre especies invasoras de m�xico cuenta actualmente con informaci�n aceca de nombre cient�fico, familia, grupo y nombre com�n, as� como h�bitat, estado de la invasi�n en M�xico, rutas de introducci�n y ligas a otros sitios especializados. Algunas de las especies de mayor riesgo ya tienen una liga directa a la p�gina de alertas. Es importante resaltar que estas listas se encuentran en constante proceso de actualizaci�n, por favor consulte la portada (http://www.conabio.gob.mx/invasoras/index.php/Portada), en la secci�n novedades, para conocer los cambios.
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